**Abstract**

Food webs are fundamental parts of all ecosystems, but factors underpinning their structure are still not totally understood. Functional response is known to drive the feasibility of predator-prey interactions and the stability of the whole food web. A better understanding of factors driving the functional response would lead to novel insights on the study of food webs. On the one hand, body size seems to play a major role in trophic interactions. On the other hand, living organisms are constrained by the physical properties of the surrounding medium. Hence, ability of moving, is an essential aspect of most predator-prey interactions, and motion is affected by physical properties such as density or viscosity. Moreover, effects of these physical properties are size-dependent. Thus, an approach that merges body size and physical properties of the medium into a functional response would provide novel insights on predator-prey interactions and food web structure.

As an example of this kind of approach, we provide a model that derives classical parameters of a functional response (i.e., attack rate and handling time) from body size and physical factors. We use a recently published biomechanical model, and compute parameter values for a functional response. A predator has to move to search for a prey. Once a prey is found, the predator has to move to capture the prey. Search and capture are key element of attack rate. Physical properties of the medium, in relation with body size, constrain predator and prey ability to move, thus affecting attack rate. Finally, the predator needs time to consume the prey. Handling time also depends on predator and prey sizes. The novelty of this approach is that parameters are not estimated from observational data. The model only needs body sizes and physical properties of the medium, which can be easily measured. Functional response becomes an emerging property of the system.

The results show a promising avenue for new approaches that would merge the biological part and the physical part of the medium. The strength of this kind of approach is to derive patterns at the community level from measures done at the individual or species level.

**Abstract**

**A novel biomechanical approach to infer size-based functional response in aquatic and terrestrial systems**

First derivations of the functional response were mechanistic, but in practice, the subsequent uses of these first mechanistically-derived functions were mostly phenomenological and, to a large degree unsatisfactory. However, a better understanding of mechanisms underpinning functional response would lead to novel insights on predator-prey relationships within natural systems.

We propose to return to the mechanistic approach, and we try to push it by including an explicit consideration of the movement of the organisms involved, and hence of mechanics. Living organisms are constrained by the physical properties of the surrounding medium. Hence, ability of moving is an essential aspect of most predator-prey interactions, and motion is affected by physical properties such as density or viscosity. A predator has to move to search for a prey, then to capture this prey. Search and capture efficiencies are key elements of attack rate. Physical properties of the medium, in relation with body size, constrain predator and prey ability to move, thus affecting functional response.

Considering mechanical effects from the medium grounds the functional response within its physical, local environment, and makes its parameterisation dependent on measurable morphological and physical traits of organisms. As an example of this kind of approach, we provide a model that derives classical parameters of a functional response (i.e., attack rate and handling time) from body size and physical factors. We use a recently published biomechanical model, and compute parameter values for a functional response. The novelty of this approach is that parameters are not estimated from observational data. The model only needs body sizes and physical properties of the medium, which can be easily measured.

Several ways for potential improvement are discussed. Further studies may include more physical factors such as temperature that affects physical properties and/or organism metabolism, or light that may be of importance for visual predators.

This approach also provides easy ways to validate of falsify hypothesis. Hence, discrepancies between predictions and real data point immediately towards an error in the modelling, or means that important mechanisms are missing.

Using this approach, functional response becomes an emerging property of the system. It opens a promising avenue for new approaches that would merge the biological part and the physical part of the medium. The strength of this kind of approach is to derive patterns at the community level from measures done at the individual or species level.