ESF Science Meeting Final Report for the Workshop on 'Body-size in a changing world' within the framework of the ESF Activity entitled 'Body-size and ecosystem dynamics: integrating pure and applied approaches from aquatic and terrestrial ecology to support an ecosystem approach'.

Summary

The workshop was successful in every single aspect. A total of 75 participants from 15 different countries meet at the Institute of Marine Sciences-CSIC (Barcelona) on June 21st-22nd to discuss about body-size in a changing world. The aim of the 3rd SIZEMIC Science Meeting was to focus on how multiple drivers and their synergies can alter body size distributions, ecological networks and, ultimately, ecosystem dynamics. We divided the meeting in four themes: Climate change, Habitat loss/ fragmentation/ degradation, Overexploitation and species invasion, and Multiple stressors, synergies and gaps. For each theme, a keynote and three invited speakers presented their work and ideas. We tried to incorporate to the ongoing network of collaborators of the two previous meetings some new and fresh people, and it really helped to expand and complement the perspectives (as an example, half of keynote speakers were new to SIZEMIC). After each theme, there was a 45 minutes discussion with the audience, the 4 speakers and the chair. This made the workshop really interactive and participative, and the feedback the organizers had from the audience was very good. In addition, we selected 22 posters from participants for a poster session, and they were displayed throughout the duration of the workshop. Discussions and potential collaborations continued over coffee breaks and meals that were covered for all participants. Several tangible outputs came from the meeting. First, some summary/perspective papers for a special issue on *Advances in Ecological Research*. Second, a draft proposal for extending the ESF Research Networking Programme SIZEMIC into a European scientific project. Third, the workshop brought together people that then participated in the SIZEMIC working groups meetings that took place at the same venue on June 23rd-25th.

Description of the scientific content and discussion at the meeting.

One of the key challenges of adopting an ecosystem approach is to understand how global changes will impact ecosystems and ultimately to develop predictive relationships between stressor(s) and ecosystem state(s). This is a challenging task since it is clear that multiple environmental and human induced stressors are occurring and these are likely to affect the structure and dynamics of ecosystems in a non-additive manner.

It is well established that body size plays an important role in structuring ecological networks, such as food webs, and that human drivers such as overexploitation can alter body size distributions. The aim of the 3rd SIZEMIC Science Meeting was to focus on how multiple drivers and their synergies can alter body size distributions, ecological networks and, ultimately, ecosystem dynamics. The meeting was really successful in achieving its goal.

A total of 75 participants from 15 different countries (UK, Spain, Italy, Ireland, Sweden, Germany, USA, The Netherlands, Chile, France, Romania, Brazil, Bulgaria, Senegal, Finland) meet at the Institute of Marine Sciences-CSIC (Barcelona) on June 21st-22nd to discuss about body-size in a changing world. We (i.e. the organizers) decided to focus on the three major stressors affecting body-size distributions, and on the synergies between them. We structured the workshop around 4 themes: Climate change, Habitat loss/fragmentation/degradation, Overexploitation and species invasion and multiple stressors, synergies and gaps. For each theme there was a keynote speech (30 minutes plus 15 minutes for discussion) and three invited talks (20 minutes plus 10 minutes for discussion). For the workshop, we tried to have a balance between speakers that are part of the ESF SIZEMIC Research Networking Programme (i.e. participants in previous meetings or part of ongoing working groups) and some new speakers that could provide some new and fresh ideas. In total, 40 per cent of speakers were new to SIZEMIC. Also, we decided to give priority to discussion time among participants. In addition to question time after each talk, for each theme we had a 45-minute discussion in which many participants were very active. In total, for each theme, there were 90 minutes for presentations, and 90 minutes for questions/discussion.

I summarize below some of the ideas presented and discussed in each of the 4 themes.

Theme 1. Climate change impacts on body-size (Monday, June 21st, 9:30-13:15, chair: Jose M. Montoya).

After a brief introduction I made to the meeting, we started this theme. Martin Daufresne made the keynote address presenting evidence for aquatic systems of what he called " the third rule of climate change: reduction on body-size". He showed ongoing warming is favoring smaller organisms at different trophic levels, and presented a general theory to predict such changes. Brad Hawkins then presented how body size of ectotherms changes at larger, geographical scales, showing that higher colder latitudes contain larger species. Then, William Cheung showed how to predict fish distributions from changes in phytoplankton communities in the face of warming. To conclude, Gabriel Yvon-Durocher presented a warming mesocosm experiment in which phytoplankton biomass and body mass was reduced by an order of magnitude under experimental warming. The discussion was mostly focused on how consistent the reduction in body size in the face of warming is across different spatio-temporal scales. A heated debate with several comments from other participants happened around the mechanisms and potential impacts of such a shift towards small things.

Theme 2. Habitat loss/fragmentation/degradation impacts on body-size (Monday, June 21st, 14:30-18:00, chair: Guy Woodward).

The keynote lecture was given by Gonçalo Ferraz, based on his work on the fragmentation project in the Amazonia. He suggested movement patterns related to species body size should be considered when predicting the effects of habitat degradation. Within forest bird communities, body size alone does not seem to be a good predictor of the effects of habitat loss on species. Chris Carbone showed how mammalian carnivores are affected by declines on their prey resources in a degraded habitat. He presented an energetic mechanism by which large carnivore abundance was reduced by 5-6 times more than that of the smallest carnivores in response to lower prey abundance. Then, Ulrich Brose introduced food web models parameterized by using prey and predator body mass and metabolic rates

to explore their persistence and resistance to extinctions triggered by e.g. habitat loss. Finally, Teresa Alcoverro used a clonal structural organism to show how reductions on its abundance and cover due to various human-induced disturbances in the Mediterranean would affect the loss of different ecosystem processes, like production of reproductive output, and loss of associated diversity. The discussion was less focused than that of the previous theme, mostly because it was more difficult to detect a pattern in the way species of different body size respond to habitat destruction and degradation, but many interesting ideas were put forward and discussed.

After this theme, there was a poster session (a total of 22 posters were selected) that last for almost 90 minutes that allow for more interactions between participants. Posters were partition among the different themes of the workshop.

Theme 3. Overexploitation and species invasion effects on body-size (Tuesday, June 22nd, 9:30-13:00, chair: Julia Blanchard).

Simon Jennings presented in his keynote lecture a comprehensive review of size-based methods to help fisheries assessment and management. It was a clear and concise example of how to translate theoretical ideas and constructs into applied ecology, one of the motivations of the SIZEMIC network. Sanne de Visser then presented her research on the Serengeti food web. She simulated the effects of increased human impact on the community composition and size-structure of this paramount ecosystem, showing that increased impact will lead to decreases of the average individual body size of vertebrates and arthropods. Ute Jacob also presented a talk with a conservation biology side, focusing on how to determine systematically species uniqueness in complex food webs and the impacts of losing these species on ecosystem services. Finally, Karen van der Wolfshaar showed the impact of invasive top predators on the size-structure of native populations, and even more importantly, under what circumstances invasive top predators might not be successful invaders. The discussion was very participative, and pivoted around the similarities and differences between the effects of species removal versus species introductions in food webs.

Theme 4. Multiple stressors, synergies and gaps (Tuesday, June 22nd, 14:15-18:00, chair: Gabriel Yvon-Durocher).

The keynote lecture was given by Owen Petchey. He presented a new meta-analysis exploring the relationship between threat of extinction and body size, with a surprising lack of any trend. He concluded a more refined data compilation and analyses was required, and suggested ways for doing so. Marie-Joelle Rochet then dealt with how multiple stressors, including overfishing and fertilizer inputs, could be assessed simultaneously in fish communities. She developed a new methods to conduct an integrated assessment of the pressures most likely responsible for changes in fish communities. Josep Gasol then open the black box of aquatic microbial communities. He presented old and new data showing the effects of different stressors (eutrophication, warming) on the size structure of microbial communities. Finally, Guy Woodward reviewed the effects of acidity, drought, and environmental warming on freshwater food webs. He showed droughts tend to simplify food web structure with further consequences on community stability. The discussion pivoted around whether different stressors are and will affect ecosystems in a similar way. In general, small things will be benefited in the face of warming, habitat loss and degradation, and overexploitation.

We had a final discussion on where to move forward in terms of science, networking, and potential funding. We concluded a final workshop will be needed and we decided some summary papers will be produced as part of a special issue in *Advances in Ecological Research*.

Results and impact on the future direction of the field.

The central aim of the workshop was fulfilled: to bring together experts to discuss the impacts of the major environmental stressors on body size. The main general result that came out of the workshop was that smaller individuals and species are generally benefited in the face of climate change, habitat loss and degradation, and overexploitation. In some cases, they are directly benefited. In others, the benefit is indirect through the detrimental effect of a particular stressor on larger species- e.g. fisheries targeting large individuals. Little is known, however, on the synergistic effects of these stressors. Throughout the workshop, there were suggestions of methods to address this issue, and this will be one of the clear directions of this field in the very near future. Actually, some of the participants are willing to elaborate a European project on multiple stressors on body-size distributions, ecological networks, and ecosystem functioning.

Another fundamental result from the workshop was the coherence of the impacts of stressors across very diverse spatio-temporal scales. This was particularly evident in the case of climatic warming. Both experimental mesocosm studies and large-scale dataset analyses showed a decrease in body sizes with increasing temperatures. At the same time, local studies and biogeographical analyses showed similar patterns: small things tend to dominate in warmer environments. This was clear after the meeting and will certainly be one of its major results and an idea to test in further studies. In the discussions, however, we identify an open question that will certainly motivate further research in the field (some people, including myself, are collaborating on answering this question): what is the mechanism behind size-reduction in the face of warming? In coming years, we will be able to get an answer and we think this workshop was very inspiring to get closer to it.

Also, through the workshop it was possible to identify a number of unexplored areas that will require further research in the near future. Some include, but are not limited to: How body size distributions change between trophic levels at biogeographical scales; How to incorporate multiple stressors in size-structure model food webs; How to identify extinction risk in the face of multiple stressors

and whether it will be related to species body size and/or alternative species traits.

Some tangible results from this workshop that will guide this research area include: (i) The publication of some papers as part of a special issue for *Advances in Ecological Research* , (ii) The elaboration of an European research project dealing with the effects of multiple stressors on body-size distributions, ecological networks, and ecosystem functioning (on its draft stage at the minute, leaded by Andrea Belgrano, and with the involvement of several participants in the workshop), (iii) The organization of the final SIZEMIC workshop in Hamburg on April 2011.

Final Programme.

SIZEMIC

Body-size and ecosystem dynamics: Integrating pure and applied approaches from aquatic and terrestrial ecology to support an ecosystem approach

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3rd Workshop of the ESF Research Networking Programme SIZEMIC

Body-size in a changing World

Institute of Marine Sciences, Consejo Superior de Investigaciones Científicas, Barcelona, Spain (http://www.icm.csic.es) June 21-25, 2009

Organisers: José M. Montoya (Institute of Marine Sciences-CSIC, Barcelona, Spain), Guy Woodward (Queen Mary University of London, UK) and Julia Blanchard (Imperial College London, UK).

Sunday: We meet at 20.30 outside "Parallel" tube station.

Monday 21st.

9:30-9:45: *Introduction*. José M. Montoya (Institute of Marine Sciences, CSIC, Spain)

Theme 1: Climate change (chair: José Montoya)

9:45- 10:30: Keynote: *Impact of global warming on body size in aquatic ecosystems* Martin Daufresne, (Cemagref, UR Hydrobiologie, France).

10:30-11:00: *The biogeography of body size*. Bradford Hawkins (University of California at Irvine, USA).

11:00-11:30: Coffee break

11:30-12:00: *Integrating eco-physiology and phytoplankton dynamics into projected changes in fish distributions and catch potential.* William Cheung (University of East Anglia, UK)

12:00-12:30: *Towards an understanding of the feedbacks between warming, community size structure and ecosystem functioning*. Gabriel Yvon-Durocher (Queen Mary University of London, UK)

12:30-13:15: Discussion

13:15-14:30: Lunch (and/or siesta)

Theme 2 : Habitat loss/fragmentation/degradation (chair: Guy Woodward)

14:30-15:15: Keynote: *Big vs. small in a changing landscape: do we know enough about movement?* Gonçalo Ferraz (IPNA Smithsonian Tropical Research Institute, Manaus, Brazil)

15:15-15:45: *Size and energetics influence responses of mammalian carnivores to declining resources*. Chris Carbone (Institute of Zoology, London, UK).

15:45-16:15: Coffee break

16:15-16:45: *What size means for a clonal plant in the face of change.* Teresa Alcoverro (Centro de Estudios Avanzados de Blanes, CSIC, Spain)

16:45-17:15: Ulrich Brose (University Göttingen, Germany)

17:15-18:00: Discussion

18:00-19:30: Posters and wine "reception"

20:45: Dinner (all) Marina Moncho´s (3 minutes from the venue)

Tuesday 22nd.

Theme 3 : Overexploitation and species invasion (chair: Julia Blanchard)

9:30- 10:15: Keynote: *Development of size-based methods to support fisheries assessment and management*, Simon Jennings (Centre for Environment, Fisheries and Aquaculture Science, UK)

10:15-10:45: *Effects of human impact on the community composition and size-structure of the Serengeti food web*. Sanne de Visser (University of Groningen, The Netherlands)

10:45-11:15: Coffee break

11:15-11:45: *Unique species: Implications for ecological conservation?* Ute Jacob (University of Hamburg, Germany)

11:45-12:15: *Top predator loss; what can we learn from invasion?* Karen van de Wolfshaar (Wageningen University, The Netherlands)

12:15-13:00: Discussion

13:00-14:15: Lunch

Theme 4 : Multiple stressors, synergies and gaps

14:15-15:00: Keynote: *Body size and threat of extinction.* Owen Petchey (University of Sheffield, UK)

15:00-15:30: *Size- and abundance-based metrics help identify the impacts of multiple stressors on exploited fish communities.* Marie- Joelle Rochet (IFREMER, France)

15:30-16:00: Coffee break

16:00-16:30: *Stressors of ecosystems and the size sructure of the microbial communities.* Josep M. Gasol (Institute of Marine Sciences, Spain)

16:30-17:00: *Impacts of environmental stressors on freshwater food webs*, Guy Woodward (Queen Mary University of London, UK)

17:00-18:00. Discussion+Conclusions

Beer/Wine at Barceloneta

Dinner (working groups)