Reply to reviewer 2's comments

Original comments appear in straight font, and our answers appear in italic.

EVALUATION
Please list your revision requests for the authors and provide your detailed comments, including highlighting limitations and strengths of the study and evaluating the validity of the results, and data interpretation. If you have additional comments based on Q2 and Q3 you can add them as well.
General Evaluation:
Main findings of the manuscript
The authors aim to improve our understanding of the predator-prey relationship by including an explicit consideration of the movement of the organisms involved, and hence of mechanics. They provide a model that derives classical parameters of a functional response from body size or organisms involved and physical factors of the medium, which can be easily measured. The novelty is that parameters are not estimated from observational predation data.

Limitations:
Some wording could be changed for clarity and brevity. In addition, the authors need to provide quantitative data on the model fits, and need to better highlight the novelty of the study.
As mentioned in the reply to reviewer 1, we added several elements to evaluate the goodness of fit. First, we computed the root mean square deviation (RMSD) that account for the mean deviation of the predicted and observed data, as recommended in Pineiro et al 2008 (Ecological Modelling). Second, we added a test on the slope and intercept of the regression of observed versus predicted data (i.e., a slope of 1 and an intercept of 0 mean that the model is unbiased) with body size as a cofactor, and the source of data (i.e., the study where the data was originally collected) as a random variable. It appears that the slope and intercept of the regression for speed, attack rate and capture probability do not significantly differ from 1 and 0 respectively, with no significant effect of size nor the source of data. On the other hand, the model fails to accurately predict handling time, which is the only parameter that does not rely on mechanical factor in our model. Results can be found in the main text (l. 252-260 pp. 12-13, l. 297-315 pp. 14-15) and the full details can be found in the supplementary material.

Strengths:
Provision of a model that derives classical parameters of a functional response from the easily measured parameters body size and physical factors. Use of the model means that the parameters so not need to be estimated from observational predation data.

Specific Evaluation:
Title:
1) Line 1: Can "biomechanical" be changed to something more informative? Line 100 talks about physical properties, which seems like it should be in the title.

We changed the title accordingly. The title is now: "Inferring size-based functional responses from the physical properties of the medium".

Introduction:
2) Lines 52-58: Has this relationship of the FR to size already been well established? Need to focus on the novelty of this study.

We edited the paragraph accordingly (l. 80-87 p.4). We explained that our understanding of this well-known relationship would be improved by incorporating the physical medium in models, since its effects mostly vary with size.

3) Lines 55-58: Could add more references from the marine realm in addition to Williams et al., such as Miller, T. J., Crowder, L. B., Rice, J. A., & Binkowski, F. P. (1992). Body size and the ontogeny of the functional response in fishes. Canadian Journal of Fisheries and Aquatic Sciences, 49(4), 805-812.

We added the corresponding reference.

4) Lines 85-88: Seems like body size VERSUS viscosity should matter in the model.

We clarified this point (l. 144-145 p. 7).

5) Line 94: Add references after "promising avenue."

Actually, the references were the topic of the remaining of the paragraph. However, we agree that it was misleading. Thus, we made it clearer (l. 154).

6) Lines 94-95: Seems like many of the concepts presented in this paper have been described elsewhere, so authors need to highlight the novelty of this study.

We added a couple of sentences to clarify this point (lines 178-181 p. 10).

7) Lines 100-101: The use of the words "physical properties of the medium" would be informative to list in the title.

We changed the title accordingly. The title is now: "Inferring size-based functional responses from the physical properties of the medium".

8) Line 105 (and elsewhere): Don't forget the period and comma after "et al".

We corrected these typographic errors.

9) Line 122: Clarify what is meant by "…attack rate and handling time would become emerging properties of the model."

Due to the revisions, this sentence has been removed. However, a clearer formulation can be found in the conclusion (l. 370-371 p. 18).

10) Line 127: Should add "and the medium" (or some such statement) after "related to body size" (because it's not JUST body size that is being considered).

We followed the suggestion.

11) Line 132: Can authors give a quantitative value for what they mean by "fits data remarkably well"?

The original model by Portalier et al (2019) predicts a range of prey sizes that a given predator can prey upon in a sustainable way (i.e., the capture is successful, and the energetic reward is greater than the energetic expense). Therefore, we cannot do the same test as we do in the current manuscript. However, in the original study (Portalier et al., 2019), in pelagic systems, and for predators that meet the assumptions of the model, 80% (for species-based data) and 90% (for individual-based data) of observed predator-prey interactions fall into the predicted rage of prey sizes. We added this piece of information in the manuscript (l. 208-209 p. 10). Moreover, predictions of food web structure for 10 pelagic food webs were compared to predictions by the allometric niche model using the True Skills Statistics (Portalier et al 2019). Portalier et al.'s model proved much more accurate. However, for brevity reasons, we do not discuss those results in the current manuscript.

12) Line 136: Unclear which model is meant by "this model". The one in Portalier 2019 or the one in the current ms?
It is the Portalier et al. (2019) model. We clarified this point.

Main framework & Validation of the model
13) Line 140: The addition of "physical features" should be highlighted.

We modified the paragraph as suggested (l. 223-229 p. 11).

14) Line 164: Can authors add a quantitative way to look at how well the model fits the data?

We replied to this comment in details above. For each parameter (speed, attack rate, capture probability and handling time), we computed a RMSD and we tested if the slope and intercept of the regression between observed and predicted data significantly differ from 1 and 0 respectively.

15) Line 184: Shouldn't the equations allow for type III FR also?

Yes, equation 4 could allow for a type-III. In Portalier et al. (2019), the encounter rate model used leads to a type-II. But if another encounter rate model is used, we could compute a type-III functional response. We clarify this point in the manuscript (l. 284-289 p. 14).

16) Line 188: For brevity, remove "in order".

We removed "in order".

17) Lines 189-190: Seems like personal notes that should be removed.

The reviewer is right. We removed this point.

18) Line 194: "It appears that the model fits the data quite well" is not at all convincing. Need a quantitative measure of model fit (e.g., goodness of fit, residuals, model skill).

We replied to this question above. We computed a RMSD and we tested the slope and intercept of the regression between observed and predicted data.

19) Line 195: Seems like there are quite a lot of data for organisms in the mg size range and below, so this is not a valid reason. Seems like the model needs to change to include small organisms.

We agree with the reviewer that the argument was not valid. Actually, the statistical analysis does not show any significant bias for attack rate according to size. Thus, our former comment (in the former version of the manuscript) is not valid anymore.

20) Line 197: Handling time is very far off and the model for this needs to be changed.

We changed the sentence. The end of the corresponding paragraph discusses the fact that handling time is not related to mechanical factors from the medium in our model, and thus Portlier et al.'s model should be revised to better model handling time.

Conclusions and future directions
21) Line 206: Not convinced that this model is useful for this type of prediction.

We agree that the sentence was misleading. Our point was to provide some potential improvements for the model. We made it clearer (l. 321-322 p. 15).

22) Line 221: Again, not convincing to just state that the model fits data well. Model may be of little value if authors cannot quantitatively demonstrate that the model processes fit real data well.

We replied to this question above. We computed a RMSD and we tested the slope and intercept of the regression between observed and predicted data.

Figures
23) Line 392: The relationship of the real data looks like it could be modeled as a sigmoid function in Figure 1.

Our model tries to be general across a wide range of sizes. However, it is possible that small organisms experience supplementary constraints that are not included in the model, which results in an overestimate of their speed. Similarly, larger animals may show specific adaptations (such as lubrification of the body) that increase their speed, and that are not size-related. Hirt et al. (2017) included a limitation for large animals due to limitations of quickly available energy. These factors were not included in the original model by Portalier et al. (2019). They should certainly in the future.

24) Line 396: Can something be added to have the model asymptote at large sizes?

See answer to previous comment.

25) Lines 399-400: This wording is repetitive of what's in the text and can be removed here.
We removed this sentence.

Concluding Remarks:
Authors need to focus on highlighting the novelty of the study and also providing quantitative evidence of model fit to convince the reader.
We hope that the revised manuscript successfully addresses these remarks.