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DEB essay
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DEB models: useful tools for the next generation of ecological models.

In the actual context, the world is facing new challenges which cover many areas (ecology, climate change, environment and human heath). To face these challenges, predictive models could give an insight of the decision-making and the whole range of measures potentially available to control risks.

My own research deals with one of this issues: the presence of xenobiotiocs in the environment and their possible effects on species populations. For this purpose, I am currently developing a model to predict the effects of chemicals (mostly pharmaceuticals) on a specific fish population. Because population models require an important amount of data, it is easier to start by developing a DEB model (Beaudouin et al. 2015). As the DEB model for my species already existed, I did not develop this model. Therefore, the DEB tele-course has given me a good opportunity to better understand the concepts of the DEB theory. Indeed, the course was really enriching.

A general idea of modelling is that models should be the less simple but also the more complex possible in order to study accurately a phenomenon. And, in my opinion, DEB models have the right balance between complexity and simplicity which allow them to be relevant and powerful tools. Indeed, on one hand, only two compartments (reserve and structure) are taken into account in the DEB theory and are enough to describe well the physiological processes of organisms. On the other hand, DEB models make the link between the environment and the organism by describing the energy taking from the food and flowing through the organism and considering the temperature effects on the physiological processes. To have a more realistic and relevant model, considering the environment in the model appears to me essential. Indeed, the health of an organism is not independent from its environment and when the environment is disturbed during a long period, at some point, the organism would be too. The last sentence takes all its sense nowadays, as the effects of climate change or pollution on ecosystems have started to be seen and pointed out. In the DEB model, the reserve is link with the stability of the environment and its role of buffer explain well why some organisms would be more resistant to a change of environment.

The other points that, I think make DEB models relevant tools are that, first, the physiological processes (growth, reproduction, maintenance) are described for the whole life cycle of the organism which make them different from the empirical bioenergetic models. Furthermore, the modeling difference between species only lies on the values of the parameters of the DEB model, the structure of the model remains the same. Then, they are relatively flexible as non-standard DEB models can be easily developed to answer to a specific problem. Finally, coupling DEB models with a population model (like individual-based models (IBM)) to describe the whole population dynamics appears logical and natural.

However, one of the issue of DEB models and maybe one of the limit of their use, is that DEB models are mainly calibrated with data from laboratory experiments made on standard species and where the conditions are far from a natural environment. The result is that sometimes, DEB models fail to predict accurately the physiological processes of an organism in some given conditions (Peeters et al. 2010, Zimmer et al. 2012). Particularly, DEB models and population models have to take into account the ecological factors as well as the toxicant stressor to conduct an appropriate risk assessment. The lack of ecological realism for models in ecotoxicology have been widely recognized (Goussen et al. 2016, Forbes et al. 2017).

For this purpose, data from field or semi-natural ecosystems like mesocosms are extremely interesting as they could give an insight of the natural temperature and food density in the environment. Furthermore, the question of how to assess the food condition of an organism in its natural environment seems also essential. Indeed, some interactions like predation or competition can significantly limit the food of an individual and, thus may be necessary to take into account in DEB models.

In conclusion, because of all the advantages that I mentioned before, I think that DEB models have the potential to be part of the next generation of ecological models. They indeed represent useful tools for many domains (management, decision-making, risk assessment) where the demand for predictive models is rising.

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