Feeding strategy of Downs herring larvae in the English Channel and North Sea

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Introduction

A large number of Downs herring larvae are usually caught at their critical period [(1)], i.e. passing from an endogenous to an exogenous nutrition, during winter in the English Channel and North Sea. Considering that feeding is a key component for larval growth and survival, assessing their feeding strategy is therefore a first step in understanding how they deal with sub-optimal feeding conditions of low prey availability encountered during winter. Whereas classical methods of diet studies based on optical microscopy might offer an incomplete view of larval feeding [(2)], Scanning Electron Microscopy (SEM) was recently used with success to enhance our knowledge on larval diet [(3)]. However, it still remains a qualitative approach.

The aim of this study was therefore to assess the feeding strategy of Downs herring larvae during winter using **both qualitative and quantitative approach**.

Material and methods

Herring larvae were caught during the French International Bottom Trawl Survey (January-February) in the Eastern English Channel and Southern North Sea from 2008 to 2014.

The qualitative approach based on SEM observations of diet contents (Fig. 1) from 2008 to 2014 was used to **1) identify preys that are consumed**, **2) determine their specific abundance and occurrence**, **3) assess their selection by herring larvae** and **4) map their spatio-temporal variations within larval diets.**

A quantitative approach was developed for this study in order to determine chlorophyll *a* concentration within herring larvae diets. This method has been adapted from gut fluorescence measurements classically used for copepods diets analysis [(4)].

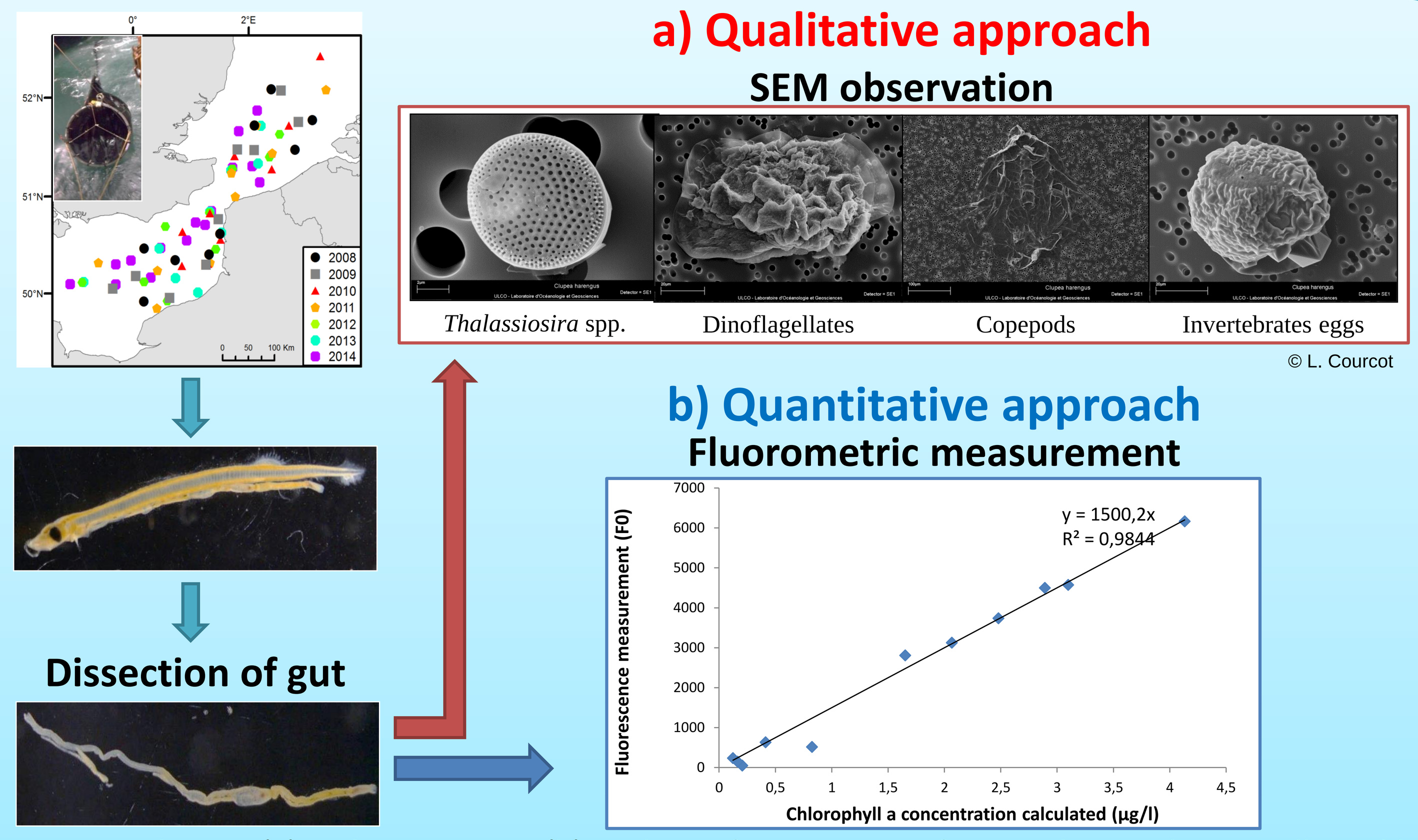


Fig. 1 Qualitative (a) and quantitative (b) analysis of gut content of Downs herring larvae collected by Midwater Ring Net in the English Channel and North Sea from 2008 to 2014.

Results

Diet composition and prey selectivity

A wide variety of phytoplankton and zooplankton preys were found in herring diets. Prey composition varied with larval length, from a more diversified diet for smaller larvae mainly composed of copepods, invertebrate eggs, diatoms and dinoflagellates to a less diversified one (copepods and diatoms) for longer ones (Fig. 2a). Downs herring larvae appeared to be specialized on copepods and invertebrate eggs (Fig. 2b).

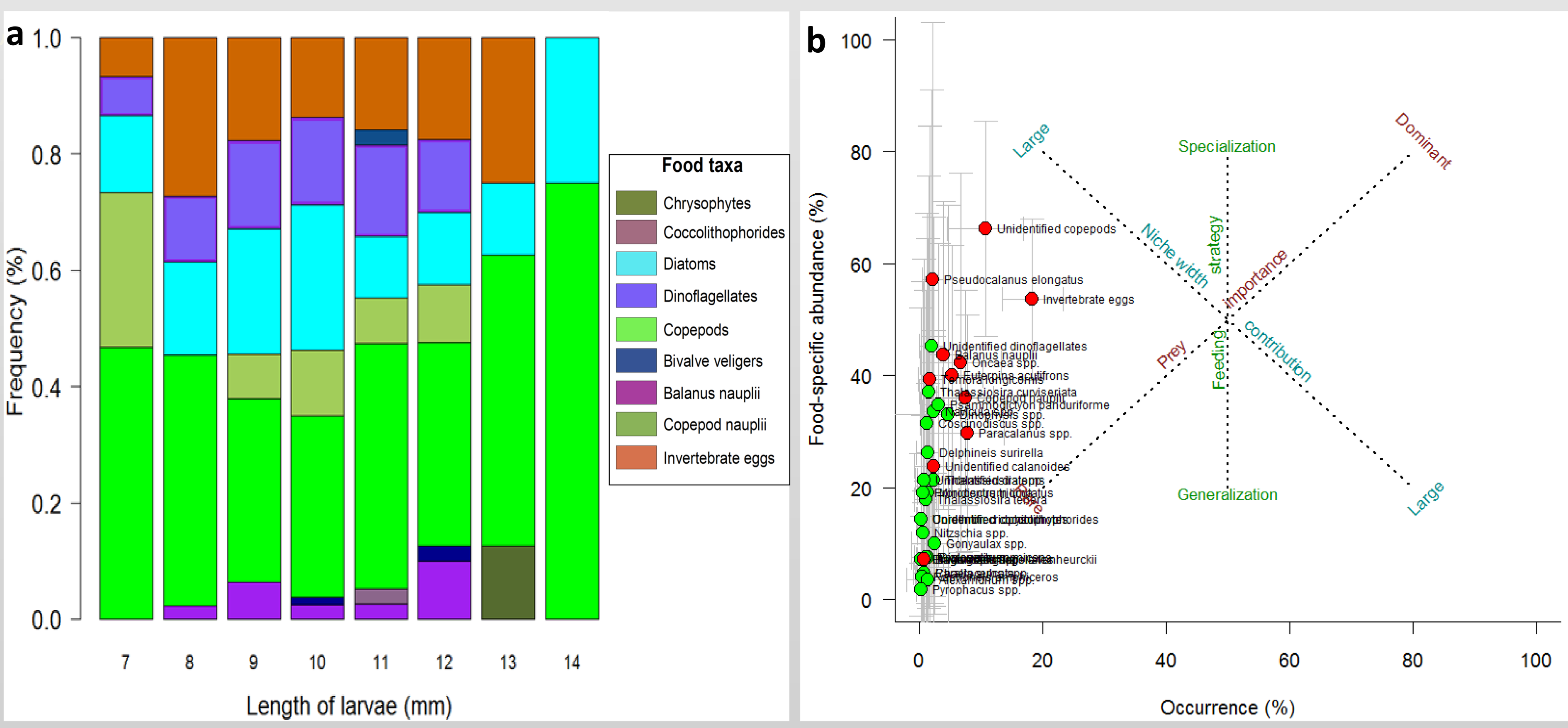
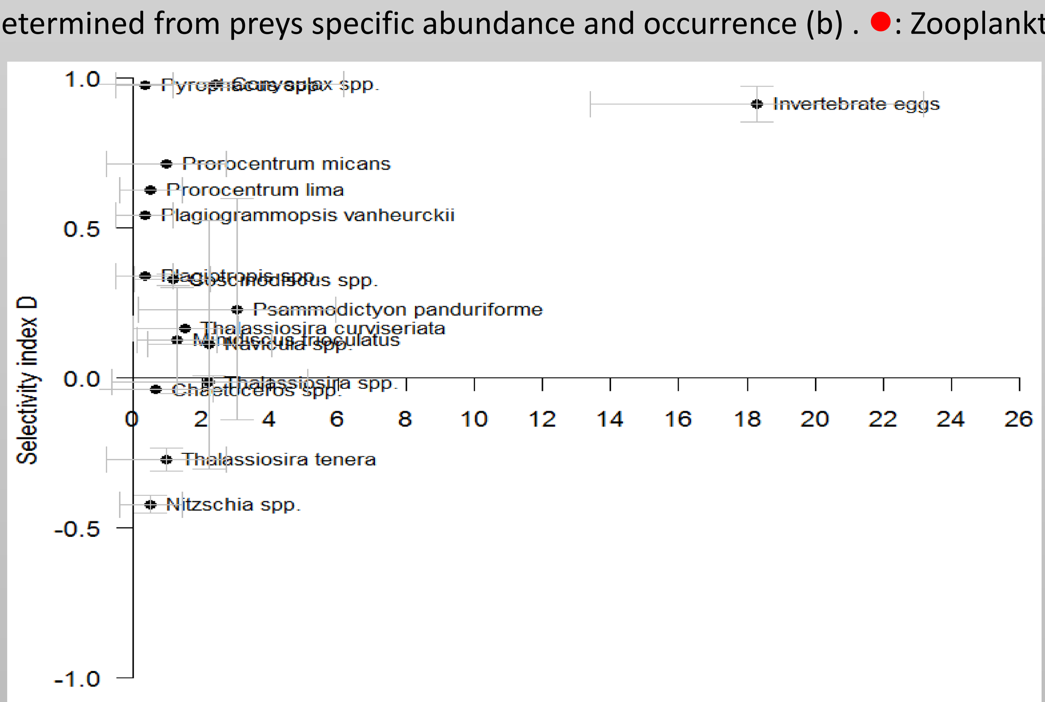


Fig. 2 : Diet composition of Downs herring larvae between 2008 and 2014 according to their length (a) and their feeding strategy determined from preys specific abundance and occurrence (b) . ●: Zooplankton ; ●: Phytoplankton.



Invertebrates eggs were highly selected, whereas among phytoplanktonic preys, dinoflagellates were selected and some diatom species like *Nitzschia* spp. were not (Fig. 3).

Fig. 3 : Selectivity and occurrence of preys encountered in Downs herring larvae diets from 2009 to 2013.

Spatial distribution of feeding activity and contribution of phytoplankton

Among the 345 larvae analysed, 56 % were empty. High level of feeding activity (number of larvae who ingested prey) was detected in two areas located (1) along the three French estuaries with a diet composition of zooplankton and phytoplankton preys and (2) south of England with diet consisting only of zooplankton (Fig. 4a, b). Chlorophyll *a* concentration within herring larvae diets spatially matched with the area south of England (Fig. 4c) whereas no phytoplanktonic prey were observed (Fig. 4b). On the contrary, lower chlorophyll *a* concentration within herring larvae diets was observed along the French estuaries whereas high *in-situ* Chlorophyll *a* concentration (Fig. 4d) and phytoplanktonic preys were observed (Fig. 4b).

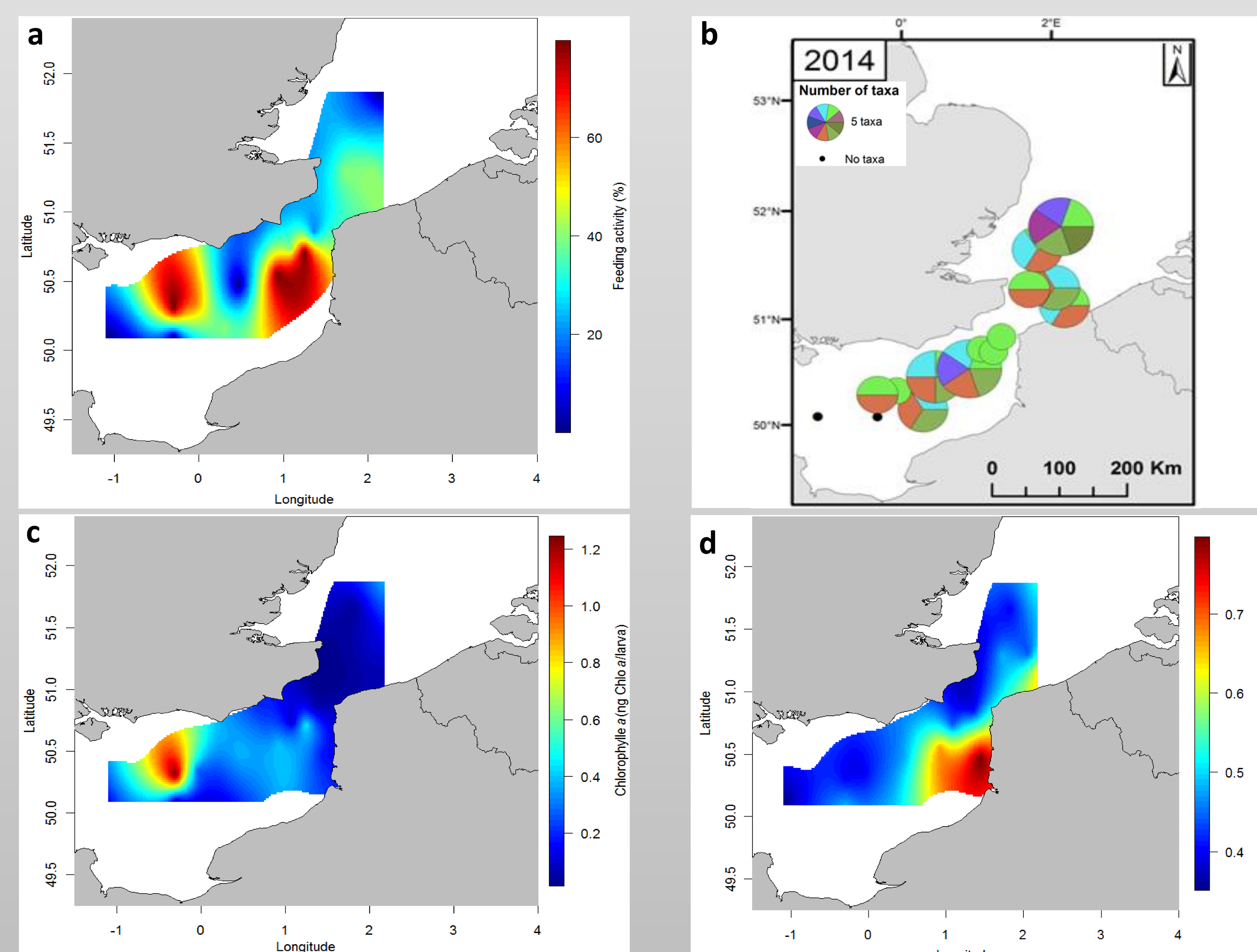


Fig. 4 : Spatial distribution of feeding activity (a), prey taxa composition (see fig. 2a for color scheme) (b) and Chlorophyll *a* concentration in the gut of herring larvae (c) and *in-situ* Chlorophyll *a* (d) in English Channel and North Sea in 2014.

Conclusion and perspective

SEM observations revealed that **Downs herring larvae were omnivorous, feeding both on phytoplanktonic and zooplanktonic preys**. They seemed to be **specialized more on zooplankton** like copepods than on phytoplankton. Among consumed preys, a huge quantity of preys smaller than 50 µm have been detected which **would not have been possible with optical microscopy**. These small preys corresponded mainly to **invertebrate eggs and dinoflagellates** and were positively selected. Presence of these eggs may reflect a **voluntary or an involuntary ingestion resulting from an escape strategy of original targeted copepods. They might also be an indirect clue of ovigerous copepods consumption**.

Phytoplankton contribution assessed with the fluorimetric method revealed that **chlorophyll a detected in larval gut might not reflect an effective consumption by herring** larvae but may be **more due to phytoplankton consumption by copepods which were in turn consumed by larvae**. Ingestion of phytoplanktonic preys can increase digestion efficiency of other ingested preys such as zooplankton [(9)]. This will be **further investigated through chlrophyll *a* measurements within diets of copepod** species consumed by herring larvae in order **to estimate their effective phytoplankton ingestion and potential competition with copepods**.

Difficulties encountered by Downs herring larvae to feed as suggested by **their pretty high vacuity rate (more than 40%) will also be assessed in term of impact on their survival and growth rates**, which in turn control larval recruitment and population renewal understanding.

References

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