Impact of *Pelagia noctiluca* jellyfish on fish populations: predation and food competition in the NW Mediterranean

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Summary

The scyphozoan *Pelagia noctiluca* is one of the most abundant species of jellyfish in the western Mediterranean Sea and its population seems to be increasing. It is a voracious predator, consuming fish larvae, fish eggs, and the foods of zooplanktivorous fish. The heavy dependence of the economies of many Mediterranean European countries on fisheries highlights the need to understand the potential impacts of this jellyfish on commercial fish populations. In the frame of the Spanish National Project *FISHJELLY*, we investigated the potential impacts of *P. noctiluca* on fish larva populations during two oceanographic cruises along the Catalan coast in the summers of 2011 and 2012. On each cruise, 81 stations were sampled to determine the distributions and abundances of gelatinous predators and their prey (zoo- and ichthyoplankton). Here we present the spatial overlaps of *P. noctiluca*, zooplankton, and ichthyoplankton, and the predation impacts, calculated from the numbers of prey eaten, the digestion times, and their abundances in situ.

Introduction

Jellyfish biomass has increased in many ecosystems around the world in the past two decades (Brotz *et al.* 2012). These aggregations are of particular interest due to their interaction with many human activities such as tourism, fisheries, or industry (Purcell *et al.* 2007). Jellyfish blooms may have important effects on the populations of mesozooplankton and due to their seasonally high abundances, their extremely high prey consumption rates, and their high assimilation efficiency can directly or indirectly control the population size of planktonic organisms, including fish eggs and larvae (Purcell and Arai, 2001). When jellyfish occur in large numbers they can impact fisheries by clogging fishing nets, feeding on fish eggs and larvae, and by competing for food resources, since they feed on the same food (Kideys and Romanova, 2001). In the western Mediterranean, jellyfish blooms, mainly of the scyphomedusa, *Pelagia noctiluca*, have been observed since the beginning of the 1980s (Canepa *et al*., 2014). This phenomenon has attracted much interest due to its severe impact on human activities in the region (Canepa *et al.*, 2014). The highest abundance of jellyfish takes place in spring and summer (Gili and Pagès, 2005), when most of the commercial fish species reproduce in the area (Sabatés *et al*. 2003).
The objective of this study is to determine the potential impact of *P. noctiluca* on commercial fish populations in the NW Mediterranean.

Materials and methods

Physical and biological sampling was conducted along the Catalan Coast at 81 stations from near the coast to the slope. In each station, vertical profiles of the basic hydrographic variables were obtained with a CTD and zooplankton was also sampled using a Bongo net with a 60 cm diameter opening and

a mesh size of 300 μm. Zooplankton samples were fixed in 5% formalin solution for sorting and indentification.
Digestion times (DT) of in-situ collected *Pelagia noctiluca* medusae (>22mm) and ephyrae (≤ 22mm) were measured on fresh fish larvae, fish eggs, and copepods during the cruises (Purcell et al., 2014). The recognition time (RT), defined as "the length of time that the prey could be recognized in the guts" (Purcell et al. 2014), was also recorded.
A total of 88 *P. noctiluca* adults and 145 ephyrae were collected individually by dip nets and by short tows with a neuston net, preserved immediately in 5% formalin solution, and analyzed in order to determine their stomach contents.
In the laboratory, all medusae were measured and their gastric contents examined with a dissecting microscope. All prey items were identified to major taxonomic groups, while fish larvae were identified to species.

Results and conclusions

Gut contents of *Pelagia noctiluca* together with digestion rates and population densities of the predators and prey were used to estimate predation effects (% prey consumed time^{-1}). Digestion times (DT) of *P. noctiluca* are from Purcell *et al*. (2014). DT of *Pelagia noctiluca* medusae and ephyrae fed one fish larva averaged 2.5–3.0 h. Fish eggs were digested more slowly (1.2–44.8 h) than fish. About half of all eggs tested were egested undigested, but, all anchovy eggs were digested.
The gastric pouches of *P. noctiluca* medusae contained mainly crustaceans and phytoplankton, although mollusks, gelatinous zooplankton and fish larvae and fish eggs also were abundant. The highest frequency of occurrence (%FO) was for fish eggs (115.2), followed by decapod/euphausid larvae (81.5), phytoplankton (69), pteropods (44) and fish larvae (41.3). *Engraulis encrasicolus* was the most numerous species of fish larva found in the gastric pouches (50% of total larvae), folowed by the scombrid *Auxis rochei* (8.6%). For *P. noctiluca* ephyrae, the most abundant prey in the guts were siphonophora, (%F 12.4). Copepods (8.3), fish larvae (8.4) and fish eggs (4.1) were also important.
Zooplankton was sorted in order to obtain densities of both prey and predators.
Potential daily predation for *P. noctiluca* ephyrae is 34.1%, being higher than those obtained by Purcell et *al*. (2014) for data obtained in 1995 in the same area. This is a high potential effect of the larval stage of this jellyfish species on fish larvae. Together with adults of *P. noctiluca*'s potential predation on fish larvae and fish eggs the impact of this jellyfish on fish populations of Catalan Coast could be very important.

References

Brotz L, CheungWWL, Kleisner K, Pakhomov E, Pauly D. 2012. Increasing jellyfish populations: trends in Large Marine Ecosystems. Hydrobiologia 690:3–20

Canepa A, Fuentes V, Sabatés A, Piraino S, Boero F, Gili J-M (2014) Pelagia noctiluca in the Mediterranean Sea. In: Pitt KA and Lucas and CH (eds) Jellyfish Blooms, Springer Science+Business Media, Dordrecht, pp 237–266

Gili, JM. and Pagès, F. 2005. Les proliferacions de meduses. Bolletí de la Societat d'Història Natural de les Balears, 48: 9- 22.

Kideys, A. and Romanova, E. 2001. Distribution of gelatinous macrozooplankton in the southern Black Sea during 1996-1999. Mar Biol 139: 535-547 .

Purcell, JE. and Arai, MN. 2001. Interactions of pelagic cnidarians and ctenophores with fish: a review. Hydrobiologia 451: 27-44.

Purcell, JE., Uye, S-i, and Lo, W-t. 2007. Anthropogenic causes of jellyfish blooms and their direct consequences for humans: a review. Mar Ecol Progr Ser 350: 153–174.

Purcell, JE., Tilves, U., Fuentes, VL., Milisenda, G., Olariaga, A. and Sabatés, A. 2014. Digestion times and predation potentials of *Pelagia noctiluca* eating fish larvae and copepods in the NW Mediterranean Sea. Mar Ecol Prog Ser in press.

Sabatés, A., Zabala, M., and García-Rubíes, A. (2003) Larval fish communities in the Medes Islands Marine Reserve (North-west Mediterranean). J. Plankton. Res. 25: 1035-1046