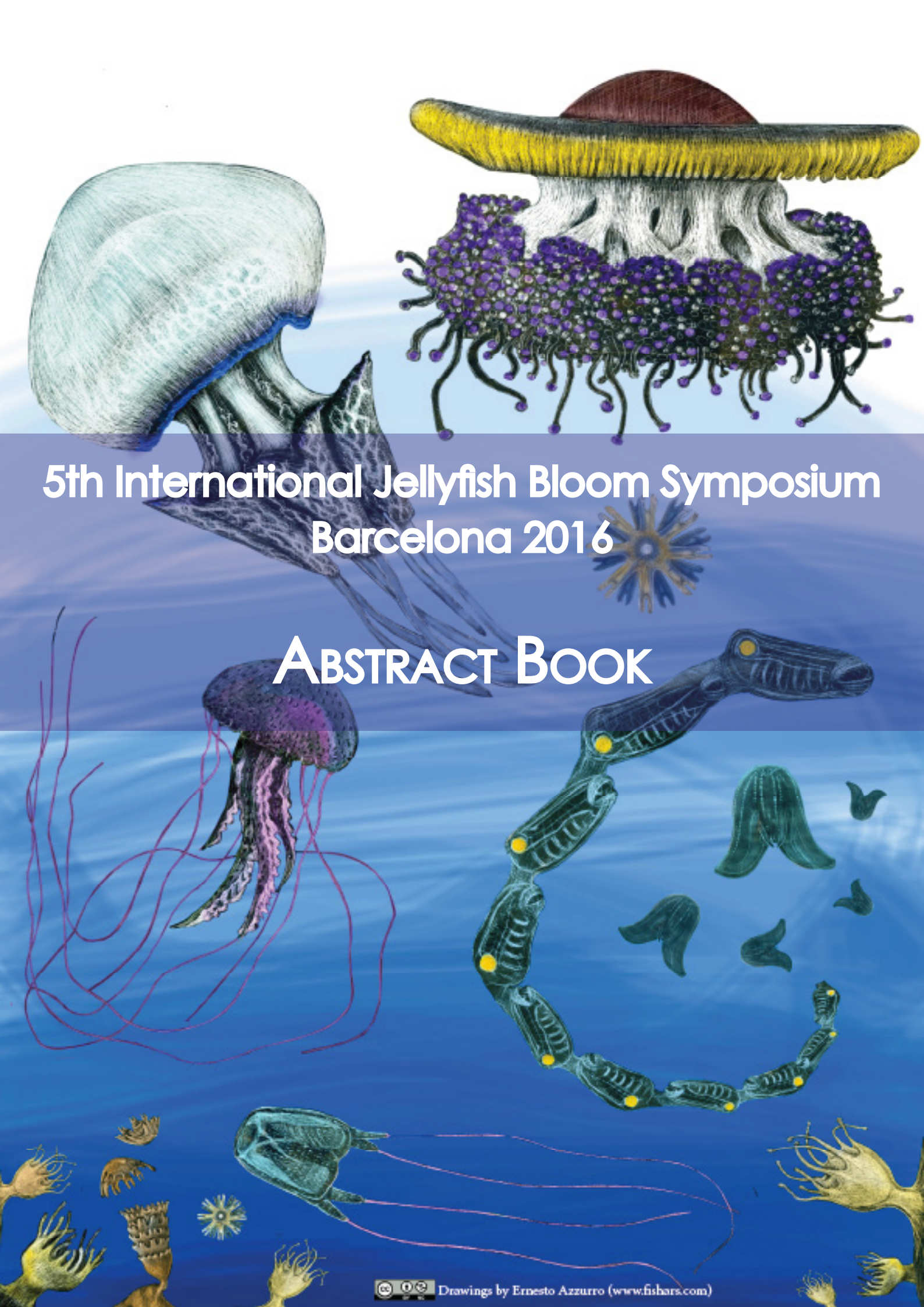
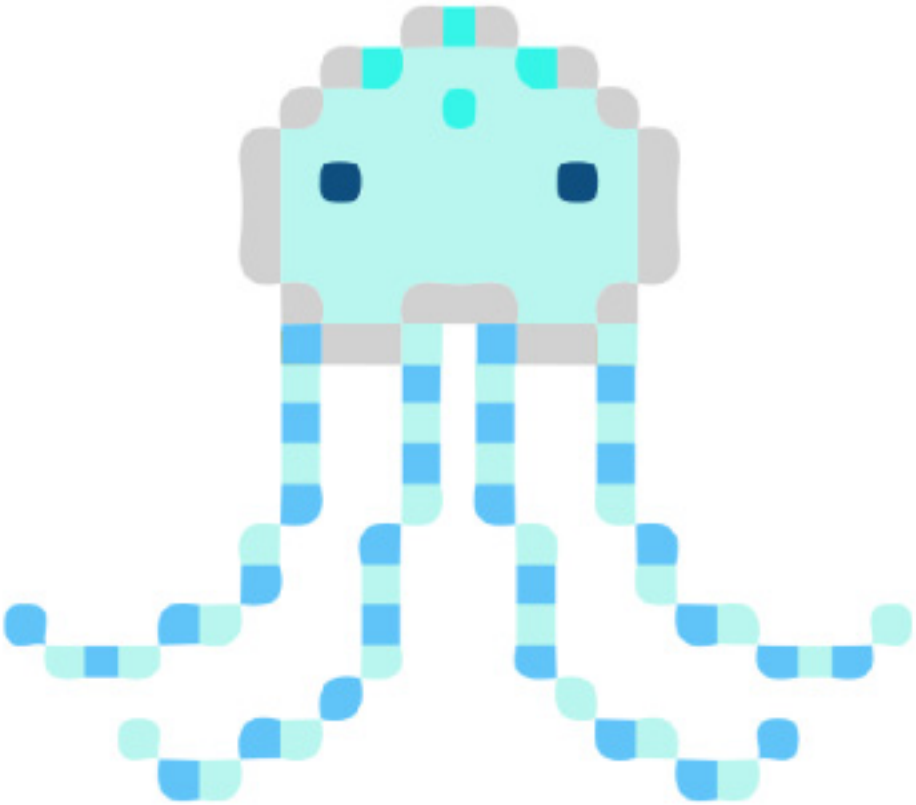


5th International Jellyfish Bloom Symposium
Barcelona 2016

Abstract Book



5th International Jellyfish Bloom Symposium
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Abstract Book

May 30 - June 3, 2016, L'Aquàrium de Barcelona (Spain)

5th International
Jellyfish Bloom
Symposium
Barcelona 2016

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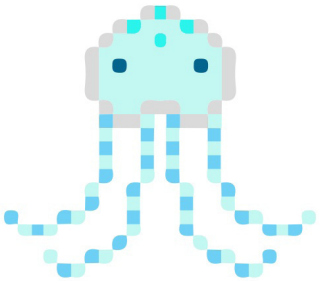

List of Participants

Alphabetical order by last name

ABSTRACTS
PLENARY PRESENTATIONS

PLENARY PRESENTATION

Michael J. Kingsford

Michael is a Professor of Marine Biology in the Marine and Environmental Sciences College. He has published extensively on the ecology of reef fish, jellyfish, biological oceanography and climate change. His major areas of research over the last 5 years can be divided into the following programs: biological oceanography (with special reference to presettlement fish); ecology of jellyfish; population dynamics of reef fish; interactions between reef fish and organisms associated with reefs; the use of microchemistry to elucidate the environmental conditions experienced by fish (specially those related to pollution) and the connectivity of population of fish. His recent projects include topics about the connectivity of coral reef fish, the influence of climate change on the population dynamics of temperate fish, the ecology of cubozoan jellyfish and the elemental chemistry for biomonitoring fish movements.

Population units of cubozoans -ecology, gaps in our understanding and how do we best respond to threats?

Michael J Kingsford, Christopher Mooney, Jodie Schlaefer

James Cook University, Australia

Cubozoans are found from tropical to temperate seas of the world, they are biologically interesting and are a threat to humans, but our knowledge of their taxonomy, ecology and population structure is weak. Here I review what is known on the ecology of the Cubozoa and particularly the spatial extent of population units from metapopulations to local populations. Of the 45 known species, most have been found at only one or two locations. Despite problems with taxonomy, three species have widespread distributions at multiple countries and sites. Where data are available on temporal and spatial patterns of abundance, there is great variance at small spatial scales. From distribution studies and research using elemental chemistry, a picture is emerging of strong local populations where there is great self-recruitment and perhaps rarer founder effects that start other local populations which in turn contribute to stocks (=mesopopulations). A bipartite life history (ie polypoid and medusoid phases) and the behavior of medusa probably contribute to strong local population structures. Cubozoans are strong swimmers and can see – limited movements and an ability to respond to currents would facilitate the resilience of local populations. The probability of envenomation to humans, therefore, is probably variable on a scale of hundreds of metres to kilometers. Risks may be better managed with stakeholders taking control at local levels using technology such as 'jellycams', physical water measurements and predictive models.

PLENARY PRESENTATION

Jennifer E. Purcell

Jenny has worked on gelatinous zooplankton for 38 years. Her research experience has included all cnidarian taxa, ctenophores, and salps in Arctic, temperate, and tropical climates, from the ocean surface to the deep sea. Her research has focused on trophic ecology and population dynamics of gelatinous species. Due to increasing deterioration of coastal ecosystems, she has studied how factors including, hypoxia, warming, and acidification, affect jellyfish populations. She especially wants to know the causes of jellyfish blooms.

Large-scale and long-term perspectives on jellyfish research

Jennifer E. Purcell

Western Washington University, USA

Many things have changed over my nearly 40-year study of "jelly" ecology, but many have not. Although jellies finally have achieved recognition as important, there remains a shortage of quantitative data on jellies around the world. This is a major impediment to understanding and predicting their abundances, biomasses, and ecosystem effects. Although jellyfish are known mostly for the problems they cause humans, and blooms occur where the environment is deteriorated by human activities, environmental deterioration is accelerating and jellies may benefit. Introductions of non-indigenous species (NIS) also have increased and probably will accelerate from increased shipping and widening of canals. Although blooms may have increased, causes of blooms are unknown for almost all species. Many basic life-history characteristics are inadequately studied, including reproduction, growth, and mortality rates that contribute to the dynamics of jelly populations. Those data are essential to understand their importance. Although of great potential significance for fisheries and aquaculture, the trophic interactions between jellyfish and fish are inadequately studied. New indirect trophic techniques have become popular to provide insight into food web relationships, but past methods should not be abandoned. Instead of laborious feeding rates, ingestion calculated from metabolic data can be combined with biomass data for use in ecosystem models. Jellyfish should be included in fishery studies, ecosystem studies, and fishery management plans. Improved and miniaturized technology has provided new techniques for studies on jellyfish. New uses for jellyfish are being developed, with many potential benefits in medicine and as food.

PLENARY PRESENTATION

André C. Morandini

André C. Morandini is currently an assistant professor and head of the Zoology Department in the University of Sao Paulo, Brazil. He is a researcher in the areas of Invertebrate Zoology, Biological Oceanography and Marine Biology. His duties include mainly teaching about Invertebrates and cnidarians, and his research line is focused on the biology and systematics of gelatinous organisms, especially cnidarians (Scyphozoa and Cubozoa). His research is focused in the South Atlantic Region, but with interests in global distribution of jellyfish.

The importance of polyps to understand jellyfish diversity, evolution and blooming potential

André C. Morandini[1], Ilka Straehler-Pohl[2], Agustín Schiariti[3]

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To understand the biology and ecology of metagenetic cnidarians, all life cycle stages must be considered. Although this statement seems obvious, historically the pelagic stage was much more studied than the benthic ones; especially considering scyphozoan and cubozoan species. Any environmental factor or biological phenomenon that affects the polyp populations certainly will have effects on the medusa counterpart, and many of them can lead to aggregation or blooming episodes. Besides several studies on the subject, we are still far from a precise answer on which factors can cause blooms, but we are moving towards a better understanding. Polyps are morphologically much simpler than medusae, and such fact makes it hard to define body characters that can be used for identification purposes. But detailed and long-term observations led researchers to find distinctive features, body patterns and reproductive strategies that enable differentiation of taxonomic units among scyphozoans and cubozoans. Furthermore, the recognition of polyps' different characters can help researchers to understand the evolutionary patterns observed in the medusa stage, corroborating, refuting or eventually creating new ideas.

PLENARY PRESENTATION

William (Monty) Graham

Monty is a biological oceanographer specialized in ecology of gelatinous zooplankton. His interest is focused in ecological implications of fishing and climate change, as well as long-term ecosystem dynamics in coastal environments. He has participated in many research projects all around the world. Currently, he works as the Chair of the Department of Marine Science and the Interim Director of the Gulf Coast Research Laboratory at the University of Southern Mississippi.

Jellyfish and Human Well-being

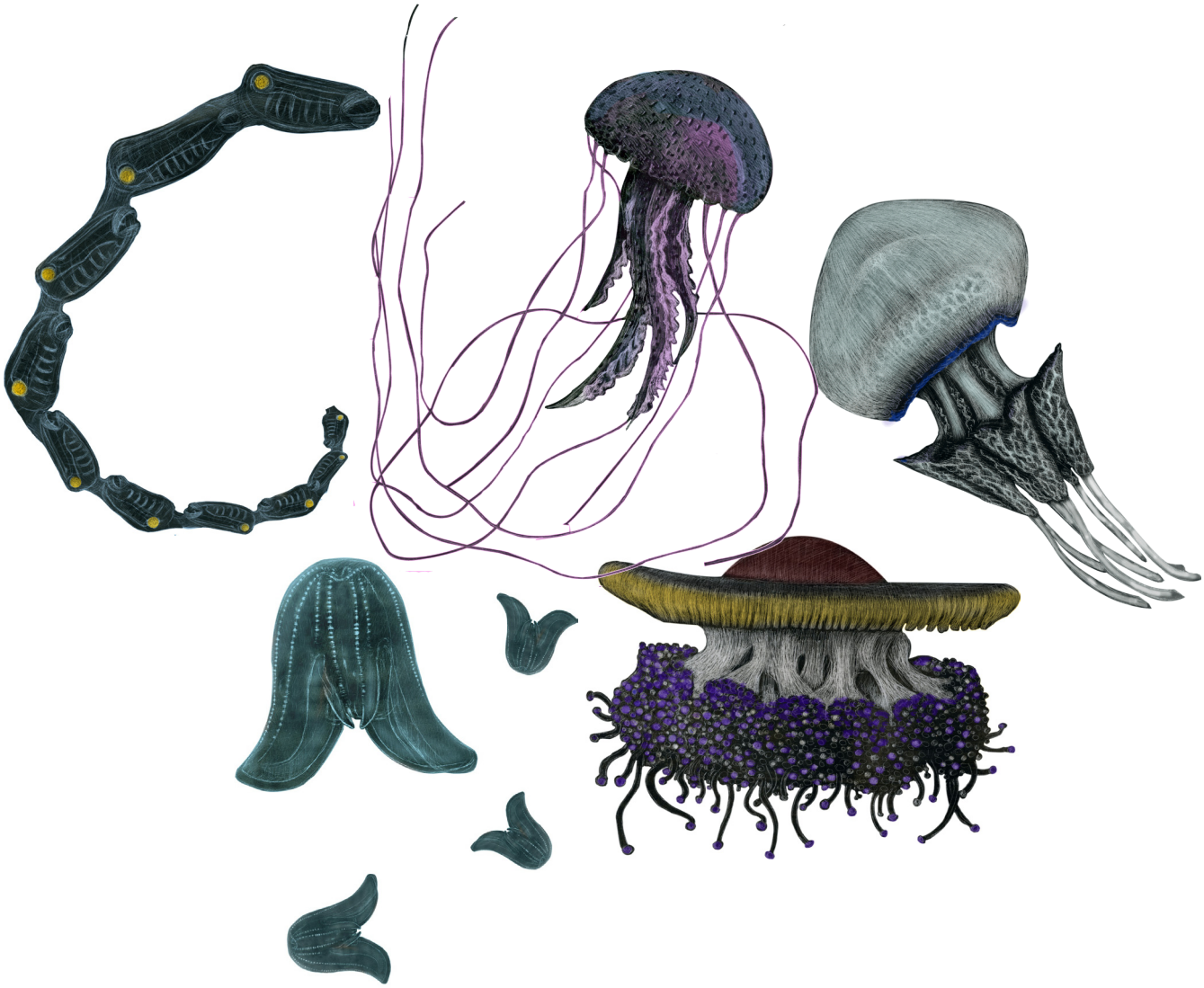
William (Monty) Graham

University of Southern Mississippi, USA

Jellyfish are widely viewed by scientists and lay-people alike as marine "pests". Several recent publications have produced a more balanced view of jellyfish, weighing their benefits as individuals and as constituents within communities and ecosystems. This talk summarizes these publications, and focuses on a conceptual model of thresholds and trade-offs when assessing jellyfish blooms and their changes over time. Particular attention is given to the role of jellyfish in heavily fished ecosystems where a growing narrative suggests removal of fish biomass leads to increased negative functioning of jellyfish within the ecosystem. The threshold model revisits jellyfish and their ecosystem services to human well-being as a means of understanding impacts and benefits in a standardized manner. It is also a useful approach to identify data needs for future studies that might move this from theoretical into practical studies of jellyfish-human interactions.

Abstracts for Oral Presentations

JBS-00
General Session



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Cesar Bordehore - IMEM "Ramón Margalef", Universidad de Alicante (Spain)
Raül Golo- Institut de Ciències del Mar - CSIC (Spain)
Melissa J. Acevedo- Institut de Ciències del Mar - CSIC (Spain)
Maria Pascual- Institut de Ciències del Mar - CSIC (Spain)

Jellyfish summer distribution, diversity and impact on fish farms in a Nordic fjord

JBS-00 / Oral Presentation_01

Claudia Halsband[1], Sanna Majaneva[2], Sverre B. Småge[3,4], Per Arne Emaus[1], Paul E. Renaud[1]

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[2] *Centre for Ecology and Evolution in Microbial model Systems, Linnaeus University, Sweden*
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[4] *University of Bergen, Norway*

Jellyfish can cause high mortality of farmed fish and hence significant economic losses for aquaculture companies. The occurrence, timing and diversity of jellyfish blooms was studied in summer 2015 in Ryggefjord (Finnmark, northern Norway), where Cermaq Norway operates a salmon farm. High abundances of jellyfish were observed in both July (net samples) and September (qualitative observations only), but different species dominated in these two months. A bloom of the cnidarian *Dipleurosoma typicum* in September coincided with high mortalities of farmed fish, suggesting a causal relationship. The diverse jellyfish community (22 taxa) in July had no such dramatic effect on the fish, despite high densities of ctenophores (*Beroë* spp.) and other species. Although ctenophores do not sting, they may clog the fish pens and reduce water flow and oxygen concentrations. Sampling for fish pathogens in jellyfish tissue revealed the presence of bacteria with *Tenacibaculum* spp. morphology in an individual of *Aglantha digitale*. These bacteria cause tenacibaculosis in fish gills damaged by jellyfish venom, and mixed infections with *Moritella viscosa* (winter ulcer) in salmonids. As the bacteria were not culturable, the role of jellyfish as vectors remains to be investigated further. We conclude that the jellyfish assemblage in Ryggefjord is highly dynamic on short time scales and requires a better understanding of seasonal population development, especially for problematic species, and the relationships between hydrography, abundance and species composition. Clear recommendations to industry may mitigate economic losses from jellyfish blooms in Nordic fjords, where aquaculture operations continue to increase.

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The role of hydrozoans in European sea bass (*Dicentrachus labrax*) gill disorders in Mediterranean aquaculture

JBS-00 / Oral Presentation_02

Mar Bosch-Belmar[1], Giacomo Milisenda[2], Albert Girons[3], Stefano Accoroni[4], Cecilia Totti[4], Stefano Piraino[1,5], Verónica Fuentes[6]

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Finfish marine aquaculture farms across European coasts have been repeatedly affected by mortality events following the occurrence of episodic high densities of gelatinous cnidarians. Due to their stinging cells and venoms, these jellyfish species may severely damage fish gills. Gill disorders were observed in sea bass (*Dicentrarchus labrax*) fish farms along the Spanish Mediterranean coast. To investigate the potential for cnidarian-related pathologies affecting cage-reared fish, biweekly monitoring of zooplankton, phytoplankton and farmed fish gills were performed at two aquaculture facilities from south-western Spain from January 2012 to June 2014 (Almería facility) and June 2013 to June 2014 (Málaga facility). Analyzed data showed significant and positive correlation between the densities of planktonic hydrozoans and the recorded fish mortalities; in particular, the most related species were the siphonophores *Muggiaea atlantica*, *Muggiaea kochi*, and the actinulae larvae of *Ectopleura larynx* hydroid which is usually forming part of cage net biofouling community. Moreover, low temperature, high cnidarians densities and farmed fish mortalities were significantly associated. Finally, gill damage scores were positively correlated with cnidarians densities, while other gelatinous zooplankton groups and the studied phytoplankton species seemed not to be related with recorded fish gill disorders and mortality, even if high density peak of *Chaetoceros* sp. was observed coinciding with fish mortality event in Almería fish farm. This work may provide baseline information to develop methodological action plans and protocols to prevent and mitigate the impacts of jellyfish proliferations on finfish aquaculture farms.

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Cryptic hydrozoan blooms and their effects on Scottish salmon aquaculture

JBS-00 / Oral Presentation_03

Anna Kintner, Andrew S Brierley

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Hydrozoan blooms have long been known to cause damage to the Scottish salmon aquaculture industry, mostly via injury and envenoming of gill tissues in caged fish. However, the majority of reports investigate blooms in the wake of a mortality event or when large-bodied jellyfish are seen en masse, thus likely missing less obvious blooms and their sub-lethal effects. We carried out a three-year monitoring program examining the hydromedusan assemblage at four farms on a weekly basis, and matched occurrence data with measures of gill health in caged salmon. We found that hydrozoan blooms, particularly of *Lizzia blondina* and *Obelia* sp., frequently preceded a rise in proliferative gill disease (PGD) and amoebic gill disease (AGD), which can lead to considerable mortality and economic losses. These blooms are often short-lived (<6 days) and can be easily overlooked using a standard retrospective approach; moreover, due to the small body size (0.5-2mm), they usually go unseen by on-site workers. It is likely that many idiopathic mortality events at aquaculture sites have been due to such cryptic hydromedusan blooms. We also found considerable spatial-temporal variation in hydromedusan population density and species assemblage in adjacent sea lochs, suggesting that highly localized environmental factors may stimulate blooms, causing difficulties for prediction and mitigation. We suggest that aquaculturists utilizing open-water environments carry out detailed, daily monitoring of hydrozoan medusa populations during high-risk seasonal periods, in order to enable remedial actions minimizing harm to fish.

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Coming soon to a fjord near you: Future jellyfish scenarios in a changing climate

JBS-00 / Oral Presentation_04

Rachel Gjelsvik Tiller[1,3], Åshild Løvås Borgersen[2], Øyvind Knutsen[1], Jennifer Bailey[3], Hans Vanhauwaert Bjelland[1], Jarle Mork[2], Lionel Eisenhauer[1], Yajie Liu[1]

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Lately, many fjords in Norway have been invaded by the scyphozoan jellyfish *Perihylla periphylla*. The jellyfish has the potential to take over the role as top predator and out-compete other species, as it has done in three fjords so far. It is a nuisance both practically and financially to the traditional fisheries as well as cod- and salmon farms. It seems to be spreading in a northwards direction, however, not all fjords are affected. The main question of interest is therefore why this jellyfish becomes dominant in one fjord and not another. The next question is what other fjords further north exist with similar characteristics that we therefore would expect *Periphylla* to invade in the future?
We used an interdisciplinary method consisting of social- and natural sciences to anticipate which fjords further north are vulnerable to a *Periphylla* invasion. We used *Periphylla*'s newsworthiness in Scandinavia's largest newspaper archive, Atekst, to determine where it has been persisting in social media, and used modeling, comparative analysis and online maps of bathymetry and topography to search for fjords with similar features as the ones invaded by *Periphylla*. Results show that three northern fjords, the Skjerstadfjord, the Holandsfjord and Stordjupna in the Vestfjord are particularly vulnerable to *Periphylla* invasions.
This paper is the first attempt at finding an interdisciplinary mix of methodologies for projecting possible *Periphylla* futures in Norwegian fjord systems. It is the first step in creating an early warning system to prepare local societies for necessary mitigations or adaptations in the case of a *Periphylla* invasion.

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Are anti-jellyfish nets a useful mitigation tool for coastal tourism? Hindsight from the MED-JELLYRISK experience

JBS-00 / Oral Presentation_05

Stefano Piraino[1], Alan Deidun[2], Verónica Fuentes[3], Mohamed Nejib Daly Yahia[4], Ons Daly Yahia[5], Macarena Marambio[3], Antonio Canepa[6], Alejandro Olariaga[3], Sonia Gueroun[4], Mehdi Aissi[4], Giorgio Aglieri[1], Giacomo Milisenda[1], Jennifer Purcell[1]

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The mitigation of coastal hazards, notably jellyfish blooms, has assumed great significance in recent years in view of the potential detrimental impact of such hazards on the welfare of coastal communities. This is especially true in a basin such as the Mediterranean with a very high degree of coastal settlement and dependence on coastal economic activities. Within the MED-JELLYRISK project and over the course of two summers (2014 and 2015), a total of 15 anti-jellyfish nets within several Mediterranean tourist hotposts were installed in Italy (islands of Lipari, Salina, Ustica, Lampedusa and Favignana), Spain (two beaches on the island of Ibiza), Tunisia (beaches at Monastir and Hammamet) and Malta. Manufactured in 25m-long modules, the nets were specifically designed to exclude individuals of jellyfish species from the enclosed bathing areas, and were installed on shallow sandy and rocky bottoms from the coastal fringe down to a water depth of 2.5m. The performance of the same nets was monitored through scientific surveys inside and outside the net-enclosed areas. In parallel, the colonization of fouling organisms on the submerged sections of the nets was investigated, and the public perception of the installed nets was assessed through ad hoc questionnaires deployed on the beaches. Useful hindsight for coastal managers, concerning best sites and conditions for deployment, net design and materials, has been gained from this experimental anti-jellyfish net deployment effort within the MED-JELLYRISK project.

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Socioeconomic impacts incurred by fishermen as a consequence of the spread of jellyfish blooms

JBS-00 / Oral Presentation_06

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Blooms of gelatinous medusae have socioeconomic impacts on coastal industries with several economic quantifications attributed to them. Such impacts coincide with increased observations of bloom manifestations which appear to be dispersing into areas where they are historically less common. Despite this, few considerations exist of the potential socioeconomic impacts if blooms were to spread into areas where stakeholders have less experience of them. This study therefore employed structured interviews of fisherman based in the UK with the aim of understanding how future blooms could cost fisheries. A description of future hypothetical waters containing blooms was discussed with respondents, who were then requested to describe actions they would take to mitigate any issues they envisaged. Responses were linked to economic data sets and fisheries statistics to estimate how the industry might change, quantifying any associated costs. Overall, minimal economic cost was attributed due to adaptive behaviours reported by respondents. Based on their expertise, fishermen indicated that compromise to operations was possible, mainly as a result of displacement, but there was little to suggest far reaching impacts to the industry. Interactions with jellyfish blooms were seen as obstacles to be overcome, with many respondents claiming that they would carry on fishing accepting interactions with jellyfish until they had reached their fishing quotas. Overall, the methodology was concluded to be a valid way of exploring the knowledge of stakeholders to understand how industries might interact with future blooms that could be adapted to consider implications for other coastal activities.

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Jellyfish information requests from tourists: Are tourist information offices responding adequately?

JBS-00 / Oral Presentation_07

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The impact of jellyfish on beach tourism has been broadly discussed in the literature. Spain has a large network of municipal Tourist Information Offices (TIO), which offer a general information service for visitors and also respond to ad hoc requests.
As part of the LIFE Cubomed project, we found that jellyfish stings account for ~65% of beach lifeguard interventions in the Spanish Mediterranean. We hypothesized that information requests on this topic were being adequately addressed by the TIO, at least as well as other requests.
We sent mystery-shopper email requests to all the Spanish Mediterranean (n=224) TIO, asking 6 types of questions about local tourist resources: restaurants, historic routes, museums, beaches, beach services and, finally, jellyfish stings. We assessed the quality of the answers (4-level scale) and response time (days).
Our findings showed that response times were similar across all questions (~1.8 days), but that the quality of the responses was higher in the case of "traditional" tourist questions than those concerning jellyfish stings. Indeed, the highest no response (~25%) and low-quality answer rates (~20%) corresponded to the jellyfish question. Some responses even suggested that jellyfish information was the remit of a different department (e.g. environment).
These results indicate that training of TIO personnel (staff and managers) is required in the area of jellyfish, as well as improved coordination between the different public services (tourism, lifeguards, environment) in order to provide a better overall response to jellyfish queries.

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DNA barcoding the venomous jellyfish in Thai waters

JBS-00 / Oral Presentation_08

Jie Xiao[1], Xuelei Zhang[1], Charatsee Aungtonya[2], Ruijuan Liu[1]

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Surveys on venomous jellyfish in Thai waters suggested high species diversity, including approximately 11 species of 6 families in both Scyphozoa and Cubozoa. Explicitly identifying these venomous jellyfish, however, is difficult due to morphology plasticity, complicated life cycles and fragile tissues etc. And the unstable taxonomy in many jellyfish genera further confounded the species designation of the jellyfish, especially those morphologically divergent with the known species. We are conducting a joint study on the genetic diversity of the venomous jellyfish observed in Thai waters, and to evaluate the feasibility of DNA barcoding these jellyfish with the common genetic markers (eg. SSU, 16S and COI genes). The major objective of this project was to assist the taxonomy, and further facilitate the research on ecology, life cycle and toxicity of the venomous jellyfish in Thai waters. The first data suggested capability of distinguishing these jellyfish using these markers, while species designation of a number of samples remained unclear due to un-resolved taxonomy, highly scattered and incomplete genetic database across the various genera in Scyphozoa and Cubozoa. Therefore, it is necessary to conduct systematic study on the venomous jellyfish combining both morphology and molecular data.

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Preliminary taxonomic survey and molecular documentation of jellyfish species (Cnidaria: Scyphozoa and Cubozoa) in Malaysia

JBS-00 / Oral Presentation_09

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Scientific enquiries into jellyfish blooms and associated problems in Malaysia are often deterred by the lack of taxonomical and ecological studies. To date, only two scyphozoan jellyfish species have been documented from field surveys in Malaysian waters, whereas other four Malaysian scyphozoan and two cubozoan jellyfish species have been mentioned in toxicological studies, all of which their species identity were not verified. Thus, this study aimed to document and to resolve the identification of jellyfish in Malaysia using morphology and molecular DNA sequencing of COI, 16S and ITS1 regions. Jellyfish specimens were collected from 2008 to 2010 in the Straits of Malacca, South-China Sea and the Sulu-Sulawesi Sea. Ten scyphozoan and two cubozoan species were recorded, which included eight species from the order Rhizostomeae (Rhizostomatidae, Lobonematidae, Mastigiidae, Catostylidae and Cepheidae), two species from Semaestomeae (Pelagiidae and Cyaneidae) and two species from class Cubozoa; one from order Carybdeida (family Carukiidae) and another from order Chirodropida (family Chiropsalmidae). The COI phylogenetic tree of Cubozoa and Scyphozoa species from the Atlantic and Pacific region showed distinct clustering of six Malaysian jellyfish species. However, most of the deeper divergences and relationships between the families were unresolved, which were also observed in the 16S and ITS1 phylogenetic trees. The Malaysian edible species *Lobonemoides robustus*, *Rhopilema hispidum* and *Rhopilema esculentum* were proven to belong to Rhizostomeae, whereas other scyphozoans showed phylogenetic affinities to Semaestomeae and Kolpophorae. *Chrysaora* and *Cyanea* appeared non –monophyletic, however their paraphyly was not confirmed. Although this study has provided much needed baseline information on the barcoding of Malaysian jellyfish species, there is still a general lack of jellyfish sequences in GenBank to facilitate better species confirmation.

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New developments in Pelagiidae taxonomy and phylogeny (Cnidaria: Scyphozoa: Semaeostomeae)

JBS-00 / Oral Presentation_10

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This study provides new and additional data on morphology and a phylogenetic inference of all genera included in Pelagiidae family, comprising the recently described species *Pelagia benovici* Piraino, Aglieri, Scorrano & Boero, 2014, from the Northern Adriatic (Mediterranean Sea). The cladistic analysis of 32 morphological characters, of which the most significant are marginal tentacles anatomy, basal pillars, gonad pattern, subgenital ostia, and exumbrellar sensory pits, revealed significant differences from the currently known pelagiid genera *Sanderia*, *Chrysaora*, and *Pelagia*, with *Cyanea* as the outgroup. The most parsimonious trees were obtained by branch-and-bound search (PAST v. 2.17) and morphological characters were considered unordered in the cladistic analysis due to many unresolved homoplasies and unknown evolution of characters. The most parsimonious tree supports a closer relationship between *Sanderia* and *Chrysaora*, and with *Pelagia* as sister taxon. The phylogenetic relationships among genera in Pelagiidae family were inferred by Bayesian approach analyzing mitochondrial genes (COI, 16S rDNA, 12S rDNA) and nuclear ribosomal genes (28S rDNA, ITS1/ITS2 regions) and again *Cyanea* as the outgroup. The results of combined data sets, morphological and gene sequences (mtDNA, 28S and ITS), gave congruent results with the gene tree. Phylogenetic inference confirmed a closer relationship of the new species, *P. benovici*, with gen. *Sanderia* and *Chrysaora*, than with gen. *Pelagia*.

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Genetic data from the scyphozoan jellyfish family Pelagiidae indicate one of the most common U.S. Atlantic jellyfish (*Chrysaora quinquecirrha*) comprises two distinct species

JBS-00 / Oral Presentation_11

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The Family Pelagiidae, made up of three genera (*Chrysaora*, *Pelagia* and *Sanderia*), contains some of the world's most notorious blooming jellyfish species, such as *Pelagia noctiluca*, *Chrysaora fulgida* and *C. plocamia*, blooms of which affect tourism, fisheries, aquaculture and power plants. Possibly the most recognizable, well-studied and ecologically important jellyfish along the U.S. Atlantic coast is the sea nettle *C. quinquecirrha*. However, there have been historic taxonomic issues surrounding *C. quinquecirrha* that are illustrative of those in the family Pelagiidae as a whole, since they involve characters that have delineated genera past and present. In order to clarify evolutionary relationships and taxonomic boundaries in the family Pelagiidae, with special focus on genus *Chrysaora* and species *C. quinquecirrha*, we collected nuclear (large subunit ribosomal DNA) and mitochondrial (cytochrome c oxidae I and large subunit ribosomal DNA) sequence data from individuals representing all three genera (*Chrysaora*, *Pelagia* and *Sanderia*), including eleven of the 14 known *Chrysaroa* species. To further examine the taxonomy of the sea nettle *C. quinquecirrha*, specimens were included from its entire range (US Atlantic and Gulf of Mexico) with samples also examined morphologically (macromorphology and cnidome). Genetic (all regions) and morphological (macromorphology and cnidome) data indicate species-level differences within the species *C. quinqueicrrha* between estuarine (and Gulf of Mexico) and Atlantic coastal individuals (Massachusetts to South Carolina). In addition, our phylogenies confirm recent taxonomic conclusions based on morphology (e.g. status of *C. melanaster*), bring doubt to some proposed alterations (e.g. resurrection of *Dactylometra*) and provide interesting insight into the taxonomic position and possible source region of the invasive *P. benovici*.

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Molecular phylogeny of *Rhizostoma* and *Aurelia* species distributed along Black Sea coasts.

JBS-00 / Oral Presentation_12

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Aurelia and *Rhizostoma* species are common in Turkish coastal waters and cause some problems. DNA barcoding is used for phylogeographic analysis, detection of invasive species and reveal cryptic species. Barcoding and defining these species is going to provide to manage problems that occur because of jellyfishes. In this study, DNA variations between jellyfishes from different regions are determined.
Jellyfish samplings were made from different locations in the Black Sea. Here, we amplified and sequenced nuclear DNA region from 9 individuals. Phylogenetic analyses have been held based on ITS regions with the help of bioinformatics tools, then sequenced data were processed to construct phylogenetic trees and variation patterns.

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Reconciling the geographic scales of scyphozoan population dynamics, genetic differentiation, and environmental variation

JBS-00 / Oral Presentation_13

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Understanding jellyfish blooms depends on understanding the distributions of populations, species, and the traits that cause them to respond differentially to changing environmental conditions. We conducted new surveys throughout Central America and Mexico (CAM) and re-analyzed existing global collections to estimate the diversity and distributions of scyphozoan jellyfishes. For specimens from CAM, we sequenced up to five loci and measured up to 60 morphological characters, on which we conducted phylogenetic and morphometric analyses. In CAM, where only five jellyfishes had been reported previously, we found a total of 25 species—22 species are new to science, two are non-indigenous, and one is a previous record (the other four prior records had been misidentified)—increasing the estimated global diversity of Discomedusae by 15% (from 154 to 176 species). World-wide, we found that approximately 20% of comparisons and 60% of sampled genera contain multiple evolutionarily significant units (ESUs, e.g. species, subspecies) within a single Large Marine Ecosystem (LME) and/or biogeochemical province (BP). Conversely, approximately 20% to 30% of comparisons (and 35% of sampled genera) showed single scyphozoan ESUs occurring in two or more LMEs and/or BPs, respectively. These results illustrate a key challenge for understanding jellyfish blooms: how to integrate the scales of jellyfish population dynamics and genetic variation analytically with the scales of putative causes, from proximate events to global change.

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Trophic ecology of *Pelagia noctiluca*: a biomarkers study

JBS-00 / Oral Presentation_14

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The syphozoan *Pelagia noctiluca* is one of the most abundant jellyfish in the Mediterranean Sea and it is known for being predator of zooplankton, including ichthyoplankton. Its abundance seem to be increasing in the NW Mediterranean Sea in the last decades and its impact on marine ecosystem is under continuous study. The objective of the present study is to identify the trophic relationships between ephyrae and adults of *P. noctiluca* and the main representative zooplankton groups (mainly fish larvae) using biomarkers (stable isotopes and fatty acids) as complementary approaches of gut contents, in order to have a broader view of these interactions. Zooplankton samples were collected using a Mocnness net and P. noctiluca specimens were individually sampled from the surface using a long hand net during the expedition FISHJELLY conducted from 17 June – 4 July 2011 all along the Catalan Coast (NW Mediterraneran). Results of linear mixing models (SIAR) showed that *P. noctiluca* is an omnivorous jellyfish that feed on a wide wariety of prey, showing a similar isotopic signature of fish larvae and with salps as the main food source for adults medusae and small crustaceans for ephyare. Moreover, fatty acid patterns confirmed these results, also reflecting differences in their diet composition. Zooplankton composition in the field and different feeding strategies between developmental stages would explain these differences. The similarity in the isotopic signatures between jellyfish and fish larvae suggests a competition between both groups, although predation on fish larvae has been demonstrated. The results of the different approached will be discussed on this paper.

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The diet composition of *Nemopilema nomurai* in Southern Yellow Sea: A stable isotope analysis

JBS-00 / Oral Presentation_15

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Stable carbon and nitrogen isotopes of *Nemopilema nomurai* and their potential food, 7 size-classes plankton (0.7-20μm; 20-100μm; 10-200μm; 200-500μm; 500-1000μm; 1000-2000μm; >2000μm), were analyzed in the Southern Yellow Sea in June and August 2014. The contributions of 7 size-classes plankton to diet of *N. nomurai* were calculated based on IsoSource model. In June, the 20-100μm plankton (mainly dinoflagellates and ciliates) were the major food of *N. nomurai* among all size-classes, which contributed 29%-64% of the total diet. The >1000μm plankton (mainly copepods and chaetognaths) was the second food items that contributed 0%-35% of the diet during this period. In August, the big size plankton (1000-2000μm), mainly consisted of copepods and tunicates, became the highest proportion in the diet that ranged from 75% to 98%, when the abundance of tunicate was high in this study area. The 200-500μm plankton (mainly Noctiluca) also contributed a considerable part of diets (9.2% on average). The results indicated that there were diet shifts of *N. nomurai* from spring to summer in the Southern Yellow Sea, which may help the giant jellyfish meet their nutritional needs and maintain high biomass in the summer.

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Jellyfish - fish trophic interactions in the Bering Sea: ecosystem impacts of jellyfish population fluctuations

JBS-00 / Oral Presentation_16

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Populations of scyphozoan jellyfish in the eastern Bering Sea (EBS) can grow rapidly within a single season and have fluctuated widely over recent decades. Understanding the role of jellyfish in the EBS ecosystem is required for fishery and ecosystem management, however we lack direct measurements of the impact that changes in jellyfish abundance have had upon this ecosystem and its fish populations. These goals are being achieved by: (1) estimating the dietary and spatial overlaps between the dominant scyphozoan jellyfish in the region, *Chrysaora melanaster*, and major planktivorous fish groups (e.g., forage fishes, age-0 groundfishes) and (2) simulating the direct and indirect impacts of jellyfish variability throughout the food web via large-scale ecosystem models. Fishery survey data was used to examine the spatial overlap of forage fish and jellyfish within the EBS between 2004-2012, a period that includes both warm and cool ocean conditions. Overall, jellyfish and forage fishes have low spatial overlap, but regions of high overlap do occur, especially in warm years. To estimate the impacts of changing jellyfish abundances and levels of spatial and diet overlap with other planktivores (forage fishes and juvenile salmon), we have developed a spatially-resolved trophic model for three coupled, cross-shelf regions. Models have been configured separately for "warm" (2001-2006) and "cool" (2007-2010) periods. Over the EBS Middle Shelf, jellyfish require 20-fold more energy from the ecosystem than forage fish but pass along only 1/10th as much energy to the higher food web, thus playing a strong structuring role when in high abundance.

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Insights into complex host-microbe interactions in *Aurelia aurita*

JBS-00 / Oral Presentation_17

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Gelatinous organisms, like the moon jelly *Aurelia aurita*, are an important part of zooplankton. However, anthropogenic effects like eutrophication and overfishing as well as global climate change might lead to blooms, which negatively affect human interests such as aquaculture, infrastructure, and tourism. Thus, it is crucial to gain a better understanding of the factors affecting jellyfish ecology and regulating bloom dynamics. To evaluate the interactions between the jelly and its environment it has to be taken into account that a multicellular organism represents a "metaorganism" comprising the macroscopic host and its synergistic interdependence with microorganisms specifically associated with the host. Until now, associated microorganisms of *A. aurita* remained undescribed. In the present study, the microbiota associated with *A. aurita* was visualized with fluorescence in situ hybridization (FISH) analysis and the community structure was analyzed with respect to different life stages, compartments and sub-populations by 16S rRNA gene amplicon sequencing. We demonstrated (i) that the composition of the *A. aurita* microbiota is generally highly distinct from the communities present in ambient water, (ii) body part-specific colonization, (iii) life stage-specific community patterns, resulting in significant restructuring of the microbiota during metamorphosis; and (iv) sub-population specific community patterns. Overall, the data demonstrate that *A. aurita* has a specific associated microbiota which most likely plays an important functional role, e.g. during the life cycle. Unravelling the physiological role of the microbiota on host fitness under changing environmental conditions might bring us one step closer to better understand the interactions among the jelly and its environment, particularly in regard to the appearance of blooms and the establishment of strategies to prevent them.

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A new challenge in jellyfish research: the use of *Aurelia* sp. ephyrae as model organisms in ecotoxicological investigation

JBS-00 / Oral Presentation_18

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In aquatic toxicology, one of the most important steps is the selection of suitable model organisms, able to provide information on acute and chronic toxicity of marine pollutants. Model species should also be easy to maintain under laboratory conditions, widely distributed and ecologically relevant. Although Cnidarian jellyfish (Scyphozoans) are known to play an important role in marine food webs and are often conspicuous components in marine ecosystems, they are not yet employed in routine ecotoxicology.
In this context, the aim of this current studies is to suggest the use of *Aurelia* sp. ephyrae, one of the most common and widespread gelatinous zooplankton species in the world, as a model organism in toxicity bioassays. A series of experiments were carried out in laboratory controlled conditions, in order to investigate the influence of different culturing and methodological parameters (i.e. temperature, photoperiod, exposure time, density, age) on ephyrae swimming performance, measured by the number of pulsations/time. After these preliminary tests, ephyrae were exposed to a wide range of potentially toxic compounds (metals, surfactants, pesticides, nano-materials and harmful algae), in order to evaluate their level of sensitivity by measuring two different end-points: frequency of pulsation and immobility. End-points evaluation was performed by using an automatic recording system coupled with a video graphics analyzer (Swimming Behavioral Recorder – SBR) developed at CNR-ISMAR and previously used with other marine organisms. In conclusion, the comparison of EC50 values obtained with different toxic compounds on *Aurelia* sp. with those obtained with other marine invertebrates, highlights that ephyrae are an interesting and promising model organisms for ecotoxicological investigations.

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Jellyfish population dynamics in the North Sea and interactions with fisheries

JBS-00 / Oral Presentation_19

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In recent years, evidence to support the hypothesis that jellyfish populations fluctuate naturally has increased. Significant attention has also been given to the interaction between jellyfish and fisheries with *Nemopilema nomurai* being the prime example; Japanese fisheries have been heavily impacted by recent blooms of this species. In the North Sea, the interactions between fish and jellyfish are poorly understood. Thus, the objective of this study is to investigate interactions between fish and jellyfish in that region. We hypothesize that jellyfish compete with fish species for resources, but also play an important role as refugia which contributes to the successful development and recruitment of fish species into the adult populations. Another objective is to explore spatial distributions and its potential drivers. Data on jellyfish abundance and physical parameters was collected during the English leg of the IBTS Ground fish survey from August to September (2012 to 2015), onboard the "RV Cefas Endeavour". Our results show a defined spatial distribution which is driven by chlorophyll a concentration and sea surface temperature. In addition, we observed that some fish species such as *Sprattus sprattus* and *Merlangius marlangus* tend to spatially overlap with jellyfish species whilst others never do. But in some cases only the juvenile or adults stages show overlap suggesting either competition for resources or that jellyfish are being used as refugia. This study highlights that jellyfish not only may have negative effects on commercial fisheries, but also potentially functions as a unique habitat which may ultimately increase fish productivity.

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Pattern of jellyfish abundance across a mid-Atlantic warm water eddy

JBS-00 / Oral Presentation_20

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Mesoscale eddies influence the productivity and structure of pelagic communities, providing a feeding hotspot for higher trophic levels. Fronts and physical discontinuities along the edges of such eddies have been shown to aggregate and partition both fish and crustacean taxa. Furthermore, regions of eddy formation, like the northwest Atlantic, demonstrate extremely dense deep scattering layers (DSLs). Similar data on gelatinous zooplankton is very sparse despite this diverse group representing a substantial component of pelagic zooplankton communities. This study describes the diversity and abundance of gelatinous zooplankton across a warm water mesoscale eddy in the north Atlantic. Zooplankton were sampled at 7 stations, using a plankton net, multinet and a mid water trawl, along a survey transect across the eddy and physical parameters were recorded using a CTD. Cluster analysis and analysis of similarity showed significant differences in the zooplankton community across the eddy both horizontally and vertically ($R = 0.52$, $p < 0.05$). Diversity and abundance was highest in the boundary zone where the physical gradients were highest. In the epipelagic layer, *Beroe* spp., *Salpa fusiformis* and *Phialopsis diegensis* accounted for >60% of the difference between the boundary zone and the centre. Mid water trawls showed that the scyphozoan, *Periphylla periphylla*, is a dominant component of the DSLs within the eddy. This study shows that mesoscale eddies have a structuring influence on gelatinous zooplankton. The boundary zone is an area of enhanced biological activity, particularly in the epipelagic zone, however, this may not be indicative of the DSL within the eddy.

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Distribution of gelatinous macrozooplankton in Sinop Peninsula of the Souhthern Black Sea

JBS-00 / Oral Presentation_21

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This study aimed to deduce variations and distribution of gelatinous organisms. The distribution, abundance, biomass and their relationship with physical parameters of the gelatinous macrozooplankton (*Aurelia aurita*, *Mnemiopsis leidyi*, *Beroe ovata* and *Pleurobrachia pileus*) were determined between March 2015 and February 2016 in the Sinop Region of southern Black Sea. Sampling was carried out monthly at the six (6) stations, located inshore and offshore. Sampling was made by plankton net (50 cm diameter mouth opening and 210 µm mesh size) in vertical. In this study, abundance and biomass of gelatinous macrozooplanton increased in the summer and autumn months. However, minimum values were found in winter. Maximum abundance were calculated in vertical as 43.33 $n.m^{-2}$ (August 2015) in offshore and 39.17 $n.m^{-2}$ (July 2015) in inshore. The highest biomass was found in inshore 282.47 $g.m^{-2}$ in April, in offshore 205.68 $g.m^{-2}$ in March. Except from the increase in the periods of reproduction, decreasing was observed in amount of gelatinous macrozooplankton. Compared with the previous years, it was determined that there are differences in frequency of occurrence of species. Consequently, it was found that species adapted to the environmental conditions and the temperature is most important factor for species diversity.

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Starvation – an important factor controlling scyphozoan population?

JBS-00 / Oral Presentation_22

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The emergence and survival of the early pelagic stage of scyphozoan jellyfish are critical in determining the size of the following medusa population. Therefore, we have tested the effects of starvation on survival of newly released *Chrysaora pacifica* ephyrae. Newly released ephyrae have remarkable starvation resistance as was manifested in median longevity of 153, >287 and 243 days at 15, 12 and 9°C, respectively. During starvation, ephyrae gradually decreased in size, the reduction being significantly greater at higher temperatures. The respiration rate of starved ephyrae (at 15°C) decreased sharply within the first 3 weeks, then slowly stabilized at 0.1 µL O_2 ind^{-1} d^{-1} after 4 months of starvation, which might represent the subsistent metabolic rate. When incubated in 0.1 M glycine-sea solution, starved ephyrae (86 days at 15°C) were capable of assimilating and metabolizing DOC; however, at ambient DOC concentrations, the DOC uptake might only prolong the survival but did not fulfil the requirement for growth and development, as starved ephyrae were gradually shrinking. Despite the reduction in body size, food deprivation for several months (160 days at 15°C) did not cause irreparable damage, so that after resumption of feeding all the ephyrae recovered and showed positive growth and development. In this regard, both decrease of metabolism to the subsistent level and utilization of DOC may enhance survival probability of ephyrae under nutritionally-limited conditions. In conclusion, our experimental observations indicate that starvation may not be a primal factor controlling the *C. pacifica* medusa population size.

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The feeding mechanism of Rhizostomeae medusae and escape responses by their mesozooplankton prey

JBS-00 / Oral Presentation_23

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The feeding mechanics of Rhizostomeae jellyfishes have important implications for marine trophodynamics, since these medusae are dominant predators mainly in tropical and subtropical coastal ecosystems. We applied high-speed videography to evaluate feeding mechanisms during ontogeny of the rhizostome species *Lychnorhiza lucerna* and *Stomolophus meleagris*. Encounters of medusae and mesozooplankton were recorded between 500 and 1000 frames s^{-1}. The viscous environment (Re<100) experienced by ephyrae constrains the feeding mechanisms that transport fluid during bell pulsation. In contrast, adult medusa fluid flows are dominated by inertial forces and bell pulsations become effective for transport of fluids and prey toward the oral arms. Vortices generated during bell pulsations are directed downstream and continuously transport fluid and prey toward the exterior oral arm surfaces. Although calanoid copepods are capable of escape velocities that greatly exceed medusae feeding current speeds, copepods often fail to detect the predators feeding currents or inadvertently jump into medusa capture surfaces during failed escape attempts. Consequently, the comparatively weak predator feeding currents successfully capture a portion of the copepods encountered. Our results demonstrated low capture efficiencies by the medusae on fast calanoid copepods, which agreed with gut content studies in *S. meleagris*. Yet, for *L. lucerna* calanoids represent >90% of the diet in larger individuals (>20 cm), thus other variables such as prey availability and the frequency of encounters in nature may influence medusae captures. These results clarify the processes that enable Rhizostomeae medusae to play key roles as consumers in tropical and subtropical coastal environments.

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The mechanisms behind the heterogeneous distribution of moon jellyfish *Aurelia aurita* s.l. across a sharp pycnocline

JBS-00 / Oral Presentation_24

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The vertical distribution pattern of moon jellyfish *Aurelia aurita* s.l. can vary within a water column, and a sharp pycnocline is reported to be one of the major factors which limit the vertical distribution. Causes of this limited distribution are likely to be either or both of two behavioral responses: a passive response to buoyancy and/or an active response related to an organism's preferences. However, these causes have yet to be verified. In the present study, we conducted behavioral and physiological experiments to elucidate the effects of salinity (density) change on the vertical distribution of jellyfish across a pycnocline. Behavioral experiments in a two-layered water tank showed that: (1) salinity discontinuity alone caused the limitation in vertical distribution of jellyfish, (2) distribution was restricted to a layer with the same salinity of a tank where jellyfish were acclimatized beforehand, and (3) jellyfish did not have any salinity or depth preferences. Analyses showed that the jellyfish had a similar density to that of the ambient seawater. When jellyfish were transferred to seawater of different salinity, they required several hours to acclimatize to the new environment. Our results indicate that jellyfish, when approaching a sharp pycnocline, are subjected to a strong buoyancy force, and thus is hardly able to swim across the pycnocline. Therefore, we conclude that the passive response is the primary mechanism behind the heterogeneous distribution of the jellyfish across a sharp pycnocline.

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Respiratory response to temperature of four populations of *Aurelia aurita* polyps from across their geographical range in NW Europe

JBS-00 / Oral Presentation_25

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The bloom forming jellyfish *Aurelia aurita* is found in northern Europe and its ability to reproduce asexually, at different times during a year, contributes towards the abundance of medusa blooms. To better understand the asexual reproduction behaviour of polyps and how this might be affected by anthropogenic climate change, a better understanding of the basic functional biology (metabolism) is required. To this end, respiration rates (RR) of polyps originating from four different locations in North West Europe were measured at 12 temperatures ranging between 2 and 26°C, exceeding their natural range. Higher RRs were observed at higher temperatures, but RR did not increase exponentially with temperature. Polyps with a narrow thermal window (<14°C) collected from higher latitudes, were able to survive temperatures as high as 22°C. Overall the metabolic response to temperature of all groups were different; with the greatest changes observed in polyps from Southern England and the smallest changes in polyps from Norway. Our results show considerable plasticity in polyps' metabolism from different areas in response to temperature. High survival suggests that polyps may be able to acclimate to warmer temperatures and potentially adapt to environmental change.

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The role of zooxanthellae in mitigating the interactive effects of hypoxia and acidification on jellyfish polyps

JBS-00 / Oral Presentation_26

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The occurrence of hypoxia is increasing exponentially in coastal waters and is hypothesised to facilitate jellyfish blooms. Hypoxic waters contain less O_2 but more CO_2 than normoxic waters because of microbial respiration and, therefore, are also more acidic. We investigated whether zooxanthellae, by producing O_2 and consuming CO_2 during photosynthesis, mitigated the potential interactive effects of hypoxia and acidification by comparing asexual reproduction rates and the buffering capacity of *Cassiopea* sp. polyps. We exposed zooxanthellate and non-zooxanthellate *Cassiopea* sp. polyps to combinations of normoxia (6.0mgL-1) and hypoxia (2.0 mgL^{-1})) and ambient (pH 8.0) and low pH (pH 7.6) in an orthogonal design. Polyps in all treatments survived and budded. Under ambient conditions, 20% more zooxanthellate polyps were produced than non-zooxanthellate polyps, however, the magnitude of this difference was greater under acidic conditions, where 70% more zooxanthellate polyps were produced than non-zooxanthellate polyps. Zooxanthellate polyps budded most prolifically under normoxic, acidic conditions and the most non-zooxanthellate polyps were produced under ambient conditions. Fewest polyps were produced by non-zooxanthellate polyps in acidic conditions. The internal pH measurements of non-zooxanthellate polyps reflected the surrounding pH conditions, however, during the daytime the internal pH of zooxanthellate polyps exposed to acidic conditions was similar to controls. Our results suggest that zooxanthellae may be important in mitigating the potential negative effects of acidification.

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Body growth and gonad development of giant jellyfish *Nemopilema nomurai* in China coastal waters

JBS-00 / Oral Presentation_27

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Jellyfish outbreaks occurred globally in many marine ecosystems in recent decades, as a regional increasing case, *Nemopilema nomurai* have formed increasingly blooms during summer and fall since the end of the 1990s in East Asia waters. Our preliminary study indicated that the contribution of the sexual reproduction to the population recruitment is larger than the asexual reproduction. Therefore this research focuses on the body growth and gonad development of the pelagic stages. To find the response process of the body growth and sexual reproduction to the environmental parameter change, we investigated sex, gonad maturity and oocyte size of the medusa specimens in situ, and also obtained the bell diameter frequency and actual wild specific growth rate of *N. nomurai* during spring-summer season in recent years in China coastal sea. The results showed that the average bell diameter and the average growth rate of this species in May, June and August in different years was variable. The male and female proportion of *N. nomurai* was close 1:1; the gonad was generally becoming more and more mature from northern to southern study area. The oocyte size frequency distribution of *N. nomurai* showed that the average size of oocyte at southern stations was larger size than that at the northern stations, and the length and width of sperm follicles were relatively complicated than females. The influencing factors including the corresponding food availability (standing stock and production of zooplankton), temperature, salinity and the abundance of *N. nomurai* in different year was analyzed and discussed.

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Life history and population dynamics of the jellyfish *Aurelia aurita* in a temperate, semi-enclosed cove (Kertinge Nor, Denmark)

JBS-00 / Oral Presentation_28

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In the shallow Danish fjord-system Kertinge Nor/Kerteminde Fjord, mass occurrence of small *Aurelia aurita* medusae (3-5 cm maximum umbrella diameter) has been observed every spring and summer during the last 25 years. Water exchange of the fjord-system is driven by frequent salinity variations in the adjacent Great Belt which connects the high saline North Sea to the brackish Baltic. Due to its semi-enclosed nature and the presence of discrete annual cohorts of local medusae, Kertinge Nor represents an excellent model system to study the key mechanisms underlying jellyfish blooms. Based on field studies combined with controlled feeding experiments in the laboratory, we describe the importance of food availability and hydrodynamics for stage-specific growth, fecundity and mortality of *A. aurita*. Our results highlight population density-dependent regulation of medusa size and reproductive output, and it is suggested that food limitation, rather than senescence, controls the life span of *A. aurita* medusae in temperate Danish waters. Emphasizing the relevance of water-exchange driven washout of medusae from the fjord system, this contribution provides an overview of recent years' studies in Kertinge Nor and outlines our present understanding of the life history and population dynamics of *A. aurita*.

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The global biogeography and morphology of two cosmopolitan deep-sea jellyfish, *Atolla* spp. and *Periphylla periphylla* (Scyphozoa, Coronatae)

JBS-00 / Oral Presentation_29

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Jellyfish, as a significant constituent of the zooplankton, form important and often conspicuous components of marine ecosystems. Deep sea jellyfish are thought to represent up to 40% of the biomass in the deep sea water column, and yet remain largely understudied. Sampling constraints and a lack of overall knowledge relating to the biogeography and ecology of deep-sea jellyfish have so far limited the scope for large-scale studies. The deep sea species *Atolla* spp. and *Periphylla periphylla* (Scyphozoa, Coronatae) are the most well-known deep-sea jellyfish and are considered to have cosmopolitan distributions. Due to mass aggregations found within various Norwegian fjords, the ecology and biology of *P. periphylla* is more understood than *Atolla* spp.; however descriptions of oceanic populations remain minimal for both species. The use of museum collections can be used to gain insights into the spatial distribution of a species, particularly for deep-sea fauna. This study used the historical collections held at the Natural History Museum, London, to describe the global oceanic macroecology and biogeography of *Atolla* spp. and *P. periphylla*. Case study areas including the Porcupine Abyssal Plain, and the Iberian and Agulhas Basins were used to provide more detailed assessments of the variation in population structure and morphology against changes in environmental conditions such as temperature, productivity and climatic indices data. Variation in morphological traits in relation to environmental drivers is considered as being indicative of either phenotypic plasticity or distinct cohorts within populations. Initial reproductive analyses suggest that development is highly variable amongst the dataset, pointing to the possibility of plastic traits or distinct sub-populations. Variation in the number of tentacles in *A. wyvillei* (range = 12 – 36) suggest the presence of morphological plasticity across different regions.

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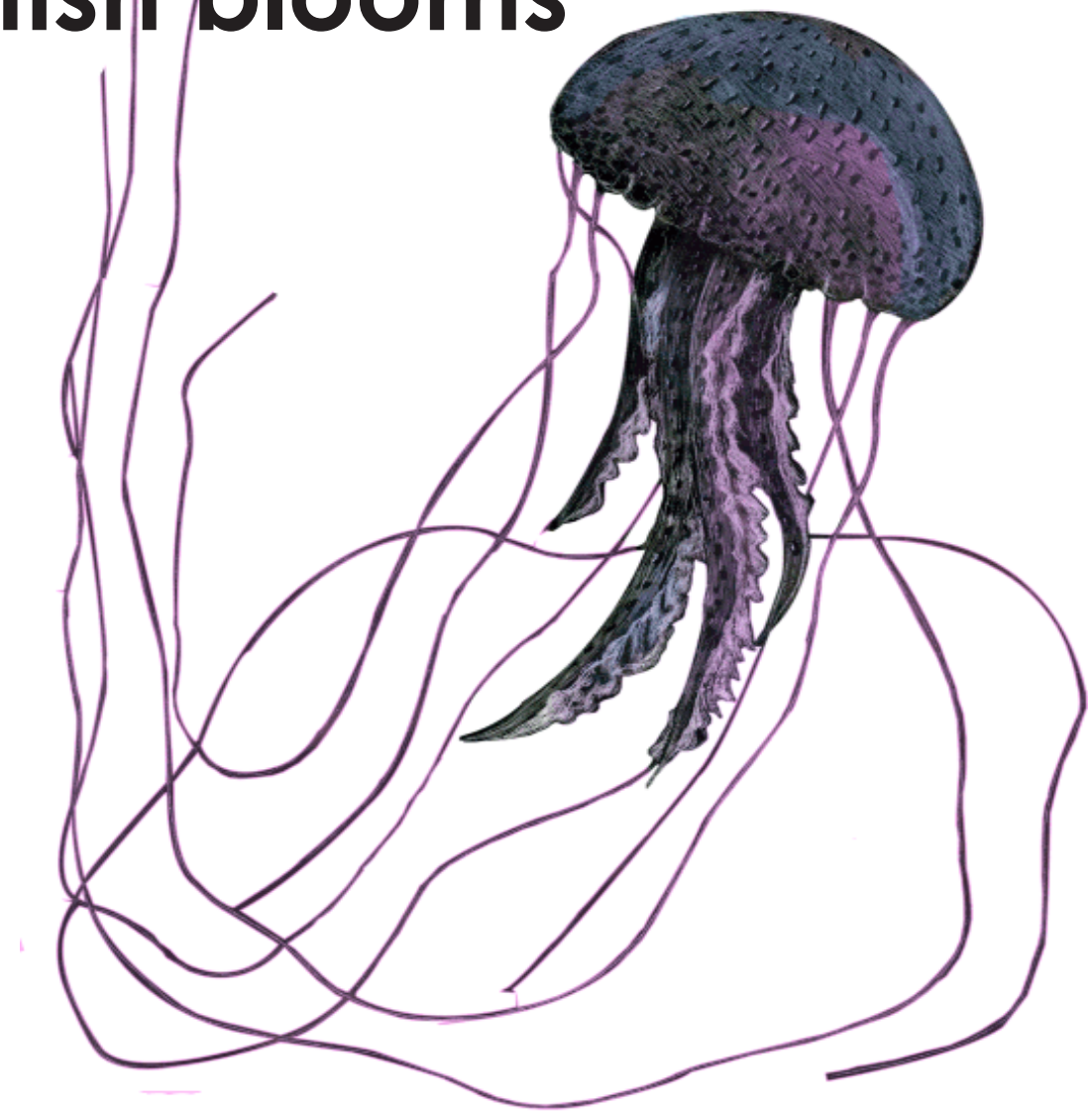
JBS-01
Environmental drivers of jellyfish blooms



Jellyfish populations fluctuate across multiple temporal and spatial scales. Globally, they exhibit multi-decadal cycles but individual populations at regional levels may fluctuate by orders of magnitude from year to year. Consequently the magnitude, timing and location of bloom events are often very difficult to predict which makes it challenging for ecosystem models to forecast future trends. Identifying the natural and anthropogenic biotic and abiotic environmental conditions that regulate bloom dynamics is, however, essential for understanding jellyfish population ecology, for capitalising on the ecosystem services they provide and for developing strategies for predicting and managing problematic and unnatural bloom events. We invite talks that aim to identify the environmental drivers of blooms at all spatial and temporal scales, particularly those studies that identify mechanisms linking metabolism to ecosystem level processes.

Chairs:
Kylie Pitt - Griffith University (Australia)
Rob Condon - University of North Carolina Wilmington (USA)
Carlos M. Duarte - King Abdulah University for Science and Technology (Saudi Arabia)

How robust is the evidence that anthropogenic stressors cause jellyfish blooms?

JBS-01 / Oral Presentation_01

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Claims that anthropogenic stressors facilitate jellyfish blooms pervade the scientific literature. We assessed the extent to which such claims are made within the literature and investigated the robustness of the evidence used to support claims. Our search of the Web of Knowledge returned 260 papers on "jellyfish blooms". Each paper was searched for statements linking jellyfish blooms to specific anthropogenic stressors. For each statement we recorded the affirmation afforded to the claim, identified the stressors purported to cause blooms, the sources cited to support the claim, the type of study cited and the species studied in the cited source. 46% of papers claimed that jellyfish blooms were facilitated by anthropogenic stressors but most afforded a low degree of affirmation to the claim. The stressors most commonly claimed to cause blooms were (in order) overfishing, eutrophication, climate change and the proliferation of artificial structures. The types of evidence cited to support claims were reviews, correlative field studies, other mensurative field studies, empirical lab experiments, models and meta-analyses. Studies of anthropogenic stressors on jellyfish overwhelmingly focused on *Aurelia* sp. and *Mnemiopsis*. Analysis of the 3 most commonly-cited reviews indicated that they often cited circumstantial evidence and other review articles and they provided a conceptual model of how stressors could influence blooms, rather than robust evidence. We conclude that, although anthropogenic stressors could enhance jellyfish blooms, robust evidence of anthropogenic stressors causing blooms is limited and the concept should be considered to be a hypothesis still to be tested.

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Modelling global ecosystem susceptibility to jellyfish blooms

JBS-01 / Oral Presentation_02

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Competition between large cruise-feeding jellyfish and forage fish for zooplankton prey is both a cause of jellyfish increases and a concern for the management of marine ecosystems and fisheries. Identifying key environmental factors affecting this competition on a general level is therefore important. However both the scarcity of good quality data and the variety of mechanisms and factors involved challenge the possibility to derive general processes. Nevertheless, some mechanisms regulating this competition may be expected to be ubiquitous, because they are linked to fundamental trait differences between fish and jellyfish forms. Using mechanistic models that explicitly consider these fundamental traits may therefore help to investigate broader patterns of jellyfish occurrence.

Here, we analyse the effects of primary production, water clarity and fisheries on the competition between forage fish and jellyfish, using a general mechanistic food web model that considers fundamental differences in feeding modes and predation pressure. Depending on the environmental conditions, the model predicts either coexistence of fish and jellyfish, or exclusion of one or the other, with forage fish dominance at low primary production and a shift towards jellyfish with increasing productivity, turbidity and fishing pressure. We present an index of the vulnerability of global coastal ecosystems to shifts in fish-jellyfish dominance and show that the distribution of this index compares well with available data on jellyfish bloom distributions and trends.

The results are a step towards better understanding of what governs jellyfish occurrences globally and highlight the advantage to consider traits in ecosystem models and management.

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Towards the quantification of climate change impacts on gelatinous zooplankton

JBS-01 / Oral Presentation_03

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There is a perceived increase in global gelatinous zooplankton (GZ) abundance due to climate change. Studies of past climate variability have shown a link between warmer temperatures and increased GZ abundance, but, we lack both the long-term observations and adequate models to infer the role of climate change. Here we present preliminary analysis of a global database of GZ abundance and of a new global biogeochemistry model representing GZ. The global database combines the MAREDAT and KRILLBASE databases for a total of 116,875 data points on abundance, and 13,125 data points on carbon content. The data are binned into 1°x1° degree grid boxes at monthly resolution, providing 11,817 semi-independent data points. The binned data has sufficient coverage to quantify the seasonal variations over multiple regions, including the North and Baltic Seas, the North-West Pacific, East and West coasts of the USA, the Gulf of Alaska and an area of the Southern Ocean. We present the baseline abundance and seasonal variations over these regions and quantify their spread and uncertainties. There is no cutoff abundance emerging from the data that can be used to clearly distinguish a bloom event from the background seasonal cycle. We modify the PlankTOM10 global biogeochemistry model to represent GZ as top zooplankton by using observations to parameterize its temperature-dependence growth rate and known feeding behavior to characterize predator-prey relationships. Preliminary results highlight the importance of GZ and its sensitivity to temperature.

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Modelling global relationships between climate and jellyfish (*Aurelia spp*.) blooms

JBS-01 / Oral Presentation_04

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To better understand controls on jellyfish distribution and their response to climate variability and change, we have developed a population model for the ubiquitous jellyfish, *Aurelia* spp., that incorporates both benthic and pelagic life history stages. This model tracks cohorts of both life stages with temperature and/or consumption driven relationships for growth, reproduction and mortality. To compare model output to empirical jellyfish biomass, the model was forced with a time-series of temperature and zooplankton biomass from the Gulf of Mexico (1982-2007). The model was then forced with temperature and zooplankton biomass derived from the COBALT marine ecosystem model to examine local and global biomass trends. Data-forced simulations reproduced seasonal ($r = 0.97$, $p < 0.01$) and interannual cycles ($r = 0.51$, $p < 0.01$) of medusa biomass in the Gulf of Mexico. In comparison, COBALT-forced simulations underestimated medusa biomass during peak years, yet could recreate distributional patterns that corresponded well to previously observed "hot spot" areas. Initial runs of the model at a global scale using COBALT-forcing indicate that the distribution of polyps and medusa are related to sea surface temperature (Polyp: $r = 0.71$, $p < 0.001$; Medusa: $r = 0.81$, $p < 0.001$). This corresponds well with a global assessment of empirical jellyfish biomass that found that sea surface temperature is one of the principal drivers of biomass distribution. The next application of the model will be forced with climate change projection simulations.

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Hydrodynamic variability and incursions of oceanic jellyfish blooms (*Pelagia noctiluca*) in the North East Atlantic

JBS-01 / Oral Presentation_05

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Mass incursions of the jellyfish *Pelagia noctiluca* are well documented in the Mediterranean Sea, where they have serious socio-economic impacts. The species had received less attention in the Northeast Atlantic (NEA) until a major and well reported fish kill in Northern Ireland in 2007. Although *P. noctiluca* aggregations in Irish/UK waters are recorded typically in offshore locations, the species can occur en masse in coastal waters in certain years. It is not clear whether years of mass occurrence in coastal waters result from changes in absolute abundance, or from meteorological variability in the NEA (i.e. shifts in the direction of prevailing currents driving offshore aggregations towards the coast). Given the logistical challenges of quantifying the inter-annual variability in abundance of *P. noctiluca* aggregations in Irish/UK waters (as blooms can span several hundred km^2) we used a Lagrangian (particle-tracking) modelling approach to consider the fate of hypothetical blooms (within the known range for the species). The model assumed a stable population of *P. noctiluca* in each year, to test whether meteorological conditions (wind-induced currents alone) in surface waters were enough to explain inter-annual variability in *P. noctiluca* incursions (recorded as stranding events in a shoreline sampling programme recorded from 2009 to 2011). The model showed a high predictive ability (>70% Area Under Curve, AUC) when compared to independent shoreline observation data. Model simulations of *P. noctiluca* stranding over four years suggested changes in wind-induced currents would lead to marked variability in the geographical end points (i.e. coastal areas) of blooms that originated in the North East Atlantic.

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Environmental and synecological causes of dramatic fluctuations in *Mastigias* population abundance in a marine lake

JBS-01 / Oral Presentation_06

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The factors driving jellyfish population dynamics are poorly understood, due partly to nescience of the geographic scale of populations. Populations bloom, so analyses at scales larger than populations could decouple the causal influences from the observed effect, obscuring the factors that cause a population to bloom. Studies in marine lakes resolve this issue by utilizing discrete, isolated populations. Within marine lakes in Palau, the abundance of *Mastigias papua* medusae, which form the top of a pelagic planktivorous trophic chain, fluctuates fifty-fold interannually. We analyzed changes in the population sizes of medusae in 'Jellyfish Lake,' their planktonic prey, and the environmental conditions for 10 years following the major El Niño-La Niña event of 1997/8. There was a rapid demographic expansion and overall population increase with high variability for the first seven years, until returning to lower mean abundance and more stable population size. There was weak negative and approximately equivalent overall correlations between medusae abundance and either zooplankton abundance or temperature, although the correlation fluctuated with time (medusae with zooplankton: rmax=-0.83, rmean=-0.15; medusae with temperature: rmax=-0.90, rmean=-0.15). The coupling between phytoplankton and zooplankton abundances, zooplankton and medusae abundances and medusae abundance with environmental conditions rapidly moved between synchronous and asynchronous periods. Studying a single population's dynamics over an extended period of time indicates there may be many factors of approximately equivalent maximum effect, alternating through time, influencing jellyfish bloom dynamics.

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Climate-driven population size fluctuations of jellyfish (*Chrysaora plocamia*) off Peru, and future perspectives

JBS-01 / Oral Presentation_07

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There is a general concern that jellyfish populations are increasing throughout marine ecosystems worldwide, mainly due to environmental and anthropogenic forces, or interactions among them. To identify drivers of jellyfish populations in the heavily fished northern Humboldt upwelling system (NHUS), we examined linkages between a 43-year-long annual time series (1972–2014) of the biomass of the scyphomedusae *Chrysaora plocamia* and several forcing factors: the Peruvian Oscillation Index, the Regime Indicator Series and commercial landings of Peruvian anchovy. We found that *C. plocamia* biomass fluctuated with climate drivers, but not with anchovy landings (a proxy of fishing pressure). Jellyfish biomass was high and variable during the warm El Viejo regime in the 1970s and 1980s, with peaks connected to intra-regime El Niño Southern Oscillation (ENSO) events. By contrast, no peaks occurred during warming events in the cold La Vieja regime in the late 1990s and 2000s when jellyfish biomass was very low or below detection; however, at the end of the study period, biomass rose slightly. The fishing pattern in the NHUS is just the opposite of those that previously have been attributed to removing small pelagic fish. We suggest that environmental factors and prey availability act synergistically to generate observed population size variability of this medusa in the NHUS. In addition, future El Niño recurrent events would influence jellyfish persistence in the area, with the economic and environmental consequences in this highly productive area.

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Forecast for the annual bloom intensity of the giant jellyfish *Nemopilema nomurai*: 10-year monitoring using ships of opportunity

JBS-01 / Oral Presentation_08

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The giant jellyfish *Nemopilema nomurai*, endemic to the East Asian Marginal Seas, shows a propensity for occasional population explosions, which become a severe nuisance for net-based fisheries in Japan and Korea. The Changjiang River estuary and adjoining shallow sea off Jiangsu Province, China, are considered the major habitat of polyps, which release ephyrae in the spring. In early summer, young medusae are distributed over the Yellow Sea and northern East China Sea, and then transported to the Sea of Japan. Monitoring of medusae in the Yellow Sea and East China Sea has been conducted for 10 years from 2006 to 2015, using ships of opportunity. In each year, medusae began to appear in June, reached an annual peak density in July, and almost died out by November. The medusa population showed a remarkable annual variation. Average density in the Yellow Sea in July varied from 0.0005 medusae 100 m^{-2} in 2014, causing no negative impact on Japanese fisheries, to 3.17 medusae 100 m^{-2} in 2007, resulting in devastating damage. Now, we are capable of forecasting the annual bloom intensity in July, 1-3 months prior to their peak occurrence in Japanese waters. When the densities are ≥1 medusa 100 m^{-2}, we immediately warn Japanese fishers to take proper measures against a big bloom. Multiple correlation analysis revealed that the average medusa density in July correlated positively with 3 parameters in the polyp habitat: sea surface temperature in February, west wind velocity in May, and south wind velocity in June.

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Causes of giant jellyfish bloom in Chinese coastal waters

JBS-01 / Oral Presentation_09

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As a regional increasing case, giant jellyfish have been increasing in recent decades in East Asia waters. To better understand the mechanisms for such a prominent increase of jellyfish and to assess their ecological and economic impacts on the marine ecosystem in China coastal water, a national research project on the causes and consequences of giant jellyfish bloom in the Chinese coastal waters was conducted from 2011 to 2015. Although some detailed scientific contributions from these projects have been published in special issues (e.g., Oceanol. Limnol. Sin. Vol. 43, 2012; Hydrobiologia Vol. 754, 2015), this presentation will summarize the research activities and main results on the causes of the giant jellyfish bloom. Based on the results of twenty jellyfish bloom surveys, scuba-diving and simulating experiment in situ, we found the correlation between the jellyfish bloom and temperature-climate, food web change caused by eutrophication and coastal modification, we also found the relationship between fish and jellyfish is more complex than our previous understanding.

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The northward distribution of *Periphylla periphylla*: a case of expansion or hiding in plain sight

JBS-01 / Oral Presentation_10

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Scientific reports of mass occurrences of the cosmopolitan scyphozoan *Periphylla periphylla* have previously been confined to western Norwegian fjords. However, in recent years there have been increasing reports from the public on the northward expansion of the jellyfish, leading the media to report on mass occurrences of *Periphylla* in the region. We conducted field studies north of 65°N in fjords that either: had reports of increased numbers of *Periphylla*, shared hydrographical features with other *Periphylla* fjords yet no reports, fjords dissimilar to *Periphylla* fjords and without reports of the jellyfish. We confirm reports of *Periphylla* populations in five new fjords, yet only two of these fjords were identified to have mass occurrences. In one mass occurrence fjord we studied *Periphylla*'s population structure over a one-year period and found a range of developmental stages, yet reproductive periods were limited to the autumn and winter months. We concluded the population was reproducing in the system. However, eight years after our initial sampling *Periphylla* was virtually absent in this fjord. A review of historical literature details the presence of the jellyfish in the region, including mass occurrences, clarifying the jellyfish is neither an alien species nor one expanding its northern distribution range. In all the sampled fjords, we tested for agreement with previously published theories behind *Periphylla* mass occurrences by use of a proxy method for calculating non-phytoplankton light attenuation. The proxy data is currently under analysis and will be presented at the symposium.

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Changes in gelatinous zooplankton communities in Barnegat Bay, NJ, USA: Impacts of Hurricane Sandy

JBS-01 / Oral Presentation_11

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Barnegat Bay, NJ is a shallow, well-mixed estuarine system with substantial anthropogenic development in the northern regions and has seen a substantial increase in the abundance of the scyphozoan *Chrysaora quinquecirrha*. Zooplankton communities were sampled monthly in the summers from 2012 to 2014. Prior to Hurricane Sandy, the gelatinous zooplankton community was dominated by two species, *C. quinquecirrha* and the comb jelly *Mnemiopsis leidyi*. Results showed significant top down control of *M. leidyi* by *C. quinquecirrha* in 2012, but following Hurricane Sandy, substantial changes in the gelatinous zooplankton community occurred. Specifically, with the destruction of polyp habitat for *C. quinquecirrha*, their population showed declines in 2013 and 2014. Concomitant with this change, *M. leidyi* populations significantly increased in 2013 as a response to lack of predator control, but dropped significantly in 2014. The drop in 2014 was unexpected as *C. quinquecirrha* populations remained low; however the increasing density and diversity of other gelatinous species in 2013 and 2014 changed the community dynamics and increased competition among these species. The change in the community was related to increases in coastal and open ocean gelatinous species including *Turritopsis nutricula*, *Nemopsis bachei*, *Bougainvillea muscus*, and *Rathkea octopunctata*, suggesting that the storm not only destroyed polyp habitat, but also impacted tidal and ocean circulation in this region and opened the system to increased competition.

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Can river flow management prevent estuarine jellyfish blooms?

JBS-01 / Oral Presentation_12

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Noxious jellyfish blooms occur frequently in many estuarine and coastal ecosystems around the world, which have been associated with numerous anthropogenic and natural changes. However, it has been observed that blooms disappear in estuarine ecosystems during wet years with high freshwater discharge. Therefore, we hypothesize that the release of freshwater pulses from dams could be a promising ecohydrological approach to control jellyfish blooms. Thus, this study aimed to describe recent variation of medusa density and freshwater inflow in the Guadiana estuary (dam controlled) and to quantify the survival and physiological responses (asexual reproduction, feeding rate, number of swimming pulses) of scyphistomae and ephyrae larvae to freshwater pulse on the blooming species *Aurelia aurita*. Experiments focused on the responses of scyphistomae and ephyrae larvae to three low salinity treatments of 3, 10 and 17, against salinity treatment of 35. The survival rate of scyphistomae and ephyrae larvae was maximum at salinities 35 and 17 for both life stages and at a salinity of 10 for scyphistomae. The survival rate was 0% in the remaining treatments. Yet, scyphistomae showed impaired physiological responses (measured as lower budding reproduction and feeding response) in salinity 10 treatment, while ephyrae's physiological responses (measured as swimming pulses) were already diminished in salinity 17. These results suggest that short-term freshwater pulses controlled by dams may induce mortality rates or impaired physiological responses during early life history phases of *Aurelia aurita*. So, it was concluded that jellyfish blooms control may be possible through river management.

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Aurelia aurita ephyrae in a changing world: facing multiple environmental stressors

JBS-01 / Oral Presentation_13

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Global change is affecting marine ecosystems through a combination of different stressors such as warming, ocean acidification and oxygen depletion. However, very little is known about the interactions among these factors, especially with respect to gelatinous zooplankton. Tolerance of jellyfish to human-driven ecosystem changes has been widely reported during the last years, thus there has been a major concern about climate variations and global gelatinous zooplankton blooms. Therefore, we investigated the direct effects of pH, temperature and oxygen availability on early medusa stages of the widely distributed *Aurelia aurita*. Ephyrae were reared from polyps of a North Sea population. Starved one-day-old specimens were exposed to a range of pCO_2 (400 to 4000ppm) and three different dissolved oxygen levels (from natural oxygen-saturated to hypoxic conditions), in two different temperatures (5°C and 15°C) for seven days. Carbon content, swimming activity and mortality were analysed at the end of the incubation period. Our results showed two- or three-way interactions among pCO_2, temperature and oxygen concentration. The effects of the stressors were small but significant demonstrating a synergistic effect of acidification, deoxygenation and warming. The clearest negative effect on carbon content occurred only with all three stressors present. Reduced activity and lower mortality rates were observed under combined low temperature and hypoxia effects, suggesting a potential stress-avoidance mechanism. We conclude that *A. aurita* ephyrae are robust, and that they are not likely to suffer from environmental stressors in a near future, what may determine jellyfish proliferations to the detriment of some other taxa.

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ETS and oxygen consumption of *Cassiopea* sp. in response to acute and chronic temperature change

JBS-01 / Oral Presentation_14

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Pelagic jellyfish blooms are ever increasing worldwide as a potential response to climate-change. However, virtually nothing is known about their physiological responses to, e.g., sudden changes in water temperature due to extreme weather events. When confronted with sudden decrease or increase (i.e., 20 or 32°C relative to the control 26°C) in water temperature, medusae of the upside-down jellyfish *Cassiopea* sp. exhibited a strong response in locomotory activity (i.e., bell pulsation increased and decreased by ca. 37 and 46% in hot and cold acute exposure, respectively) relative to control . Although medusae have significantly (i.e., p-value < 0.05) gained in body mass (wet weight) upon chronic (2 weeks) heat stress, their body size (e.g., bell diameter) did not change over this time interval. In contrast, chronic cold stress resulted in both significant shrinking (reduced diameter) and mass loss. Measurements of mitochondrial electron transport system (ETS) activities and rate of respiratory oxygen uptake (MO_2) are good estimates of energy consumption and the potential aerobic metabolic rates of an organism. While both acute cold/heat-stress (2 hours) have significantly increased ETS-activities, acclimation over two weeks (chronic cold/heat-stress) resulted in a drop in activities to the control levels. Whereas, acute heat-stress has significantly increased MO_2, the chronic acclimation resulted in significant decrease in MO_2 to the control level, but no changes could be observed in both acute and chronic cold treatment. Overall these results suggest an enhanced growth in response to global warming, whereas low temperatures may set the limits for successful invasion of *Cassiopea* into colder water bodies.

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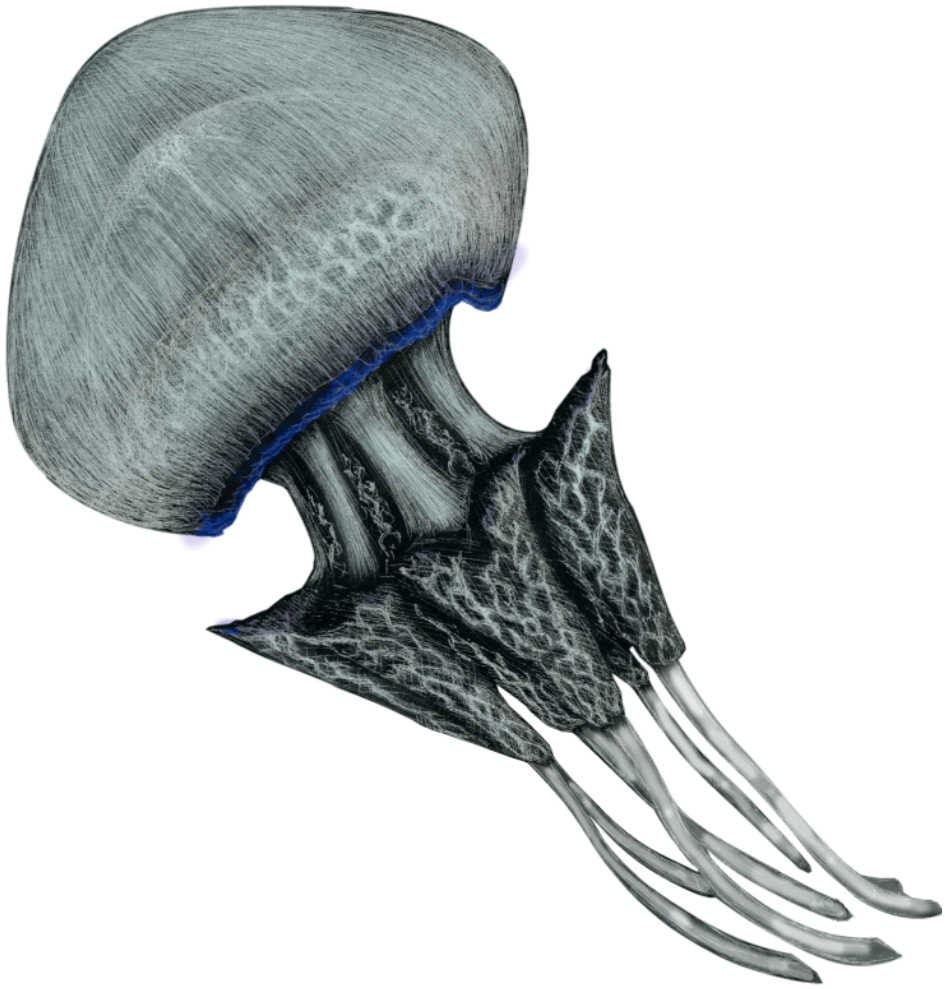
JBS-02
Post-bloom impacts on the marine environment



Jellyfish blooms appear to be increasing in frequency in numerous areas around the world. Whilst studies have sought to identify the driving forces and effects of blooms on the pelagic environment, the subject area of 'post-bloom' processes (i.e., the fate and ecosystem impact of sinking and decomposing jellyfish carcasses) has received little attention. Furthermore, the effect of decomposing jellyfish acting together with other anthropogenic stressors on marine ecosystem services is completely un-quantified. As such, the full socio-economic impact from jellyfish blooms is still unknown. In this session, we welcome novel empirical, experimental and modelling studies that shed light on post-bloom processes and/ or synergistic effects of decomposing jellyfish and other stressors in the marine environment. We also encourage presentations on how post-bloom processes alter the provision of ecosystem services by the marine environment.

Chairs:
Andrew K. Sweetman - International Research Institute of Stavanger (Norway)
Paul E. Renaud - Akvaplan-niva (Norway)

Phytoplankton succession during metabolism and decomposition processes of *Nemopilema nomurai*

JBS-02 / Oral Presentation_01

Xiaoxia Sun, Shan Zheng

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The succession of phytoplankton community during the processes of metabolism and decomposition of *Nemopilema nomurai* was studied. Results indicated that the seawater acidification and hypoxia occurred during the respiration of *Nemopilema nomurai* in 24 hours. Meanwhile, inorganic nutrients regenerated by *N. nomurai* greatly increased the concentrations of DIN and DIP in the seawater, and the release rates achieved 683.07 μmol/(kgWW·h) for DIN and 49.06 μmol/(kgWW·h) for PO_4^{3-} respectively. The concentration of chlorophyll a doubled with the input of nutrient. Similarly, the decomposition of *N. nomurai* resulted in significant hypoxia and acidification of seawater, and it got more severe when the biomass of *N. nomurai* was higher. The release rates of DIN and PO_4^{3-} ranged from 156.31 to 354.02 μmol/(kgWW·h), and from 7.31 to17.01 μmol/(kgWW·h), respectively. The dinoflagellates and green algae bloomed during the decomposition process, with the dinoflagellates dominated in the first 5 days and green algae dominated after that. Furthermore, the abundance of ciliates increased due to the sufficient food accordingly.

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Jellyfish decomposition at the seafloor can rapidly alter biogeochemical cycling and substantially modify carbon flow through benthic food-webs

JBS-02 / Oral Presentation_02

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We quantified the effect of deposition of jellyfish carcasses on short-term benthic carbon cycling dynamics in cold, deep fjord environments. Respiration was measured in benthic cores, and ^{13}C-labeled algae was used as a tracer to quantify C flow through benthic macrofauna and bacteria over 5 d in the presence and absence of jellyfish detritus. Linear inverse models (LIMs) were also generated to identify pathways of C-flows in the food web when exposed to the 2 different treatments. Benthic respiration rates increased rapidly (within 17h) in the jellyfish-amended experimental cores, and were significantly higher than those from cores that were supplied with only labeled phytodetritus. When cores were supplied with only labeled phytodetritus, macrofauna were the main agents of C-uptake over the 5 d study. In contrast, the tracer study and LIM model revealed that addition of jellyfish detritus caused a rapid reversal in C-uptake dynamics; macrofaunal C-uptake significantly decreased and bacterial C-uptake increased significantly relative to the cores supplied with only phytodetritus. Our results suggest that the addition of jellyfish detritus to the seafloor can rapidly alter benthic biogeochemical cycling, and substantially modify C-flow through benthic communities. If our results are representative for other areas, they suggest that jellyfish blooms may have knock-on effects for benthic ecosystem functions and services when blooms senesce.

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Rethinking the role of salps in the ocean

JBS-02 / Oral Presentation_03

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Salps have historically been ignored, because they are difficult to sample and maintain in the laboratory, and their gelatinous body structure suggests they are unimportant in food webs and biogeochemical cycles. We challenge these misconceptions and collate evidence to overturn several common myths and misunderstandings about salps that have hampered research. We show that salps are key components of marine food webs, as they form large swarms that dominate the zooplankton and incorporate large quantities of primary production into their tissues. They are a food source for many commercial fish species and other organisms, and play a major role in carbon sequestration. Future research avenues include novel sampling techniques developed specifically for gelatinous organisms and the establishment of long-term monitoring programs.

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Experimental flume studies into the modification of benthic boundary layer flow by jellyfall carcasses

JBS-02 / Oral Presentation_04

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Post-bloom processes on the benthic environment are poorly known and in particular the effect on benthic boundary layer flow dynamics [1]. Large masses of jellyfish carcasses on the seafloor are hypothesised to induce `skimming flow' [2 - 4], which can potentially reduce shear stress at the sediment-water interface. This would result in a thicker diffusive boundary layer and a reduction in oxygen flux to the sediments. As part of the JellyFarm project, flume experiments have been conducted to simulate and provide initial results to determine the effect of relatively small, medium and large jellyfalls on the benthic boundary layer. Artificial jellyfalls of varying size were created in the flume with specific reference to the scyphozoan *Periphylla periphylla*, a common bloom species in Norwegian fjord systems [5]. Detailed measurements of benthic boundary layer current velocities and sediment oxygen microprofiles were recorded using a 3D acoustic doppler velocimeter. This is the first study of the physical effects of jellyfalls on benthic fluid dynamics and has significantly advanced understanding of post bloom seafloor impacts. Data will be used to evaluate the combine effect of organic stressors (such as aquaculture) and jellyfalls to enable effective management of aquaculture activities in jellfish bloom affected areas.

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JBS-03
The biology an ecology of polyps and their role in jellyfish population dynamics

Many bloom-forming jellyfish are members of the Scyphozoa with bentho-pelagic life cycles consisting of a sexually reproducing medusa and asexually reproducing polyp. Polyps propagate asexually and produce and release great numbers of ephyrae back to the pelagic realm leading to population pulses that can sometimes result in the so-called jellyfish blooms. Therefore, the perennial benthic life stage plays a critical role in population dynamics of these species. Understanding how environmental variables affect the distribution, survival and reproductive growth of benthic polyps and to what degree this manifests itself in the formation and maintenance of jellyfish outbreaks, whether cyclic or in response to climate change, is essential for our ability to predict and manage potential jellyfish bloom events. However, the study of the life history of these species is still in the infancy. Indeed, roughly one quarter of Scyphozoa life cycles is described and, among them, the main ecological features of the benthic phases are still ignored. Intensive research on life cycles and the role of benthic stages in the ecosystem is needed.

Chairs:
Cathy Lucas - National Oceanography Centre Southampton, University of Southampton (UK)
Agustín Schiariti - Instituto Nacional de Investigación y Desarrollo Pesquero, INIDEP (Argentina)

Strobilation: state of the art and perspectives for future investigations

JBS-03 / Oral Presentation_01

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Strobilation is the process by which scyphistomae produce and release medusae from the benthos back to the plankton. It also signals the onset of sexual reproduction in blooming medusae and it is considered rare outside Scyphozoa. Hence, strobilation has important ecological and evolutionary implications. Accordingly, empirical and experimental knowledge has been accumulating rapidly. There is a general agreement about the importance of some factors (e.g. temperature, nutrition, light) on stimulating strobilation and regulating their rates. However, a close-up view shows that beneath these general trends results appear to be rather contradictory. In drawing together literature about strobilation, we reconsider some of the generalizations that were deduced from previous controversial results. We classified these studies into categories defined by goals, methodologies and main results. We aimed to analyze apparent exceptions and assess how representative they are, seeking patterns, primarily to understand how the environment controls the magnitude of jellyfish blooms through strobilation rates. We found that, in addition to the natural remarkable variability of strobilation, the enormous diversity of utilized methodological approaches makes the identification of patterns even more complicated. Unless the process of strobilation is studied under a common methodology allowing the comparison of results, the distinction between the effect the natural and artificial variability will keep faint. Finally, we re-analyzed the literature excluding the information about *Aurelia*. We think that the enormous variability characteristic of this genus probably makes them inappropriate to be used as a study model if we are seeking patterns in Scyphozoa.

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In situ comparison on strobilation of three scyphozoan species on settling plates in Jiaozhou Bay, China

JBS-03 / Oral Presentation_02

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Scyphozoan jellyfish *Aurelia* sp.1, *Nemopilema nomurai*, and *Rhopilema esculentum* massively occurred in the East Asian Marginal Sea. Strobilation of the benthic polyps, crucially regulating the abundance of medusae, has rarely been investigated in the natural environment and never for *N. nomurai* or *R. esculentum*. To evaluate strobilation of these species in situ, we continuously monitored the survivorship percentage, strobilation duration, strobilation percentage, disc number per strobila and ephyra production of newly-settled polyps on settling plates for eight months in Jiaozhou Bay, China. The results demonstrated that significantly various survival patterns were observed among three kinds of polyps, in company with species-specific strobilation strategies. *Aurelia* sp.1 polyps survived, and even multiplied to 1.5 times than the beginning, but all the *N. nomurai* and *R. esculentum* polyps eventually died. Strobilation started earliest in *Aurelia* sp.1, followed by *N. nomurai*, *R. esculentum*. The percentages of polyps strobilating and mean disc number per strobila significantly differed. However, ephyrae production relative to the number of initial polyps was similar (≤ 2.0 ephyrae polyp-1), which was inferred to be dominated by the mortality rate of polyps in situ. The results also indicated that in natural environment, owing to latest strobilation, *R. estulentum* ephyrae or young medusae may subjected to the threat of competition for food and predation from larger *Aurelia* sp.1 and *N. nomurai* medusae in June.

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Relationship between polyp population, ephyrae liberation and young medusa population in Gamak Bay, Korea

JBS-03 / Oral Presentation_03

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To understand to what extent polyp population of *Aurelia* sp. 1 contributes to the jellyfish bloom, we determined total amount of polyps, ephyrae liberated and young medusa in Gamak Bay in 2015. To estimate the total amount of polyps, underwater photographs were analyzed from downside surface of 145 floating piers and barges of 645 in total in Feb to early Mar. Strobili formation and ephyrae liberation were recorded every 30 min with six close-up cameras installed underwater during 37 days, and 10,015 shots of photographs were analyzed. Ephyrae liberated from the polyps and young medusa in the water column were collected with a net at 58 stations for 1 to 7 days intervals from 17 Mar to 23 Apr. Ephyrae started to be liberated below 5 °C, accelerated with temperature increase and continued for 32 days. Total individuals of polyps in Gamak Bay before ephyrae occurred were ca. 516 x 106 individuals, and expected numbers of total ephyrae were ca. 4,053 x 106 individuals. Total number of ephyrae and metephyrae at the peak in the water column were ca. 1,136 x 10 individuals, thus corresponded to 28.79 % of the expected total number. Young medusae were predominant without possible influx from the outside in 23 Apr, and total numbers were ca. 96 x 10 individuals. While the abundance was still at bloom level, it corresponded to only 2.44 % of total amount of ephyrae expected to be liberated before, suggesting ephyrae are extremely susceptible.

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Abundance and distribution of *N. nomurai* in offshore waters of Liaodong Bay and mechanism of accumulated temperature and food regimes increasing on the blooms

JBS-03 / Oral Presentation_04

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The abundance and distribution of juvenile and adult medusa of *N. nomurai* were summarized based on the sampling data obtained by the anchor drift net and trawl net surveys in offshore waters within a 10m isobath of the northern Liaodong Bay, Bohai Sea from late May to mid-to-late July. The abundance fluctuation indicated that the population in Liaodong Bay was not the same cohort as those in the Korea waters, Yellow Sea and East China Sea. Considering the circulation characteristic of Liaodong Bay and the DNA analysis result, the part of population of *N. nomurai* in southern offshore waters of Dalian originated from Liaodong Bay. Meanwhile, based on the ecological experiment we found that the warm temperatures and abundant plankton biomass during the previous season should result in high productivity of polyps and have the significant contribution to the blooms of large jellyfish in the following year. The seasonal regular pattern of strobilation induced by temperature and food can help us to identify the time of strobilation and temperature conditions in the natural state and the further study about the function and mechanism of accumulated temperature and food regimes increasing on the blooms of the giant jellyfish *N. nomurai* and *Aurelia* sp.1 have been carried out.

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Does temperature and salinity limit asexual reproduction of *Aurelia aurita* polyps in the Gulf Of Gdansk (southern Baltic Sea)?

JBS-03 / Oral Presentation_05

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The moon jellyfish *Aurelia aurita* occurs massively in the Baltic Sea and is the dominant scyphomedusa species in the Gulf of Gdansk (southern Baltic Sea). Medusae blooms are observed seasonally in the gulf but field observations of sedentary polyps are scarce suggesting that asexual reproduction of scyphistomae is restricted in this water basin. Low salinity was suggested as the main limiting factor of polyp reproduction. Our aim of study was to investigate the effect of temperature (3, 5, 10, 15, 20 and 25°C) and salinity (2, 4, 7, 12 and 18 PSU) on polyp strobilation and budding under gradually changing exposure conditions (laboratory experiment). Duration and intensity of strobilation increased in low temperatures while higher temperatures reduced (20°C) and ceased (25°C) production of ephyrae and enhanced budding activity. The asexual reproduction is therefore synchronised well with environmental conditions with strobilation occurring in spring and autumn/winter and growth of colonies (budding) taking place in summer. This provides a potential of scyphistomae to develop benthic colonies and support population size of medusae in the gulf. Salinity of 4 PSU caused absorption of tentacles and in 2 PSU 100% mortality of polyps was noticed indicating high sensitivity of scyphistomae to low salinity. An increase in water salinity induced more numerous strobilation as well as enhanced and longer budding suggesting that scyphopolyps can be more abundant in the more saline western Baltic. Our findings suggest that salinity and temperature are not limiting factors for polyp reproduction in the Gulf of Gdansk.

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In situ population dynamics of *Aurelia aurita* s.l. polyps: a modelling perspective

JBS-03 / Oral Presentation_06

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The drivers of moon jellyfish outbreaks are still uncertain, despite considerable research efforts in the last decades. The perennial benthic polyps determine to a large extent the medusae numbers. Our study was designed to assess annual and seasonal changes in polyp density and asexual reproduction rates in naturally occurring populations of *Aurelia* scyphistomae. A three-year survey of polyp populations attached underneath oysters at five locations in the bay of Koper (Slovenia) indicated significantly higher densities at protected sites and in the temperature window 20 – 25 °C. Budding was not significantly related to either temperature or salinity although it was more intense during warm months. In contrast, strobilation was significantly higher in the temperature window 10 – 15 °C and did not occur at temperatures < 8 or >17 °C. In order to better understand the causes of periodic dynamics observed in the population of *Aurelia* polyps we propose a family of non-autonomous models. The models are based on the continuous-time logistic model but include a periodic intrinsic growth rate r(t) and/or a periodic carrying capacity K(t) that reflect seasonal changes in the environment. We put forward several biologically meaningful functions r(t) and K(t) and estimate the yearly mean values of r and K from empirical data. In situ estimated values are compared with published data from laboratory experiments carried out with polyps of *A. aurita* collected from our monitored site.

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Spatial and temporal dynamics of *Chrysaora quinquecirrha* (Atlantic sea-nettle) polyps: an in-situ experiment in Chesapeake Bay

JBS-03 / Oral Presentation_07

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Existing studies on the inter-annual variation of *Chrysaora quinquecirrha* (Atlantic Sea-nettle) in Chesapeake Bay have focused mainly on delineating explanatory factors (salinity, temperature, advection, trophic etc.) that contribute to the spatial and temporal bloom dynamics of pelagic adults. There are a number studies on *Chrysaora quinquecirrha* early life stages such as ephyrae and polyps but they are mostly limited to laboratory experiments with few in-situ observations. To explore polyp density across different habitats and seasons in the Chesapeake Bay, polyp "settlement towers" were deployed at ten different sites along the western and eastern shores of Chesapeake Bay from late summer to late winter. Due to the nature of the study design, we were able to characterize favorable polyp habitat and observe polyp density across different seasons and environmental conditions. The implications of our results provide insights on the spatial and temporal dynamics of sea nettle populations and testify that the importance of benthic stages and their role in the variability of adult bloom dynamics should not be overlooked in future studies

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Life cycle of the edible jellyfish *Acromitus hardenbergi* (Scyphozoa: Rhizostomeae) that lives in a brackish environment

JBS-03 / Oral Presentation_08

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The edible jellyfish *Acromitus hardenbergi* is harvested throughout the year at the river mouth of the Perak River, Malaysia. Although this species is an important component of the local capture in that area, limited biological and ecological studies have been carried out on this species. The aim of this study is to clarify the life history of this unique brackish jellyfish to allow a sustainable jellyfish fishery and conservation of this species. Mature jellyfish were collected at the river mouth of the Perak River, Bagan Datoh, Perak, Malaysia in October 2012, September 2013 and January 2016. Temperature and salinity depth profiles were measured using a CTD meter. Collected live jellyfish were kept in a 500L tank filled with sea water (15‰ and 30 °C). Fertilized eggs were collected on the following morning. Fertilized eggs developed to planulae within 24 hrs. Planulae attached on the bottom of plastic vessels and metamorphosed into polyps two days from fertilization. The primary polyp had a long stalk with a small stolon at the base of the calyx. The secondary polyp was bowl-shaped, however the starved polyp elongated its stalk. Asexual reproduction was of the budding type, and no podocyst formation was observed. Strobilation was of the monodisc type and occurred at least 16 days after fertilization. The stimulus of strobilation was starvation. These characters may be an adaptation to the environment of its habitat, which has a lot of variation in salinity, a constant flow at the river mouth and muddy water.

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Coronatae polyps and jellyfish in Caribbean Colombian waters

JBS-03 / Oral Presentation_09

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Coronatae jellyfish are carnivores gelatinous organisms, characterized by a rigid mesoglea with a coronal sulcus in the exumbrela and coronal pedalia, are animals that live mostly neritic waters, found at depths between 0 and 2900 m. Polyps are often found in samples of benthos, they are different from other scyphozoans polyps, because they are cone-shaped, with a hard periderm light or dark brown and transparent. In Colombian waters, this group is unknown and few worked, most of the efforts to work with jellyfish are in Rhizostomeae jellyfish. During a review of the cnidarian collection of the Museum of Marine Natural History of Colombia – MAKURIWA, were found 13 "stephanoscyphistoma" polyps collected at 62-63 m depth in Colombian Caribbean Sea, this information plus the crown jellyfish (Nausithoidae and Periphyllidae) collected at depths between 150 and 1000 m, in some exploration perimeters in Caribbean and Pacific Colombian seas, have helped update inventory and distribution maps of crown jellyfish. In the Caribbean Coronatae order have been reported in the Gulf of Mexico and Venezuela, for Colombia is the first time the presence of this kind of polyps is reported, or maybe investigators omitted of his identifications. Therefore, Coronatae order has a wide range of distribution in the country, in both the Pacific Ocean and the Caribbean Sea, off the coast of Cordoba department (Ecoregion Darien-DAR) to the Guajira (Ecoregion Guajira-GUA), which shows the need to generate information on their distribution and ecology, as they are one of the least studied groups in the country.

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Are marinas leading to jellyfish blooms?

JBS-03 / Oral Presentation_10

Clive Fox, Craig Morten, Karen Boswarva

Scottish Association for Marine Science, Dunstaffnage, Oban, Scotland, UK

Increasing numbers of marinas are being constructed in many coastal areas. Several studies have reported finding high densities of scyphozoan polyps on the underside of marina floats and it has been suggested that the proliferation of marinas could therefore lead to increased blooms of jellyfish, such as *Aurelia aurita*. We developed a cheap underwater video system which was used to survey the undersides of thirty randomly chosen floats within eight marinas along the Scottish west coast. We found that the density of *Aurelia* polyps was highly variable between and within sites. Polyp abundance was weakly but positively related to water depth under the individual floats and negatively related to the presence of other fouling organisms such as anemones, tunicates and mussels. Although tunicates and mussels also provide a substrate for polyps, these potential hosts may filter out most settling planulae when at high densities. Our results suggest that marinas do not automatically harbour dense polyp communities and whether such populations develop is likely controlled by complex interactions between planula supply, local environmental conditions and competition with other fouling organisms. We conclude that the increasing number of marinas in many coastal areas will not necessarily lead to increases in local jellyfish blooms but further research is needed to understand when or where this may occur. Future work should focus on collecting longer-term environmental data and on artificial manipulations of fouling communities within marinas in order to disentangle the processes of planula supply and settlement and polyp growth and competition.

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JBS-04
To bloom or not to bloom? Factors affecting hydrozoan abundances

True (or remarkable) blooms are often considered as such mainly because of high biomass.However, we believe that especially high abundances of jellies should be considered 'blooms', even if they are short-lived and low biomass, such as for most hydromedusae. Therefore, we invite papers that consider all aspects of hydrozoans that contribute to the occurrence or formation of blooms. We would like to emphasize biological and ecological mechanisms leading to high abundances the hydroid and medusa stages of hydromedusae. Siphonophores will be covered in another session.

Chairs:
Jennifer E. Purcell - Western Washington University (USA)
Stefano Piraino - CONISMA, Università del Salento (Italy)
Josep Maria Gili - Institut de Ciències del Mar, CSIC (Spain)

Do abundance time series identify the same Hydromedusae bloom events as biomass estimates?

JBS-04 / Oral Presentation_01

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Time-series are able to show trends in the abundance of gelatinous zooplankton, but the level of taxonomic detail is generally subject to the skills and time available to the analysts. Here we look at the inter-annual patterns in the abundance of hydromedusae at the long-term monitoring station of L4, 12 miles offshore from Plymouth, UK. The site is subject to both coastal and oceanic water mass influences and has been studied since 1988 and with detailed hydromedusae identification since 2009. We used environmental data to describe the drivers of patterns within and between species. Annual and seasonal baseline abundances for individual species and the Hydrozoa were determined; thereby allowing the identification of bloom events at this site. Additional morphological measurements and taxa-specific carbon conversions allowed the calculation of comparable seasonal and annual biomass estimates of hydromedusae species for the site. Abundance and biomass measures showed different 'bloom' events, resulting from changes in size and biomass carbon content of the species involved. The merits of these two currencies to determine bloom events are discussed.

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Hydromedusae in the White sea: phenology of the medusae species in the sea in compare to aquarium experiments

JBS-04 / Oral Presentation_02

Andrey Prudkovsky, Irina Ekimova

Lomonosov Moscow State University, Russia

The White sea is a cold one with large temperature change during the year. The sea is covered by the ice in Winter and Spring months and temperature of the sea surface rises up to 15-20C in Summer months. Twenty hydromedusan species inhabit the White Sea. Most species appear in Spring when the ice is melting and only a few species (mainly *Sarsia* (Stauridiosarsia) *producta* and *Obelia geniculata*) appear during the temperature maximum. In the work I compare the temperature range of medusae appearance in the sea with aquarium experimental observations. Change of the temperature in aquarium is an essential step for realization of seasonality and study of hydrozoan life cycles in the laboratory. In the work I maintained several White Sea hydroids (*Catablema vesicarium*, *Halitholus cirratus*, R*athkea octopunctata*, *Sarsia* sp, *Sarsia producta*, *Obelia longissima*, *Bougainvillia superciliaris*) in aquarium with natural or artificial sea water. The change of the experimental temperature encourage the hydroids to produce the medusae buds or gonophores. The hydroids was affected by reduction in temperature (down to 0-2C, 2-4C, 4-6C) or by warming (up to 4-6C, 10-12C). Several species produced medusae buds or gonophores in such condition about a 2-4 weeks after the temperature change. Two species (*C. vesicarium* and *R. octopunctata*) produced medusae in the most experiments after decrease the temperature. But the other species vary in their reactions. The food and flow conditions as well as chemical inductors or light may be essential for medusae production in the sea.

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Loss of metagenesis and the evolution of a parasitic life style in trachyline jellyfish (Cnidaria: Hydrozoa)

JBS-04 / Oral Presentation_03

Bastian Bentlage

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Loss or stark reduction of the free-swimming medusa stage is common across Hydrozoa (Cnidaria: Medusozoa). In the hydrozoan subclass Trachylina, however, many species do not possess a polyp stage. Trachylines inhabiting freshwater and coastal ecosystems (i.e., Limnomedusae) possess the ancestral metagenetic life cycle involving benthic, sessile polyp and free-swimming medusa. On the other hand, open ocean inhabiting trachylines generally develop from zygote to medusa via a free-swimming larva, forgoing the polyp stage. In some open ocean trachylines, development includes a sessile stage that is an ecto- or endoparasite of other pelagic organisms. Direct development has been used as a character to unite several trachyline families as Trachymedusae, but this classification has been shown to be in disagreement with the evolutionary history of the group. Since this discovery, I expanded the phylogeny of trachylines significantly, increasing taxon and molecular marker sampling. I use this recent phylogenetic hypothesis in conjunction with ancestral character state reconstructions to better understand the evolution of life cycles in trachyline hydrozoans. Mapping the known life cycles onto the phylogeny so far confirms that the polyp stage was lost at least twice independently, concurrent with a transition to an open ocean life style. Further, a sessile, parasitic stage arose once in the open ocean inhabiting Narcomedusae. In addition, I uncovered the non-monophyly of multiple taxa suggesting a need for taxonomic revisions of trachylines on multiple levels.

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JBS-05
Siphonophores: biodiversity, ecology and their role in the ecosystem

These colonial hydrozoans can become very abundant during seasonal plankton blooms and may consume large numbers of copepods, fish eggs and larvae, other small planktonic organisms and in some species even small fish. Their size, tentacle morphology and feeding strategies vary greatly and prey consumed depends on the type and size of nematocyst batteries (Purcell 1981, 1984), the vertical strata occupied and any diel migrations undertaken. Prey capture has only been described in detail for two species (Chun 1891, Mackie & Marx 1988) and little information is available on numbers of individuals in siphonophore blooms, quantities of prey consumed per colony and the impact of siphonophores on pelagic food webs. Papers are invited on all topics relevant to the systematics, biology and ecology of siphonophores.

Chairs:
Gill Mapstone - The Natural History Museum, London (UK)
Aino Hosia - University Museum of Bergen, University of Bergen (Norway)
Elena Guerrero - Institut de Ciències del Mar, CSIC (Spain)

Siphonophores distribution in Mediterranean Sea across biotic and abiotic gradients and the influence of these factors on their reproduction stage

JBS-05 / Oral Presentation_01

Raül Golo[1], Alex Damián[2], Antonio Canepa[3], Patrizia Ziveri[4,5], Verónica Fuentes[1]

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In the frame of the European MedSeA project research cruise (May 2013) zooplankton samples were collected by multi-net system (MOCNESS, covering the upper 600m) and Bongo nets (at 200m) from 21 stations distributed along the entire Mediterranean Sea from the Atlantic off Cadiz, Spain, to the Levantine Basin. At the same time biotic and abiotic parameters (including seawater carbonate chemistry) were collected. The main aim of this study is to improve our understanding of the environmental factors controlling the understudied gelatinous plankton (mainly Siphonophores) distribution in the Mediterranean Sea. 22 species of Siphonophores and their reproductions stages were manually sorted and identified under a stereoscopic microscope. We will present results on the geographical and vertical distribution and the environmental drivers of its biogeography, including a highly difference between two species distribution, *Muggiaea atlantica* (West Mediterranean) and *Eudoxoides spiralis* (East Mediterranean). The distribution models developed with the data contribute with the prediction of the species distribution and realize under which environmental conditions siphonophores breed.

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Siphonophorae community in Chilean Patagonian Fjords: biodiversity, spatial distribution and environmental association

JBS-05 / Oral Presentation_02

Antonio Canepa, Carolina Pérez, Antonia Bennewitz, Nelson Silva, Sergio Palma

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The National Oceanographic Committee (CONA) has developed from 1995 an extensive research in southeastern pacific fjords as part of the Marine Research Cruises in Remote Areas (CIMAR) Program. Along these campaigns great effort has been developed to understand the biodiversity patterns and spatial distribution of the planktonic cnidarian community, specially focused on the siphonophorae community. The present work is focused on the analysis of the information gathered from nine campaigns in order to understand the possible changes in abundance, distribution and composition of the most studied gelatinous group. Results showed that the southeastern pacific fjords have been surveyed mostly in spring time and the scientific effort have been conducted predominantly in the northern part of the ecosystem. From the dominant species is interesting to show the abundances and contrasting distribution of *Muggiaea atlantica*, *Lensia conoidea* and *Pyrostephos vanhoeffeni*. In general the highest abundance of siphonophores are associated with interior waters characterized by strong vertical gradients (halo and thermocline), diminishing to open ocean waters. Species richness was higher in spring than winter and a north-south gradient in abundance and species richness is also evident. Some species have been signaled as indicative of particular water masses and the role of environmental variables in the spatial distribution of the dominant species is also discussed.

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Planktonic cnidarians in the neustonic layer: their diversity and abundance off the Catalan coast (NW Mediterranean)

JBS-05 / Oral Presentation_03

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The surface layer of the oceans, the neuston, is a highly specialized habitat. Although it is a relatively known system, little is known about the presence and role of the gelatinous zooplankton in the neustonic community. This study aims to analyse the planktonic cnidarian populations of the neuston layer along the Catalan coast (NW Mediterranean) in July of two consecutive years of contrasting climatic conditions: the exceptionally warm summer of 2003 and the summer of 2004 with temperatures within the climatic average. The near surface layer (between 0 and 1.5 m depth) was sampled by means of a neustonic net (800 µm, 0.5 m x 1 m mouth). A total of 133 samples were analysed collected during day and night hours. A rich cnidarian community was detected (28 species), dominated by Siphonophorae (15 species). Some of them were species that inhabit along the water column but concentrate in superficial layers at night (e.g.: *Chelophyes appendiculata*), while others were typical inhabitants of this layer (e.g.: Sulculeolaria species and the free-floating hydrozoan colonies *Porpita porpita* and *Velella velella*). Differences between both years were principally found in the abundance but not in the specific composition. Three times lower abundance was observed in the warm year (2003) with respect to the standard one (2004). Siphonophores were the most representative group in both years (83 and 53 % of total abundance). The spatio-temporal distributions were related to different environmental factors and the potential trophic impact of carnivore gelatinous zooplankton on the neustonic community is discussed.

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Siphonophore blooms. Could a long siphonophore colony be considered a "bloom" on its own?

JBS-05 / Oral Presentation_04

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High abundance of siphonophores has been recorded in different areas around the world. Usually, short colonies such as diphyid and abylid calycophorans, Sphaeronectes, the cystonect *Physalia physalis* and the small physonect *Nanomia bijuga* are cited as occurring in high abundance, forming blooms, mostly in epipelagic waters and often near the coast (neritic). However, long siphonophore colonies such as apolemiids, other large physonects, some prayids and diphyids of the genus Sulculeolaria, seem not to congregate in such high numbers. These individuals usually inhabit the open ocean, often at depth. Diphyid calycophorans can bear a dozen or more gastrozooids (mouth-stomachs) with c. 10 tentilla (nematocyst batteries) per gastrozooid tentacle, giving at least one hundred tentilla per colony. Long colonies, in contrast, can bear hundreds of gastrozooids with close to 100 tentilla per tentacle, giving thousands of tentilla per colony. Short colonies (cited so far) in high abundance may have considerable predatory impact. In this context, and given the comments above, we pose the question: could a single long siphonophore colony be considered as a "bloom" itself, from the point of view of its potential predatory impact? The volume occupied by several long siphonophore specimens (of different species) in the water column, when relaxed with their tentacles fully extended for feeding, is estimated. We compare true medusa blooms with siphonophore blooms. Finally, we pose a second question: how extensive could a siphonophore bloom be and what might be its trophic impact on the pelagic species assemblage of which it is a member?

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Latitudinal range expansion of the siphonophore *Muggiaea atlantica* in the northeast Atlantic

JBS-05 / Oral Presentation_05

Michael Blackett[1,2], Cathy Lucas[1], Priscilla Licandro[2]

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As a result of their opportunistic ecology, jellyfish populations fluctuate dramatically in space and time. To understand the mechanisms that drive these changes, we must discriminate between biological factors that affect demographic rates, and physical factors that influence dispersal. Over recent decades, the siphonophore *Muggiaea atlantica* has expanded its distribution, invading novel habitats in the North Sea and successfully colonising areas of the Mediterranean and Pacific. These changes are not clearly understood because they involve a complex interaction of biological and physical factors. We investigated long-term changes in the abundance and distribution of *M. atlantica* in UK waters using time-series data from coastal monitoring stations. Our aims were to assess the extent of the species' latitudinal range expansion and to identify the key mechanisms that modulate its population dynamics. Our results revealed a dramatic progressive northward extension of this species' distribution in the northeast Atlantic since the late 1960s. These changes involved the establishment of a resident population in the Western English Channel (WEC) and the subsequent development of seasonally transient populations in Scottish coastal waters. In the WEC the *M. atlantica* population was modulated primarily by the availability of suitable local environmental conditions that influenced demography and secondarily by changes to water circulation patterns that influenced its dispersal. In contrast, in Scotland *M. atlantica* populations were primarily modulated by immigration via current-driven transport and secondarily by the availability of suitable local environmental conditions. These distributional changes are discussed in the context of source sink-dynamics and the species ecological requirements.

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Elucidating larval development and ontogenetic traits of zooids in *Agalma* siphonophores

JBS-05 / Oral Presentation_06

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Only three species are nested within the genus *Agalma*, which is one of the most often studied genera amongst physonect siphonophores. Although species descriptions come from the 19th century, there is still an extensive lack of understanding of their biology, particularly their larval development.
With the help of both historical samples from the collections of the Natural History Museum, London (western Indian Ocean, central Atlantic), and newer ones from the Gulf of Aqaba (2013, Red Sea), the Gulf of Villefranche (2013, Northern Mediterranean) and the Isles of Scilly (2009, western English Channel), we were able to shed light on the ontogenesis/development of *Agalma* species.
The majority of our research is the description of an exclusive life stage in *Agalma okeni*, for which we propose the name *Crystallomia* post-larva in honour of A. K. Totton, who already in 1954 suggested the necessity of merging *Crystallomia polygonata* and *A. okeni* into one species. Also, because of the complex species-specific development patterns in most siphonophores, which involve probud subdivision (underlying the cormidial arrangement of zooids), we have been able to follow zooid ontogenetic changes at both morphological and morphometric levels along the length of the stem.

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JBS-06
Pelagic tunicates blooms: an interdisciplinary approach

Pelagic tunicates are gelatinous herbivorous plankton adapted to effectively grow in patchy and temporally variable environments. Although all groups, including Larvacea, Salpida, Pyrosomida and Doliolida are quite different, they share some feeding and reproduction traits. These unique characteristics allow them to increase in abundance and efficiently feed on algal blooms and other heterotrophic microplankton. The ephemeral massive appearance of pelagic tunicates has a relevant effect on the biochemical cycles. Nevertheless, little is known about some fields such as population genetics or ecological strategies behind what triggers the bloom, especially in groups like Pyrosomida or Doliolida. This session wants to bring together researchers that work on physiology, genetics, behavior and modeling to study either spatial or temporal scales of different pelagic tunicate families. We hope this approach will give a better understanding on how pelagic tunicates blooms can be influenced by changing environmental conditions and how this changes can affect marine ecosystems.

Chairs:
Laurence P. Madin - Woods Hole Oceanographic Institution (USA)
Maria Pascual - Institut de Ciències del Mar, CSIC (Spain)

A Survey of the Salps (and their cousins)

JBS-06 / Oral Presentation_01 Special Talk

L.P. Madin

Woods Hole Oceanographic Institution

Not as bizarre as appendicularians, complex as doliolids nor obscure as pyrosomes, salps are perhaps the most understandable of the pelagic tunicates. They are big enough to see, robust enough to collect and maintain (at least briefly) and often very abundant. They are a small group – perhaps 50 species – with fundamentally similar modes of locomotion, feeding and reproduction. Their population dynamics can give rise to extraordinary blooms that dominate some planktonic ecosystems, but some also seem to exist at sparse levels in the oligotrophic ocean. They are frequently a dominant form in the Antarctic region but entirely absent from the Arctic. While they share a basic body plan and mechanism, there are surprising variations in their morphology and colonial architecture of their chain forms, and in their behavior. Some species are powerful diel migrators, while others seem restricted to epipelagic or mesopelagic depths. In many places salps affect the structure of zooplankton communities and contribute significantly to the transfer of carbon to deeper waters. Despite progress in recent decades working with living salps, there are still many unanswered questions about their feeding mechanism, growth and reproduction, sensory and nervous systems and evolutionary relationships to other tunicates. This presentation provides an overview of the salps, including comparisons with their Thaliacean cousins the doliolids and pyrosomes. I will discuss the diversity of species, morphologies, distributions and behaviors, and some of the remaining mysteries.

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Population structure of *Salpa thompsoni* in the Atlantic sector of the Southern Ocean.

JBS-06 / Oral Presentation_02

Anna Panasiuk-Chodnicka, Angelika W. Słomska, Justyna Wawrzynek, Agata Weydmann

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In the last 50 years in the high latitudes region of Southern Ocean was observed advection of warmer water masses as well as strongly associated with it repeatedly occurrences of salps. This phenomenon was closely connected with an increase frequency of winters with decreasing sea ice surface. Data sets on salps and krill biomass as well as sea ice cover discloses a significant correlation between these parameters. Biological material analyzed in this work has been collected in the Atlantic sector of the Southern Ocean over the years 1975-2001. The German surveys utilized RMT to catch salps, with a real-time depth recorder (TDR). Results of laboratory tests and comprehensive environmental data made it possible to conduct detailed statistical analyzes, which show that significant factors determining the occurrence of salp in Antarctic waters were the temperature, the presence of ice, the depth of the basin and salinity. The main aim of this study was to confirm the thesis that environmental changes taking place now in the Southern Ocean generate mass emergence of gelatinous animals. At the same time results may provide important information testifying to climate change taking place in this unique ecosystem.

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Modelling environmental drivers of population dynamics in the salp *Thalia democratica* from in situ, short-term observations

JBS-06 / Oral Presentation_03

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Blooms of the salp *Thalia democratica* are a recurrent feature in many coastal areas where they have significant ecological and societal impacts. To understand the environmental drivers of those blooms in the Catalan Sea, we conducted 8 sampling surveys of *T. democratica* populations at contrasting seasonal, temperature and chlorophyll conditions. During each survey we used a drifting buoy to track a salp population which we sampled every 30 minutes during a period of three hours, and determined short term variations in the abundances of the different stages. We built a set of different stage-classified population matrix models, each one representing different assumptions about the influence of temperature and chlorophyll on the different stages. The best model was one where only the females were affected by temperature, while matrix elements for the other stages were fixed. Elasticity analysis indicates that females drive the population dynamics through arrested reproduction at high temperatures. Whether this is a direct influence of temperature, or an indirect effect reflecting low food availability remains to be solved. In contrast to previous ideas, our results suggest that it is the female, and not the asexual oozooid, that is responsible for latency periods in salp populations.

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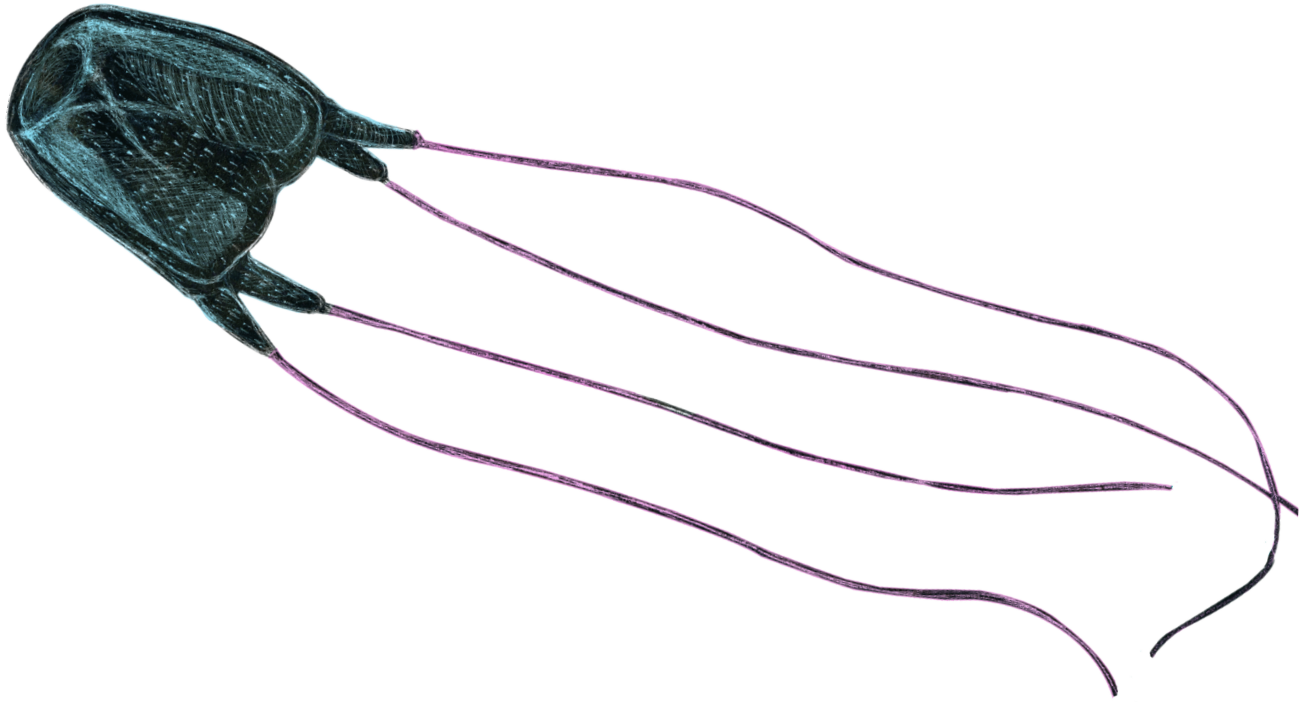
JBS-07
Cubozoan biology, ecology and management



This session will cope with different aspects of Cubozoans such as biology, ecology, taxonomy and management. Cubozoans, or box jellyfish, are the smallest class of Cnidaria, with only about 50 species, which occur in tropical and subtropical waters. Cubozoans are of great biological and social importance. They are active fish and zooplankton predators. They have complex eyes and visual capabilities, mating behaviour, and high to extreme toxicity, provoking painful stings to humans. Their toxicity depends on the species, being the tropical ones the most dangerous. Despite their biological and socioeconomic importance, studies on the biology, ecology, taxonomy and management of cubozoans are scarce.

This session pretends to exchange the current knowledge and research on Cubozoans around the world, including the Mediterranean species *Carybdea marsupialis*.

This session is organised in the frame of LIFE Cubomed project (www.cubomed.eu).

Chairs:
Cesar Bordehore - Universidad de Alicante (Spain)
Michael Kingsford - James Cook University (Australia)
Melissa Acevedo Dudley - Institut de Ciències del Mar, CSIC (Spain)

Updating the Systematics of Cubozoa

JBS-07 / Oral Presentation_01

Allen G. Collins[1], Bastian Bentlage[2], Cheryl Lewis[2]

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The 2000's was marked by notable improvements to cubozoan systematics, with the establishment of new families and the first class-wide phylogenetic hypothesis. During that time and through to the present, a steady stream of new species have been added to the global diversity of the group. Nevertheless, the overall richness of Cubozoa remains small, with only about 50 accepted species. We present new molecular sequence data from mitochondrial and nuclear loci from a large portion of cubozoan diversity. These data are used to construct the most comprehensive working hypothesis for the phylogeny of Cubozoa to date. In turn, this working hypothesis is used to evaluate the current classification of Cubozoa. Overall, our data present a range of different patterns at the level of species, from those that encompass more than one species name to those under a single name that appear to encompass multiple as yet unnamed lineages. We discuss whether widespread species, those present in multiple ocean basins, have their present distributions as a result of human-mediated introductions or whether they maintain population connectivity via natural means.

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A preliminary study on the ecology and genetic characteristics of Mediterranean box jellyfish (*Carybdea marsupialis*) populations from Maltese waters (Central Mediterranean)

JBS-07 / Oral Presentation_02

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Recently, new genetic and morphological data has suggested that *Carybdea marsupialis* is an endemic species of the Mediterranean Sea. The main aim of this project was to identify the factors associated with the recent increase in numbers of *C. marsupialis* in Maltese waters. Bi-monthly monitoring of the abiotic/biotic factors and individual abundance of this species was carried out within two Maltese embayments between July 2014 and July 2015. Individuals were collected through the deployment of a hand net and local samples were genetically compared to samples obtained from the Mediterranean coast of Spain and Tunisia (Hammamet Beach), and to Atlantic samples from Cádiz. Genetic characterisation was carried out through the analysis of the mitochondrial 16S rDNA region and of the region between the 18S and 28S of the rDNA.
Over the study period, population numbers showed strong seasonality. The appearance of juveniles (5-15mm DBW) was recorded at the end of May 2015, with the abundance of non-mature adult stages (>15mm DBW, no gonads) reaching the highest densities between June and July 2015. Populations from both sites were strongly and positively correlated with sea water temperature and negatively correlated with phytoplankton and chlorophyll levels.
Whilst a high degree of uniformity between the three Mediterranean populations (>98.0% similarity) was demonstrated, sharp differences were recorded between the genetic sequences of the analyzed Mediterranean populations and the Atlantic (Cádiz) one (~81.0% homology). The result for the Cádiz population further suggests the hypothesis that the Mediterranean supports a different *Carybdea* species than the Atlantic.

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Identification of *Chironex indrasaksajii* sp. nov. (Cnidaria, Cubozoa): a new box jellyfish from Thailand

JBS-07 / Oral Presentation_03

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Box jellyfish are known to be lethal to human; however, due to scarce educational databases in Thailand, only a few species were recorded. On 28 January 2015, an unidentified box jellyfish taxon was collected from Chanthaburi province by Marine and Coastal Resources Research and Development Center, The Eastern Gulf of Thailand. However, the specimen could not be classified into two species within the genus, *C. fleckeri* and *C. yamaguchii*, since they do not conform to the available key. Besides, never before had members of this genus been reported in this region. Herein, the unidentified specimen was classified using a mitochondrial and ribosomal gene (COI and 18S) and morphological structures investigation. The dome shaped pedalial canal of the unknown *Chironex* was found different from *C. fleckeri* with thorn shape and *C. yamaguchii* with volcano shape. Apart from the morphological difference, the molecular difference within the genus using COI gene was also observed. The genetic difference between *C. yamaguchii* (Accession number FJ665180.1) and the unknown *Chironex* was 14.0% and between *C. fleckeri* (Accession number FJ665181.1) and the *Chironex* (Accession number KT223648) was 15.3%. Likewise, the genetic variation between *C. yamaguchii* (Accession number FJ665180.1) and *C. fleckeri* (Accession number FJ665181.1) was 15.3%. Not only does its morphology contrast to the available keys but it also has a significantly different genetic identity from its congener.

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Transcriptome profiling reveals genes implicated in venom, vision and sex in the aggregating box jellyfish *Alatina alata*

JBS-07 / Oral Presentation_04

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The broadly distributed venomous box jellyfish *Alatina alata* (Cubozoa; Alatinidae) is notorious for its painful and debilitating stings during monthly spermcasting aggregations along beaches in Atlantic and Indo-Pacific localities. These monthly aggregations coincide with the lunar cycle (8 – 10 days after the full moon), during which time the usually deep-sea (up to 1600 m) *A. alata* migrates to shallow water generating countless planulae (larvae). With a focus on differential expression of genes implicated in venom, vision and sex, this study provides the first attempt to profile biologically relevant transcriptome components of *A. alata*, emphasizing the importance of comparative gene expression across multiple body parts and early life stages. RNASeq with Illumina technology was used to sequence transcripts from tissue samples excised from the ovoviviparous *A. alata*'s 1) gastric cirri, 2) ovaries, 3) tentacle 4) rhopalium, and 5) planulae. A pooled transcriptome was assembled de novo (Trinity suite software), and downstream bioinformatics analyses included transcript quantification, expression profiling and annotation of recovered candidate genes with biologically relevant patterns of differential expression. Additionally, phylogenetic analysis was conducted of core putative proteins identified in adult samples to assess their homology to similar proteins previously documented in other cnidarians. The high quality of these data together with the depth of gene discovery has the potential to greatly contribute to our knowledge and understanding of the molecular underpinnings of complex behaviours exhibited within Medusozoa (jellyfish).

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Seasonality, interannual variation and distribution of *Carybdea marsupialis* (Cnidaria: Cubozoa) in the Mediterranean coast: influence of human impacts

JBS-07 / Oral Presentation_05

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This study addresses the seasonal and interannual variability in box jellyfish abundance for a population of *Carybdea marsupialis* monitored along the coast of Denia (NW Mediterranean, Spain). Environmental data and cubomedusae density have been monthly recorded from March 2010 to December 2013. Environmental variables registered included water temperature, salinity, nutrients concentration (i.e. DIN, phosphate and silicon), chlorophyll concentration and zooplankton abundance and composition. Generalized Additive Models (GAM) have been fitted to understand the relationships of aforementioned environmental variables and *C. marsupialis* abundance. Salinity and chlorophyll concentration have been reported as the most important variables influencing *C. marsupialis* abundance, as well as N and P concentrations. Also, LUSI (Land Use Simplified Index) showed a positive correlation with the presence of this box jellyfish; this index reflects the impact of nutrient inputs along the coast. Moreover, an ensemble platform for species distribution model (*Biomod2* package for R software) has been fitted using the sightings of the species recorded through different citizen science databases from the Mediterranean region (ENPI-Medjellyrisk and LIFE+ Cubomed projects). A forecasting of the probability of occurrence of this species under current environmental conditions was developed, and the results indicate that *C. marsupialis* inhabits in coastal areas characterized by a high degree of human disturbance. This and other previous studies relating box jellyfish blooms with the intensity of human coastal activities need to be considered during the development of coastal management protocols.

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Micro-scale distribution of recently-detached *Carybdea marsupialis* box jellyfish along the coast of Denia (W. Mediterranean)

JBS-07 / Oral Presentation_06

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Carybdea marsupialis have been found in high densities (~90 ind m^{-3} juveniles, ~51 ind m^{-3} adults) in shallow waters along the coast of Denia (W. Mediterranean) since summer 2008, varying significantly in abundance from year to year.
In order study the role of juvenile stages in population dynamics, we analyzed the seasonal and micro-scale spatial distribution of recently-detached cubomedusae (~0.5 mm DBW). The main objective was to determine whether their distribution was focused or dispersed, as a means of revealing the location of the polyps. We also tested the correlation between environmental variables such as nutrient (P, N, Si), Chl-a and zooplankton abundance. During 2015 we collected samples from 33 points: 11 points along 15km of coastline at 3 distances from the coast (0m, 250m and 500m).
Recently-detached *C. marsupialis* were almost only present at a depth of 0m in the samples collected from May to July. Maximum densities (~5 ind m^{-3}) were recorded in June in the centre of the study area. We hypothesized that the polyps would be located where the adults had mated the previous year. However, the distribution of recently-detached individuals did not coincide with the higher 2014 adult densities. This might be ascribed to the advection caused by the currents, which alternate along the coast. Abundance was not directly correlated with either zooplankton, nutrients or Chl-a. The next step would be to model the currents pattern and its effect in the dispersion and survival of juveniles.

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Retention of the cubozoan *Chironex fleckeri* at sheltered beaches

JBS-07 / Oral Presentation_07

Jodie Schlaefer, Eric Wolanski, Michael J Kingsford

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The potentially lethal *Chironex fleckeri* (Class Cubozoa) inhabits estuaries and nearshore coastal waters which can be spatially complex. There is a growing body of evidence suggesting that cubozoans can maintain populations at small spatial scales. Local geography and coastal orientation can shelter habitats from external forcings, influencing local currents. Sheltered habitats can have relatively weak currents that may facilitate the retention of medusae. Here we test this model by comparing the swimming capabilities of *C. fleckeri* medusae to the currents at beaches with different levels of shelter. The currents were either measured in the field or predicted using a hydrodynamic model. The movements of *C. fleckeri* medusae, ranging in size from 4 to 12 cm inter pedalia distance (IPD), were quantified in the field at Port Musgrave, Cape York Peninsula, Queensland, Australia. Medusae swam long-shore at speeds of up to 9.95 m/min which was much greater than the local current speeds of ≤ 5.3 m/min measured in the field. Medusae, ranging in size from 0.8 to 3.6 cm IPD, were collected and swum in a flume tank at speeds of up to 8.8 m/min. Sections of coastline in Port Musgrave were categorized based on their level of shelter from the prevailing wind conditions. The predicted and measured currents were far smaller than the measured medusae swimming speeds. We conclude that a combination of medusae swimming behaviour and weak currents are potentially important causal factors in maintaining local populations.

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Does light pollution drivenear-shore aggregations of the box jellyfish *Alatina moseri* in Hawaii?

JBS-07 / Oral Presentation_08

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The majority of Earth's species have evolved under predictable cycles of natural sunlight, moonlight and starlight, which influenced behavior, development, and evolution. Due to the global and accelerating trend of coastal human population growth, the near-shore marine environment is particularly vulnerable to night-time light pollution. However, the impacts of anthropogenic light pollution on the ecology of coastal marine communities remain largely unexplored. We examined the potential role of artificial night light pollution in the recurrent near-shore aggregations of the stinging box jellyfish *Alatina moseri* on Oahu (Hawaii). In this study we 1) experimentally tested *A. moseri* phototactic behavior in response to different light stimuli (incandescent, LED), 2) calculated annual frequency of occurrence (2000-2011) from 17 beaches around Oahu, and 3) evaluated satellite-derived artificial radiance data for these areas. *Alatina moseri* medusae displayed significant positive phototaxis ($r^2 > 0.8$, $p < 0.01$) to incandescent, yellow, red, and white LEDs at irradiances ~80 times dimmer than that measured in developed areas of Oahu, suggesting an ability to detect light at the sea surface from at least 1.6 km offshore. The frequency of occurrence (number of month per year) of box jellyfish on Oahu was strongly positively correlated with artificial radiance ($r = 0.82$, $p < 0.01$) at the beach. These findings strongly suggest a link between near-shore light pollution and regional aggregation patterns of box jellyfish in Hawaii, warranting further investigation here as well as in other regions globally where shoreline development and cubozoan influx are concurrent.

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Feeding of *Carybdea brevipedalia* (Cubozoa: Carybdeidae) in Dugok and Namildae, Korea

JBS-07 / Oral Presentation_09

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Feeding of *Carybdea brevipedalia* Kishinouye, 1891 (Cubozoa: Carybdeidae) was observed and recorded in Dugok Beach and Namildae, a small fishing port adjoining a beach in Aug to Sep 2014 and 2015. Data were collected separately at night under artificial light and dark/ dim light condition to consider the possible artefact of the light on their feeding behavior. Decapod larvae, mysids, swimming larvae of polychaetes and larval fish were the major prey items, while copepods, the most predominant zooplankton in the study area were not found in their gut. *Carybdea brevipedalia* was a strong vertical migrator, conspicuously ascending right before sunset in Dugok, while its distributional depth was not clearly different between day and night in Namildae. Individuals' gut contents were observed to be minimal during the day, while they started to prey on after sunset and finished 1 – 2 hour before sunrise. Since the preying organisms were usually faster swimmers, they were captured passively by elongated tentacles of *C. brevipedalia*. More than 90 % and 80 % of individuals observed between 20:30 to 03:00 involved 1 – 4 preys in their guts in Dugok and Namildae, respectively. Digestion time varied from ca. 1.5 to 4.0 hours, depending on prey species. Abundance and carbon amount of prey organisms as well as *C. brevipedalia* were also analyzed to evaluate the species' impacts on the zooplankton community.

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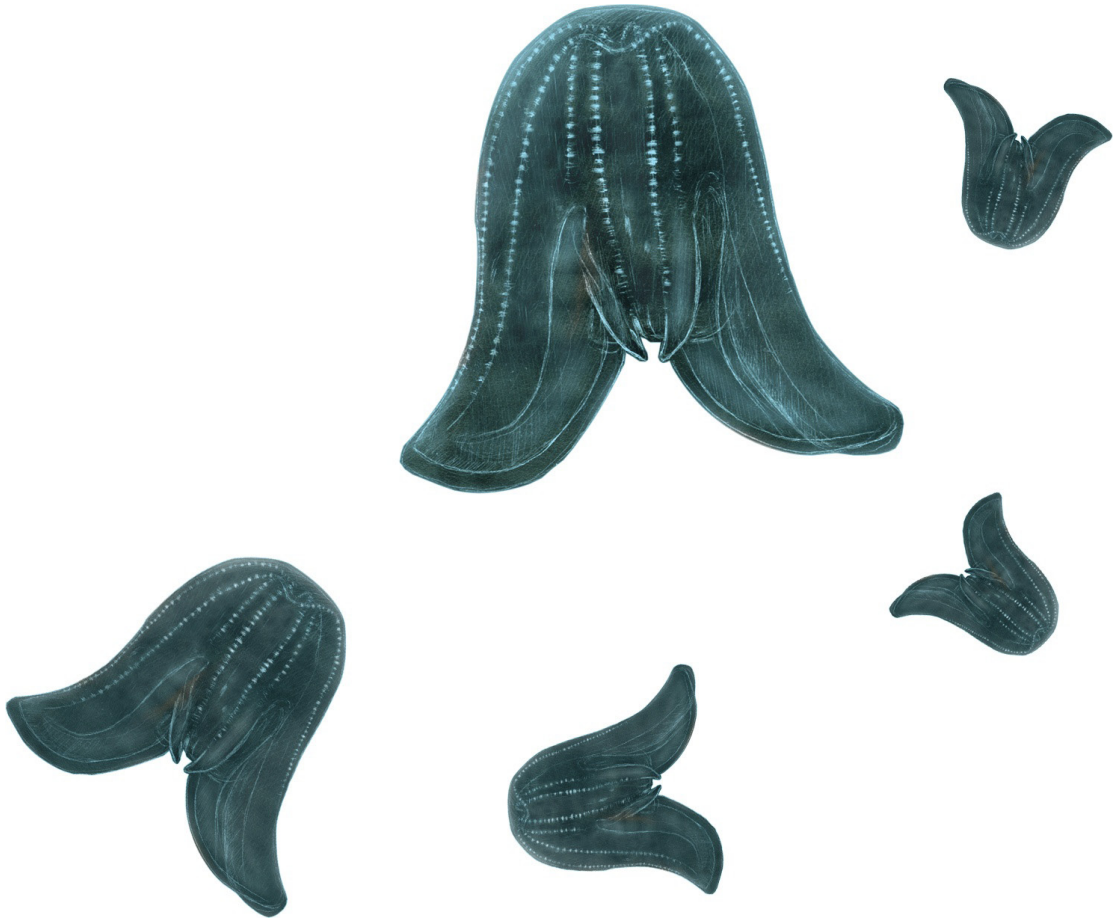
JBS-08
Alien jellyfish species



Non-indigenous (= alien, exotic, non-native) species (NIS) are introduced organisms outside their natural (past or present) range of distribution, and outside their natural dispersal potential, which might survive and subsequently reproduce, threatening biodiversity. Species of unknown origin that cannot be ascribed as being native or alien are termed cryptogenic species.

As other translocated organisms, NIS jellyfish life stages traverse the globe in ballast waters, on ship hulls, or epibiotic on harvestable shellfish. Some of the most successful travellers may reach large abundances becoming invasive in non-native aquatic ecosystems, eventually developing into nuisance for human activities and ecosystem functioning, from reduction of fish catches, aquaculture finfish mortality, clogging water intakes of coastal plants, stinging and concern for human health, and shifts of energy flow in food webs.

This session aims to be a forum where existing knowledge will be gathered to inform scientists and policy makers on current distribution, biological traits, patterns of invasions, early detection, taxonomic and prevention tools, and potential management of non-indigenous and cryptogenic jellyfish species worldwide, with special reference to "nuisance species".

Chairs:
Stefano Piraino - CONISMA, Università del Salento (Italy)
Macarena Marambio - Institut de Ciències del Mar, CSIC (Spain)

Unmasking *Aurelia* species in the Mediterranean Sea: an integrative morphometric and molecular approach

JBS-08 / Oral Presentation_01

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Molecular analyses have increased knowledge of the number and distribution of morphologically cryptic species in the world's oceans and, concomitantly, the identification of non-indigenous species (NIS). However, traditional taxonomy and accurate delimitation of species' life histories and autecology lag far behind, even for the most widely distributed taxa such as the moon jellyfish *Aurelia* species complex. Here we analyse mitochondrial cytochrome c oxidase subunit I (COI) and nuclear 28S ribosomal DNA (28S) gene sequences to assign polyps, ephyrae, and medusae collected in the Mediterranean Sea to different phylogenetic species. We find evidence for three *Aurelia* species, none referable to the type species of the genus, *A. aurita*, and describe the anatomical, morphometric, and developmental variation within and between them. We identify *A. coerulea* and *A. solida* as established non-indigenous species (NIS) in the Mediterranean Sea. We describe *A. relicta* sp. nov., an endemic species currently unique to a population in the marine lake of Mljet (Croatia). These results demonstrate the usefulness of integrative approaches to resolve taxonomic uncertainty about cryptic species complexes, identify patterns of marine biodiversity, and recognize NIS in marine ecosystems.

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Dynamics and trophic impact of two Lessepsian Scyphozoa species in the Lagoon of Bizerte (South-Western Mediterranean Sea)

JBS-08 / Oral Presentation_02

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Alien Scyphozoa species might be a threat for the zooplankton community and therefore for the entire pelagic trophic web, which can lead to socio-economic repercussions. Here we investigated the population dynamics and predatory impact on mesozooplankton community structure of two Lessepsian immigrant Scyphozoa species, *Aurelia* sp.8 and *Phyllorhiza punctata* in Bizerte Lagoon (Tunisia, SW Mediterranean Sea), over a two-year period, from June 2012 to June 2014. The two species exhibited two different occurrence periods driven by environmental parameters (temperature and salinity mainly). Differences in the abundance of both species were observed between the two years, with a higher abundance in 2012 for *Phyllorhiza punctata* and in 2013 for *Aurelia* sp.8. The predatory impact of *Aurelia* sp.8 was specially investigated through gut contents analyses, and measurements of digestion times, feeding rates and of the predation impact on mesozooplankton daily production. The results suggest a high but temporally-limited predation impact of *Aurelia* sp.8. The combination of different multivariate statistical analysis (PCA, CA and CCA) showed the top-down control imposed by *Aurelia* sp.8 and *Phyllorhiza punctata* on the mesozooplankton community structure in Bizerte Lagoon. We hypothesize that the relatively low abundance and the short life span of each species avoids potential overexploitation of the mesozooplankton community, allowing the establishment of resident jellyfish populations.

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Effect of invasive ctenophores *Mnemiopsis leidyi* and *Beroe ovata* on low trophic levels of the Black Sea ecosystem

JBS-08 / Oral Presentation_03

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The idea of the study was to investigate the impact of excretion and mucus released by ctenophores *Mnemiopsis* (*M. leidyi*) and *Beroe* (*B. ovata*) on the low trophic levels of the Black Sea ecosystem. Hydrochemical and biological parameters were monitored in two experiments in lab aquaria in Gelendzhik and Varna (August, 2013, 2014). The experiments showed an evident effect of excretion and mucus release of both species revealed in pronounced PO_4 and NH_4 increase and pH decrease, which was much higher in *Beroe* case. Both species considerably changed the ratio between nutrients predetermining possible "stoichiometric modulations" over the growth of biotic components. Phytoplankton increased in all experiments with both ctenophores. The highest growth was observed in *Beroe* trial. At the end of experiment, biomass increased 8 times and reached 6.5 g/m^3. In trials with *Mnemiopsis* and Control this increase was equal to 6 and 3.5, respectively. The growth of Diatoms and Euglenophytes was similarly stimulated by both ctenophores. Dinoflagellates showed outburst in *Beroe* experiments. Flagellates demonstrated an increase on the 2nd day with the following decline that coincided well with bacteria changes. Bacteria also increased first consuming released mucus, and then decreased due to flagellate's consumption. Experiments showed increase in concentration of chlorophyll and primary production higher in *Beroe* case. The highest impact on lower trophic food-web recorded in trials with *Beroe* likely related to the amount of released mucus and nutrients. Plotting interactions promises a deeper understanding on the functioning of lower trophic food-web under the impact of ctenophores.

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Selection for high reproduction rates during establishment of non-indigenous species: A case study of a successful marine invader

JBS-08 / Oral Presentation_04

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Successful invasive species, hence non-native organisms forming self-sustaining populations, are often characterized by intrinsic attributes such as fast growth, high reproduction and phenotypic plasticity. The comb jelly *Mnemiopsis leidyi* is known for its fast growth and large reproduction capacity and native North American populations have successfully established populations in European waters at least twice. Due to different selection regimes in native and invasive populations, we hypothesize that populations differ in life history characteristics with invasive populations optimizing for a positive population growth rate (r) compared to native population which are assumed to be in steady-state. We investigate this hypothesis by a combination of laboratory and in situ measurements of *M. leidyi*'s egg production and growth capacity along with a review of published rates from its distributional range. Further, a theoretical model framework for competing life history traits during invasion is applied. Our results show that the size at first reproduction is lower and the size specific reproduction rate higher in invaded compared to native habitats. We hypothesize that size at first reproduction and overall reproduction rates are important invasion traits which were positively selected for during the *M. leidyi* invasion in European waters following both independent colonization´s of northern and southern Europe, respectively.

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Gross morphology and cnidocysts of the *Edwardsiella* anemone and larva (Anthozoa, Edwardsiidae) from the Swedish West Coast – The larva is parasitic in the invasive *Mnemiopsis leidyi* (Ctenophora)

JBS-08 / Oral Presentation_05

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The American ctenophore *Mnemiopsis leidyi* (Agassiz) invaded the Swedish west coast in huge numbers during the years 2007-2009. After being absent for a couple of years, *M. leidyi* reappeared in large numbers during resent autumns. A parasite, presumably an *Edwardsiella* larva, was attached inside *M. leidyi*. Questions arose: to which anemone does the larva belong? Anemones identified as *Edwardsiella carnea* (Gosse) from the Swedish west coast is one suggestion; or does the larva belongs to *E. lineata*? In the American habitat of *M. leidyi*, parasitic infections from *Edwardsiella lineata* (Verill) larvae are common. It is possible that *E. lineata* has followed the host across the Atlantic and been established in the new habitat. Or is *E. carnea* and *E. lineata* one or two separate species? Morphology and cnidocyst comparisons of the *E. carnea* anemones plus *Edwardsiella* larvae from the Swedish west coast showed close similarities to the American *E. lineata* anemones and larvae. Three of seven larval cnidocysts are similar to cnidocysts in *E. carnea* and in *E. lineata* anemones, namely: microbasic b-mastigophores; thin, long basitrichs and spirocysts. Narrow microbasic b-mastigophores and microbasic p-mastigophores present in the two anemones were missing in the larvae. Present investigation confirmed that our parasitic larvae inside the American ctenophore *M. leidyi*, collected at the Swedish west coast, belonged to the genus *Edwardsiella*, but not to which species. Prevailing cnidocyst data and gross morphology descriptions are, however, not enough strong evidence to confirm if *E. carnea* and *E. lineata* are one or two separate species.

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Here and here to stay: Proliferation of two (invasive?) scyphomedusae in the eastern Mediterranean Sea

JBS-08 / Oral Presentation_06

Zafrir Kuplik, Dani Kerem, Dror Angel

University of Haifa, Israel

Sudden blooms of jellyfish are a global phenomenon, but the factors responsible for occurrence of such swarms are still not well understood. In many cases the organisms involved are identified as invasive or exotic species and this is a point worth dwelling on. The scyphomedusae *Rhopilema nomadica* and *Cassiopea andromeda* are two species, commonly considered invasive that occur in the Levant. Whereas the pelagic *R. nomadica* forms annual or multi-annual swarms in the eastern Mediterranean, the adult benthic photo-symbiotic *C. andromeda* is rarely seen. Co-cultivation of the two species in a laboratory seawater flow-through system demonstrated multiple seasonal proliferations (asexual reproduction) of benthic and pelagic stages of both species. We present our observations of these to highlight the difficulty in defining when an exotic species with a complex life cycle, such as the scyphozoa, becomes established, i.e. invasive. Noticeable only as adult pelagic organisms, their microscopic, long-lived benthic stages, e.g. polyps may obscure their presence in a given environment due to the fact that they are generally cryptic, thereby leading to underestimation of the date they were introduced to that environment. Determining the factors responsible for what seems to be a sudden outburst of a new 'invader' may require us to look further along and deeper into the 'invasion' timeline.

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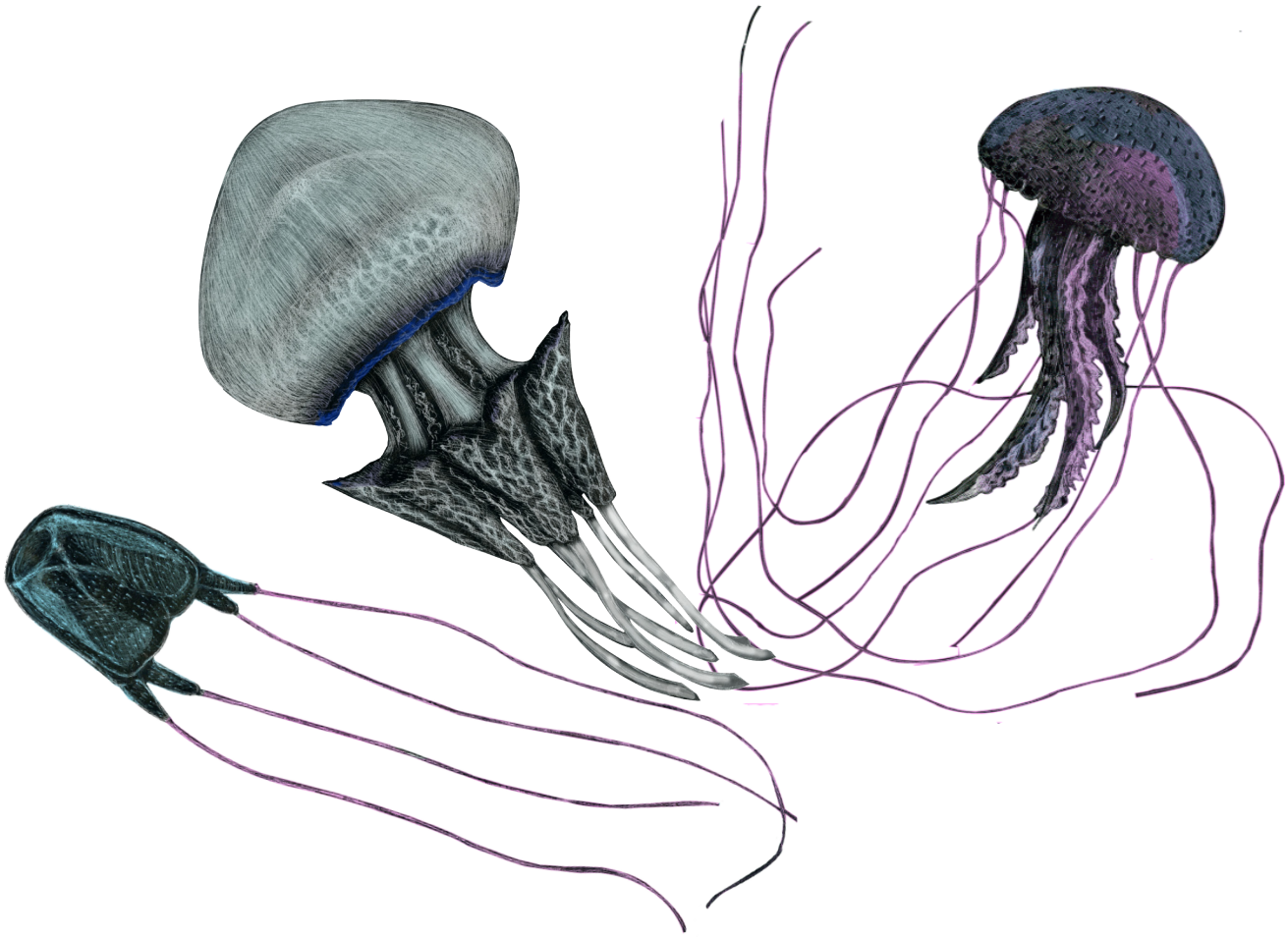
JBS-09
Public health and jellyfish envenomation medical and prophylactic treatments



Jellyfish stings are a common occurrence among ocean goers worldwide. Jellyfish sting symptoms range from burning sensation through erythema to severe systemic reactions and occasionally death.
The session will review three topics related to human health and jellyfish sting:
1. Encounter with jellyfish at sea: studies of protective management tools, stinger suits and prophylactic products to prevent jellyfish sting.
2. First aid on the beach: studies on envenomation management and tentacle removal.
3. Sever systemic stings: studies on jellyfish stings treatments in hospitals and case reports.
Protocols to harmonized treatment of jellyfish sting would be discusses.

Chairs:
Amit Lotan - Nidaria Technology LTD (Israel)

Study on jellyfish venom is the key way to treatment jellyfish stings

JBS-09 / Oral Presentation_01

Huahua Yu, Rongfeng Li, Yangyue, Pengcheng Li

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Jellyfish sting on swimmers and fishermen is very painful, with erythematous eruptions, itching and burning sensations. Syndrome includes fever, fatigue, muscle aches, tight breath, dropsy, blood pressure depression and even death. Bloom of jellyfish is recently becoming more and more serious. Jellyfish venom is the primary cause of sting. Study on jellyfish venom is the key way to treatment jellyfish stings. We analyzed the components of venom from jellyfish *Nemopilema nomurai* by venomics and venom gland transcriptomics. A total of 218 toxins were identified including C-type lectin, phospholipase A2, potassium channel inhibitor, protease inhibitor, metalloprotease, hemolysin and other toxins, most of which might be responsible for the sting. The hemolytic activity and lethal activity of venom from jellyfish *Nemopilema nomurai* and *Cyanea nozakii* were also analyzed. HU_{50} value against chicken erythrocyte was 5.08 and 2.80 μg/mL, respectively. LD_{50} value against rat was 2.92 and 29.5μg/g.bw, respectively. Temperature, pH and metal cation affected the hemolytic and lethal activity. In addition, we developed an external drug JSM for treatment jellyfish stings according to the physical and chemical properties and biological activity of jellyfish venom. JSM is deep yellow and pH of JSM is 6.5. More than 500 voluntaries were involved to evaluate the effect of JSM on jellyfish stings from 2012 to 2015. JSM can shorten the course of dermatitis and obviously relief the itching, pain and swelling according to the data of preliminary investigation.

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Jellyfish stings in Western Mediterranean beaches: epidemiology and analysis of tourist perception may support the improvement of local adaptation policy and the adoption of countermeasures in coastal areas

JBS-09 / Oral Presentation_02

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Within the framework of the LIFE CuboMed and Med-Jellyrisk projects, a retrospective study on the epidemiology of jellyfish stings -based on datasets of beach lifeguard stations- was carried out along the Spanish Mediterranean and Maltese beaches. This study aimed to identify best practices and opportunities for injury reduction, leading to substantial improvements in touristic experience. The cooperation with local authorities and lifeguard volunteers allowed the gathering of information on lifeguard assistance from the beaches of 183 out of the 234 coastal cities along the Mediterranean Spanish coasts, from late June to the beginning of September 2012. A total of 176,021 injuries were reported, with jellyfish stings ranking as the main lifeguard assistance category (66%). Jellyfish stings were the prevailing assistance category also in Malta, for the 2011-2015 summer seasons, being responsible on average for 51% of all lifeguard assistance calls.
A complementary study was carried out in summer 2012 and 2013 to detect the stinging jellyfish impact on human health at the Italian island of Lampedusa in the Sicily Channel. A total of 1,000 tourists were directly interviewed over the two years. The jellyfish impact was higher in 2013, with up to 33% of respondents being stung by jellyfish. More than 60% of the stung bathers adopted self-medication, preferring ammonia to alcohol, water, vinegar, cortisone or ice. Effective preventive and mitigation strategies will require targeted planning and monitoring of health services and lifeguard stations at tourist hot spots, possibly implemented through a real-time web tool at local, national, and basin-wide levels.

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Evaluating vinegar, hot pack and novel first-aid formulation. Efficacy in Cubozoan (*Alatina* sp.) and *Physalia* Stings

JBS-09 / Oral Presentation_03

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Cnidarian envenomations are a significant and growing medical burden worldwide. Contradictory first-aid management recommendations create additional public angst. Critical barriers to progress have been the difficulty in interpreting the clinical implications of indirect in vitro experimental models and the lack of reproducible non-redundant experimental models in which venom activity can be directly assessed. We report the design and implementation of an integrated array of three experimental approaches: (1) direct application of test solutions on live tentacles (tentacle solution assay, or TSA) (2) spontaneous stinging assay using freshly excised tentacles overlaid on substrate of live human red blood cells suspended in agarose (tentacle blood agarose assays, or TBAA); and (3) a "skin" covered adaptation of TBAA (TSBAA). We evaluated recommended first aid measures for the treatment of Cubozoan and *Physalia* stings for efficacy in a) inhibiting cnidae discharge and b) reducing venom activity. Tentacular responses to applied rinse solutions, as well as the efficacy of various sting treatments including hot and cold packs were assessed. We found evidence supporting the use of vinegar to rinse undischarged cnidae from the sting site, and strong support for the use of hot water immersion or hot packs to reduce venom activity. Other well-known response solutions, including urine and ice, failed to show any significant benefit in our sting models. The most striking inhibition of both tentacle firing and subsequent venom-induced hemolysis was observed using newly-developed (DOD funded, patents pending) spray and cream formulations (Sting No More®) containing copper gluconate, magnesium sulfate, and urea.

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Harmonized first aid solution to treat jellyfish sting on the beach

JBS-09 / Oral Presentation_04

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Jellyfish sting symptoms range from an annoying burning sensation to severe systemic afflictions and occasionally death. However, there are no regulations or an agreement regarding the first aid treatments on the beach. For example vinegar was found to cause opposite effects. In cubozoans vinegar inhibits nematocyst discharge, whereas in some scyphozoans and hydrozoans it activates the discharge. In the talk I will discuss how a global harmonized treatment can be achieved.
Nematocyst discharge depends on an increase of osmotic pressure (up to 150 bar) in the nematocyst capsule. This high pressure accelerates the ejection of the nematocyst's needle to penetrate the skin at an acceleration of more than 5,000,000xg, followed by injection of toxins into the body. Within the nematocyst capsule high aggregation of short negatively charge poly-gamma-glutamate polymers are densely packed with high concentration of metal cations. The high osmotic pressure is generated by the dissociation of the cations from the polymers. Therefore, changing nematocyst pH may influence the polymer affinity to these cations and can result with either inhibition or activation of nematocyst discharge.
In the presentation, a simple bioassay for testing different first aid treatments will be discussed and I will present a universal solution that can inactivate/block nematocyst discharge in all types of cnidarians.

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Optimization of emergency care treatments for the poisonous stings of various kinds jellyfish species

JBS-09 / Oral Presentation_05

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Gyeongsang National University, South Korea

Jellyfish stingings have been one of the main health problems for many sea bathers in each summer. When the jellyfish tentacles contact with human skin, their nematocysts are activated and inject their venom into the victims. Stinging of venomous jellyfish induces redness, local edema, skin necrosis and burning sensations. It is generally recommended to rinse the stinging area with vinegar, alcohol or baking powder as a first aid treatment. However, this first aid guideline may not be the choice of treatment for the stingings of some jellyfish species, such as *Nemopilema nomurai* (scyphozoan) which mostly appers in the oceans of Korea, China, and Japan. During the direct application of various kinds of rinsing solutions on live tentacles, *N. nomurai* nematocysts were significantly discharged upon the exposure to vinegar that aggravated the stinging associated local tissue pain. On the contrary, in *Carybdea brevipedalia* (synomym: *Carybdea mora*), their it did not show significant nematocyst discharge against acetic acid. Sea salt water does not appear to induce any nematocyst discharge and can be safely used as a first aid rinsing solution for jellyfish stingings which might be applied to all kinds of jellyfish species. Also, other recent discoveries will be also discussed.

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In vitro evaluation of venom activity as a tool to develop first-aid treatments of jellyfish sting

JBS-09 / Oral Presentation_06

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First aid treatments of jellyfish envenomation lack general agreement on their efficacy[1]. Based on its experience on emergency response to chemical contamination, Prevor started a research effort to understand jellyfish venom toxicity[2], and to develop new products in response to jellyfish stings.
In association with the jellyfish team of the ICM in Barcelona, specimens of jellyfish were collected in the Mediterranean Sea. Two species were used: *Pelagia noctiluca* and *Rhizostoma pulmo*. Nematocyst isolation was performed in Barcelona. The isolation protocol was adapted to each jellyfish species. Lyophilized nematocysts were then transferred to Prevor and venom was extracted by bead mill homogenization. The toxicity was evaluated on culture of keratinocyte (HaCaT cell line). This in vitro model was used to assess the ability of a molecule designed by Prevor to prevent venom toxicity.
A simple model to test jellyfish venom activity and potential antidotes in vitro has been established in our lab. Models closer to the configuration of human envenomation are necessary to fully validate first aid treatments.

1. Ward, N. T., Darracq, M. A., Tomaszewski, C. & Clark, R. F. Evidence-Based Treatment of Jellyfish Stings in North America and Hawaii. Ann. Emerg. Med. 60, 399–414 (2012).
2. Badré, S. Bioactive toxins from stinging jellyfish. Toxicon 91, 114–125 (2014).

Sophie Badré
Prevor, Valmondois
France

The painful truth on European jellyfish life histories and envenomation treatment

JBS-09 / Oral Presentation_07

Louise Montgomery, Jan Seys, Jan Mees

Flanders Marine Institute, Belgium (VLIZ)

Due to the perception of expanding jellyfish sightings in European waters, there has been elevated awareness on the threat to tourism, public health, fisheries and other industries. With the problem of jellyfish blooms, climate change and globalization displacing species, there is a growing cause for concern on the problems faced with envenomation, the factors that cause jellyfish blooms and how these issues can be tackled. The objective of the research was to identify the available information on the European species lifecycles, threats to humans and treatment of envenomation. Within the framework of the 'Sea Change' H2020 project a thorough literature review was carried out on envenomation, toxicology and life-histories of European jellyfish species. Little is still known about the factors that affect jellyfish lifecycles, but also where their life-histories take place, as well as the true composition of their toxins. There was found to be a great deal of contradictory and questionable information available on how to treat injuries with many poorly researched and detrimental treatments recommended and pointing to prevention being the key. Very little is known about the toxicity of jellyfish with variability found to occur worldwide within a single species, thus jellyfish envenomation has proven to be a complex issue to treat. In order to fill knowledge gaps and be prepared for heightened jellyfish problems, we recommend a vital increase in directed research on life-histories, how environmental factors affect jellyfish, and on the mechanisms and prevention of envenomation.

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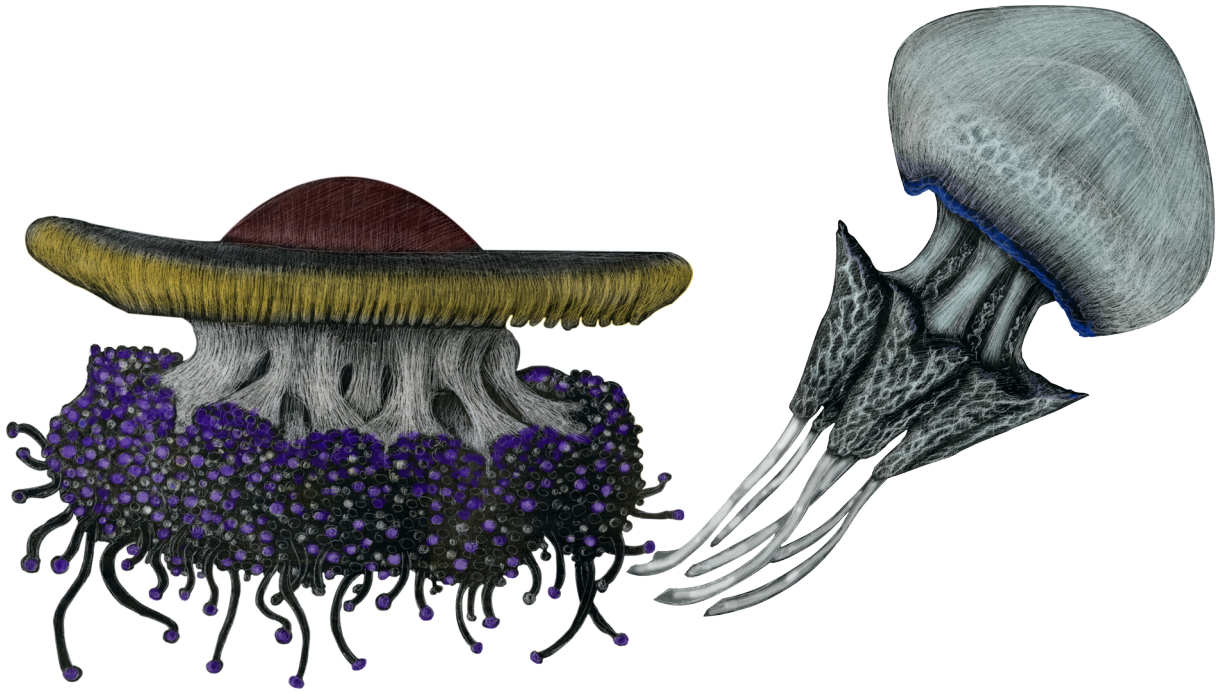
JBS-11
From ecological to economic benefits: the positive sides of jellyfish



Jellyfish blooms and outbreaks are often perceived as negative, not only when they interfere with human population needs such as in the tourist, industrial, fisheries, and aquaculture sectors, but also regarding key ecological functions. However, they also play an important and beneficial ecological role, and also represent a substantial stock of biomass which could be used for different purposes. Indeed, both attenuating or protecting against the negative impact of jellyfish presence and favouring its positive uses represent large technological, economic, and societal challenges which sometimes may even be combined. We invite contributions that study the positive and negative imprints of jellyfish occurrence on ecological functions and human activities, as well as on solutions developed to either diminish their negative impact or use jellyfish for recreational (including aquariums), nutritional, biomedical, agricultural, or bioindustrial means.

Chairs:
Fabien Lombard - Laboratoire d'Océanographie de Villefranche sur Mer (France)
Alenka Malej - Morska Biološka Postaja Piran, NIB (Slovenia)

Solving the jellyfish paradox: life history traits in the evolution of fish-jellyfish interactions

JBS-11 / Oral Presentation_01

Donal C. Griffin[1], Isabella Capellini[2], Chris Harrod[4], Jonathan D.R. Houghton[1,3]

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Within marine systems, phylogenetically-based comparative analysis has been used to address key questions on everything from speciation rates and body size evolution in fishes, to the evolutionary origins and ancestral state reconstruction of cephalopods. Here we adopt this approach to investigate the evolution of a long standing paradox in jellyfish ecology; namely, how gelatinous species that are often portrayed as negative stressors of fish communities can serve as habitat providers during their early life history. Specifically, we explore the evolutionary history of fish-jellyfish associations and test hypotheses on the potential selective forces that have promoted the evolution of such associations across 24 families and 86 different species of fish from across the world's oceans. Given the wide-spread occurrence and diversity of fish species involved in these associations, they provide a valuable model to explore the evolutionary origins of a jellyfish-fish interaction occurring on a global scale. Moreover, the potential role of jellyfish as ecosystem providers in this respect is not insignificant considering 72% of the fish species identified in this study as displaying this association were economically important either as commercial species or as gamefish. As pressure on fin-fish stocks continues to mount year on year, it is important to consider all potential impacts, both negative and positive, jellyfish can have on fish communities.

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Temporal variation in abundances and life stages of associates of the scyphozoan *Catostylus mosaicus*

JBS-11 / Oral Presentation_02

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Jellyfish are important hosts for a diverse fauna including parasites and commensals yet ecological data on these associations, particularly time-series, are rare. This study examined temporal variation in the abundances of symbionts of *Catostylus mosaicus* over two years. Jellyfish were captured from Port Phillip Bay, Victoria, Australia approximately every six weeks and inspected for symbionts. Parasitic amphipods (*Hyperia gaudichaudii*) and anemones (*Anemonactis clavus*) were observed, as were an associated sphaeromatid isopod (*Cymodoce gaimardii*) and juvenile fish. There was temporal variation in the presence and abundances of the symbionts. Eggs and juvenile *H. gaudichaudii* were endoparasitic within the jellyfish, and juveniles and mature males and females attached to the outer surfaces. The highest intensities of *H. gaudichaudii* occurred prior to the disappearance of jellyfish from the sampling area in September 2008 (maximum intensity of 229 juvenile and adult amphipods). The isopod occurred on *C. mosaicus* on 16 of the 19 sampling occasions, prevalences ranged from 5 to 85%, and were highest in summer and autumn. Intensity ranged from 1 to 5 isopods per jellyfish. Juvenile, immature and mature isopods were present. The parasitic anemone *A. clavus* occurred only between May and September. Prevalences were lower than for the isopod (on 5 to 20% of jellyfish when present) as was maximum intensity (two anemones per jellyfish). *Catostylus mosaicus* appears to play an important role in the life history of a suite of symbionts, and this is the first study to examine temporal changes in the populations of these symbionts.

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Jellyfish fisheries – what's the catch?

JBS-11 / Oral Presentation_03

Lucas Brotz

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Jellyfish have been the target of fisheries in China for centuries, where they are celebrated as a traditional food. In the latter half of the 20th century, fisheries for jellyfish expanded throughout Southeast Asia, primarily for export to China and Japan. Concomitant with increasing demand from China and collapses of local seafood stocks, jellyfish fisheries have recently been attempted in numerous countries around the globe, with varying degrees of success. Despite this history, information on jellyfish fisheries is sparse and disaggregated. Catches are often not reported explicitly, and both research and management are lagging behind the rapid expansion of jellyfish fisheries. A global catch reconstruction for jellyfish reveals that the number of species, fishing countries, and total landings are much larger than previously thought. While some see jellyfish fisheries as a potential solution to increasing jellyfish populations, there are many unique challenges and unknown impacts that result in high uncertainty, making the future of jellyfish fisheries unclear.

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Do not afraid of jellyfish blooms: use it for healthy eating

JBS-11 / Oral Presentation_04

Cansu Metin, Hatice Hasanhocaoğlu Yapıcı, Yunus Alparslan, Taçnur Baygar

Muğla Sıtkı Koçman University, Turkey

Becoming more of an issue of healthy eating, dietetic foods began to take important part in our lives nowadays. People are in research of new flavors, appealing to taste as well as nutritionally healthy, head to alternative foods. Seafood has an important role in these kind of foods.

Jellyfish is considered among food that can be consumed as an alternative and functional food. Low but significant amounts of lipids and cholesterol contents, containing fatty acids, high protein and minerals make jellyfish significant in terms of nutrition. They have active proteins which have antioxidant properties. Indeed containing collagen amounts allows jellyfish to use in different fields. As treating obesity, hypertension, gastric ulcers, asthma they would also be useful in terms of medical.

Jellyfish consists high amounts of water therefore after harvesting it requires to keep optimum conditions and removal of water. By removal of water and treating salt and alum jellyfish maintain for a long time. Although they are not consumed common in our country, Turkey, amount of processed jellyfish exportation can not be ignored. They are consumed commonly in Far East Asian countries and it is thought that jellyfish may be a promising food because of its high nutritional value.

This study reviewed included edible jellyfish species, their nutrition content and importance for human health, jellyfish processing methods and food products obtained from jellyfish. Mentioning the positive rather than the negative side of the jellyfish blooms will be bring a different perspective.

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Productive ecology and utilization as food of hydrozoan jellyfish *Eutonina indicans*

JBS-11 / Oral Presentation_05

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Mass occurrence of jellyfish includes serious problems in many coastal waters. On the other hand jellyfish is ingested as food by many organisms, such as crustaceans, fish or turtles. If we can use jellyfish as food, capture of jellyfish blooms will lead to effective utilization. For the effective utilization of jellyfish as food, it is also required to supply jellyfish continuously by culture. Hydrozoan jellyfish, *Eutonina indicans*, is known that is easy to culture and reproduce medusae continuously from their hydrozoan polyps. Actually *E. indicans* is supplied as food for other jellyfish in many aquariums in Japan. We tried to appear the basic productive ecology of *E. indicans*, and feeding experiments of *E. indicans* to other marine organisms such as other jellyfish, fish and phyllosoma which is larvae of lobsters are conducted. *Eutonina indicans* was ingested by many kinds of jellyfish and fish. A lot of phyllosoma larvae supplied *E indicans* as food were successfully developed into benthic nisto stage. Hydrozoan jellyfish, *E. indicans*, will be effectively utilized as food for various marine organisms. If various gelatinous zooplankton such as *E. indicans* are used as food in aquaculture, fish farming and aquarium, jellyfish blooms may decrease in many coastal waters.

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Jellyfish as novel food in Mediterranean countries: Blue Growth resource or multi-cultural, ethnic adaptation?

JBS-11 / Oral Presentation_06

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The growing interest in diversification of sustainable food sources and the discoveries on the biological, nutritional and nutraceutical properties of several scyphozoans suggest the Mediterranean jellyfish as potential resource for biotechnological and food production sectors, in line with the EU Blue Growth recommendations. In Eastern Asian countries edible jellyfish represent an appreciated food with a worldwide catch over 1 million tons. The development of a Mediterranean jellyfish food system would require integrated management and sustainable exploitation, embracing ecological, safety, nutritional, legal, economic, social and public acceptance issues. The lack of safety protocols and processing methods for jellyfish products in compliance with EU rules, together with a restricted market size, resulted in the absence of a comprehensive food system, from harvesting to processing to consumption. Investigations on innovative processing methodologies and their effect on the biochemical features of key components (eg collagen) are leading to considering Mediterranean jellyfish as putative food or feed ingredient or as a still unexplored resource for bioprospecting. Recent biochemical research on the composition of Mediterranean jellyfish demonstrated the occurrence of bioactive metabolites with antioxidant and cancer-preventive properties. It is worth investigating the potential of a jellyfish productive system based on culturable species, or as a case-by-case local adaptation against massive jellyfish outbreaks recognized as damaging to local economies. The involvement of multiple stakeholder categories, including productive sectors, managers of biodiversity conservation, as well as potential consumers and final users, will be key to the socio-economic and ecological assessment of a new sustainable jellyfish food/feed processing system.

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Utilisation of jellyfish as food in spiny and slipper lobster aquaculture

JBS-11 / Oral Presentation_07

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There is evidence showing that the larvae of spiny and slipper lobsters consume jellyfish in the wild, whereas there is limited information on feeding trials of commercially important lobster larvae with jellyfish. To assess the potential of jellyfish to be utilised as food in the production of lobsters, we fed the larvae of slipper lobsters with moon jellyfish, *Aurelia aurita*. Complete larval development from newly hatched larvae to juvenile has been achieved in three species of slipper lobsters (*Ibacus novemdentatus*, *I. ciliatus* and *Thenus australiensis*) with utilising the moon jellyfish as a sole food. Moreover, the larvae of *I. novemdentatus* were able to consume various species of jellyfish including giant jellyfish (*Nemopilema nomurai*) and Japanese sea nettle (*Chrysaora pacifica*). Early stage larvae of Japanese spiny lobster have also been observed to prey on the ephyrae of moon jellyfish. These results indicate that jellyfish is potentially a suitable food for the larvae of spiny and slipper lobsters. Jellyfish has also been suggested as a supplemental food for the juveniles of some fish species. The recent studies suggest that the huge biomass of bloomed jellyfish in the coastal area may be useful as a nutritional resource for fish and crustaceans in aquaculture industries.

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The potential use of jellyfish as biofertilizer in basil (*Ocimum basilicum L.*)

JBS-11 / Oral Presentation_08

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CIBNOR, Mexico

Biofertilizers are still a promising alternative to sustainable agriculture. New marine products are being studied, but no information is currently available on the use of jellyfish. We tested jellyfish as a promotor of growth for basil plants. Ten treatments, three jellyfish concentrations, one organic fertilizer, and water, at two different doses were tested. Seeds planted in trays of inert commercial substrate were raised for one month and then transferred to pots where they were raised for 9 weeks. All treatments were applied in two doses each week. At the end of the experiment, stem height, root height, fresh and dry weight of leaves, fresh and dry weight of roots, and foliar area were measured. Chlorophyll was also measured. Most variables were significantly higher at the highest concentration of jellyfish and at the highest doses, and some variables were significantly higher at intermediate concentration and highest doses. No significant effect occurred in root height and chlorophyll. Basil stem was approximately 13% larger with the jellyfish treatment at the highest concentration than commercial organic fertilizer. In summary, we demonstrated that jellyfish extract will provide better growth than a standard organic fertilizer. Further research could document the benefits to soil quality and crop yield.

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Using jellyfish mucus to trap nanoparticles from waste waters

JBS-11 / Oral Presentation_09

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Current anthropogenic changes are causing numerous perturbations to the environment including the proliferation of jellyfishes and also the contamination of waste water by nano-particles. Would it be possible to use one problem to solve the second?
On one hand, whatever the result of the current debate about jellyfish increasing (or not) at the global scale, they already represent an impressive stock of organisms and biomass with very little use for human populations.
On the other hand, the economic and societal impacts of nano-materials are enormous and their use has increased drastically, but the issues with releasing such materials in the environment are poorly understood and could be detrimental to both human health and ecosystems.
Here we demonstrate that nanoparticles bio-accumulate into mucus materials coming from jellyfish. Different sources of mucus have been tried and the efficiency on nanoparticle removal tested. Rapid capture of particles at nearly 100% efficiency has been observed depending on the mucus source. One strategy that emerges from this finding would be to take advantage of these properties to capture nanoparticles in order to address the nano-waste issue, and maybe solve two problems at once.

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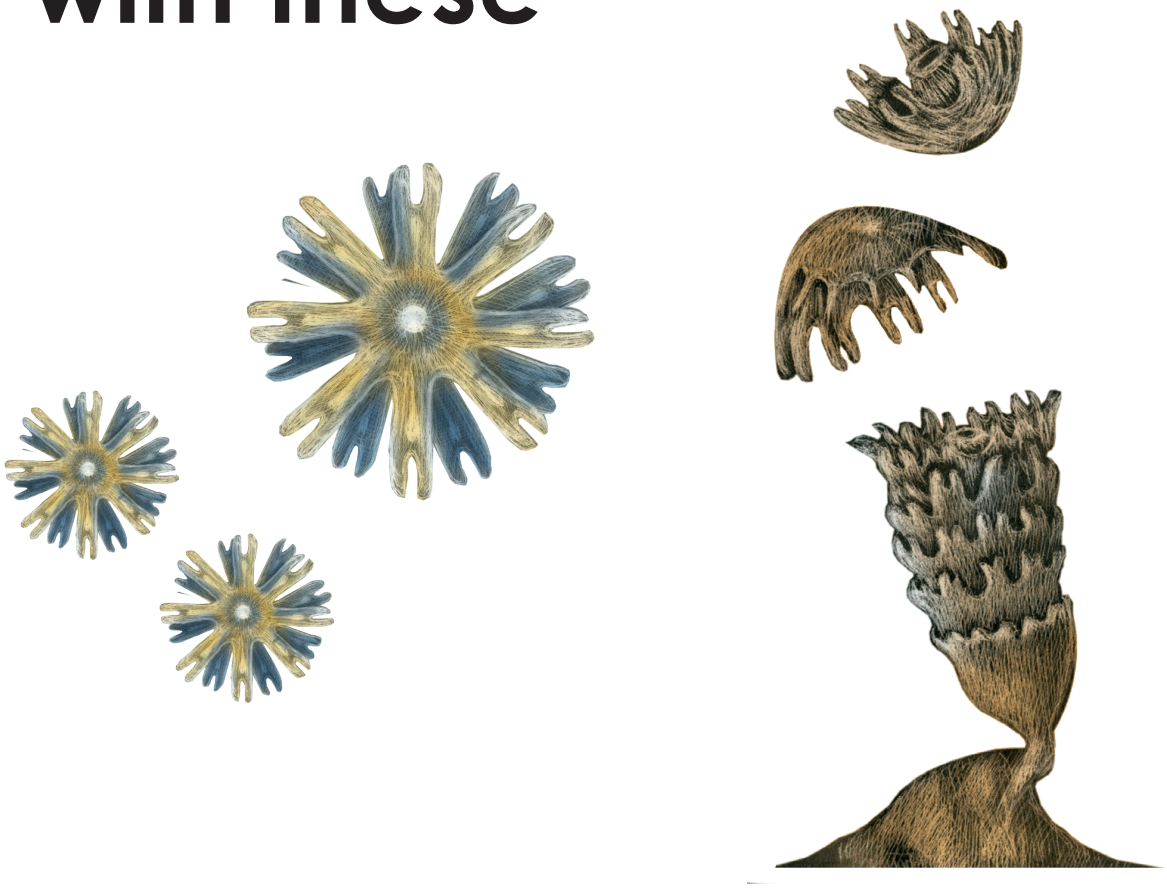
JBS-12
Challenges in jellyfish research and how we deal with these



Jellyfish research is an evolving field that faces many challenges, largely due to practical and technical limitations. As has been shown for a few species, e.g. *Aurelia aurita*, if enough effort is invested in their study, this leads to advances in our understanding of its biology and ecology. Our knowledge of most other scyphozoa is rather limited because: a) relatively few researchers work on jellyfish, and b) we lack suitable methods. This session will be dedicated to defining the gaps in both knowhow and necessary methods to help advance our knowledge. Examples of just a few of these shortcoming include: 1) locating the elusive scyphozoan polyps in the sea, 2) the lack of affordable and reliable protocols to determine abundances of medusae at sea, 3) calculating clearance rates, feeding rates and prey preferences in-situ and in-vitro. We would like to solicit contributions to this session which describe such methodological gaps, and we encourage the presentation of new and innovative methods to study jellyfish biology and ecology.

Chairs:
Dror Angel - University of Haifa (Israel)
Zafrir Kuplik- University of Haifa (Israel)
Agustín Schiariti- Instituto Nacional de Investigación y Desarrollo Pesquero, CONICET (Argentina)

Aerial and underwater photographic sampling of scyphozoan medusae

JBS-12 / Oral Presentation_01

Jennifer E. Purcell[1], Christopher Krembs[2], Casimir A. Rice[3], Correigh Greene[3], Andrew R. Juhl[4]

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[2] Washington Dept. of Ecology, USA
[3] NOAA Fisheries, USA
[4] Lamont-Doherty Earth Observatory, USA

Scyphozoan medusa sampling in situ presents many difficulties, in part due to the large sizes and patchy distributions of many species. We report insights gained from photographic sampling from two in-progress studies. First, we quantify aggregations of *Aurelia labiata* medusae from aerial photographs taken from 2009-2015 in Puget Sound, Washington. The aerial photographs are ortho-rectified to accurately quantify the surface area of each aggregation. We present simultaneous net data on medusa densities inside and outside of the aggregations. The combination of numbers and surface areas of the aggregations with medusa densities in them yields the abundances of *A. labiata* medusae. 2015 had many more aggregations than all other years suggesting that the *A. labiata* population was large as a result of the Pacific warm SST anomaly in 2015. In the second study, we photographically quantify *Chrysaora melanaster* medusae beneath the Arctic ice in 2011-2014. Our data demonstrate that the previously-reported population increases (1990–2000 and 2006–2012) in the Bering Sea could be due to adult medusae over-wintering beneath the Arctic ice cover. Our results demonstrate that photography is a cost-effective method to quantify medusa populations over large regions and multiple years and in physically-challenging environments.

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Potential and limitations of X-ray micro-computed tomography for statolith investigations and taxonomic studies on jellyfish

JBS-12 / Oral Presentation_02

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Scyphozoan and cubozoan statoliths can provide information on systematics and ages of medusae. Therefore, statolith analyses could present a useful method for investigations on population dynamics of jellyfish. However, examinations on statoliths are difficult since they dissolve when exposed to air or aqueous solutions. Another challenge in jellyfish research is the taxonomic work on delicate gelatinous animals as preservation can lead to distortion of morphological diagnostic features and especially long time storage of medusae in museum collections is problematic. We evaluate the benefit of the non-destructive analysis using micro-CT (Xradia MicroXCT-200) for various cnidarian taxa (Scyphozoa, Cubozoa, Hydrozoa, Staurozoa) with particular focus on scyphozoan and cubozoan statoliths. The specimens were preserved in different media (e.g. ethanol, glutaraldehyde, Trumps) and part of the samples were additionally treated with contrast agents (iodine or osmium tetroxide) before they were embedded in LR-white resin or critical point dried. The reconstruction of tomographic data (software Avizo) demonstrated that the treatment with contrast agents significantly enhanced the visualization of diagnostic morphological features of the analyzed specimens. The 3D-reconstructions of scyphozoan and cubozoan statoliths allowed detailed analyses on their natural arrangement in the statocyst and automated morphometric measurements in three dimensions. However, the visualization of statoliths was limited by the resolution of the used scanner (~0.5 µm/pixel). In conclusion, micro-CT allows for the digitization of taxonomically important morphological information which could be used as "cybertypes". Moreover, computer-based 3D-reconstructions provide sophisticated analysis methods on statoliths expanding the opportunities for future research on these structures.

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Numerical modelling to the rescue: environmental models as a novel tool in simulating the trajectory of jellyfish blooms within coastal ecosystems – a case study from the Maltese Islands (Central Mediterranean)

JBS-12 / Oral Presentation_03

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A numerical tool based on coupled hydrodynamics and environmental models was developed and applied to the coastal areas of the Maltese archipelago, with the aim of implementing a decision-support system for coastal managers. The hydrodynamic component of the system (ROSARIO-SHYFEM) is operational and provides daily a 4 days forecast of the main 3D hydrodynamics fields for the areas covering the Malta-Sicily Channel with a spatial resolution varying between a few km up to 50 m.
The main objective of the tool is to predict the trajectory to be assumed by a jellyfish bloom by providing a four-day forecast of the path to be taken by the same bloom. The ROSARIO-SHYFEM model was coupled with a particle-tracking Lagrangian model in order to simulate the diffusion of numerical particles, proxy of jellyfish, inside the area of interest, providing a 4-day forecast for the trajectory of a jellyfish bloom.
The system was integrated into a Web Application which will allow users to define the position in time and space of a hypothetical bloom found in the Maltese waters, to select the amount of particles to simulate the jellyfish biomass and to choose between blooms of *Pelagia noctiluca* and *Cotylorhiza tuberculata*, the two main blooming species in this part of the Mediterranean. The tool is freely available through the MED-JELLYRISK Project website (www.jellyrisk.eu). Full validation of this dispersión forecasting system, through the deployment of water drifters for example, is still ongoing.

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Determination of digestive enzyme activity in *Stomolophus meleagris* polyps, ephyrae, and medusae stages

JBS-12 / Oral Presentation_04

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There is limited understanding of the digestive physiology of jellyfish and variations with developmental stages. We determined trypsin, chymotrypsin, amylase, lipase, acid and alkaline phosphatase in polyps, ephyrae, and medusa of *Stomolophus meleagris* raised in the laboratory, using either fluorometric and photometric protocols in microplates. Ephyrae were separated into 1, 5, and 15 day treatments to distinguish between metamorphic changes. Enzyme assays were performed on tissue homogenates from 6–1,174 individuals per sample, depending on weight and stage. Activity of all enzymes was detected at all stages with fluorometric protocols. Total enzyme activity, specific activity, and individual activity were determined. Lower individual enzyme activity was detected in 1-day ephyrae followed by polyps, ephyrae, and medusae, except alkaline phosphatases, where polyps had the lowest activity. In contrast, the highest specific activity was detected in ephyrae and less specific activity in medusae. Polyps showed low phosphatases and lipases specific activity. This is the first time that developmental stages are shown to reflect changes in the digestive enzyme activity of *S. meleagris*.

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Precautionary management of jellyfish bloom through polyp mapping of Korea

JBS-12 / Oral Presentation_05

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Massive blooms of the moon jellyfish occurs every year bringing various kinds of damages to fisheries, recreation as well as power plant operations. Jellyfish such as *A. aurita* and *Nemopilema nomurai* have been designated as harmful marine organisms in Korea. National organizations such as the KOEM, NIFS have collaborated to mitigate the damages caused by jellyfish bloom. Out of the various stages in the jellyfish life cycle, the benthic stage is the best effective management timing to suppress jellyfish bloom. Through this concept, precautionary management policy to handle jellyfish bloom has been adopted in Korea. Therefore, survey of jellyfish polyp hotspots located in southern and western coastal area in Korea had been conducted. Furthermore, elimination activities for jellyfish polyps using high pressure sea water mechanism in the Siwha Lake was first utilized which was later expanded to areas such as the Masan bay, Saemangeum area, etc. On closed areas such as Sihwa Lake and Saemangeum area, productive results have been monitored through continuous monitoring surveys. Semi closed or open areas such as Deukrayng Bay showed positive results in the early ephyra stage, however exogenic sources of adult jellyfish from neighboring waters brought the jellyfish population back to its original state. We expect a more effective control of jellyfish bloom and the restoration of the natural coastal ecosystem with minimal management through further researches: the anticipating diffusion pathways of ephyra with hydro-dynamic understandings and the recovery of ecosystem resilience damaged by the abnormal dominant of jellyfish polyp in benthic habitat.

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The development and utilisation of a real-time monitoring system for jellyfish populations in the Menai Strait, North Wales, UK

JBS-12 / Oral Presentation_06

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Given that jellyfish blooms are hypothesized to be on the rise in many regions worldwide, time-series studies to regularly monitor blooms are necessary but currently rare. To quantify changes in surface abundances of jellyfish over time, we have developed a time-lapse camera system that can be attached to above-water structures, such as bridges and piers. During the initial phases of development in 2014 and 2015, the camera system was placed on the Menai Suspension Bridge which crosses the Menai Strait in North Wales, UK, 29 m above the water surface. Digital images were taken of the strait surface every 5 minutes during the summer months of 2014 and 2015. The camera system was proved effective as many species of jellyfish were identifiable from the digital images. Species-specific patterns throughout both summer observation periods were clear to see, with *Aurelia aurita* peaking in mid-June, followed by *Cyanea capillata* and *Chrysaora hysoscella* peaking late July. *Rhizostoma octopus* was present in low numbers throughout the summer and all observations decreased dramatically by mid-September. Although the actual numbers were different between 2014 and 2015, the patterns of abundance were similar. A correlation with abundance and sea-surface temperature was also observed. Our intentions are to expand the observations year-round and to eventually include camera systems attached to structures in other parts of the UK.

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Spatial and temporal variations of jellyfish abundance and biomass in the Ligurian Sea (NW-Mediterranean Sea): A quest for an efficient, cost effective and quantitative method

JBS-12 / Oral Presentation_07

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Monitoring either spatial or temporal variations of jellyfish abundance raise large problems in finding good and efficient indicators of their abundance and ideally of their biomass. For example, most historical records (>80y) only recorded presence/absence periods, and recording abundance remains tricky, notably because they often occurs in patchy environments, are too scarce or in too thin-shallow layers to be correctly sampled by plankton nets, and too fragile to be sampled by trawls.
Coastal observation on fixed sites, using several different methods such as scientific monitoring using classical plankton tows, beach stings records or citizen science observations all shown their wide potential in term of continuous monitoring, but also their flaws and biases.
In the Ligurian Sea, most observations of jellyfish correspond to the Scyphozoan *Pelagia noctiluca*, which, in top of usual difficulties to sample jellyfishes, migrate to depths >400m during days and mostly occurs offshore. Therefore most classical observations do corresponds to populations transported to shore and highly aggregated by coastal topology. Here we show that using knowledge about jellyfish ecology leads to obtain simple, efficient and cost effective methods allowing to both monitor the spatial and temporal variations at the level of a wide area.
The results shows that jellyfish abundance in the Ligurian Sea is continuous with abundances encompassing 10t km^{-2} in most surveys, with extremes above 200t km^{-2} depending on favorable environmental conditions.

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Untangling Portuguese Man-of-War swarms in the Mediterranean Sea

JBS-12 / Oral Presentation_08

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Even if the Portuguese Man-of-War (*Physalia physalis*) is not a native species in the Mediteranean basin, the region experienced a high number of swarms in 2010 that had dramatic consequences, including the first human fatality caused by a jellyfish sting. In this work, a comprehensive analysis of the meteorological and oceanographic conditions of the NE Atlantic Ocean during the months previous to the appearance of *P. physalis* was performed. A virtual experiment of the drifting of the individuals using a hydrodynamical model, consisting of a ROMS based numerical simulation forced with realistic winds (ASCAT) and heat fluxes from ERA-Iterim, together with an Individual Based Model simulations was implemented. The values during the winter of 2009-2010 of the North Atlantic Oscillation (NAO) were among the most negative since recordings began (150 years ago). The intensity of westerly winds was between one and a half to four times higher than average. The study concludes that these unusually strong winds, along with the prevailing ocean currents, are likely to have moved the *P. physalis* population from the open Atlantic Ocean towards the mainland, through the Strait of Gibraltar, and into the Mediterranean basin. Field data and modelling simulations confirm this hypothesis. Sightings of *P. physalis* have fallen dramatically since 2010, indicating that they will not pose a continuous problem along Mediterranean beaches and, unless the extreme negative values of the NAO become more frequent due to climate change, the 2010 exceptional occurrence of *P. physalis* is unlikely to reoccur on a regular basis.

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Working with live jellyfish: a challenge during the last eight years

JBS-12 / Oral Presentation_09

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Jellyfish are fragile and poorly understood but amazing marine animals. Trying to create adequate technics to keep them alive and in good conditions in aquaria represents a great challenge. Moreover the interest for culture these animals has been significantly increasing in the last decades. Growing techniques with a scientific purpose are improving and in continuous evolution but private enterprises, as exhibition aquariums, have demonstrated an interest in maintaining jellyfish in tanks. Since 2007, the "Medusa" group of Barcelona dedicates a large part of his research to study some species of interest in captivity. Different aquaria and experimental setups have been developed in order to conduct experiments and to better understand their life cycles.
Due to the location of the Marine Science Institute (Barcelona, next to the beach with direct access to the sea water) and also to the ability to build and to modify every part of the aquariums manually, we can integrate the knowledge learned during the years to adapt them depending on the needs of the animal´s biology or the experiment. This has allowed us to developed collaboration projects with research institutions and private companies. In this presentation we would like to share some of the challenges were faced and how we solved in order to stimulate future collaborations.

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Look and you shall find – jellies and standard zooplankton surveys

JBS-12 / Oral Presentation_10

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Gelatinous zooplankton is often neglected in zooplankton surveys. The reasons are many: It may be presumed that jellies are due to their fragile nature too damaged during standard sampling to be of any use, some species don't fare well with routine fixation in ethanol or formalin, taxonomic expertise may be lacking, or they may simply not be considered significant enough. Valuable data on diversity, distribution and abundances can nevertheless be gained also from net surveys not specifically targeting jellies, at least for some groups. We present case studies from large zooplankton surveys (e.g. Mar-Eco, Euro-Basin) where a variety of nets and optical methods were utilized. Jellies range in size from millimeters to meters, and selectivity of gear should be considered both in survey planning and interpretation of collected data. Ctenophores are particularly poorly sampled using routine net approaches, necessitating examination of the live catch pre-fixation and/or utilizing optical approaches for estimation of their diversity and abundances. DNA barcoding may in the future prove helpful in cases of identification problems due to lack of taxonomic expertise or morphologically indistinct damaged, digested or juvenile specimens.

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Recent advances in ctenophore culture

JBS-12 / Oral Presentation_11

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Past efforts directed at long-term culture of ctenophores over multiple generations have suffered from low yields of individuals reaching reproductive maturity and adult size, significantly hampering studies focused on understanding ctenophore biology. Many ctenophore species are self-fertilizing hermaphrodites possessing transparent embryos and fast generation times making ctenophores attractive model systems for embryology and developmental biology. We have recently made significant progress developing a simple, effective, and robust system designed for the long-term maintenance of ctenophores in culture generation over generation. Application of new aquaria design, development of appropriate food sources and feeding regimes are presented. The ability to reliably mass culture ctenophores in the laboratory allows for the investigation of many novel aspects associated with the ontogenesis of these holoplanktonic organisms and their pelagic life histories which are extremely difficult or impossible to study in the field.

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Application and evaluation of various investigation techniques for analyses on scyphozoan statoliths

JBS-12 / Oral Presentation_12

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Investigations on scyphozoan statoliths have demonstrated their increase in number and size growth with increasing medusa age indicating that the crystals are potentially useful for the age determination of medusae. Unfortunately, studies on statoliths are rare and adequate investigation methods are lacking because of the fragile structure of the numerous tiny crystals and the unstable nature of their chemical composition. We applied a combination of various investigation techniques (light microscopy, SEM, calcein labeling, X-ray microcomputed tomography) on the statoliths of early medusa stages (0 – 6 weeks) of the jellyfish *Sanderia malayensis* to evaluate their potential for future investigations. Light microscopic studies with a slide scanner were most useful to follow the increase of statolith numbers and confirmed positive correlations between statolith number per statocyst and medusa age. SEM micrographs depicted different statolith shapes most accurately revealing four statolith shape types. Calcein labeling allowed the visualization of statolith growth in layers and the analyses of tomographic data provided morphometric measurements of single statoliths in three dimensions. The choice of the best method for future investigations on statoliths depends on the scientific research question of the study, however, most information on statoliths of a certain species is achieved by a combination of different methods.

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Polyp counting made easy: two stage scyphistoma detection for a computer-assisted census in underwater imagery

JBS-12 / Oral Presentation_13

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Moon jellyfish have a complex life cycle that alternates between a pelagic free-swimming medusa and an attached polyp. Understanding the population dynamics of the latter is of vital importance for understanding the abundance of the bloom forming medusa stage. In order to efficiently analyze a large corpus of underwater photographs taken during a 3-year survey of *Aurelia* polyps in situ, we have developed software that is capable of automatic detection and counting of polyps present in the image. We combined state-of-the-art computer vision and machine learning methods in a two-stage approach: first, potential scyphistoma candidates are identified by an Aggregate Channel Features (ACF) detector, and then verified by a combination of Support Vector Machine (SVM) classifier and features, extracted using a Convolutional Neural Network (CNN). This approach was tested on several photographs, each containing roughly a thousand polyps, and its accuracy was compared to the accuracy and variance of a manual census performed by multiple experts using two different manual counting methods. The computer-assisted approach was shown to drastically reduce the effort and time spent counting polyps in an image at a minimal reduction in accuracy, thus enabling processing of much larger datasets. The developed program can be used for the detection of different scyphistoma on virtually any substrate; and being based on machine learning, it is also highly flexible and can be further improved through user interaction. The program itself will be made publicly available.

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New *Tamoya* species from Africa - an example why traditional taxonomy and old museum collections are still important in the age of genetics

JBS-12 / Oral Presentation_14

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There are regions in the world where it is hard to get an overview on the biodiversity, as these regions have either no sufficient infrastructure or these regions lay in war areas like the West African coast or the Arabian Sea. But about 100 years and more back, there had been times when specimens had been collected in these areas during the big surveys. These collections still exist but are kind of forgotten as very few "waste" their time on sorting them through e.g. there is no money to take care of these old collections and the knowledge on anatomical features as important tool gets lost in the age of genetics and ecology.
In 1934, Stiasny described specimens from the West African coast as *Tamoya haplonema*. He presented also line drawings of the habitus that raised some doubts on the identification of the species. In the old collections of the Natural History Museums of London, the described specimens were still available and in good condition due to the storage in formalin. More specimens could be found in other museums. The formalin made a genetic analysis impossible but as all anatomical structures were excellently preserved a direct comparison with the structures of other *Tamoya* species was possible. The comparison confirmed that the African specimens are an unknown *Tamoya* species.
This is to show that there are biodiversity data hidden in the old collections if an effort is made to spend small time, money and classical knowledge on their discovery.

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Using water content as a continuous trait to better understand gelatinous zooplankton growth and feeding

JBS-12 / Oral Presentation_15

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Studies have shown that gelatinous zooplankton have faster specific growth rates and higher carbon specific feeding rates than other planktonic animals. The low carbon content (carbon mass as a proportion of wet mass) of gelatinous zooplankton has been suggested as the cause of these differences, but it has not been studied before on a continuous scale across both gelatinous and non-gelatinous taxa. We investigated whether zooplankton carbon content varied along a continuous spectrum, and subsequently whether this trait improved current models of zooplankton growth. We found that carbon content is a continuous trait, and that specific growth rates g (d-1) were negatively related both to carbon content and carbon mass. Carbon content was found to enhance the power of models for both gelatinous and other zooplankton growth based on carbon mass and temperature. Experimental trials on the growth rates of *Aurelia aurita* ephyrae conformed with the theoretical models and showed varying carbon content through development. A greater appreciation of this trait will help to further our understanding of energy budgets across the full spectrum of zooplankton taxa.

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Modeling the top-down control in the plankton community by *Aurelia aurita*: application in a neritic ecosystem (Kiel Fjord)

JBS-12 / Oral Presentation_16

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Ecological features of cosmopolitan *Aurelia aurita* (Linneaus, 1758) have been widely described, especially in terms of its trophic role as a key predator in high productive planktonic systems. Although research efforts on jellyfish ecology have substantially increased in the last decade, modeling works focusing on their population dynamics and trophic interactions remain scarce. Here we present a food-web dynamic model aiming to assess the role of *Aurelia* in the seasonal plankton cycle of Kiel Fjord (KF). Low trophic levels included a classical NPZD model with different functional groups, coupled to a stage resolved copepod model (referencing *Pseudocalanus* spp.). Top predators are represented by *Aurelia* pelagic stages (ephyra and medusa). The model captures the main pattern of the seasonal plankton succession in KF: starting from a diatoms bloom followed by copepods dominance during spring. Results highlight that *Aurelia* predation yield a dominance of medusae-ciliates in the zooplankton biomass by the end of the summer. Winter temperature and the number of ephyrae released appear as leading factors driving the bulk of *Aurelia* annual biomass. Overall, the modeling approach used captures the main features driving the population dynamics of *Aurelia*, including the effect of interspecific competition, which control the average size/weight of the medusa, and has been described as key factor for the sexual reproductive strategy of the population at the end of the pelagic phase. Lastly, we stress the need of modeling the population dynamics of scyphomedusae to reduce uncertainties regarding the potential effect these organism may have on ecosystem functioning.

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Jellyfish monitoring advances and challenges in the Barents Sea

JBS-12 / Oral Presentation_17

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The ecosystem monitoring in the Barents Sea is a joint effort between Norway and Russia based on collaboration between the two countries starting with initiation of a survey to investigate the 0-group of commercial fish species in 1965. Due to international agreements and attempts to improve the efficiency and enhance the ecological focus and scientific merit of the 0-group fish survey and other join surveys, they were gradually merged to form the joint Barents Sea ecosystem survey (BESS). The timing of the surveys is optimal for covering the entire Barents Sea because most or all of the sea is ice-free in autumn, which represents a period in which organisms display minimal migration due to their feeding activity, and the 0-group fishes and jellyfish (mostly *C. capillata*) are large and thus effectively caught by pelagic trawls. The jellyfish (mostly *C. capillata*) biomass estimation based on these surveys will be discussed focusing on limitations and ecological benefits. Additionally, the overview of jellyfish monitoring, lessons learned and the methodological advances and challenges will be also discussed.

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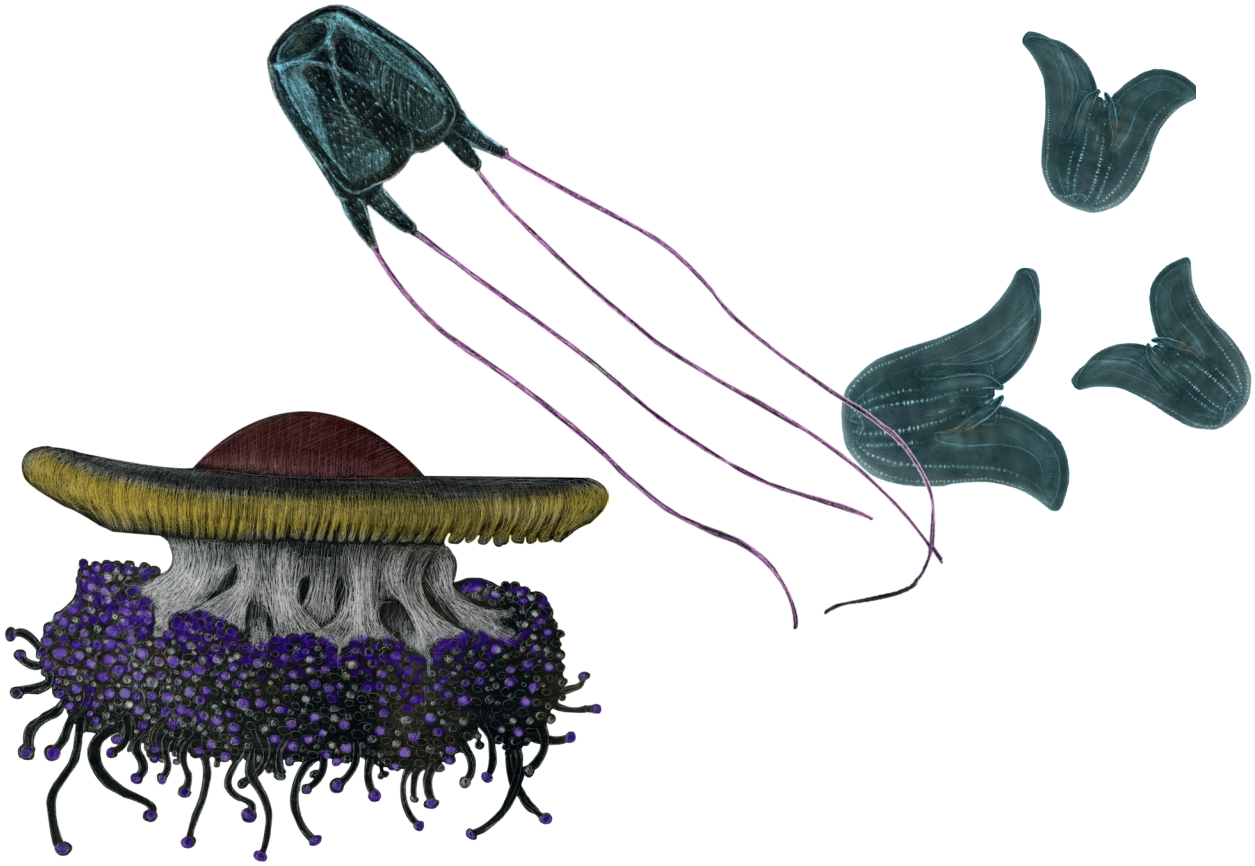
JBS-13
Citizen science and jellies



Citizen science is a progressively booming approach for research in all areas and also for conservation of nature projects. The effort is dedicated on creating more public involvement in inquiry and discovery of new scientific knowledge, where many people collaborate towards a common goal. Considering that gathering data and analysis is complex and time-consuming when it covers wide territories, citizen science is a powerful tool that facilitates the objectives. At the same time, involving citizens or non-professional scientists is one of the most efficient ways for the generation and spread of scientific knowledge. In the jellyfish research field, counting on volunteers for the observations and records of presence and absence of different species is an invaluable contribution. Through citizen science is possible to obtain data from multiple geographic points contributing to databases records and producing preventive information, for early alerts of jellyfish presence and mitigation tools for its negative impacts. This session aims to put in common results of innovative projects and approaches, which consider citizen science as part of jellyfish research. Explaining methodologies used, sharing experiences and also proposing future guidelines in this topic.

Chairs:
Ferdinando Boero - Università del Salento (Italy)
Verónica Fuentes - Institut de Ciències del Mar, CSIC (Spain)
Dacha Atienza - Museu de Ciències Naturals de Barcelona (Spain)

Proactive Jellyfish Citizen Science – much more than "just adding water"

JBS-13 / Oral Presentation_01

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Jellyfish ecology has undergone notable advances in recent decades, with the apparent proliferation of gelatinous animals in our seas, but many basic questions regarding these fascinating creatures remain unknown. "Where do they come from?" is a common question that interests both scientists and citizens and is largely unanswered due to the fact that the whereabouts of the polyps of most species is unknown. Likewise, "how many jellyfish are there in a given swarm?" and "how old are they?" are generally beyond our current understanding, and one of the ways to increase our knowledge is to engage the public in citizen-science initiatives. Citizen science projects generally focus on increasing the number of people making observations, or collecting data, with an emphasis on citizens serving as "helpers" who may also learn about some of the related environmental issues, but that is generally where their participation ends. As citizens become more involved in the environment around them it is becoming increasingly clear that the public is both willing and able to take on a lot more than just data gathering. In some cases, for example, citizens may analyze data that they collect and engage in the process of science-based decision making. Exploring jellyfish, with their mysterious and rather cryptic nature is a wonderful opportunity to engage citizens and build on their natural interest and curiosity in order to explore different modes of participation in citizen science, as will be discussed in this presentation.

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Indigenous and non indigenous species along Italian coasts: jellyfish records from a "Citizen Science" approach

JBS-13 / Oral Presentation_02

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Sentences such as "little is known about benthic polyps", "little is known about the effect of temperature on feeding and growth of jellyfish", "we lack information on the polyp stage" are frequent in the scientific literature. Gelatinous plankton in general is difficult to monitor due to the sudden appearance and disappearance of gelatinous organisms, the scarce knowledge of their biology and the lack of historical data. Citizen Science proved to be a good tool to monitor the spatial and temporal distribution of gelatinous organisms in a wide spatial scale otherwise impossible to collect due to the high quantity of data collectors needed. Estimates of the presence and the abundance of indigenous and non indigenous jellyfish species along 8500 km coastline in Italian waters has been monitored with a Citizen Science approach from 2009 to 2015. The study involved tourists, divers, swimmers, fishermen, and leisure boat users who uploaded records from the link http://www.focus.meduse.it/meduse/ or used the smartphone app "focus meteo medusa". At least 25 species (*Aurelia* is a complex species) were identified, many are native and few are spreading in the Mediterranean Sea from the Atlantic or the Suez Canal. Species are not equally distributed, but each follows a species-specific spatial distribution along the Italian sectors of the Mediterranean Sea, probably due to specific environmental conditions mainly temperature and sea bottom depth. Improvements on the knowledge of the ecology and distribution of jellyfish species identifying hot spot areas for blooms will contribute to our adaptation to the impacts on tourism activities, fisheries, and aquaculture.

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The Medjelly App: a preventive and mitigation tool against jellyfish blooms involving a citizen science network

JBS-13 / Oral Presentation_03

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Jellyfish blooms in coastal areas usually generate public alarms and socio-economic impacts. Delivering up-to-date information is a strong countermeasure against this problem and developing mitigation tools helps reduce its impact. Considering this, the Medusa research group of the Institute of Marine Science (ICM-CSIC) from Barcelona developed the Medjelly App. The Medjelly mobile application works daily during the summer season providing citizens with real-time information about jellyfish presence in coastal areas. Within the framework of the Med-Jellyrisk Project, this App has also been developed for Malta and Tunisia. Along the Catalan coast (Spain), the App works within a collaborative citizen science approach, involving coastal municipalities and administrations, through a jellyfish observation network formed by trained personnel from the Rescue Services of 260 beaches. Volunteers collect the information about presence of jellyfish, together with beach flag status and some environmental parameters every morning, and after jellyfish experts validate the information, it is posted daily in the application. Results showed that this kind of tools are highly appreciated within society as a way of providing users with a useful tool to address jellyfish outbreaks, and volunteer participation is being rewarded by public information feedback on jellyfish awareness. This App is the first worldwide App that delivers daily updated information about jellyfish presence in coastal areas. Since 2015, the MedJelly App also includes predictive models for the presence of jellyfish blooms in the next 24 and 48 hours.

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Forecasting jellyfish blooms in the Mediterranean Sea: The Med-JellyRisk Project

JBS-13 / Oral Presentation_04

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Different approaches have been developed with the aim of mitigate the impact of jellyfish blooms in coastal areas. These include warning flags, specialized anti-jellyfish nets and, to a much lower extent, risk maps for jellyfish blooms. The Medjellyrisk Project (www.jellyrisk.eu) aimed to create a western and central Mediterranean Basin forecasting platform. An integrated Collaborative Citizen Science approach has combined abundance data on stranded individuals of jellyfish and those recorded in coastal waters from four different Mediterranean countries (Spain, Italy, Tunisia and Malta) in a single database. The aim of this work is to create a forecasting platform where the probability of a jellyfish bloom arising can be foreseen. Stranded and near-to-coast jellyfish presence data was processed using a Species Distribution Model (SDM) approach, where different correlative and classification models were fitted on the abundance data so as to create an ensemble of predictions. Different water environmental variables were used as explanatory variables, depending of the spatial location and jellyfish species of concern. Those spatially-explicit predictions were then projected in time using data from the MyOcean program (http://www.myocean.eu/). Jellyfish presence data as well as the forecasted probability of a jellyfish bloom arising was communicated to the general public through the free-download mobile App (iMedjelly) and from the project's webpage (http://jellyrisk.eu/en/jellyfish-presence-forecasting-selector), providing citizens with up-to-date and validated information. In this way, this project reacted to the large demand by different beach users, stakeholders and institutions for such management tools within bathing areas.

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Citizen science: a tool to the past and present occurrence of the sporadic *Rhizostoma luteum* in the NE Atlantic and Alboran Sea

JBS-13 / Oral Presentation_05

Karen Kienberger, Laura Prieto

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Rhizostoma luteum is a scyphomedusea that was first described in 1827 by Quoy & Gaimard under the name *Orythia lutea* based on nine specimens collected from the Strait of Gibraltar (Southern Iberian Peninsula). After 60 years of no scientific records of this species, in 2013 a phylogenetic analysis ratified that *R. luteum* differed from *Rhizostoma octopus* and *Rhizostoma pulmo*. In this present study, we report historical and recent records of living and stranded specimens of *R. luteum* since 1998 to evaluate the frequency of sightings of this considered rare specie. We analysed citizen science data to review historical accounts from the Northeastern Atlantic and the Alboran Sea. Photographic materials were taken by professional and amateur underwater photographers and videographers. Because of its similarity with the closely related Mediterranean *R. pulmo*, *R. luteum* was frequently misidentified in the Alboran Sea and, likewise, with another medusa from the order Rhizostomeae *Catostylus tagi* in the adjacent Atlantic Ocean coastal regions in the last two decades. In the past 17 years, we were able to confirm more than 150 observations of *R. luteum* in coastal waters of South Iberian Peninsula and Northwestern Africa, demonstrating that this medusa is not such a rare species after all. In this framework, citizen science campaigns are an effective tool to study the past occurrence of gelatinous macroplankton.

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Physalia physalis along the Southeastern Pacific Coast: Two years of unusual massive arrivals

JBS-13 / Oral Presentation_06

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Physalia physalis inhabits tropical to templates waters from 55°N to 40°S. Along the Southeastern Pacific the scarce reports shows sporadic events of stranded colonies in the continental coast and oceanic islands. Massive arrivals have been documented previously accounting for hundreds of stranded colonies mostly in central Chile. All these events were reported during the spring-summer period and were assumed to be related to warm ocean conditions and speculations about the ENSO role in its arrivals were proposed. During the years 2014 and 2015 the Chilean Navy, trough their Port Captaincy, reported massive arrivals of colonies of Portuguese man-of-war during the winter/spring seasons along the Chilean coast. Due to the magnitude, in terms of abundance and geographical spread, of the stranding a collaborative work among the Chilean Navy, the Ministry of Health of Chile and the Gelatinous zooplankton ecology group (Catholic University of Valparaíso) was necessary. The analysis of data showed an increase in the maximum numbers of colonies stranded from 2014 to 2015 (1021 to 2780), possibly reflecting favorable conditions for *P. physalis* reproduction offshore. Contrasting temporal stranding patters were observed and even though the central coast of Chile received the highest levels of stranding, the northern area reported the majority of people stung by these arrivals. We extend the southern limit of the species (until 42° 38' S) and discuss about the role of environmental variables associated with the transport of colonies to the coast associated with the strong ENSO registered for those years in the Southeastern Pacific Coast.

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What do we know about the stinging beauty of the sea?

JBS-13 / Oral Presentation_07

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This study is about a questionnaire developed to increase people's awareness of jellyfish. A questionnaire was distributed to 226 people in the touristic areas of the west and the southwest regions of Turkey, with the participants consisting of holiday-makers, people working in the tourism sector, fishermen, divers as well as local dwellers. Overall, 78% of the participants had previous awareness of the existence of jellyfish, whereas the remaining 22% had heard about jellyfish for the first time only. The most known jellyfish species were *Aurelia aurita*, *Cotylorhiza tuberculata*, *Chrysaora hysoscella* and *Rhizostoma pulmo*. In total, 42% of the participants had run into jellyfish at least on one occasion before. The most common injuries were erythema, itching and blistering, and two people retained scars caused by *Pelagia noctiluca*. Of the participants that were injured by jellyfish, 88% did not seek hospitalization or health care, 76% were unaware of the measures necessary following jellyfish injury, and 96% of those who spotted jellyfish whilst swimming or from the beach did not inform any academic institution or research organization.

The present questionnaire-based study, the first of this kind in Turkey, has shown that even people affected by jellyfish injuries fail to notify relevant institutes or organizations. Further questionnaires and related projects should be implemented so as to increase people's awareness of jellyfish-related risks in other parts of Turkey.

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Abstracts for Poster Presentations

Gaining insights into deep-sea medusae: Population ecology of *Periphylla periphylla* within a Norwegian fjord

JBS Poster Presentation_01

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Periphylla periphylla is a mesopelagic jellyfish species that is well adapted to the deep-sea environment. However, mass occurrences of *P. periphylla* have been discovered within various shallow Norwegian fjords, including Lurefjorden and Halsafjorden. As many as 2.5 ind m^{-3} have been reported within these areas, which are abundances two to three orders of magnitude greater than oceanic environments. These deep-sea medusae are found at atypically shallow depths in fjords and as such can be sampled with greater ease than the open ocean. The aim of this study was to provide a basis for understanding the population ecology of medusae within Lurefjorden, and also contribute to the current biological understanding of the species. In this study, morphological and biomass data collected from Lurefjorden during August 2015 was combined with previous data from 2010-11 to produce an assessment of seasonality within the fjord. The reproductive traits of 68 sampled individuals were described using histological methods on gonad tissue. Investigations into the sclerochronology of scyphozoan jellyfish as a whole were attempted on dissected marginal sense organs of *P. periphylla*. This was in an effort to better understand the ages of individual medusae, which currently cannot be accurately established due to their morphological plasticity. Isolated statoliths were imaged using scanning electron microscopy (SEM), and ImageJ was used to count individual liths to provide an assessment of age. This study will be combined with the results of reared individuals of a known age to produce a more accurate understanding of individual medusae.

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Moon jellyfish, *Aurelia aurita*, in the Gulf of Gdansk (southern Baltic Sea): threatening predator or not?

JBS Poster Presentation_02

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The moon jellyfish *Aurelia aurita* occurs continuously in the Baltic Sea and is the dominant scyphomedusa species in the Gulf of Gdansk (southern Baltic Sea). The occurrence of *Aurelia aurita* and population size in the Polish fisheries zone of the Baltic Sea was described for the first time in 1993, however no data on the size, weight, diet of the medusae or their significance in the pelagic food web were presented. Therefore, the aim of our study was to investigate present population size of *A. aurita* in the Gulf of Gdansk and to determine their prey structure to define their role in the regulation of the mesozooplankton community in this area. Our investigation showed that medusae were present in the water column from June to November, with maximum occurrence in August and September. The medusa bell diameter and weight increased beginning in July and reached maximum values in October. A strong relationship between bell diameter and wet weight was determined. No ephyrae were observed during the study period. Gastric content analysis revealed that the medusae fed mainly on copepods and cladocerans. The rotifers that dominated the water column throughout the study period were not identified in the contents of the jellyfish guts. Low numbers of plankton prey and the lack of fish larvae in *A. aurita* guts suggest that the jellyfish is of minor relevance as a predator and competitor in the Gulf of Gdansk.

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Phenology and abundance of the schyphomedusan *Discomedusa lobata* in Boka Kotorska Bay (Montenegro)

JBS Poster Presentation_03

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Discomedusa lobata, a rare schyphomedusan in the Mediterranean Sea, recently has been observed in Boka Kotorska Bay. Jellyfish sampling and abundance estimating was done by SCUBA. Additional observations were made by remote video from a research vessel. The first reliable record was in 2013 when specimens were found sporadically from early March to mid-July in the inner bay. The first bloom, estimated at 100 individuals per 10 m^2, was in April 2014, with another in mid-May. The latter lasted two days, after which no individuals were observed. High numbers (10 ind. per 10 m^2) also were present for over 8 days in February 2015, after which individuals were found only sporadically. An extremely dense bloom at the end of March 2015 occurred in a shallow area influenced by spring water. Water temperature during blooms ranged from 13.5 to 19.1 C. Salinity generally was low, between 8.5 and 25.5. Bell diameters averaged 4.6±0.9 cm (range: 2.1 to 8.2 cm). Guts (50 specimens) contained prey (exclusively the salp *Thalia democratica*) only in March 2013. Stomachs were empty during other blooms. This, and the absence of past *D. lobata* blooms, is difficult to explain and underlines that the biology and ecology of this species is fairly unknown. Present observations suggest that low salinity and low temperature are important in their presence and abundance.

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Diversity and spatial distribution of Scyphomedusae and Cubomedusae from Argentina and Uruguay

JBS Poster Presentation_04

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We present the frequency of occurrence and spatial distribution patterns of Scyphomedusae and Cubomedusae from the Argentinean and Uruguayan continental shelf and their adjacent ocean basin. We gathered information collected by 72 oceanographic and fishery surveys carried out between 1981 and 2015 encompassing an area of ca. 1 million km^2 (34-56°S, 45-70°W). The main goal of those surveys was to collect data on fish stock assessment. However, the bycatch of non-targeted species provided the opportunity to assemble information about macromedusae over the broadest spatial scale ever studied in the region. We confirmed the occurrence of 14 scyphozoans and 1 cubozoan species previously reported for the region. *Lychnorhiza lucerna* and *Chrysaora lactea* were the most abundant species blooming every summer and reaching the highest abundances/biomasses. *Desmonema gaudichaudi, Chrysaora plocamia* and *Periphylla periphylla* were frequently observed at low abundances blooming only occasionally. The species *Phacellophora camtschatica, Aurelia aurita* s.l., *Drymonema gorgo, Atolla chuni, Stygiomedusa gigantea and Pelagia cf. noctiluca* were observed in different occasions throughout the study period but never reaching high abundances. Spatial distribution patterns and their main oceanographic features of all these species are provided. *Atolla wyvillei, Stomolophus meleagris, Desmonema comatum* and *Tamoya haplonema* were reported one or two times over the 34-years period. Although new species/reports can be found as surveys are undertaken, these results are considered as a reliable baseline for ecological studies aiming to understand the ecological role that these jellyfish can play in the marine ecosystems due to the analyzed spatio-temporal scales.

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Mnemiopsis leidyi in the Berre lagoon: predation, reproduction, and population dynamics

JBS Poster Presentation_05

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The Berre lagoon is the largest French water body located near Marseille. It has been under strong anthropogenic pressures since the Romans leading to pollution events as well as large freshwater inflow starting in the '60s from the St Chamas EDF power plant. The status of the lagoon after ~20 years of rehabilitation efforts is of a typical brackish environment where increasing numbers of marine species. For the first time observed in blooming conditions in September 2005, the invasive species *Mnemiopsis leidyi* has become a dominant component, forcing through its high abundance, high reproduction and predation rates the functioning of the whole lagoon. Spatial distribution through the lagoon appeared to be forced mainly by temperature, as salinity plays little role; *Mnemiopsis* being often found in large aggregations at the mouth of the main rivers and within the outflow of the power plant. Winter temperature minima (<3°C) are driving the survival of the population. Impact of *Mnemiopsis* on the zooplankton community structure has been assessed through gut contents observations as well as feeding experiments. The ctenophore appear to favor copepods nauplii, and adults but also large amphipods and cirripeds. The potential top-down control of *Mnemiopsis* on the secondary producers might alleviate pressure on the phytoplankton population, maintaining the eutrophic status of the lagoon. Additional work on the local *Aurelia* sp. population is also presented with information on the population dynamic, feeding rates on zooplankton community. Potential competition between *Mnemiopsis* and *Aurelia* (adult *Mnemiopsis* on ephyrae or adult *Aurelia* on larval stage).

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Dynamic and somatic growth of *Pelagia noctiluca* in SW Mediterranean Lagoon

JBS Poster Presentation_06

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The scyphozoan species *Pelagia noctiluca* is predominant jellyfish species with direct development in the Mediterranean Sea, however few data exist on its population dynamics and even less on its growth. Pelagic population dynamics and somatic growth of *Pelagia noctiluca* were investigated in Bizerte Channel (SW Mediterranean) in 2007. In this work, we provide a seasonal survey on the seasonal abundance changes of *Pelagia noctiluca*, individual size of juveniles and adults, maturity stage and the role of environmental parameters. Bi-monthly to monthly field observations showed a consistently presence of this species year round, with a seasonal oscillation in abundance. Highest values were reported during winter (6.5 ind. m^{-3} on February 2007). Juveniles were only present in winter indicating the reproduction period. Bell diameter displayed a constant growth, with a daily growth ranging from 0.2 to 0.8 mm, reaching a maximum bell diameter of 13 cm on July. Temperature appeared to be the lending factor of *Pelagia noctiluca* growth.

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Patterns of spatial and temporal variation of jellyfish abundance along the coast of Uruguay (South America) using shoreline surveys

JBS Poster Presentation_07

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Several jellyfish species have the ability to form large nuisance blooms which negatively impact coastal industries, particularly tourism. A lack of crucial baseline data in Uruguay prevent us from predicting and responding to such events. Thus, the main objective of this study was to elucidate patterns of spatial and temporal variation of jellyfish species along the estuarine and oceanic coast of Uruguay. Shoreline surveys were made along 350 km of the coast divided into three zones: estuarine (15 sites; 1194 surveys), intermediate (15; 1108) and oceanic (7; 327), during summer at the peak of tourist season (Dec-Mar, 2011-2015). Fourteen jellyfish species stranded have been identified. Frequency of strandings increased from the estuarine (22-55%) to the oceanic zone (81-80% of surveys). Most strandings took place in December and January in all zones. Species composition and relative abundance varied significantly among zones and over time within zones (PERMANOVA, $p < 0.01$). *Chrysaora lactea* and *Lychnoriza lucerna* were the most dominant species in the three zones; *Liriope tetraphylla* and ctenophores were most abundant in estuarine and intermediate zones. Contrarily, *Velella velella, Porpita porpita* and *Physalia physalis* were abundant and stranded more frequently in the oceanic coast. This study represent the first continuous beach survey (ongoing effort) for Uruguay and also for South America. Our beaches surveys provide valuable information on distribution and temporal variation of abundance for several jellyfish species, not only to the scientific community, but also to the general public, on the distribution, abundance and period of occurrence of jellyfish.

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The neustonic environment in the Gulf of Lion: contribution of gelatinous zooplankton and microplastics

JBS Poster Presentation_08

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Air/ocean interface is largely influenced by the environmental stressors such as winds, river flows, and rain falls. Neuston community composition and functioning within the top 30cm of the ocean are specific reflecting these environmental constrains. Neuston is inhabited by commercially important crustacean and fish larvae, copepods, but also large numbers of gelatinous zooplankton. Siphonophores, pteropods, heteropods, cnidarian and chaetognathes are very common components. Characteristics of the community of neustonic gelatinous zooplankton in the Bay of Marseille and the gulf of Lion is presented. Clear seasonal variations as well as short term variation linked with outflows of the Rhone River are presented. Siphonophores appeared to be descending to deeper waters when the top layer is characteristics of the freshwater Rhone river plume. Pteropods and heteropods abundance is highest in spring and summer. The impact of pH variations following CO_2 increases is estimated on the calcification of pteropods. Surface layers of the oceans are also an important sites for plastics accumulation. Also microplastic are often present in the samples, their contribution to the overall neustonic community biomass is often low. Are microplastics increasing the survival of some neustonic species by providing larger support surfaces? Examples of larger plastic as support for hydrozoans polyps' development in the North Atlantic are also presented.

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Feeding and growth rates of scyphozoan ephyrae (*Aurelia* sp., *Chrysaora plocamia* and *Lychnorhiza lucerna*) under distinct food regimes

JBS Poster Presentation_09

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Basic aspects of the feeding biology of scyphozoan ephyrae are important for understanding their ecological role and are essential for efficiently cultivating distinct species. This study investigated feeding and growth responses by recent released ephyrae of *Aurelia* sp., *Chrysaora plocamia* and *Lychnorhiza lucerna*, fed two different diets: Artemia nauplii and suspended POM (particulate organic matter); other food sources (rotifers) will be tested. Experiments were carried out with 15 ephyrae per species at saturated food concentration (220 ind. l^{-1}; 704µg AFDW l^{-1} for Artemia nauplii and 4mgl^{-1}; 2400µg AFDW l^{-1} for POM) at 18°C, over 10 days. For Artemia nauplii, clearance rates were on average 166.47, 56.69 and 240.24 ml ephyra^{-1} day^{-1} for *Aurelia* sp., *C. plocamia* and *L. lucerna* respectively. For the same treatment, daily ration (in terms of AFDW) were on average 166%, 56% and 247% When feeding on Artemia nauplii, the specific growth rates of these species were 53.7%, 19,6% and 41,9% day^{-1}. However, when feeding on POM these species had lower growth rates of 5%, 4,8% and 10.3% day^{-1}. All three species can nourish on Artemia nauplii and POM. The specific growth rate of the species decreased along ephyrae growth for both food types. Despite *L. lucerna* had the highest feeding rates, its growth rate was lower than *Aurelia* sp., which indicates higher growth efficiency by the latter. Although ephyrae representing distinct scyphozoan lineages share remarkable morphological similarities they have distinct feeding and growth rates, which should be considered in ecological and population dynamics studies.

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Does environment temperature rules morphological development patterns in rhizostome medusae?

JBS Poster Presentation_10

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It has been demonstrated that the early morphogenesis in *Aurelia* sp. can respond to altered fluid regimes, imposed by changes in temperature. We investigated whether *Lychnorhiza lucerna* have developmental patterns of umbrella and of oral arms filtering structures that can be explained by differences in flow regimes, imposed by changes in temperature during development. Specimens were photographed every two days during the first ten days and every four days until thirty-five days under temperatures of 15, 20 and 25°C (n=5 per treatment), with standardized ration. We measured spacing and length of digitata (on oral arms), and bell continuity (BC), as the percentage of the potential bell area comprised of tissue. Data were analyzed through Linear Mixed Effect and Generalized Least Square models. Temperature did not influenced digitata dimensions, as its spacing ($x^2(1)=0.24$, $p=0.89$) and length ($x^2(1)=0.59$, $p=0.74$). However, our preliminary data suggest temperature has affected bell development (as BC) ($F=4.69$, $p<0.0001$). Similar to *Aurelia* sp., ephyrae of *L. lucerna* cultivated at lower temperature developed lower BC (i.e. larger gap areas between lappets) than those at higher temperatures (Post-hoc: 15x20°C, 15x25°C, and 20x25°C $p<0.001$). This effect is attributed to the increased boundary layer surrounding lappets (at lower temperatures), which provides an additional paddling surface enabling the discontinuous bell margin to operate as a continuous surface during swimming. Yet we found that the digitata are covered by motile epidermal cilia, which enhance fluid transport through filtering gaps and minimizes the potential effect of increasingly boundary layers thickness at lower temperatures.

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Population predation impact of jellyfish (*Aurelia aurita*) controls the maximum umbrella size and somatic degrowth in temperate Danish waters

JBS Poster Presentation_11

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The population density and individual size of the common jellyfish *Aurelia aurita* were studied during 2014 and 2015 in two Danish fjord systems, Kertinge Nor and Mariager Fjord in order to obtain a better understanding of the driving forces for somatic degrowth (shrinkage) of medusa during late summer and autumn. In both fjord systems the numerous medusae were characterised by their small body size and by a distinct phase of degrowth. The population predation impact of *A. aurita*, with estimated zooplankton half-lives of only about 1 to 3 d, indicated that shortage of prey controls the maximum umbrella size of only 60 to 100 mm and the subsequent degrowth. When jellyfish were brought into the laboratory in the late degrowth period and continuously fed with natural zooplankton concentrations, this resulted in initial growth rates of 11.3 and 24.4 % d^{-1} in two series of experiments with 56.9 and 5.5 mm umbrella diameter, respectively, and considerably longer survival than of jellyfish in their natural environment. The degrowth rates in Kertinge Nor (-1.2 % d^{-1}) and Mariager Fjord (-1.5 and -0.7 % d^{-1} in 2014 and 2015, respectively) were slightly lower than observed in laboratory starvation experiments (-3.2 and -4.2 % d^{-1}), indicating that the starvation of jellyfish in nature was less pronounced, i.e. some prey organisms may have been available although the short estimated half-lives of zooplankton suggested a pronounced predation impact exerted by the jellyfish.

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Seasonal length-weight relationship of moon jellyfish *Aurelia aurita* in Black Sea coast of Turkey

JBS Poster Presentation_12

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In the study were determined seasonally length-weight relationship of moon jellyfish *Aurelia aurita*. Data were collected monthly (December 2012-November 2013) from Sinop coasts the Southern Black Sea of Turkey. Standard plankton nets were used on sampling. A total 1358 individual were measurement in the study. Size and weight of samples was taken as disc diameter and wet weight (volume). Seasonal (autumn, winter, spring and summer) relationship were calculated length-weight relationship, $Ww = 0{,}1251L^{2.5567}$ ($R^2 = 0.9136$; n=704), $Ww = 0.0815L^{2.7181}$ ($R^2 = 0.9646$; n=222), $Ww = 0.1012L^{2.6813}$($R^2 = 0.9678$; n= 307), $Ww= 0.1289L^{2.6844}$ ($R^2 = 0.9484$; n=125) respectively. Results showed that "a" and "b" value of moon jellyfish *Aurelia aurita* varied with season in the Black Sea.

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Distribution and taxonomic status of the species *Chrysaora lacteal* (Cnidaria: Scyphozoa) in the southwestern Atlantic

JBS Poster Presentation_13

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Chrysaora lactea is one of the most common Scyphozoa species and widely distributed in Brazilian coast, reaching about 25 cm in bell diameter, showing a remarkable variation in colour patterns (mainly milky-white, thus the name). The distribution of the species is continuous from the Gulf of Mexico to the north coast of Argentina. The aim of this study was to verify the morphological and molecular structure of *Chrysaora lactea* specimens distributed throughout the Southwestern Atlantic comparing individuals from different regions. This approach focused on the detection of possible cryptic species among individuals identified as *C. lactea*. The study dealt with comparative observations of morphological characters and morphometrics (mainly nematocysts). At the same time, we also evaluated the variation of the mitochondrial marker 16S searching for possible variation between the specimens from different places. The sampled area comprised the entire Brazilian coast and northern Uruguay (0.5°S, 23°S, 24°S, 34°S), reaching more than 5,000 km. The morphological and morphometric (cnidome) results indicate that there were no significant variation between specimens, and the data showed no separation between sampled populations. The measured variation of the molecular marker was 0-4% (K2P) and it was observed in specimens collected in the same place or in separate locations. The common genetic distance for this marker compared to other species of the genus is always above 10%. Concluding, specimens collected in northern Brazil are similar to those collected in Uruguay, independent if they came from estuaries or open ocean environments.

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Genetic diversity of a commercially-harvested jellyfish, *Rhopilema hispidum* in the Southwest Asia

JBS Poster Presentation_14

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Jellyfish bloom occurs in various regions in the world ocean. However, the mechanisms of forming blooms remain unclear in most of the species/locations. To clarify whether the jellyfish bloom occur as a result of rapid growth in local populations or a result of physical accumulations of the populations from wider regions, it is important to know the genetic structure of blooming populations and their connectivity in various locations. We investigated the genetic structures of local populations of the rhizostome jellyfish, *Rhopilema hispidum* that has been harvested as a human food, mainly in Southeast Asia, and their connectivity. The jellyfish samples were collected at 6 different locations in Malaysia, Thailand, and Vietnam, and a mitochondrial DNA maker, cytochrome c oxidase subunit I (COI) were amplified. Of 530 nucleotides of the COI sequenced from 93 individuals, 30 haplotypes were identified. Haplotype diversity (h) for samples from 5 different locations ranged between 0.667 and 0.879, and nucleotide diversity (π%) ranged between 0.183 and 0.486. These values were within the range those reported in other species in Rhizostomeae. Haplotype network analysis showed that *R. hispidum* population has two genetically distinct groups: one consisted of all locations investigated that suggested high connectivity, and the other consisted of specimen endemic to Malaysia. This endemic group may be a part of the Indian Ocean population.

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Molecular confirmation of nudibranch predation on cnidarian species in Barnegat Bay, NJ USA

JBS Poster Presentation_15

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Large populations of the scyphozoan jellyfish, *Chrysaora quinquecirrha*, occur during the summer months in Northern Barnegat Bay, NJ USA and its adjacent lagoon systems. *Chrysaora quinquecirrha* has been considered a resident nuisance species within the bay since 2008. While medusa are present from late spring through early fall, the sessile polyps and podocysts of this species can be found year round and the exceptional rate at which these sessile forms reproduce asexually ensures the continuation of the species in this system. Barnegat Bay is home to several species of *Eolid* nudibranch species, which are known to feed upon cnidarian polyps, like that of *C. quinquecirrha*. Field settling plate data reveal an inverse relationship between the abundance of settling polyps and the relative abundance of nudibranchs in samples. Additionally, lab investigations have shown active consumption of *C. quinquecirrha* polyps by nudibranchs. Using a CTAB chloroform extraction method, we have been able to extract cnidarian DNA from the gut and cerata of field collected nudibranch species collected in Barnegat Bay. This DNA was subsequently amplified via PCR with Universal Cnidarian primers, followed by DNA sequence analysis. Through these techniques we have been able to confirm that wild *Eolid* nudibranchs are feeding upon sessile cnidarians including the polyps of *C. quinquecirrha*, showing that nudibranchs may be able to exert substantial top down control on populations of sessile polyps.

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Morphological variation among Brazilian and Mexican populations of *Cassiopea andromeda* (Forskål, 1775)

JBS Poster Presentation_16

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Species identification among members of the genus *Cassiopea* is a hard task due to the overlap of morphological features, and variation can be detected at intraspecific and interspecific levels. In order to compare the morphological variation of two putative populations of *C. andromeda*, we analyzed specimens from the SE regions from Brazil and Mexico. Specimens were preserved in 4% formaldehyde solution in seawater and 96% ethanol for morphological observations and comparison using sequences of the molecular marker COI. Macro-morphological characters observed were: diameter and shape of bell, number of rhopalia, length of oral arms, number of marginal lappets, and sex ratio. We found a wider morphological variation and also a set of abnormalities in the number of oral arms and subgenital ostia, in the northernmost population. All the jellyfishes analyzed from the Brazilian population were males while the Mexican population showed a ratio of 3:2. On one hand, the almost absence of phenotypic variation observed in the Brazilian population could be related with the lack of genetic difference, probably because they arose from asexual reproduction by the polyps; such morphotype could represent a genotype adapted to the wide fluctuations of salinity and temperature, being able to be present in large numbers. On the other hand, a wider variation in the Mexican population could be the result of a broader genetic variation between individuals as a consequence of sexual reproduction, thus giving rise to a larger number of morphotypes, each one with different abilities to respond to distinct selective pressures.
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Genome size and Jellyfish Evolution

JBS Poster Presentation_17

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The study of genome size diversity is an ever-expanding field that is highly relevant in today's world of rapid DNA sequencing. Despite that, our knowledge on the distribution of and reasons for why certain lineages contain large genomes while others do not is still very poor. Three classes of Cnidarian present mutualistic interaction with *Symbiodinium*, a photosynthetic dynoflagellate, and the implications of the presence of symbiont on the systematics and genome of the species that host it is still unknown. To help clarify this uncertainty, the genome size of 54 species of the 18 families of Scyphozoa will be estimated by flow cytometry. Due to the almost obligate *Symbiodinium* presence in Scyphozoa that host it and due to the longevity of the association (about 240 million years), I hypothesize that some metabolic paths might have been lost in the host, resulting in reduction of genome size. The results have implication for the systematics of Scyphozoa as well as genome size evolution.

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Nematocyst types of *Chrysaora hysoscella* (Linnaeus, 1766) from Turkey

JBS Poster Presentation_18

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In this study, types and length-width values of nematocysts of *Chrysaora hysoscella* were investigated. Five *C. hysoscella* specimens were obtained in March and April 2012 from Güllük Bay, Muğla Province, Turkey. Samples were taken from tentacles of the specimens. Frozen samples were keep on +4°C and then stirred by homogenisator. Samples were centrifuged for five minutes on 5000 rpm. Squash preparation method was used to identify discharged and undischarged nematocysts and samples were observed on light microscope. A hundred nematocysts of per individual were selected randomly, identified and measured. Measurements of discharged and undischarged nematocyst capsules were made with using ocular micro meter at x100 objective and photographed.

Four types of nematocysts which are holotrichous O-isorhiza, holotrichous a-isorhiza, holotrichous A-isorhiza and heterotrichous microbasic eurytele were identified. a-isorhizas and O-izorhizas were the most frequently seen in the samples, while euryteles were rarely found. Mean lengths of the discharged and undischarged euryteles were 6.33 and 8.45 micro meters, respectively. Holotrichous O-isorhizas which were noticeable with very long threads, had up to 18 micro meters length and width. Mean length and mean width of the holotrichous a-isorhizas were 4.61 and 3.07 micro meters in discharged and 6.02 and 3.88 micro meters in undischarged nematocysts in the specimen with 25 cm bell diameter. Length and width range of the undischarged A-isorhizas was found 13-11 and 8-6.5 micro meters, respectively. Also, immature A-isorhizas were determined in the observations.

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Hitchhikers on Jellies. The opportunity of the Mozambique current

JBS Poster Presentation_19

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Phoresy between marine organisms and jellies is poorly investigated due to the difficult to find and follow these associations in open waters. Scyphozoans, cubozoans, hydrozoans, and tunicates can be carriers of crustaceans, echinoderms, fishes but also other cnidarians. However, we are far from understanding the degree of dependence linking the two symbionts. Some relationships may evolve from simply phoresy to cleptocommensalism, parasitism or predation.
Beside transport, jellies provide protection from predators, food and a habitat suitable for reproduction; moreover, they increase the chances of dispersal of the phoronts. Since jellyfish blooms can occur during a limited period of the year, the temporal associations ask for finely tuned synchronization.
Possible mechanisms of meeting between jelly-carriers and their phoronts have been hypothesized:
1) Encounter in the planktonic realm between the jellyfish and the adult/juvenile phase of the symbiont
2) Meeting occurring at the surface, with vagile organisms associated to other living carriers or floating litter
3) Meeting on the seafloor due to vertical migrations of the zooplanktonic host
The increasing blooms of gelatinous plankton in the last decades could have impacts on trophic webs, since jellyfish are predators of eggs and fish larvae and compete with fish for planktonic preys. It is also likely that huge blooms influence the dispersal and the survival of hitchhiker symbionts. At Ponta d'Ouro (Southern Mozambique) these relationships are seasonally documented with a very high diversity. Here, we show some of these relationships and suggest this area as a key one for this kind of studies.

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Analysis of correlationship of long-term sea temperature variation on the jellyfish blooms in Korea

JBS Poster Presentation_20

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The objective of this study is to empirically analyze the relationship between sea temperature and jellyfish blooms. Ever since the 2000s, jellyfish population has been dramatically increased, which brought negative influence on the Human safety and the fisheries activities. Jellyfish blooms have been recognized as an effect of climate change, but there has been no empirical evidence to support such relationship. In this study, the relationship between sea temperature and jellyfish blooms has been analyzed by using the regional jellyfish monitoring data(2010~2015) and all coast of the country stationary observing data(1993~2015) of National Institute of Fisheries Science. Since the dependant variable carries left censoring issues, we used the panel tobit model. Our results indicate that there are statistically significant relationship between sea temperature and jellyfish blooms.

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Population variability of *Aurelia aurita* in the Beaulieu River; with comparison to Southampton Water and Horsea Lake

JBS Poster Presentation_21

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The common jellyfish *Aurelia aurita* typically follows a seasonal reproductive cycle, forming annual spring-summer blooms in many coastal brackish water systems on northern Europe. In order to understand the variability in extent and timing of bloom formation, the population dynamics of *A. aurita* was studied in a number of locations in southern England.
The population dynamics of *A. aurita* medusae in the Beaulieu River, a small tidal estuary connected to the Solent estuarine system, differed between 2011, 2014 and 2015. The Beaulieu River consists of a dense *A. aurita* population following a typical seasonal cycle from February to June. During 2015 there was evidence of an unusually prolonged bloom occurrence – until October. Bell diameters of medusae increased from February through to June, which was driven by an increase in temperature and zooplankton abundance. Considerable inter-annual differences have also been observed in the *A. aurita* population in the nearby industrial estuary, Southampton Water, with ephyrae and medusae completely absent during the mid-2000s and in 2014. It appears that the medusa population has declined in Southampton Water from the late 1990s, but the reasons are unclear. In contrast, the jellyfish population in the enclosed Horsea Lake still persists but differences are observed in the timing of recruitment. For example, ephyrae were found in the water column throughout the winter-late spring in 1994 to 1996. Similarly, strobilating polyps and ephyrae have been observed using underwater photography in December 2015. By contrast, in 2010, ephyrae only started to occur in June following an extremely cold winter, and medusa remained small. This study shows considerable plasticity in terms of timing, growth and reproductive behaviour of *A. aurita* , even in closely located populations.

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Predictive modelling in brazilian jellyfish

JBS Poster Presentation_22

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Jellyfish have a unique life cycle that allows them to reproduce at an accelerate rate and are able to tolerate harsh conditions. Jellies are top plankton predators, affecting the abundance of fish larvae and eggs, consequently fish stocks and populations of other organisms that spend their life or just part of it in the plankton. There are considerable sources of distribution data of some species and based on that we were able to collect presence and absence data for two species, the *Rhacostoma atlanticum* and *Chrysaora lactea* that are very common in Brazilian coast. Based on abiotic layers obtained from Bio-Oracle system and NOAA, we applied MAXENT algorithm to predict the actual and future distribution (2100) for both species. According to the results obtained, both species have high resistance to several of the abiotic data, such as pH and temperature, one of the several aspects that have been changing in the oceans due to climate change caused by anthropic actions and global warming. The predisposition of these aspects is to keep increasing and therefore the jellyfish populations will equally increase. People have been experiencing problems regarding both species in fishery, mainly the *R. atlanticum*, as the individuals tend to clog the nets and overweight the fish catch; especially double-rig trawling and bottom gillnet. The problematic on *C. lactea* is mainly regarding painful sting in tourists. Both scenarios are bound to happen more often overtime, once these animals have few predators and high resistance to the changes in the environment.

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An integrated approach to enhance predictive accuracy of jellyfish impact on coastal marine ecosystems

JBS Poster Presentation_23

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Climate change and overfishing promote marine ecosystem instability, thereby fostering low-economic value species with rapid turnover, such as jellyfish (i.e. cnidarian medusae and ctenophores). Growing evidence shows that jellyfish blooms have increased in coastal areas of Europe leading to a wide range of societal implications, including detrimental effects for fisheries and tourism. High abundance of jellyfish has caused important reductions of zooplankton biomass in Portuguese coastal ecosystems, with potential negative effects on early life stage of fish (eggs and larvae). To what extent such phenomenon is driven by global anthropogenic changes and their synergies, and how the increase of jellyfish abundance could influence the pelagic realm is still elusive due to the scarce studies on jellyfish in coastal areas of Southern Europe. Project JELLYFISHERIES (2016-2018) aims to unveil the underlying mechanisms through which global anthropogenic changes interact with jellyfish populations in Portuguese coastal ecosystems. This project relies on an interdisciplinary approach that includes retrospective analysis of bio-climate data plus experimental and field work, complemented by remote sensing data, new molecular-based tools (DNA barcoding, pyrosequencing) applied to biological samples, controlled laboratorial experiments and the development of predictive models in association with hydrological parameters. Results will provide new insights into the underlying mechanics linking global changes with jellyfish dynamics in Portuguese coastal ecosystems and assist in predicting jellyfish responses under future scenarios of Global Change.

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Jellyfish population in the Golden Horn Estuary, Istanbul

JBS Poster Presentation_24

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The numbers of jellyfish are perceived to be increasing in many areas worldwide, and this has triggered a growing scientific interest in the ecological importance of these organisms and species seem to be undergoing range expansions into new areas. The Golden Horn Estuary has been the favorite recreational area of Istanbul's cultures for centuries. It is 7.5 km long, 150–900 m wide, located southwest of the Strait of Istanbul (Bosphorus). Maximum depth is 40 m at the entrance and decreases below 10 m at inner parts where a 3–4 km zone was completely filled with runoff carried by two small streams until the early 1990s. So far, although several studies have dealt with changes occurred in water and sediment quality, macrobenthic fauna, ichthyoplankton and blooming of algae in the Golden Horn Estuary, only few studied zooplankton, and there were no jellyfish data. We focused on the jellyfish dynamic and their impacts on zooplankton in Golden Horn Estuary. Five jellyfish species (*Aurelia aurita, Mnemiopsis leidyi, Beroe ovata, Pleurobrachia pileus* and *Rhizostoma pulmo*) were seasonally encountered. The highest average abundance was recorded during autumn, while the least was observed during spring, as shown by the most common species in the area, invasive *M. leidyi* and resident *A. aurita*. Jellyfish abundance fluctuated with temperature and chlorophyll a. As a result, it is important to monitor the abundance of jellyfish species in the Golden Horn which is considered to be an extremely polluted estuary.

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Disentangling drivers of *Aurelia* sp.8 growth in SW Mediterranean Lagoon

JBS Poster Presentation_25

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Massive proliferations of jellyfish have ecosystem-wide implications and constitute an increasing concern in many coastal areas. Identifying the factors leading jellyfish growth and their life expectancy is essential to understand the proliferation causes. Here we assess the pelagic population dynamics and somatic growth of the scyphozoa *Aurelia* sp.8 in the Bizerte lagoon (SW Mediterranean). Seasonal population dynamics, individual size, environmental parameters and zooplankton density were monitored twice a month during 4 years (2012-2015). Field observations showed an ephyrae release in winter time (December-January) followed by a pronounced increase of bell diameter during spring (February to April) (daily growth 0.7 – 7.4 mm) before a decreasing period (daily shrinkage: -0.1 to -2.1 mm) until medusae disappeared totally from the water column. Despite an annual common pattern among the years, a marked variability was observed in the onset of medusae growth and in the bell diameter size between 2013 and 2014 populations. While in 2013 medusae growth onset began in February and the population bell diameter averaged 10.1 ± 4.8 cm, in 2014 the onset was observed earlier, in January, along with a significant larger bell diameter (mean 11.1 ± 4.9 cm). Statistical analyses (Linear regression, SEMs) pointed out that temperature, salinity, zooplankton and medusae abundance appeared as leading factors of *Aurelia* sp.8 growth in Bizerte Lagoon

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High temporal resolution study all year round of *Pelagia noctiluca* in the NE Alboran Sea

JBS Poster Presentation_26

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Of all the gelatinous organisms species that usually appear on the Northern Alboran coast (Western Mediterranean), the most common and the one, which has the greatest negative impact on the ecosystem and on human coastal activities is the scyphozoa *Pelagia noctiluca*. This jellyfish has substantial socioeconomic consequences, causing major concern for the sectors of fishery and tourism. Gelatinous zooplankton populations are affected by large-scale climate variation and regional environmental conditions associated with weather variability. Therefore, investigating the population dynamics of these organisms throughout all seasons of the year, and not just during the summer months, are mandatory. For the first time in the NE Alboran Sea, the abundance of *P. noctiluca* was studied at a fixed station in La Herradura (36.720278° N, 3.728333° W), Spain, between four consecutive years, from 2012 to 2015. Daily observations of presence (including abundance per square meter) and absence of this medusa were crossed with oceanographic and meteorological variables. Results demonstrate the year round presence of this species and its extreme fluctuations in abundance. Understanding the variables interfering with the presence of *P. noctiluca* at various time scales is crucial in order to implement this ecological knowledge in operational tools for coastal management in the future.

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Changes of jellyfish fauna after the Great Tsunami by the 2011 Tohoku Earthquake in southern part of Sanriku coast, Iwate, Japan

JBS Poster Presentation_27

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The Great Tsunami caused by the 2011 Tohoku Earthquake disturbed the seafloor and much Tsunami-derived debris was swept out to sea. Extensivesinkage of land was also observed. These events have the potential to affect the occurrence of jellyfishes that have a polyp stage in their life cycles. We have been studying the seasonal occurrence of jellyfishes in Ofunato bay and Okirai bay in the southern part of the Sanriku coast, Iwate, Japan since 2008. Soon after the tsunami, no *Chrysaora pacifica* were observed in Ofunato bay and no *Proboscidactyla flavicirrata* were observed in Okirai Bay. In 2012, the jellyfish fauna was almost the same as before the Tsunami. Reconstruction of fishing ports and coastal facilities for coastal safety began after late 2012, however, the jellyfish fauna has not changed. *Eutonina indicans* and *Tiaropsis multicirrata* in Ofunato bay and *Nemopsis dofleini* in Okirai bay have not appeared. Many *Cladonema pacifica* occured on seaweed on the new walls of piers in Okirai bay in 2014. The jellyfish fauna in 2015 was similar that in 2014, however, blooms of some species, like *Cl. pacifica*, were not observed. These changes may be caused by the increase of biodiversity of sessile organisms on the walls of piers and finishing of construction at fishing ports. The jellyfish fauna was not as affected by the tsunami as it has been by the subsequent human activities of dredging and reconstruction of facilities in coastal areas.

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Aurelia spp. Ecology in the Mediterranean Sea

JBS Poster Presentation_28

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Aurelia spp. are cosmopolitan scyphozoan species and probably the most studied jellyfish in the world. They inhabit nearshore waters, especially closed basins, such as coastal embayments, fjords and estuaries, occupying a great variety of habitats worldwide. Recent studies have addressed the biogeography of the genus *Aurelia* and reported that it constitutes a species-complex embracing numerous locally adapted species.
The Mediterranean Sea is a hotspot of biodiversity threatened by climate change, which is expected to have a significant influence on the biodiversity and biogeography of marine populations. Here we compiled a comprehensive data set on *Aurelia* spp. occurrence in the Mediterranean Sea and assessed the thermal niches as well as the phenology of the various populations.
Our results indicate that the species biogeography is restricted to temperate areas of the Mediterranean basin, whereas the seasonal pattern generally displayed an unimodal peak that occurs earlier in warmer systems. Our results highlight that the thermal niche of the species, where the bulk of the population (90%) is present, shows a temperature window from 12 to 20°C, although it is further constrained when accounting only for the northern populations of the western and Adriatic basins. Hence, while global warming has been claimed as one of the most important triggers for jellyfish outbreaks, the projected temperature increase of the Mediterranean Sea warns on the shrinking of favorable environmental conditions for the species with the concomitant risk of its potential decline and perhaps extinction in the Mediterranean Sea.

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Quantifying relationship between environmental changes and Giant Jellyfish (*Nemopilema nomurai*) blooms

JBS Poster Presentation_29

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The Giant Jellyfish *Nemopilema nomurai* is one of the largest medusae on Earth. This scyphozoan has the ability to form large blooms in the semi-enclosed basins of the East Asian Marginal Seas. Regional blooms of *N. nomurai* have become more frequent in the past 20 years than in any period previously recorded. In Japan, *N. nomurai* blooms are responsible for huge revenue losses and extensive equipment damage in commercial fisheries and other industries. Therefore, there is a need to improve our understanding of the causes and mechanisms behind *N. nomurai* blooms. The main objective of this project was to explore potential significant relationships between *N. nomurai* blooms and previously unexplored environmental factors. We tested aquaculture increases (especially shellfish), changes in fisheries, bottom salinity near polyp beds, hypoxia and monsoon event frequencies in EAMS. Environmental factors were analyzed using generalized additive models (GAMs). Our preliminary results indicate that the high frequency in *N. nomurai* blooms coincided with a sharp increase in aquaculture (particularly shellfish) in the East China Sea and the Yellow Sea. We speculate that a rise in shellfish aquaculture output would ecologically affect jellyfish population ecology because of increased polyp habitat from raft structures used to grow species and shell surfaces. Furthermore, aquaculture could impact the food web and even change local circulation patterns. Given a connection between rise in aquaculture and change in *N. nomurai* bloom frequency, this is an area for future research. This study contributes to our ecological understanding of *N. nomurai* and its blooms.

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Salinity-driven patches of *Pelagia noctiluca* and their top down impact on the northern Gulf of Mexico plankton community described with an in situ imaging system

JBS Poster Presentation_30

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Medusae of the holoplanktonic jellyfish *Pelagia noctiluca* are top planktonic predators, feeding on almost all zooplankton, eggs and fish larvae. Although this species is well documented in the Mediterranean Sea, records of *P. noctiluca* blooms in other locations are scarce and their predatory impact on zooplankton is relatively unknown. In this study, we used a high resolution plankton imaging system (the In Situ Ichthyoplankton Imaging System – ISIIS) to assess distribution of *P. noctiluca* medusae in relation to fine-scale biological and physical parameters in the Northern Gulf of Mexico during summer 2011. Our results indicated that *P. noctiluca* was most abundant in shallow waters (~10m) during the daytime, just below a surface plume of fresher water. Medusae displayed reverse diel vertical migrations (DVM), which is contrary to the DVM pattern seen in the Mediterranean. Average concentrations in shallow waters (10-25m) ranged from 0.2 to 0.9ind.m^{-3}, with an average Lloyd's patchiness index of 13.87, indicating strong aggregation tendencies, especially in the vicinity of salinity gradients. *P. noctiluca* abundance was significantly negatively correlated ($p < 0.0001$, Spearman rank correlations) with the abundance of several zooplankton taxa, including chaetognaths, hydromedusae, siphonophores, and ctenophores. These finding suggest that salinity changes can drive the abundance of *P. noctiluca* on small scales, and medusa can exert a top down effect on the abundances of zooplankton prey. *P. noctiluca* blooms have the potential to have widespread ecosystem effects if their abundances reach critical levels allowing them to deplete zooplankton populations on a large scale.

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Hydrographic variability as a driver of asexual reproduction and strobilation rates of *Aurelia* spp.: implications on long-term blooms

JBS Poster Presentation_31

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The Sea of Marmara is a permanently stratified basin with a salinity gradient from 18 to 38 and harboring a dense *Aurelia* population throughout the year. The asexual reproduction and strobilation rates of scyphistomae were tested for three temperatures; in-situ, in,situ+4°C (to simulate IPCC 2100 scenarios) and 15°C (as the year round temperature of the lower layer, deeper than 40 m) and four salinities (18, 24, 30 and 35) for a period of six months. The results demonstrated that asexual reproduction of the scyphistomae were higher at 30 and 35 salinity for all three temperatures, the difference being the highest at in-situ+4°C and 15°C constant enclosures. On the contrary, released ephyra numbers were the highest at 18 and 24 salinities, followed by 30 salinity. The strobilation percentages were higher at in-situ experiments at all salinities. The different salinity preferences during asexual reproduction and strobilation phases might possess an important contribution to high *Aurelia* abundance in the basin. In addition to the wideness of artificial substrates providing habitat for the scyphistomae, we have calculated that the seasonal extension of the upper layer thickness from 10 meters to 25 meters provides an additional 630 km² area with a changing salinity regime. The polyps inhabiting ~30-35 salinity strata during winter undergoes mainly asexual reproduction, while the extension of the upper layer thickness during spring-autumn provides a less saline environment for the same strata, enhancing ephyra release, thus contributing to the evolution of dense and long-term blooms.

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Winter occurrence of medusa *Liriope tetraphylla* (Cnidaria: Trachymedusae) in the western Portuguese Coast

JBS Poster Presentation_32

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Recent observations suggest that gelatinous zooplankton, which is ubiquitous in pelagic ecosystems, is increasing in temperate systems worldwide. These organisms play a key role as predators and competitors that can modulate the structure and dynamics of marine communities. Hydromedusae are numerically abundant and the most diverse group of gelatinous zooplankton in the world's oceans. However, due to their small sizes and the distinct life cycle these organisms are often ignored in sample analyses. *Liriope tetraphylla* is a common oceanic medusa frequently registered in coastal Mediterranean waters. The species has also been registered in eastern Atlantic waters in different seasons.
Zooplankton samples collected at the nearshore area of Nazaré and at the Berlengas-Watch biodiversity monitoring station (northwestern Portuguese coast), in winter 2015, revealed high population density of *Liriope tetraphylla*, the main medusa captured. The high abundance registered for both young and old specimens, indicated a high reproduction rate. Data is analysed in the view of the local oceanography and the possibility of a winter bloom is addressed. The discussion of eventual influences of climatic variability in the observed patterns and the issue of invasive species is also included.

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Spring bloom of *Velella velella* (Cnidaria: Anthoathecatae) off the western Portuguese coast

JBS Poster Presentation_33

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Rapid growth rates with consequent population increases of gelatinous plankton have been reported worldwide. The impact of the high abundances of jellyfishes on the decline of zooplankton communities has also been increasingly reported.
Velella velella is a pleustonic medusa that occurs in coastal temperate and tropical waters worldwide in high concentrations. It presents a life cycle, comprising a colony from which pelagic larvae are released. These larvae must ascend in the water column back to the surface, developing the characteristic sail-like structure that floats above the water surface.
Zooplankton samples collected with neuston nets in the northwestern Portuguese shelf off Aveiro coastal lagoon during a spring survey revealed a high abundance of *Velella* specimens, mostly in the colonial stage. Their direct exposure to the wind and surface circulation variability was responsible for a concentration of these organisms in superficial oceanic convergences areas. Their occurrence, following the predominant local alongshore currents, is discussed according to the local dynamics and the spring bloom characterized. The potential dispersal range in the area is also examined.

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Jellyfish organisms in the Cascais-watch biodiversity monitoring station time series

JBS Poster Presentation_34

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The patchy distribution of zooplankton in general and of gelatinous in particular is one of the problems limiting the correct depiction of distribution patterns. High concentrations of these organisms can be related with rapid growth (blooms), but also with local oceanic and wind dynamics that promote a concentration in superficial convergence areas. The increase of jellyfish populations has been recently related with major impacts on the dynamics of other zooplanktonic organisms. Thus, monitoring the abundances of these organisms is extremely important to examine changes in zooplanktonic communities.
Samples collected a coastal station off Cascais, Portugal for biodiversity monitoring since February 2005, has been providing long-term data on zooplankton for the north-western Portuguese coast. Data on gelatinous zooplankton were analysed and compared with other zooplankton groups, namely meroplankton and copepods. Ratios between these groups of zooplanktonic organisms over time were estimated to examine community changes throughout small and large time scales.

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Combined effects of multiple organic stressors from jellyfish blooms and aquaculture operations on seafloor ecosystems

JBS Poster Presentation_35

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Ocean health is declining due to a combination of climate warming and human activities, and is accompanied by a concomitant reduction in ecosystem services. This decline is particularly evident in coastal regions where inputs from municipal, agricultural, aquaculture, and industrial sources lead to blooms of algae and gelatinous plankton. Whereas these stressors have been studied individually in Norway, combined effects of the most prevalent sources of organic loading have not been addressed. This project uses an inter- and multi- disciplinary approach to investigate the effect of organic loading from jellyfish detritus and aquaculture waste on seafloor ecosystems along the coast. We investigate the cumulative effects of anthropogenic climate change and pollution on populations of marine species, the ecosystem as a whole, and society at large, including processes and interactions within and between these levels using field, laboratory, and modeling activities. Our results will feed into a socio-economic study exploring the effect of interactions between anthropogenic and natural changes in climate and the environment on ecosystem functions and services in Norway's coastal environments. Finally, it will provide an assessment of the impact and probability of wide-ranging changes in the composition, function and dynamics of ecosystems. This is critical for sustainably managing marine ecosystems, quantifying ecosystem resilience in the face of combined stressors, and providing projections of society's ability to adapt to such changes.

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Effect of light on polyp phase reproduction of cannonball jellyfish (*Stomolophus meleagris*)

JBS Poster Presentation_36

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Few studies describe the effect of light on reproduction in polyps. No information is available on cannonball jellyfish polyps; the aim of our study was to test lighting condition on podocyst and ephyra production, growth, and survival of polyps. Three experiments test light, shade, and dark conditions over 6 weeks, using primary polyps that grew from wild spawns in 2014. Aquarium lamps were used to control light, calibrated to 400 lux with a submersible light meter. In shade, a screen was placed next to the lamp to reduce light by 50%. For dark conditions, no light was use in the aquariums. All aquariums were painted black and completely covered with aluminum foil. Measurements were made with HOBO data loggers to record homogenous lighting condition within the aquariums in each experiment. Each week, polyp size, number of ephyra and podocysts formed, new polyps, and survival was recorded in each of the 18 polyps exposed to the different lighting conditions. Lighting had a significant effect on polyp reproduction, where more podocysts were produced under light conditions and fewer ephyra. Under dark conditions, less podocysts were produced, but more ephyra ($P < 0.05$). No podocyts were produced under the shaded condition. Survival was similar in the light and dark trials (nearly 60%), while survival was low (11%) under shaded conditions. In summary, we demonstrated that dark conditions lead predominantly to a reproduction strategy of strobilation and that light conditions lead to formation of podocysts. Shade conditions negatively affect survival and reproduction in cannonball polyps.

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Effects of temperature changes on strobilation in *Stomolophus meleagris* (Cnidaria: Scyphozoa)

JBS Poster Presentation_37

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Laboratory experiments were conducted to examine the effects of varying temperatures on strobilation in *Stomolophus meleagris*. Scyphistomae were obtained after incubation of mature medusae collected in 2014 in Bahía de La Paz, Mexico. Polyps were fed *ad libitum* twice weekly with *Artemia* nauplii. Strobilation was observed in those treatments where temperature remained constant (25°C) or increased (25->30°C; 20->25°C). The number of released ephyrae was not affected neither by temperature values nor temperature increases. However, strobilation reached its maximum rate when the temperature raise was preceded by a drop (25->20->25°C). Whereas scyphistomae strobilated continuously under constant or increasing temperatures, the ephyrae production ceased soon after the temperature drops (30->25°C). These results confirm that although temperature and food are key factors, other unidentified ones are also involved in the ephyrae production. Further, not only the temperature values are important but also their variations (in both directions). From these facts, some hypotheses can be stated: 1) *S. meleagris* presents a strobilation main peak after the increase of temperature normally occurring from winter to spring; 2) minor strobilation events occur during spring and summer; 3) strobilation cease once temperature falls down in autumn. These hypotheses could explain in general terms the seasonal patterns observed for *S. meleagris* medusae in the pacific coasts of Mexico. Finally, we suggest that the identification of the factors regulating strobilation rates could be split into the "inducing" factors, the "inhibiting" ones, and those that, once strobilation has been triggered, regulate the number of ephyrae produced.

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Adaptation strategy and control of phase transition in *Aurelia* spp. polyps in response to environmental variability

JBS Poster Presentation_38

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Aurelia spp. is the most abundant gelatinous predator in the Sea of Marmara. The year round occurrence of the species in high numbers raises questions regarding the adaptive life cycle of the species, since the region displays very strong seasonal vertical gradients of salinity, temperature and available prey. The growth (calix diameter), asexual reproduction (budding), strobilation rates (strobilation period, strobila disc number), ephyra release and mortality rates of polyps were tested for three temperatures; in-situ, in-situ+4ºC (to simulate IPCC 2100 scenarios) and 15ºC (as the year round temperature of the lower layer, deeper than 40 m) and four salinities (18, 24, 30 and 35) for a period of four months. Another experiment was run at 18 salinity to evaluate the impacts of food availability. Salinity and food limitation appeared as the most important factor regulating strobilation rates. 18 and 24 salinity had the highest strobilation at all temperatures, while 35 had the lowest. Calix diameters were also smaller at all 35 salinity experiments, where highest mortality rates were also observed. Budding at in-situ temperatures showed a more seasonal pattern when compared to other enclosures and was significantly higher at 18 and 24 salinities at all temperatures, in-situ+4ºC experiment having slightly higher numbers. As an adaptation to limited food, calix diameters remained almost half of polyps fed *ad libitum* and the tentacles that were significantly longer were preserved while strobilating. The ephyra numbers were fewer and strobilation period was very short when compared to well-fed batch. The results of the still ongoing experiments showed that *Aurelia* spp. scyphistomae might adapt to a wide range of environmental variability by regulating the growth and phase transition period.

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In-vitro fertilization techniques used to start polyp cultures of the Barrel jellyfish - *Rhizostoma pulmo*

JBS Poster Presentation_39

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In 2015 the Horniman Museum & Gardens Aquarium successfully produced viable *R. pulmo* polyp stocks via in-vitro fertilisation, further diversifying the museum's collection.

R. pulmo is one of the largest jellyfish found in British waters, with sporadic population blooms through our summer months around the UK coast line. These large jellyfish are gonochoristic with fertilisation occurring externally, factors that create significant barriers in starting captive polyp stocks. The aim was to capture adult jellies from the wild and collect samples of their gametes to produce a polyp stock through varying techniques of in-vitro fertilisation. The success of the in-vitro fertilisation method used has led to the generation of a healthy polyp stock. This has enabled the culture of this species in captivity and allowed improvements in husbandry techniques to be implemented.

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Polyp mapping of *Aurelia* sp. 1 in the southern and western coast of Korea

JBS Poster Presentation_40

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We have located polyp populations of *Aurelia* sp. 1 and determined their total amount around the southern and western coast of Korea using underwater photographs by SCUBA diving in 2012- 2016. Major habitats where the gross amount and/or density of the polyps were extremely high (the polyp hotspots) were identified at thirteen areas. Majority of polyp habitats were found in artificial constructions except for Manjasuh, a natural rock bed, providing compelling evidence that coastal development is inducing more jellyfish-bloom. Polyps of high density were found in dike ripraps, submersing pillars of power-line tower, concrete dock walls, floating piers, abandoned fishnet and barges for aqua farms mainly located in inner bays and enclosed sea. Downward-facing surface of the various artificial structure were the most important habitat of polyps enabling them to direct their mouth downward as well. Conspicuous preference to attach on substrates was not observed among concrete, painted steel, stone, polystyrene and polyethylene plastic, while shell surface of other attaching animals such as oysters (*Crassostrea gigas*), mussels (*Mytilus edulis*) and tubeworms (*Hydroides ezoensis*) often played a role on habitat selection of the polyps.

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Direct eliminating of polyps of jellyfish: an effective countermeasure of blooms of *Aurelia* sp. 1?

JBS Poster Presentation_41

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Direct elimination of polyps may be effective means to decrease possibility of medusa bloom in the next season. While it is quite difficult to pinpoint the exact location of the polyp populations in the field, we have found several polyp hotspots and tested the effects of polyp-elimination on jellyfish population size. We also tested in situ several chemical, physical and biological measures to downsize polyp population, and results showed that using a water-jet may be very effective to drop polyps from hard substrates to soft bottom, inducing their death. Divers eliminated ca. 960 million individuals of polyps of *Aurelia* sp. 1 from submersing pillars of power-line towers in Sihwa Lake, a seawater lake (ca. 56.5 km^2) semi-enclosed by dikes in 2012 and 2013, and we compared the amount of polyps before and after the elimination as well as density of ephyrae liberated from the polyps during 2011 – 2016. Ephyrae were significantly decreased from 23.63 individuals m^{-3} in 2011 to 0.07 – 0.29 individuals m^{-3} in 2012 and 2013. Medusae have been captured little by a plankton net or not observed since the polyp-removal, while a little growth of polyp population have been observed, which was probably recovered from remaining individuals. Similar applications were carried out in Masan Bay and Deungnyang Bay in 2013 and 2015, respectively, and we discussed about effectiveness of direct elimination of polyp as a countermeasure of jellyfish bloom.

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Combined effects of food quality, food quantity and temperature on somatic growth, asexual production and fatty acid composition of *Aurelia aurita* polyps

JBS Poster Presentation_42

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Summer blooms of scyphomedusae are dependent to the proliferation of sessile-overwintered polyps (strobilation). So far temperature was defined as the main abiotic factor driving presence/absence of some jellyfish outbreaks. However little is known about combined effect of biotic vs. abiotic factors on strobilation rates. To investigate the phase transition ecology of *Aurelia aurita*, we designed a factorial experiment on polyps manipulating food quality (in four levels), food quantity (in three levels) and temperature (in three levels). Polyps of *A. aurita* were monitored over 60 days. Our first results show that somatic growths of polyp were more determined by food quantity. The asexual production of polyps (budding) was determined by the combined effects of food quantity and temperature. The strobilation of polyps were only observed in low temperature treatments whereas its rate was influenced by both food quality and quantity. Total fatty acids were also affected by food quantity, while the composition of fatty acids was more affected by the food quality. The combined effect of manipulated factors on strobilation and role on summer bloom of medusa will be discussed.

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Simulation of the summer–autumn temperature variation on *Stomolophus meleagris* polyp reproduction: effect of three frequency rates

JBS Poster Presentation_43

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Understanding the effect of temperature in the reproduction of Scyphozoans is limited. To our knowledge, no information is available to describe how periodic fluctuations due to seasonal changes in sea temperature affect polyp reproduction dynamics. We created a continuous thermal wave in the laboratory, with a peak at 30° C and a minimum at 20° C, simulating the summer-autumn seasonal temperature change. We exposed mother-polyps of *S. meleagris* to three treatments in which the thermal wave repeated after 7, 14, and 28 days to produce a high, medium, and low frequency wave, respectively. Asexual reproduction (number of ephyrae, podocyts, and new polyps) was registered at the crest and trough of each thermal wave for three months. We found that the frequency wave had a significant effect on all reproductive variables, but no effect was detected when compared between the crest and trough of the thermal wave. A high frequency wave lead predominantly to podocyst production with negligible ephyrae and new polyp production at a lower survival rate. More podocysts (approximately 40%) were produced at both low frequency wave at the crest, and medium frequency wave at the trough. More ephyrae (almost double) were produced at both medium frequency at the trough and low frequency at the crest. These results indicated that a high frequency wave was a stressful condition for ephyrae recruitment and polyp survival. The highest ephyrae production found at the low frequency wave at the crest agrees with the hypothesis that suggests more jellyfish production at warmer temperatures in temperate species. Further research is needed to understand the dynamics found at the medium frequency wave.

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Polyp proliferation helps to explain the abundance of jellyfish off Namibia

JBS Poster Presentation_44

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It is widely accepted that an increase in temperature leads to an increase in the rate at which scyphozoan polyps proliferate. As too does an increase in food concentration. The experiments on which these generalisations are based have mostly been conducted on species of *Aurelia*, although the effects of both variables on strobilation, survival and podocyst formation have been documented for a wider variety of species. Here we report on the effects of temperature, food concentration and feeding frequency on polyp growth and development of *Chrysaora fulgida*. The results are in general agreement with those observed for other taxa, and, given changes to the environment off Namibia, could go some way to explaining the increased abundance of medusa seen in the northern Benguela upwelling ecosystem in recent decades.

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Repopulation of hydromedusans in the northern Adriatic Sea

JBS Poster Presentation_45

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Forty-two hydromedusan species were found in the northern Adriatic Sea in the early 20th century: 35 meroplanktonic and 7 holoplanktonic. There was a dramatic drop from the 1960s to 1980s, with only 16 species (13 meroplanktonic) observed. Low bottom oxygen has been documented since 1955, and it has been suggested that composition and abundance of meroplanktonic hydromedusae might be indicators of such hypoxia. Hydrographic changes over the past 20 years have led to oligotrophication, fewer hypoxic events, and repopulation of the benthos. Regular monitoring along the Rovinj-Po Delta transect with a WP2 zooplankton net has documented noteworthy changes in hydromedusans since 2009. Thirty-two species were recorded, 15 Anthomedusae and 9 Leptomedusae. Species rarely seen in the northern Adriatic since the 1970s -- *Ectopleura dumortierii, Euphysa aurata,* and *Laodicea ocellata* -- now are common. Further, some permanent species now have unusually high maxima: *Clytia* spp 1024 ind.m^{-3}; *Solmaris* spp., 622 ind.m^{-3}; *Lizzia* blondina, 293 ind.m^{-3}; *Podocorynoides minima*, 279 ind.m^{-3}; *E. dumortierii*, 87 ind.m^{-3}. The higher number of Trachymedusae indicates greater influence of the open middle and south Adriatic. Fewer species and lower abundance in 2014 coincided with circulation favoring reduced water inflow in the northern Adriatic. These observations support the earlier thesis that hydromedusae are useful indicators of the state of marine ecosystems.

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Biogeographic patterns of benthic and planktonic hydrozoans from the southwestern Atlantic Ocean

JBS Poster Presentation_46

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The rarity of studies on marine biogeographic patterns may be related to the lack of clear barriers in the oceanic system and to the three-dimensional capacity of occupation inherent to oceans. We analyzed patterns of distribution of benthic, pelagic and benthopelagic non-siphonophore hydrozoans of the southwestern Atlantic Ocean (SWAO), using three different biogeographic methods to test previous hypotheses of regionalization and to propose additional hypotheses of biotic elements for the SWAO. Distribution data for 214 hydrozoan species from the SWAO (20°-60°S, 33°-75°W) were organized in different data matrices (Concatenated, Benthic, Pelagic, and Benthopelagic) according to the different life-cycle strategies in Hydrozoa. All matrices were analyzed using the Endemicity Analysis (EA), Three-Item Analysis of Distributions (3ID), and Parsimony Analysis of Endemism (PAE). The resulting areas showed three broad patterns, (1) Tropical, (2) Warm-Temperate and (3) Cold-Temperate, all of which concord with previous biogeographic hypotheses for the SWAO. The output patterns varied according to the life cycle, demonstrating the importance of separate analyses for different life-cycle strategies. Each method performed differently, and we concluded that the use of 3ID and EA as complementary methods is the best approach to provide inferences on marine biogeographic patterns.

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HYPNO – Hydrozoan pelagic diversity in Norway

JBS Poster Presentation_47

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Pelagic Hydrozoa include solitary hydromedusae as well as colonial siphonophores and porpitids. Their size ranges from small medusae of <1 mm to siphonophore colonies of several meters. As predators on other zooplankton, hydrozoans are important components of the pelagic community. Unfortunately, many pelagic hydrozoans are fragile and difficult to sample in good condition. For morphological studies, they are best preserved in formalin, since most other fixatives used for zooplankton -including ethanol- cause severe distortion and shrinkage. Formalin fixation, however, hinders further genetic work. Due to these challenges, gelatinous zooplankton has generally been less studied than the hardier crustaceans, and is often neglected in plankton surveys. Ongoing project HYPNO aims to chart the diversity of pelagic Hydrozoa in Norwegian waters, and to document it in a manner facilitating future identification of hydromedusae and siphonophores by both scientists and non-specialists. Net sampling is carried out in several environments along the Norwegian coast. Collected samples are immediately examined for hydrozoans, with morphological examination and photographic documentation of live specimens subsequently fixed in ethanol for DNA barcoding of COI and 16S sequences. Specimens are also preserved in formalin for a reference collection. The project will produce an up-to-date list of pelagic hydrozoans found in Norway, with several new species records expected. The resulting publicly available DNA barcodes with photo vouchers will be valuable tools for systematics as well as identification of morphologically indistinct specimens, e.g. juveniles or stomach contents. Here, we present the project and activities so far since project start in April 2015.

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Hydromedusae and Siphonophorae community in Campos Basin – SE– Brazil

JBS Poster Presentation_48

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This study aims to describe hydromedusae and Siphonophorae assemblages, their associations with the water masses, as well as their distribution along environmental gradients. Samples (n=192) were collected from five water masses (Tropical Water, South Atlantic Central Water, Antarctic Intermediate Water, Upper Circumpolar Deep Water and North Atlantic Deep Water) along six transects perpendicular to the coast, from the 25m to the 3000m isobath with a Multinet of 120 and 200µm on dry and rainy season in 2009. We analyzed 7.161 individuals representing 24 genus of hydromedusae and 7.438 individuals representing 22 genus of Siphonophorae (26 and 41 species, respectively). The dominant species were *Aglaura hemistoma* (78% and 3962 org*100/m^3 of maximum density) and *Liriope tetraphylla* (10% and 5866 org*100/m^3) for hydromedusae and *Diphyes bojani* (52% and 4039 org*100/m^3) and *Muggiaea kochi* (14% and 1039 org*100/m^3) for Siphonophorae. The highest number of species per sample (n=12) was found in the TW, while in the NADW individuals were absent in 96% of the samples. We found minor differences on species compositions along the coast-ocean gradient for both groups. However, the vertical gradient became evident due to a TW assemblage formed by *A. hemistoma, D. bojani, M. kochi* and *L. tetraphylla*, in both season. For the deeper water masses distinct assemblage were not characterized because of the lower frequencies or the seasonal changes on species contribution. The canonical correspondence analysis and redundancy analysis analyses showed low explanation of abiotic variables (10.4 % to 21%) for the species variability.

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First report of a *Cnidostoma fallax* (Hydrozoa, Hydractiniidae) swarm during a La Niña event in the Patos Lagoon Estuary, Southern Brazil

JBS Poster Presentation_49

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The Patos Lagoon (PLE) is the biggest chocked lagoon worldwide. The hydrodynamic in the estuarine portion is wind and water discharge dependent and is influenced by large-scale phenomena, like the El Niño Southern Oscillation (ENSO) and La Niña events. Since 2009 a long-term biweekly monitoring has been carried out aiming to recognize factors that influence the zooplankton assemblage. A standard plankton net 200 µm mesh size, with flowmeter were used. From April 2009 to March 2010 the estuary was under the influence of an ENSO event, which resulted on a community dominated by fresh-water copepods and cladocerans during the austral summer months. From April 2010 to March 2012 the estuary was under the influence of a La Niña event with the dominance of marine copepods. During that La Niña it was observed an increase in hydromedusae diversity, with the occurrence of *Liriope tetraphylla*, *Olindias sambaquiensis, Amphinema dinema, Niobia dendrotentaculata, Eucheilota* sp. and *Cnidostoma fallax*. The latter one were found at densities of 9 ind m^{-3} (25°C and salinity 33) early in March 2012 and attained densities >11.000 ind m^{-3} (28°C and salinity 10) a fortnight later. This is the first record for *C. fallax, N. dendrotentaculata, A. dinema* and *Eucheilota* sp. for the PLE. This is the third record of *C. fallax* after its description and the first report of the species in higher densities. These results highlight the importance of long-term monitoring to understand the influence of large scales phenomenon in the variability of zooplankton communities.

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Morphology aspects of Hydromedusae (Cnidaria: Hydrozoa) of the zooplankton communities of the Bahia state.

JBS Poster Presentation_50

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Hydromedusae have been characterized by highly variable patterns of morphology. However, taxonomy of these fragile organisms rely majorly on structures associated to umbrella. In this way, important diagnostical characters may be easily lost during collection, handling, sampling, fixation and/or analysis. Most species diagnosis may be subject of a 'biased' taxonomy – some structures are expected to support the identification, but depend upon the specimen conditions. Damage artifacts must be avoided. Therefore, the species identification is a very difficult task. One classical example: Anthomedusae and Leptomedusae, the former do not have statocysts at all (in many cases, the ocelli is the only sense organ), while the latter usually present ectodermal statocysts, the number varying conspicuously among distinct species. In this work, the hydromedusae were collected in two estuaries, being one formed by two rivers, the Tabatinga and the Apraius, both flowing into the Real River Basin located in the Jandaíra City (11°32'45" S, 037°29'19" W). The second one comprises the Itapicuru River, principal effluent of the Itapicuru River Basin located in the Conde City (11°47'38" S, 037°30'53" W). Mesozooplankton samples were collected through horizontal drags at 0.1 m from the surface, during 3 minutes, using a conical net (200 µm mesh size), being preserved in 4 % formalin solution. The samples remained in a very good shape, providing important cues on morphological structures previously described, supporting important differences among Leptomedusae, Anthomedusae and Trachymedusae.

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First record of a non-native hydrozoan *Blackfordia virginica* Mayer, 1910 and its bloom event in Sihwa Lake, Korea during 2013 – 2015

JBS Poster Presentation_51

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The hydromedusa, *Blackfordia virginica* Mayer, 1920 (Hydrozoa: Blackfordiidae) has been known as an invasive species in brackish estuaries around the world. In the East Asia region, since Hsu and Chin (1962) recorded its occurrence for the first time from the Jiulong River mouth, China, there has been no record until recent new finding of Toyokawa (2015) from the mouth of the Rokkaku River in Ariake Bay, Japan. This study marks another occurrence from innermost part of Sihwa Lake, Korea. Our analysis confirmed that 18S and 28S rDNA sequences between samples from Sihwa Lake and Jiulong River are exactly identical. Since the first record of the medusa in Sihwa Lake, *B. virginica* showed extremely high density of bloom level each year with the maximum average density above 650 individuals m^{-3} from 2013 to 2015. Salinity of medusa occurrence ranged from 17 to 32 psu and abundance was higher in 20 – 25 °C. Average bell diameter increased initially then decreased before disappearance. Further studies investigating the species' impacts on the estuarine ecosystem as well as passible mechanisms for introduction as an invaded species are required.

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Jelly-eating anthozoans: an underestimated trophic net

JBS Poster Presentation_52

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Gelatinous plankton still represents a mysterious ring in trophic food chain of the sea world. In the pelagic realm, jellyfish are among the major plankton consumers, but they can also represent a food source for other jellies, fishes, turtles and humans.
The role of jellyfishes as possible food for benthic organisms is little explored, especially in the Mediterranean Sea. During their circadian and seasonal migrations and at the end of their life cycle, Jellyfishes can easily get in touch with benthic communities. Through field and laboratory observations, we documented several benthic invertebrates able to exploit jellies as food source. The monitoring of species has been done both in the wild and with jellyfishes kept in aquarium. Peculiar predation behaviours of anthozoans have been detected. When the jellyfish preys were larger than the oral disc of the predator, the jellies were shared and digested by several polyps. The anthozoans *Anemonia viridis, Parazoanthus axinellae* and *Leptopsammia pruvoti* can feed on three species of jellyfish (*Pelagia noctiluca, Rhizostoma pulmo, Aurelia aurita*. Moreover, the predation of ephyrae of *P. noctiluca* from *P. axinellae* and the scleractinian *Astroides calycularis* was also documented, suggesting that early developmental stages of the jellyfish could represent a consistent trophic resource for benthos. On the other hand, these jellyfish eating anthozoans may represent a control factor at local scale towards coastal blooms.
These considerations highlight the necessity to understand to what extend jellyfish represent a trophic source for benthic organisms and re-define the role of jellies in the bentho-pelagic coupling.

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Riding a crab: ecological interactions between *Hydrichthella epigorgia* (Hydrozoa, Ptilocodiidae) and *Achaeus spinosus* (Decapoda, Inachidae)

JBS Poster Presentation_53

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The polyp stage of the Hydrozoa plays a crucial role in population dynamics of meroplanktonic species; thus, understanding the biology and ecology of this stage is necessary in order to better predict and manage potential jellyfish blooms. Despite this, our knowledge of the benthic hydrozoan stages in the sea is still far from being complete, especially in small and poorly known taxa such as the Ptilocodiidae. *Hydrichthella epigorgia*, a widely distributed ptilocodiid species reported only a few times, has been found epibiotic exclusively on octocorals. In situ observations coupled with several photographic evidences confirmed the presence of this species in the Red Sea, resulting in the first record from that area. Its reproductive strategy and the key role of its eumedusoids in the distribution of the species is discussed in the light of ptilocodiid diversity. Additionally, a previously unreported basibiont is recorded: the decorator crab *Achaeus spinosus*. Given the high prevalence of this relationship, we hypothesized that the ecological interaction between the two species seems to go beyond a cryptic or defense mechanism. The feeding behavior of *A. spinosus*, a nocturnal planktivore, seems to be enhanced by the presence of high quantities of the hydroid. The crab apparently "uses" the sticky dactilozoids of the hydrozoan as fishing rods, increasing its capture rate. Subsequently, the preys are easily recovered by the long appendices of the crab and they are directed to the mouth. If confirmed, this phenomenon would represent a new kind of symbiotic interaction among crustaceans and cnidarians.

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Spatial distribution of pelagic hydrozoans in a specially-protected area in the Southeastern Aegean Sea during spring and summer

JBS Poster Presentation_54

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Pelagic hydrozoa (siphonophores and hydromedusae) are the most diverse and abundant representatives of gelatinous zooplankton. Widely distributed but inconspicuous, these organisms are often neglected in plankton studies and their blooms may easily go unnoticed by standard plankton sampling techniques. Furthermore, our understanding of the population ecology of pelagic hydrozoa is hampered by a lack of knowledge of their "normal" baseline dynamics, especially in undersampled places such as the Eastern Aegean Sea, where the Specially-Protected Area of Datça-Bozburun is located. Thus, in this contribution we present the spatial distribution and abundance of hydromedusae and siphonophores in five sectors of this protected area. Thirty-five zooplankton samples (vertical hauls) from spring and summer 2002 and 2003 were analyzed, with 27 terminal taxa being present in total. Holoplanktonic hydromedusae and siphonophores were both more abundant and common than meroplanktonic species, the latter being concentrated mainly in the inner bays of Bozborun peninsula. *Bassia bassensis* and *Eudoxoides spiralis* were the most common and abundant species in all the study, being present in high numbers in spring and summer 2003 in the southern coasts of Datça, where their predatory impact was estimated as very high. In summer 2002, *Eucheilota paradoxica* reached high numbers in a small section of Bozborun peninsula, likely driven by asexual medusa budding from other jellyfish. Our results highlight the need to conduct more surveys of gelatinous plankton in the Turkish coasts, as over 40% of the observed species represent new records for the country.

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Physonectae siphonophores from deep-water plankton tow in Colombian Caribbean

JBS Poster Presentation_55

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The study of the siphonophores in Colombian waters are limited because there are few investigators researching this group; these organisms are extremely fragile, also they have the ability of autotomize as an adaptive response to the stimulus that could represent his collection during tow plankton, making it difficult their identification and classification. That is why taxonomy of this group is based on parts of the colony as nectophores, bracts or pneumatophores. The first report of five families of siphonophores was described in 2002 from isolated structures, collected by surface tows using a simple conical net of zooplankton of 300 µm in diameter, being without studying the different water masses below 50 meters depth. Therefore, since the year 2013, in the framework of agreements between INVEMAR and the National Hydrocarbons Agency (ANH), zooplankton samples were obtained in some Colombian Caribbean exploration perimeters by vertical trawling, using a simple conical net of 200 µm with an opening-closing system; different samples were obtained according to the layers of water formed in the first 1000 m depth of water column (0-20 m; 70-100 m, 150-450 m and 600-1000 m). In some samples obtained, we found the presence of siphonophores specimens of the suborder Physonectae: *Athorybia* and *Nanomia* genera. This is the first report in the Colombian Caribbean Sea of these siphonophores at a depth greather than 100m. This finding highlights the need to train specialists in this group and continue sampling not only in the epipelagic zone (0-200 m) but also in midwater (200-1000 m).

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Deepest salp-fall event ever recorded from the deep-sea mining DISturbance and reCOLonisation (DISCOL) experimental test site, Peru Basin, Pacific Ocean

JBS Poster Presentation_56

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Salps, colonial tunicates, often form large episodic blooms in shallow water. The bodies from salp blooms can settle on the seafloor as salp-falls, where they most likely significantly influence benthic diversity and biogeochemical cycling. Salp-falls have also recently been recorded at the deep seafloor, thereby providing proof that salps can act as vectors for nutrient transport from the pelagic zone to the benthic realm. During the RV Sonne cruise SO242-2, that set out to assess the impacts of simulated mining disturbance in the deep sea, a large salp-fall event was observed at 4200m depth by the Ocean Floor Observation System (OFOS), designed by the Deep-Sea Research Group at the Alfred-Wegener Institute. Falls accumulated on undisturbed seafloor, as well as in seafloor troughs that were created 26 years ago by an experimental mining plough. Fauna (e.g. isopods) were observed feeding on the carcasses. The abundance and length of salps were recorded from stills images, which will enable carbon transport estimates by the salp-falls to be determined. This data will be presented in this poster, which describes the ecology of the deepest salp-fall event ever recorded, and which further highlights the importance of gelatinous zooplankton falls in the deep sea.

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Introduction to Tunicate (class Thaliacea: order Doliolida and Salpida) in fauna of Korea

JBS Poster Presentation_57

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Due to climate change, the number of class Thaliacea order Doliolida and Salpida is increasing every year in Korea. Massive blooms of the Doliolida and Salpida have caused severe damages to fisheries on Jeju island. Thaliacea bloom keeps increasing every year in the East Sea and southeast coast of Korea, which are the way of warm current. 24 species, 11 genera, 2 orders are currently known in Korea. This taxonomic study is dedicated to a better preparation against the damages incurred by Thaliacea bloom.

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Pyrosoma atlanticum in the Mediterranean Sea: abundance and spatial distribution from extensive planktonic and benthic surveys

JBS Poster Presentation_58

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Pirosomatida, the only colonial order within the class Thaliacea, is still a little-known group of marine gelatinous animals inhabiting warm and temperate waters of all oceans that may form immense swarms. *Pyrosoma atlanticum* is the most widespread and common species of pyrosomid between 50° N and 50° S and the only species recorded so far in the Mediterranean Sea. Fresh individuals of this species were collected in different planktonic and benthic oceanographic cruises, carried out from 1991 to 2015, covering the whole Mediterranean Sea, and more intensely in the Catalan coast. A total of 475 planktonic and 342 benthic samples were analysed. Planktonic samples were taken by means of Bongo (300 µm mesh size), neuston (800 µm) and Mocness (330µm) nets, from a maximal depth of 600 m to the surface. Benthic samples were taken by single warp Otter-trawl Maireta System (6 mm), Agassiz trawl (6 mm) and other commercial-trawl nets in bottoms depths from 300 to 2800 m. Maximum abundances of 19 and 2 ind. $1000m^{-3}$ were found in the water column and in the bottom, respectively. The presence of pyrosomes was more frequent in benthic samples (38%) than in planktonic ones (13%). The highest planktonic abundances were related to open-ocean areas and night hours (in surface, 0-60 m). No pattern was detected for benthic abundances related either to day and night hours or to the different bottom depths sampled. This is the first large-scale and extensive study on *P. atlanticum* in the Mediterranean Sea and the first integrating planktonic and benthic data in the same area and time.

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The ciliated groove of salps: enigma and riddle under pressure

JBS Poster Presentation_59

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We examined the ciliated grooves of *Pegea socia, Salpa maxima* and *Cyclosalpa affinis* by video and/or high resolution scanning electron microscopy to reveal details of the enigmatic ciliary organization and activity. *P. socia* and *S. maxima* revealed very similar overall organization, with lateral fields of cilia that beat with symplectic metachrony (i.e. waves in direction of the power stroke) that concentrate algal particles and transport them to the center of the ciliated groove. The algae heavily wrapped in mucus concentrate and are excluded from the anterior pouch by ciliary action; they do not pass through the ciliary pump, formed of knifelike flattened cirri. In contrast, single mucous-free styrene fluorescent particles pass through the ciliary pump into the bloodstream. The upper limit for particle passage is ~15 µm dia; they are ejected at high speed indicating that the particles are under significant pressure. Particle diameter equates with circulation access pores in the radialmost regions of the pouch. In contrast, *C. affinis* lacks the pouch-enclosed ciliated complex and instead bears a serpentine ciliary band that covers the posterior wall of the anterior chamber, in roughly the same location as the ciliated groove pouch in *P. socia* and *S. maxima*. Transport of fluids and associated algal particles is unclear in this species. There appears to be no access to the blood volume from the *C. affinis* ciliated band and the primary mechanism appears to be the clearance of material from the anterior chamber so that it flows into the algae-collecting mucus nets.

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Life cycle of *Carybdea brevipedalia* Kishinouye, 1891 (Cnidaria: Cubozoa) collected from the Pacific, northern Japan

JBS Poster Presentation_60

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The cubozoan *Carybdea brevipedalia* was collected from the Pacific, northern Japan in November 2013, in order to observe its life cycle including polyp formation and metamorphosis. Fertilization occurred externally, blastulae developed into planulae bearing about 30 larval ocelli, and then settled two to three days. Attached planulae metamorphosed into primary polyps bearing one to four tentacles. Primary polyps developed into adult polyps within 80 days, and both polyp stages could actively detach to change location by creeping on the central part of their body midst. Budding occurred in three to four-tentacled polyps, and buds were released two days after the commencement of budding. Complete metamorphosis of a whole polyp into a single medusa occurred within five days. Newly detached medusae were distinguished from those of other cubozoan *Carybdea marsupialis* by the pattern of nematocyst warts on the exumbrella, tentacle shape and number of tentacles. Gonads appeared within 60 days. The developmental features of *C. brevipedalia* resembles most closely those of *C. sivickisi, Tripedalia cystophora* and *T. binata* than *C. marsupialis*. The similarities in all life cycle stages of those species support the close relationship in the family Tripedaliidae and *Carybdea brevipedalia*.

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Comparison of spermatogenesis in the cubozoans *Tamoya haplonema* and *Chiropsalmus quadrumanus*, highlighting the gonadal cycle

JBS Poster Presentation_61

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Spermatogenesis has been little studied in cubozoans. In this study we describe spermatogenesis, under light microscopy and histochemical techniques of two Brazilian species, viz. *Chiropsalmus quadrumanus* (Müller, 1859) and *Tamoya haplonema* Müller, 1859. We highlight aspects and stages of the gonadal cycle. Specimens were collected by hand at the water surface or with shrimp trawls in Cananéia Estuary, in Santos and São Vicente Bays and in São Sebastião and Ubatuba, all in São Paulo state, Brazil. Samples of male gonads were excised and embedded in historesin, serial sections were performed, and the resulting slides were stained with hematoxilin and eosin and techniques for proteins (mercuric bromofenol blue) and neutral polysaccharides (PAS). Male box jellyfish reproductive structures are located between the mesoglea and gastrodermis, organized in elongated follicles, resembling a fingerprint pattern. Spermatogonia and spermatocytes are found near the follicle wall while spermatids and spermatozoa are located at the center of the follicle. Sperm release occurs through rupture of testicular follicles in both species. We documented four maturation stages for *T. haplonema*, viz. rudimentary, developing, mature, and spawned; and three stages for *C. quadrumanus*, viz. rudimentary, developing, and mature. Sperm of *C. quadrumanus* has a rounded head while in *T. haplonema* it has a conical shape with an elongated projection. In both species there was no positive histochemical reaction for the vesicles precursors of acrosome. The sperm of *T. haplonema* has a different morphology to that observed in scyphozoans, while the sperm of *C. quadrumanus* is more similar to scyphozoan sperm.

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Is the Mediterranean box jellyfish *Carybdea marsupialis* prey for *Caretta caretta*?

JBS Poster Presentation_62

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Jellyfish are often consumed by sea turtles, and it has been observed that the more abundant a potential prey, the greater its representation in the turtles' diet. *Carybdea marsupialis* is a Mediterranean cubozoan that is seasonally present in high densities (90 ind/m^{-3} juveniles, ~51 ind/m^{-3} adults) in some coastal waters. As part of the LIFE Cubomed project, we tested whether *Caretta caretta* might be a potential predator of this jellyfish.
Experiments were carried out at the Oceanogràfic in Valencia. We used 6 rescue turtles, each in a separate tank (8m^3). Around 50 adult *C. marsupialis* (~30 mm DBW) were captured the night before in Denia (W. Mediterranean) and kept in good health.
The experiment proceeded as follows: 5 minute turtle observation; 1 box jellyfish was released into the tank for 10 minutes, then a second for 10 minutes, and finally three more (5 in total) for a further 10 minutes. After that, we tried to feed the turtles directly.
During our experiment we observed no anomalous behaviour in either the jellyfish or the turtles (i.e. no stress). The turtles neither actively chased nor ate the box jellyfish; 2 turtles gently nibbled on one, but spat them out without eating them. None of the turtles showed sustained interest in the cubozoans. Contrary to other researchers' observations of turtles eating Scyphozoa and other cubozoan species (e.g. *Chelonia mydas* eating *Chironex fleckeri*), this preliminary experiment indicates that *C. caretta* is likely not a potential predator of *C. marsupialis.*

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An embedding method for the analysis of tiny statoliths: preliminary results for the Mediterranean box jellyfish *Carybdea marsupialis*

JBS Poster Presentation_63

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Statoliths are inorganic crystals located on the rhopalia of jellyfish that serve as gravity sensors. Morphological and geochemical analysis of these rhopalia are considered useful means of understanding their taxonomy and ecology. Cubozoan statoliths are made of calcium sulfate hemihydrate (bassanite) and tend to disintegrate rapidly once removed from the rhopalium and preserved (e.g. frozen or preserved in 4% buffered formaldehyde). Moreover, the small size of the statoliths of some species, such as *Carybdea marsupialis* (~40µm juveniles, ~400µm adults), makes them even more difficult to work with. The aim of this study is to provide a method which enables us to slice the statolith with micrometer precision, making their study and characterization possible, focusing on *C. marsupialis* from Malta and Spain. Although the literature includes some references to epoxy resin embedding procedures for statoliths of other species, none of these papers indicate the component proportions in the embedding medium or other specific requirements. Steps: 1) dehydration in ethanol; 2) infiltration with several ratios of propylene oxide and Embed 812 embedding medium; 3) transfer to a mold filled with Embed 812 embedding medium 100%; 4) curation at 60ºC in an oven for 48h; 5) sectioning in a microtome (~4µm precision); 6) the embedded sample was polished using 0.25 µm diamond-dispersion powder. Different techniques can then be used to characterize the statolith section, including whole analysis, mapping, compositional profiles and punctual data. Scanning electron microscopy, X-ray photoelectron and raman spectroscopies and micro-X ray diffraction were successfully applied.

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Identification of cnidocytes in box jellyfish from the Caribbean Sea in Colombia

JBS Poster Presentation_64

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The information about Box jellyfish from the Caribbean coast in Colombia is limited, thus, the importance in conducting research on the Box jellyfish type to know its representations, where and when appear to avoid hives in people along the year, this situation makes the identification of Cnidocytes in the Box jellyfish tentacles a key aspect. Taking into account the above aspects, someexploratory sampling were done in the departments of Cordoba and Magdalena in the Caribbean region of Colombia, between January 2014 and April 2015 to determine the species presented in the region, which were collected and identified. Likewise, a revision was done in the Museum of Natural Sea History from Colombia (MHNMC). A total of five cnidocytes were identified in the Box jellyfish were, genders *Chiropsalmus, Alatina* and *Carybdea*, that constitute the first study of cnidocytes in Box jellyfish in the Caribbean coast of Colombia.

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Venom Proteome of *Alatina alata*

JBS Poster Presentation_65

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We conducted LC-MS/MS analysis of venom preparations from purified nematocysts of *Alatina* sp. collected from Honolulu, Hawaii and Ponce, Puerto Rico. Utilizing a public database "Alatina Zapata" comprised of 122,976 assembled contiguous cDNA sequences, we derived 1006 unique proteins to which our MS/MS data yielded matches. 866 sequences yielded BLAST hits, with 752 matches to annotated proteins. When we subjected the 1006 matches to GO analysis, we determined that among the most common enzyme types displayed in the *Alatina* sp proteome were hydrolase, oxidoreductase and transferase enyzmes. We identified 34 proteins matching entries in known toxin databases. This is the first confirmation of the presence of several venom proteins previously associated via transcriptomic data to cubozoa. In addition, proteins were identified with homology to venom proteins from distant species that not been previously described as cubozoa venom proteins. We further analyzed the proteins matching venom/toxin database to determine potential common structural features. InterProScan revealed that the *Alatina* venom proteome contains proteins representative of von Willebrand factor, Kazal, and Sushi/SCR/CCP domains as well as members of the Cysteine-rich secretory, Pentaxin-related, Neprilysin, and peptidase families. Our data provides the first report on the *Alatina alata* venom proteome and significantly expands our knowledge of the venom components of this medically important cubozoan.

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The early life history of *Malo maxima* Gershwin 2005 (Carukiidae, Cubozoa) with comparison to other members of the family Carukiidae

JBS Poster Presentation_66

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Spawning medusae of *Malo maxima*, a tropical Australian cubozoan from the family Carukiidae, were collected from Port Douglas in Far North Queensland, Australia and their development from fertilized eggs to medusa production was recorded.
Malo maxima differed from the majority of class-defining charateristics of cubozoans with a lack of eye pigments on the planula, a secondary swimming polyps and medusa development by mono-disk strobilation with full regeneration of the polyp before medusa detachment.
These features are commonly observed in the class Scyphozoa but have only recently been recorded in two closely related species of carukiid, *Morbakka virulenta* from Japan and *Carukia barnesi* Australia. Our observations lend further support to the possibility of the family Carukiidae as an evolutionary link between Cubozoa and Scyphozoa.

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Blackfordia virginica mayer 1910 (Leptothecata: Blackfordiidae): new occurrence of an invasive hydromedusae to northeastern brazil

JBS Poster Presentation_67

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Highly tolerant to variable conditions of temperature and salinity, the invasive hydromedusae *Blackfordia virginica* Mayer 1910 has been reported in estuarine ecosystems worldwide, being its widespread distribution attributed majorly to ballast water. Along Southwestern Atlantic, *B. virginica* may be found into two distinct Brazilian coastal sections: northwards, under influence of warm waters of the Brazilian Current, and southwards in colder waters, zone of the Subtropical Convergence. For the first time, *B. virginica* has been identified in two estuaries Northern Bahia State (11oS), supporting the extension of the species distribution range to Northeastern Brazil. One of the studied estuary is formed by two rivers, namely the Tabatinga and the Apraius, both flowing into the Real River Basin located in the Jandaíra City (11°32'45" S, 037°29'19" W). The second one comprises the Itapicuru River, principal effluent of the Itapicuru River Basin located in the Conde City (11°47'38" S, 037°30'53" W). Mesozooplankton was collected through horizontal drags at 0.1 m from the surface, during 3 minutes, using a conical net (200 µm mesh size). Samples were preserved in 4 % formalin solution, and a total of 200 individuals of *B. virginica* were taxonomically identified – following the literature, based on the finger-shaped projections towards the mesoglea. Due to predation, the presence of *B. virginica* may impact zooplankton stocks, affecting fisheries and regional economy, bringing great concern to environmental policies. Thus, the new record shows that the species is effectively expanding its distribution along the Brazilian coast.

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Phylogeography, ecology, life cycle, and toxicology of the invasive clinging jellyfish *Gonionemus vertens* in Cape Cod, Massachusetts, USA

JBS Poster Presentation_68

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The clinging jellyfish *Gonionemus vertens* (Cnidaria, Limnomedusa) is an invasive species in Cape Cod, Massachusetts, USA, and elsewhere. *G. vertens* is strongly associated with eelgrass and macroalgae, to which they cling using adhesive pads on their tentacles. Populations from *G. vertens*'s native eastern Pacific range are non-toxic to humans. However, stings from some western Pacific populations can cause severe pain, respiratory distress, paralysis, and other neurological and neuropsychiatric symptoms. These symptoms can persist 3 – 5 days, although the individual victims appear to vary in their reactions. *G. vertens* was first observed in the Cape Cod region in 1894, but was not known to be toxic to humans despite frequent handling by scientists and others. We recently documented several severe sting reports in the Cape Cod area beginning in 1990 that suggest a new introduction of the more toxic western Pacific form. We are using single nucleotide polymorphisms obtained by RAD-sequencing and mitochondrial DNA markers to investigate the origin and dispersal history of Cape Cod *G. vertens*. Our preliminary results suggest population genetic signatures of lineage admixture consistent with multiple introductions and structure over a small geographic scale. We also obtained new observations on *G. vertens* life cycle and ecology from laboratory cultures and from the field. Lastly, we used high-performance liquid chromatography – mass spectrometry on *G. vertens* tentacle extracts to look for a signature of platelet aggregating factor (PAF), which has been implicated as a toxic component of the venom.

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Jellyfish aggregations cause sting outbreaks in southern Brazil

JBS Poster Presentation_69

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Over the past 15 years a considerable number of accidents caused by jellyfish has been reported along the southern Brazilian Coast. The region receives tourists from both Brazil and neighboring countries and the concern about jellyfish has prompted state health departments to collect data about the accidents in some municipalities. We report about 55,000 accidents caused by jellyfish of a five-year (2012-2016) survey carried out by the state Firemen, along the five southernmost municipalities of Santa Catarina State (28°S) in Brazil. Remotely-sensed data of sea surface temperature (SST), and zonal and meridional wind components (monthly averaged) were used to explore possible correlation with the monthly number of accidents during this period. Around 90% of the accidents occurred during the two last summers (2015 and 2016). It was not possible to identify which species caused accidents during the first four summers, however in 2016 pictures of bathers and of the local media indicated an aggregation of *Chrysaora lactea* caused this outbreak. Medusae of this species caused over 20,000 accidents in Paraná State (400 km north) during the 2012 summer. We found a weak correlation coefficient (r=0.3) between the number of accidents and SST, while wind components were not clearly correlated to the accidents through a cross-correlation analysis. These episodes have forced both local authorities and the research community to increase collaborative efforts in order to better understand the local context of these jellyfish aggregations and their accumulation in shallow waters, which represent a major threat to bathers and to the local tourism.

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Protecting the skin from medusa sting

JBS Poster Presentation_70

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Every year millions of people are being stung by jellyfish around the world. Jellyfish sting symptoms range from a burning sensation through erythema and pain to severe systemic disorders and, occasionally, death.
We developed a topical lotion that neutralizes the activation of the stinging cells and thereby inhibits and prevents nematocyst discharge and stinging. The product is commercially available in more than 20 countries and was tested in clinical trials and field tests. The inhibitory effect of Safe Sea lotion was evaluated in double blind clinical trials against the stinging of the following jellyfish: Sea Nettle *Chrysaora* Sp. (tested in Stanford Hospital), Box jellyfish *Chiropsalmus* Sp. (tested in BFMC, Florida), *Rhopilema* (tested in RAMBAM Hospital, Israel), Lion's mane *Cyanea* Sp. (tested in Oslo University). In addition, the inhibitory lotion was evaluated in laboratory tests against *Rhizostoma pulmo*, Blue Bottle *Physalia utriculus*, *Carybdea* SP and others.
The results of the above testing demonstrated that the Safe Sea eliminates nematocyst discharge and provides protection against Jellyfish sting.

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Beach lifeguard intervention data as a tool for detecting jellyfish population trends and jellyfish sting "hot spots"

JBS Poster Presentation_71

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Despite their ecological and socio-economic impact, on tourism, fisheries and aquaculture, for instance, quantitative data on jellyfish abundance in coastal areas is scarce. As part of the LIFE Cubomed project, we explored the usefulness of data on beach lifeguard interventions as a tool for monitoring seasonal trends and spatial distribution of coastal jellyfish.
Lifeguard services in the Spanish Mediterranean cover almost all beaches during the tourist season and attend around 200,000 non-severe injuries each year. Jellyfish stings account for around 65% of these interventions. We developed a Sting Index (SI) to determine the seasonal trend of jellyfish stings at different spatial scales and consider it a good indicator of jellyfish abundance. The number of stings is standardized by the sum of injuries (wounds, dislocation, bruising, bone fracture, fainting and sunburn), which are proportional to the amount of people on the beach.
We calculated the average SI over 4 years (2010-2013) at some 400 lifeguard stations along the Spanish Mediterranean. SI values ranged between 1.8 and 2.7 and showed no significant trends during this period. This could reflect stable population levels in the area. However, the SI did allow us to detect "hot spots", where the rate of stings was up to 10 times the average, and we were able to correlate these areas to the presence of certain jellyfish species. This kind of information can be obtained from places where records are kept on jellyfish stings and can help to obtain data on jellyfish at a larger geographical scale.

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Spatial overlap of jellyfish and fishing resources in northern Patagonia, Argentina

JBS Poster Presentation_72

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The neritic environment in northern Patagonia (43-47°S, Argentina) is a productive, economically valuable ecosystem, supporting two of the most important Argentinean fishing resources (Argentinean hake *Merluccius hubbsi*, Patagonian shrimp *Pleoticus muelleri*). In this area, jellyfish are abundant during summer coinciding with the recruitment peak of these fishing resources. We measured the spatial overlap and co-occurrence of jellyfish and *M. hubbsi* and *P. muelleri* in Patagonia by analyzing the data set obtained in fishery surveys performed by the INIDEP each January from 2005 to 2014. We used spatial analyses tools to determine the species that have potential to affect the recruitment of these fishing resources and the areas in which these interactions are likely to occur. Significant spatial overlap occurred between the ctenophores *Mnemiopsis leidyi* and *Pleurobrachia pileus* and the Argentinean hake (eggs and larvae), although the results were highly variable amongst years. Only *M. leidyi* overlapped with the early stages of the Patagonian shrimp. Conversely, there was a negative relationship between the distribution of the 8 hydromedusa species and both fishing resources. This could be explained by the low frequency of occurrence and abundance of most hydromedusae except *Aequorea forskalea* s.l. In this case, although highly frequent and abundant, this species seems to occur in colder water masses. In locations overlap is high, predation by ctenophores on fish/shrimp eggs and larvae, and their preys, may be an important factor in the dynamics of commercially important species.

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Growing on jellyfish: The PERSEO Project

JBS Poster Presentation_73

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Scyphozoan jellyfish outbreaks have great socio-economic and environmental impact. These Jellyfish blooms have been increasingly raising alarms in both popular and scientific media worldwide in the last twenty years. Jellyfish are clearly shifting habitats and causing economic stress to coastal populations. Fishers report clogged nets and even capsized boats; coastal resorts, stung swimmers and beach closures, and coastal industries, clogged cooling systems. Consequently, municipalities and businesses are appealing to scientists for advice on the proper response to these occurrences, however, little is known about Jellyfish biology and scientists are often at a loss as to how to help. The PERSEO project, that aims to investigate these outbreaks, has two overriding goals. The first is to research jellyfish physiology, biochemistry, life cycles and ecology and through an improved understanding of these marine creatures, offer solutions to the problems caused by their increasingly prevalent blooms. The second is to convert jellyfish outbreaks into a boon for society by learning to harvest them for commercial export, for medical purposes, and as sources of pharmaceutical biotechnology products.

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Comparative proteomics reveals common components of a powerful arsenal in the earliest animal venomous lineage, the cnidarians

JBS Poster Presentation_74

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Venom evolution venom has underpinned predatory success and diversification of numerous animal lineages. Nematocysts of Cnidaria are the most evolutionarily ancient venom apparatus. In cnidarians the stinging apparatus actively translocate venom compounds into an external target. Cnidarian predators use this mechanical device to capture and subdue prey. Herein we compare venom composition and identify recruitment patterns of toxin families found in venom proteomes from four cnidarian classes (Anthozoa, Hydrozoa, Cubozoa and Scyphozoa). 28 toxin families were identified in the venom proteome of the eight species studied. Eighteen of these families have been previously found in the venom of cnidarians. Twelve types of toxin families were shared between the four classes, suggesting common proteome functionalities. Character mapping analysis revealed that at least fifteen toxin families were likely recruited into the cnidarian venom proteome before the split between Anthozoa and Medusozoa. Eleven of these types (AhpC/TSA, sodium channel inhibitor, phospholipase A2, phospholipase D, peptidase S1, metalloproteinase, SCRIPs, potassium channel inhibitor, complement C3, Latrotoxin, Snake three-finger) were identified before. However, conotoxins, Flavin monoamine oxidase, Glycosyl hydrolase 56, and Latarcin were recorded herein for the first time. We demonstrated that more types of toxin families are continuously recruited into venom proteome during the evolutionary process of each cnidarian classes. This analysis is the most comprehensive comparative study on cnidarian venom composition. We also provide new insights into the evolutionary assembly of the complex biochemical arsenal of cnidarians, and addressed a partial insight into the composition of the earliest cnidarians venoms.

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Taxonomy and fisheries of a jellyfish *Crambionella* (Scyphozoa) from central Java, Indonesia

JBS Poster Presentation_75

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Crambionella helmbiru Nishikawa et al. was newly described from central Java, Indonesia in 2014. The combination of the mean number of lappets per octant (14), presence of foliaceous appendages amongst frills on oral-arms, absence of tubercles on the velar lappets, proportion of terminal club length to oral-arm length (0.28), and the body colour distinguished this species from three previously-described congeners. In addition, the analysis of partial sequences of the cytochrome c oxidase subunit I gene indicated substantial genetic differences from both *C. orsini* and *C. stuhlmanni*, supporting the validity of this species. A combination of morphological and genetic approaches determined that the remarkable differences in exumbrellar colours observed in specimens were intra-specific variation. Surprisingly, this species has been commercially harvested for more than 20 years and is well-known to the local people in the region, yet it had remained unknown to science until this point. The commercial fisheries targeting this formerly unknown species are also described in detail. Discovery of this commercially-harvested species is considered important not only for its contribution to taxonomy, but also for the conservation of species diversity as well as the sustainability of fisheries targeting this species.

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Predator diet as an indicator of comb jellyfish (Ctenophora) abundance dynamics in the Barents Sea

JBS Poster Presentation_76

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During the Barents Sea surveys a range of methods and gears have been used from water sampling, to plankton nets, pelagic and demersal trawls, and echo sounders. Even though the use of modern research vessels, equipment and methods there are still limitations regarding to gear: small plankton nets underestimate Ctenophora due to avoidance, while pelagic trawls underestimated Ctenophora due to escapement or damage of fragile ctenophores in the cod-end. We propose using fish stomach content data to acquire insight in to the Ctenophora fluctuations and increase our understanding of species interactions in the Barents Sea. Ctenophora can be prey for many marine organisms such as cnidaria, various fish such as cod, lumpfish and mackerels, seabirds, and other Ctenophora, but their importance considerably varied among predators.
The stomach content quantitative data for the period 1984-2014 (cod, haddock) as well as qualitative data for 1949-2014 (cod, haddock) were used to evaluate the role of Ctenophora in the fish diet. Cod mainly prey on Ctenophora in the eastern and southern part of the Barents Sea in the winter period, and the proportion of Ctenophora in cod diet increases with increasing cod size.

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Gelatinous zooplankton community structure as revealed by size-spectral analysis

JBS Poster Presentation_77

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Accurately characterising marine food webs is often complicated and labour intensive. Recent advances in statistical modelling have helped greatly to overcome such difficulties in understanding, with size-spectral analysis (SSA) key amongst them. These approaches use abundance-body mass relationships to explore energy transfer between trophic levels and are founded on the theory that when food availability falls with body size (as in most aquatic food webs where larger predators eat smaller prey), the scaling between abundance and biomass is steeper than when organisms of different sizes compete for a shared resource. More broadly, body size is an easily obtained metric in marine studies that provides insights into the function of organisms, and underpins their inherent physiology, metabolism and ecology. Such data have been used extensively in fisheries modelling, yet have been directed towards gelatinous zooplankton less frequently despite the diversity of the group (i.e. >1200 species), and ubiquity in marine systems. Here we argue that such an approach would be logical given the trophic breadth of gelatinous species, from grazers to active predators of small fish, and from micro- through to macro-zooplankton species weighing > 200kg. We present our case using nine years (2007-2015) of archived jellyfish by-catch data from the Irish Sea (n>614 trawls), with an overall prediction that established patterns in abundance-body mass relationships hold true for gelatinous species, opening the door for their more effective inclusion in ecosystem models.

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Jellyfish, a new model in nanoecotoxicology?

JBS Poster Presentation_78

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Considering the number of applications, nanomaterials can enter in environment. That is why nanoecotoxicology has emerged as an important field of toxicological research to identify and predict effects induced by nano-sized material on organisms, and more generally on ecosystems. In ecotoxicology in general, there is still an urgent need to identify new model organisms, and to develop sensitive and reliable test methods for bioassays. Gelatinous zooplanktons are rarely represented in routine ecotoxicology tests despite the importance of its role in marine ecosystem balance. The Berre lagoon (southern France) is a brackish stretch of water, particularly subject to human disturbances. Since the 1930s, it became a receptacle for a lot of xenobiotic and toxic compounds. It is also home of the scyphozoan jellyfish *Aurelia aurita* (L., 1758), which has normally four gastro-gonadal pouches at the adult stage. In the Berre lagoon an unusual proportion of individuals differed since they had variations in radial symmetry number and teratogenic characters. The responsibility of chemical contaminants is highly suspected. Because of lack of marine organisms as bioindicators, this research focused on an analysis of the toxic effects of silver nanoparticles (AgNPs) – the most commonly used for their antibacterial and antifungal properties – on the *Aurelia aurita* jellyfish in order to determine whether it could be a pertinent bioindicator for the presence and the amount of silver nanoparticles in marine environment. Dose-dependent responses of on the proportion of abnormal morphogenesis of *A. aurita* via the morphology of ephyra larvæ were identified in response to low concentrations of AgNPs exposures.

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Effects of ocean acidification and increased temperature on the development and statoliths formation of *Pelagia noctiluca* ephyrae

JBS Poster Presentation_79

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In order to assess the impact of ocean acidification and climate change conditions (temperature increase) on the morphology and eco-physiology of the jellyfish *Pelagia noctiluca* a study has been performed based on a 2100 future ocean scenario (IPCC). Additionally, it has been study the effects of the interaction of both mentioned factors on young jellyfish specimens and its statoliths, firstly described in the present study. In order to evaluate these effects, ephyrae of *Pelagia noctiluca* cultured at the ICM (CSIC) were exposed to 4 different pH and Temperature treatments: pH (-0.3 pH); Temperature (+3ºC); both pH and Temperature (pH & Tª; -0.3 pH and +3 ºC) and the Control.
Total diameter, gastric cavity length and rhopalia-rhopalia distance and morphologic (maturation assessment) parameters were estimated in a weekly basis. In addition, Scanning ElectronicMicroscopy (SEM) analyses were performed on statoliths.
Mortality rate was 50% higher in Temperature treatments at the end of the experiment.
Nevertheless no significant differences on ephyrae size were found between any treatment and the Control. Significant differences were found between Temperature treatments and pH treatment suggesting opposing effects.
Statolith, described as hexagonal elongated prisms, suffer an alteration on its ends in acid treatments, this effect was soften by temperature. Although the whole acidification and temperature increase effect is negative a benefit effect is expected in a future for this species at the expense of its natural competitors, more sensitive affected to physicochemical factors.

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Evaluating energy flows through large jellyfish and forage fish and the effect of forage fish fishery in the Northern Humboldt Current

JBS Poster Presentation_80

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Gelatinous planktivores not only compete directly with forage fish for food, but also feed on fish eggs and larvae. Shifts in the relative importance of forage fish to jellyfish occur in ecosystems supporting major forage fish fisheries due to increased harvesting pressure, and this may have substantial consequences throughout the ecosystem. When jellyfish are abundant, the energy available to upper trophic levels within the pelagic food web is reduced relative to periods when forage fish are more abundant. We explored the roles of large jellyfish and forage fish as energy transfer pathways to higher trophic levels in the Northern Humboldt Current (NHC) ecosystem. A trophic network model with 33 functional groups was developed using ECOPATH and transformed to an end-to-end model (ECOTRAN) to map food web energy flows. Reach and Footprint metrics of each group's energy demand and contribution to the rest of the food web were obtained and used as proxies of energy transfer efficiency. Four model simulations were used to estimate ecosystem-wide effects of changing jellyfish and forage fish abundances: 1) 50% forage fish consumption increase, 2) 50% jellyfish consumption increase, 3) 50% forage fish removal by fisheries, and 4) no fishing harvest. Jellyfish were an energy-loss pathway for high trophic-level consumers, with a reach:footprint ratio significantly smaller than that of forage fish. Simulated increase in forage fish consumption depressed productivity of large jellyfish, while increase jellyfish consumption depressed forage fish and high-trophic level consumer production. These findings support the hypothesis that forage fishing provides a competitive release for large jellyfish, and increase our understanding of trophic interactions between forage fish and large jellyfish, an important, but overlooked component in most ecosystem models to date.

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Cydippids rule - Jellies in VPR images from the Trans-Atlantic Euro-Basin cruise

JBS Poster Presentation_81

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Cydippid larvae of ctenophores are only a few millimeters in size and exceedingly fragile. In addition to being easily damaged in net tows, many of them do not tolerate common fixation methods, making them difficult to identify and enumerate from standard plankton samples. An optical approach allowed us to estimate the distribution and environmental preferences of small cydippids. A towed MESSOR platform fitted with CTD-F, digitally-autonomous video plankton recorder (VPR), OPC, and multifrequency acoustics was employed between 0-400 m depth on 9 instances during the 2013 Trans-Atlantic Euro-Basin cruise between Bergen, Norway, and Nuuk, Greenland, in order to study the fine scale distribution of hydrography, fluorescence, plankton and fish. Resulting VPR images of gelatinous zooplankton were manually sorted based on morphology. Several taxa of gelatinous zooplankton were identified, although picture quality often precluded identification to species level. The most commonly observed gelatinous organisms were small cydippid ctenophores belonging to several species. Numerous young *Mertensia ovum* were observed in the upper 100 m in cold (~1 °C) waters of Arctic influence. Also commonly observed were mesopelagic cydippids (or cydippid stage larvae) occurring in warmer water (~2.5-5 °C) at ~100-300 m depth. The latter do not appear to belong to any of the species commonly reported from the region. Small cydippids did not contribute in comparable proportion to net samples collected during the same cruise, nor were the collected specimens in good enough condition to be identified even at this level, suggesting that this group is particularly poorly sampled using traditional methods.

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Ctenophores – native aliens in Norwegian waters (GooseAlien)

JBS Poster Presentation_82

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The disproportionally fast warming of the Arctic together with massive reduction of sea ice thickness and extent mean that an ice-free Arctic summer is likely to occur within the next few decades. This, as well as increasing shipping traffic, will pose significant challenges for the Arctic organisms. There is strong evidence that southern species are expanding their distribution ranges northwards and increasing in population size, whereas some of the northerly species are declining. Shifts in biodiversity can directly and indirectly change species interactions and ecosystem processes, resulting in large cascading changes with implications for the entire Arctic ecosystem as well as for ecosystem services. The role of ctenophores in the Arctic and temperate systems is often ignored, although the few existing studies indicate more important ecological role than expected. At the same time, our taxonomical knowledge of the comb jellies in this region remains rudimentary at best. Here, we present preliminary results of an incipient project with the primary goal of describing and documenting the biodiversity of ctenophores in Norwegian waters, from the North Sea to the Arctic. Combining morphological and molecular methods, GooseAlien will increase taxonomic knowledge, which is a valuable first step towards establishing a baseline for future ecological studies, monitoring of climate impacts, and assessing the threat of introduced species in the High Arctic. By engaging the public audience in collecting samples, the project will increase the geographical area coverage and, in return, the laymen involved will come to appreciate completely new aspects of their own environment.

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Polyp elimination methods for an effective and inexpensive jellyfish bloom control

JBS Poster Presentation_83

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Massive blooms of the moon jellyfish have caused various kinds of damages to fishers, beach lovers as well as power plant operations. In Korea, moon jellyfish bloom has been steadily increasing from 1990s to the present. Recently, moon jellyfish blooms are controlled by effective and inexpensive methods in Korea. National organizations such as the Korea Marine Environment Management Corporation (KOEM) and National Fisheries Research and Development Institute (NIFS) have collaborated to develop various polyp elimination methods and implement such methods. The chronological order of the polyp elimination is hotspot search, test elimination, actual elimination and monitoring. The most common method is water jet elimination. But various methods such as flat shovel, scraper, brush and etc can be applied depending on situations. At present, new methods including replacing the old buoy and drying out the polyp are devised.

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Predicting the density of Scyphozoan jellyfish in the Northern Gulf of Mexico

JBS Poster Presentation_84

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Jellyfish are an important food source for many marine species as well as considered a nuisance to industrial and economic trades. Therefore, the development of a predictive biophysical jellyfish model could provide assistance in ecological research and undesirable human interactions. In this study, the collection data of two scyphozoan medusae, *Chrysaora quinquecirrha* and *Aurelia* spp., were extracted from SEAMAP trawling surveys and were used to determine environmental predictors for the abundance of large jellyfish medusae in the northern Gulf of Mexico. Both in situ and remote sensing oceanographic measurements (28 total) were obtained from 2003 to 2013. These measurements were filtered through three statistical tests: 1) Permutation Test, 2) Information Value, and 3) Cluster Analysis to determine the parameters with the highest predictability. A generalized additive model (GAM) was run for three methods (remote sensing, in situ, and all parameters) for the summer and fall season. The deviance explained was higher for the in situ and all parameter methods when compared to the remote sensing method. This distinction is most likely due to the strongest predictive parameters occurring at mid-water column depths.

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Using *Aurelia* abundance as a proxy for the presence of pink meanies (*Drymonema larsoni*), an important food source for leatherback turtles in the northern Gulf of Mexico

JBS Poster Presentation_85

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Medusae of the genus *Drymonema* are considered rare throughout the world. In the northern Gulf of Mexico (nGoM), *Drymonema larsoni* often occur in large numbers and feed almost exclusively on *Aurelia* spp., thereby it is likely that their abundances depend upon the population dynamics of *Aurelia* spp. As a top consumer of gelatinous zooplankton, leatherback turtles (*Dermochelys coriacea*) require high consumption rates to meet their metabolic needs. In many foraging areas, leatherbacks are observed selecting prey that offers the highest nutrient value for the least effort (i.e. a dense jellyfish). The objective of this study is to determine the occurrence and relationship to the abundance of *Aurelia* spp. for *D. larsoni* which could potentially be the preferred prey of leatherbacks in the nGoM. Observations of *D. larsoni* were gathered from multiple databases to establish a timeline of presence in the nGoM and compared to the abundance of *Aurelia* spp. for the same years. For the available trawl collection data (SEAMAP), the number of *D. larsoni* was compared to the number of *Aurelia* spp. per station. A positive relationship was shown between high levels of *Aurelia* spp. and the presence of *D. larsoni*, making *Aurelia* spp. a possible proxy for the abundance of *D. larsoni*. During a survey in September 2015, all leatherback foraging observed was on *D. larsoni* off the coast of the Florida panhandle (n=4). Understanding the population dynamics of *D. larsoni* could provide important ecological information to assess the foraging potential of leatherback turtles.

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Abundance and patchiness of *Chrysaora quinquecirrha* medusae from a high-frequency time series in the Choptank River, Chesapeake Bay

JBS Poster Presentation_86

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Despite strong control over marine plankton dynamics and negative impacts on human activities, jellyfish are not well quantified due primarily to sampling difficulties with plankton nets or fisheries trawls. Therefore, some of the longest records of jellyfish are visual shore-based surveys. As this method is inexpensive and simple, our goal was to determine what could be learned from such records as well as the usefulness of surface counting. We analyzed a 4-year, high-frequency time series of *Chrysaora quinquecirrha* medusae in the Choptank River, Chesapeake Bay and compared it with two other sampling methods. Medusae abundance was modeled by change points. The remaining signal was random and indices of aggregation (Negative Binomial coefficient, Taylor's Power Law (TPL) coefficient, and Morisita's Index) indicated that medusae were aggregated. An idealized conceptualization of the temporal sampling scheme into space suggests that the upper bound of the patch size is on the order of kilometers. TPL indicated that patches grew in the number of individuals as abundance increased. Abundance was similar between the sampling methods. Our results enhance knowledge of *C. quinquecirrha* population biology and behavior as well as help to assess the quality of population estimates from visual shore-based surveys.

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Preliminary results on the effect of electromagnetic fields on swimming patterns and the umbrella contraction of two scyphozoans: *Rhizostoma pulmo* and *Pelagia noctiluca*

JBS Poster Presentation_87

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Few studies have covered the effect of induced electromagnetic fields (IEMF) on jellyfish swimming patterns. To explore the hypothesis that IEMF have an impact on jellyfish movements, we exposed individuals from *Rhizostoma pulmo* and *Pelagia noctiluca* to different IEMF frequencies.
Toroidal and solenoidal copper coils were used to generate the magnetic fields. The coils were powered by a sinusoidal wave of 4V peak-to-peak amplitude. The copper wire used had a diameter of 0.4mm. The smallest coil used had 20 spires and a diameter of 12mm. The frequencies used ranged from 100 kHz to 1000 kHz, increasing 100 kHz per test. The exposure period was at least 20 seconds for each frequency.
The pulsation rate among the *R. pulmo* did not show changes below 800 Khz. However, between 800 and 1,000 Khz, their pulsation rate slowed until reaching a complete stop, after which the jellyfish sank to the bottom. When the function generator was turned off and IEMF ceased completely, pulsation recommenced after 10 seconds and their behaviour appeared normal. Meanwhile, the *P. noctiluca* showed no changes in either swimming patterns or pulsation rates across all frequencies.
Although this experiment is in its initial stages, we plan to use it to explore the effect of IEMF on different jellyfish species (scyphozoan and cubozoan). Specifically, we will be studying the biological explanation for these effects, as well as the possibility of using IEMF to detect jellyfish using secondary coils, to detect magnetic field variations due to the presence of the jellyfish.

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Seawatchers.org: a web platform to collect and visualize jellyfish citizen data in the Mediterranean Sea

JBS Poster Presentation_88

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Seawatchers.org is a citizen science platform that aims to involve society in data collection for different marine research projects. It started in 2012 as a pilot in the Catalan region and evolved in 2014 to collect data from the whole Spanish coast. As part of this platform, the Jellyfish project seeks a better understanding of jellyfish population dynamics and it reached more than 600 records in 2 years. It collects data from swimmers, divers, kayakers and other volunteers. Unlike citizen science campaigns based on mailings, this platform displays both the collected data and the name of volunteers or associations involved. Behind the Project, experts validate data and are responsible for highlighting the most interesting observations for research. All participants receive feedback concerning the validation from the expert, its comments and whether the observation is a remarkable one. The collected data during more than 10 years by the Catalan municipalities and those from the App Medjelly will be incorporated soon. As Seawatcher.org allows citizens to collaborate and get involved in scientific research of several marine related projects other than jellyfish (such as corals, fishes, invasive species or marine litter) it provides a bridge between fishermen, diving clubs and students, allowing the interaction among different social communities in the Mediterranean Sea. Moreover, recent incorporated social networks (Twitter and Facebook) facilitate the spreading of scientific research objectives to the general public, thus promoting its participation. The sewatchers´s team is always searching for innovative methods to improve the engagement of the society in marine related issues.

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Jellywatch: A global citizen science project for monitoring the ocean

JBS Poster Presentation_89

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JELLYWATCH.ORG - Monitoring the ocean on a global scale can be an expensive and frankly impossible undertaking. The area that has to be covered is simply too large for any ship, expedition, or research team. However thousands or millions of people experience the ocean each day in all corners of the earth. By tapping into this pool of citizen scientists, we can aspire to generate a global network of observers to monitor the state of ocean health. In particular, at jellywatch.org we are interested in the timing and distribution of blooms of jellyfish. Since launching the site in early 2010, we have received 4900 sightings from North and South America, Indo-Pacific, Africa, the MidEast, Asia, and Europe — from the Arctic Ocean to the Coral Triangle. The database and images that are submitted are freely available to anyone to use in their own research. So far, our jellywatchers have identified blooms across broad regions of the Gulf of Mexico, revealed interesting and unusual species, and mapped out global occurrence of several species, including "By the Wind Sailors". Future plans include improved visualization tools for examining the ever-growing time series.

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The cnidarians of Cispatá Bay, Córdoba, Colombian Caribbean

JBS Poster Presentation_90

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Oceanographic dynamics in the southern Gulf of Morrosquillo plays an important role in the distribution patterns and abundance of cnidarians, so it is essential to review the impact of these conditions on assemblies anemones, jellyfish and hydroids colonies, and what so it is reflected autecology of many of these groups so the present study determined the composition and abundance of cnidarians of the Hydrozoa, Cubozoa, Scyphozoa, Anthozoa and Staurozoa class in five field trips between 2014 and 2015. Material planktonic (floating) was collected in different microhabitats surface using manual collection methods and shrimp trawl fisheries with 1.2 cm eye mesh in the cod. For samples attached to the submerged roots *Rhizophora mangle*, was introduced by its bottom in a canvas bag previously labeled then proceeded to wash the roots to achieve relaxation and separation of individuals attached to the roots; step followed the roots are placed in plastic trays to prevent loss of organisms. Anemones and hydroids colonies, separated from the rest of invertebrates and placed in plastic bags labeled. Seven jellyfish were identified, of which two were hydromedusae (*Porpita porpita* and *Physalia physalis*), two cubomedusas (*Chiropsalmus* sp. and *Alatina* sp.) and five escifomedusas (*Lychnorhiza* sp., *Chrysaora* sp. *Stomolophus meleagris*) and anemones (Anthozoa) in *R. mangle* 2 identified which correspond to *Aiptasiia* sp, *Bunodosoma* sp to complete the study.

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5th International
Jellyfish Bloom
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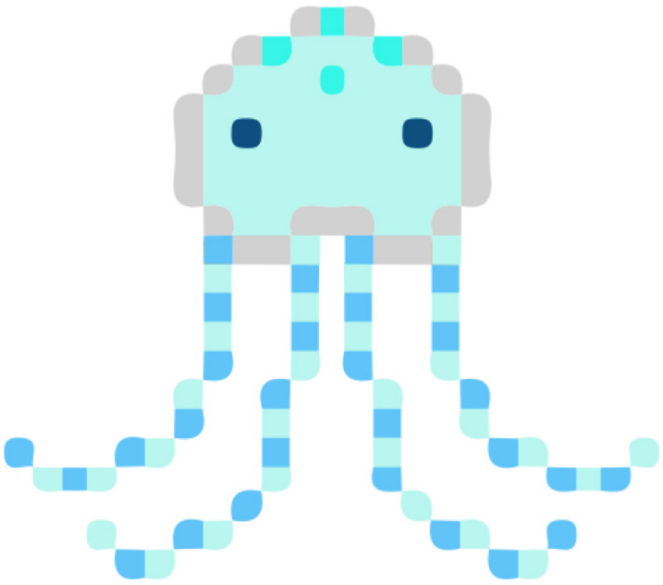

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