Gelatinous zooplankton – a contributor to the decline of small pelagic fish, with an update on *Mnemiopsis leidyi*

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Gelatinous Zooplankton, Mediterranean >400 sp.

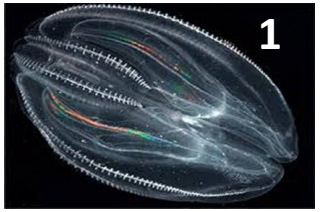
A **diverse** group of organisms can form **massive blooms** with **deleterious consequences** on fisheries, tourism, ecosystems, and human health.

They are predators to other plankton.

But display different dynamics and impacts on the ecosystem and human activities.

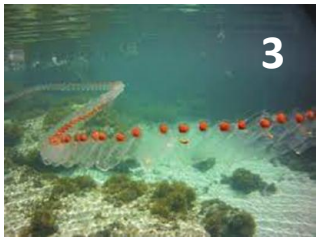
Adriatic Sea – Dominant Groups

N Adriatic – Mass Occurrences & Threats



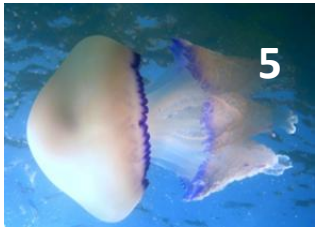
Mnemiopsis leidyi consumes large quantities of zooplankton, including fish eggs and shellfish larvae, and affects the distribution of small pelagic fish.

Pelagia noctiluca consumes zooplankton and small fish, and it is a known threat to beach activities as it is a stinging jellyfish.



Salpa spp. can also feed on smaller foods, such as phytoplankton, affecting their abundance, and destabilizing the food chain.

Aurelia spp. can threaten zooplankton funds and, by covering extensively large areas, create a displeasing sighting for visitors.

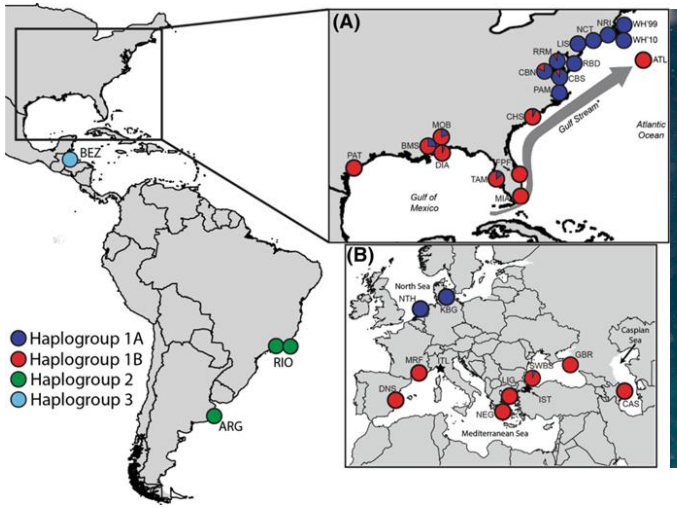


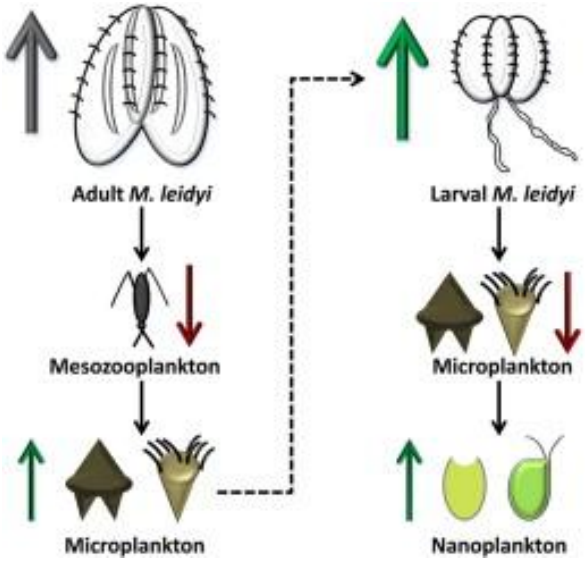
Rhizostoma pulmo, due to its large mass and size, can interfere with fishing activities and damage fishing equipment.

Invasive Ctenophore *Mnemiopsis leidyi*

1st arrival to European waters in the early 1980s, likely through ballast water from its native habitat, W Atlantic (N America to Argentina).

Since then, it spread across many seas, causing great ecological and economic damage.





'Problematic' traits

M. leidyi **competes with fish** for food and **feeds** on their eggs and larvae, leading to **massive losses** in small pelagic fish (anchovies, sardines).

Fast reproduction leads to a rapid build-up in their numbers **clogging fishing nets,** posing challenges for commercial fishing.

Mnemiopsis leidyi in the Adriatic Sea

1st appearance: Gulf of Trieste in 2005, followed by its disappearance.

2nd appearance, a whole N Adriatic in 2016, followed by its regular re-appearance.

High fecundity rates enabled rapid population growth in favorable conditions and led to the establishment of the population in the N Adriatic.

Diet: predominantly **copepods**, **cladocerans,** and **shellfish larvae,** underscoring its role in altering the local marine food web.



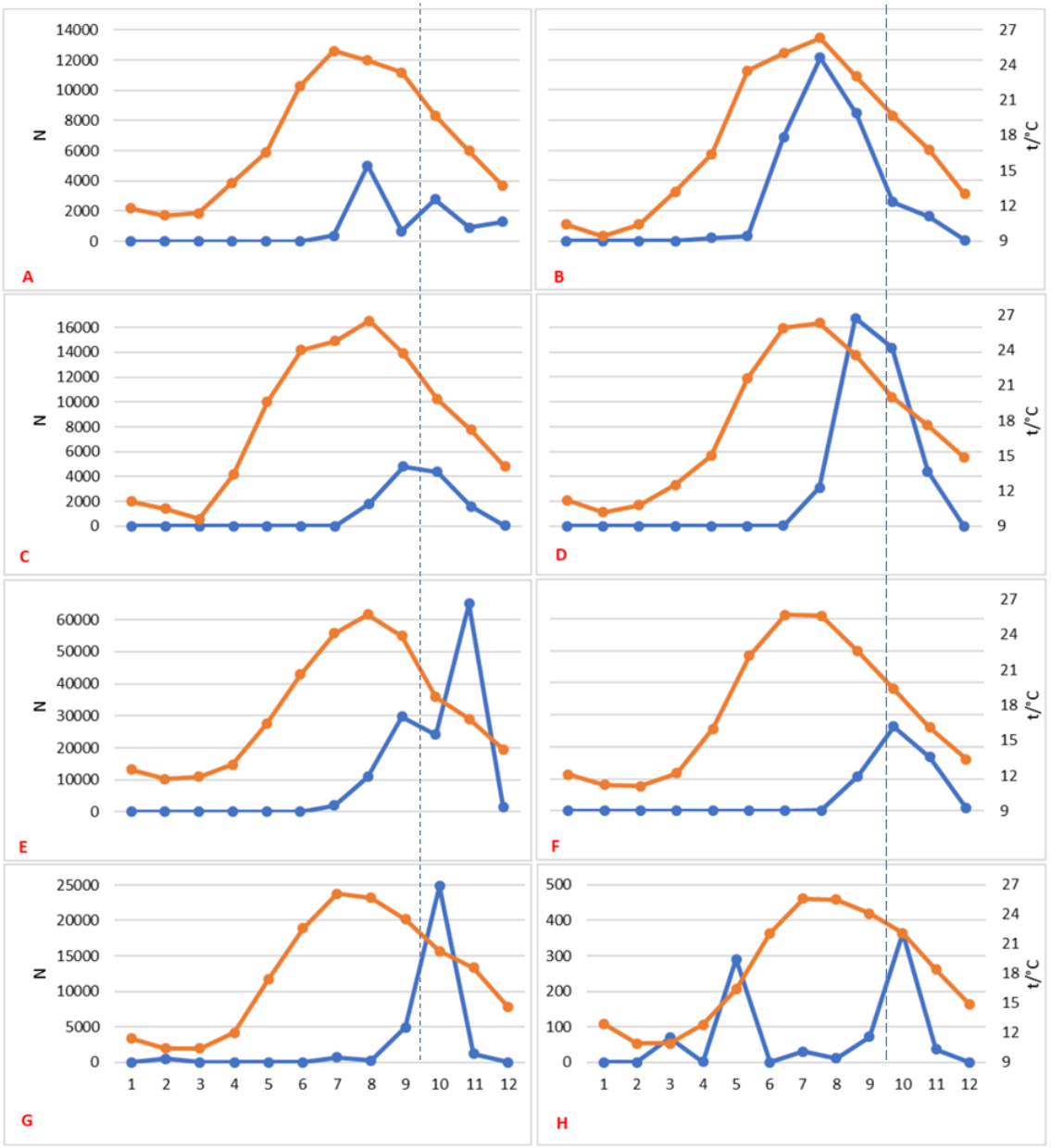

Its predation has already adversely affected commercially important species such as anchovies, which have been displaced from their usual habitats.

M. leidyi blooms are starting later

Bloom peaks:

2016 August
2017 August
2018 September
2019 September
2020 October
2021 October
2022 October
2023 October
2024 October

This trend could be ascribed to climate change, resulting in milder autumns and a possible delay of precipitations.



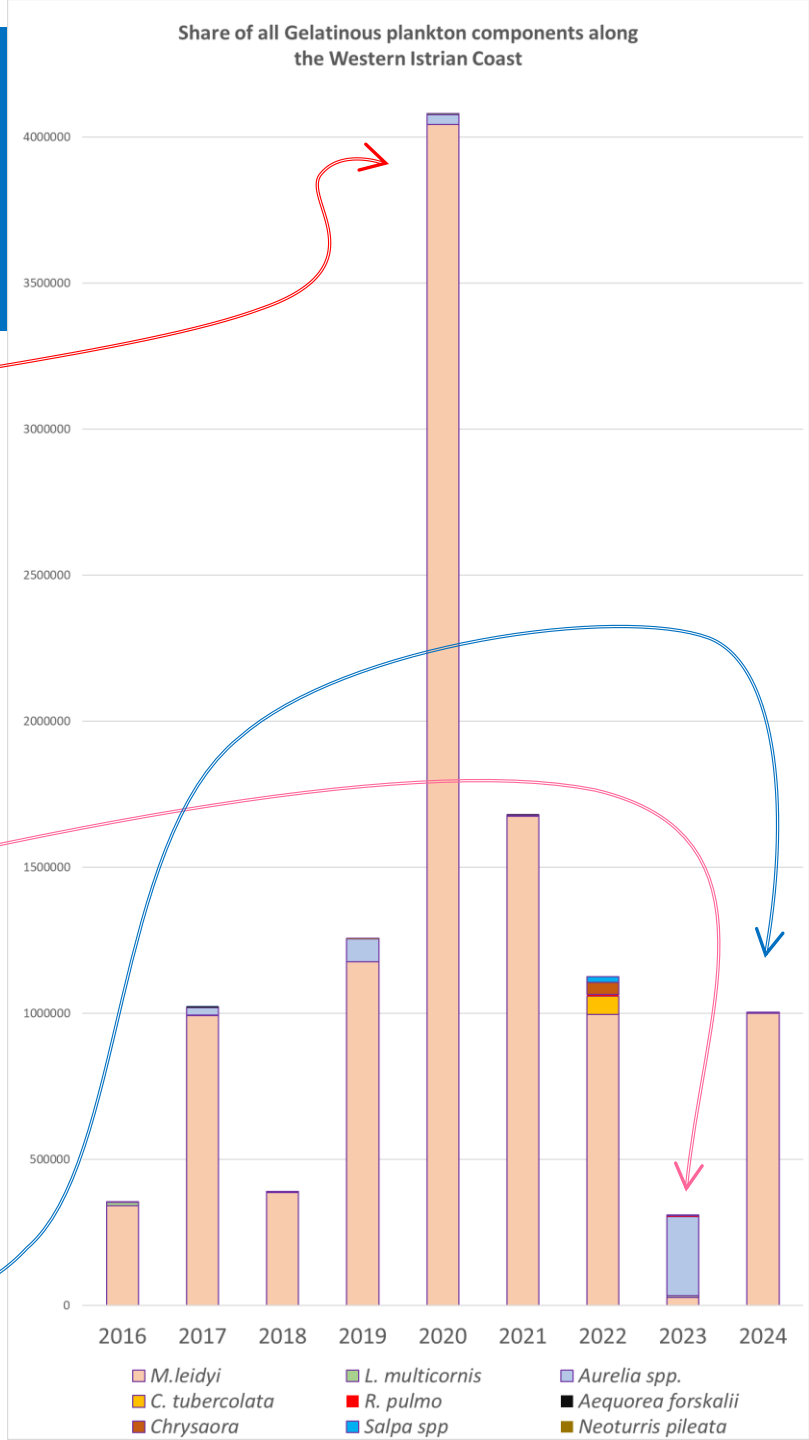
M. leidyi – dominant gelatinous zooplankton (GZ) in the N Adriatic since 2016

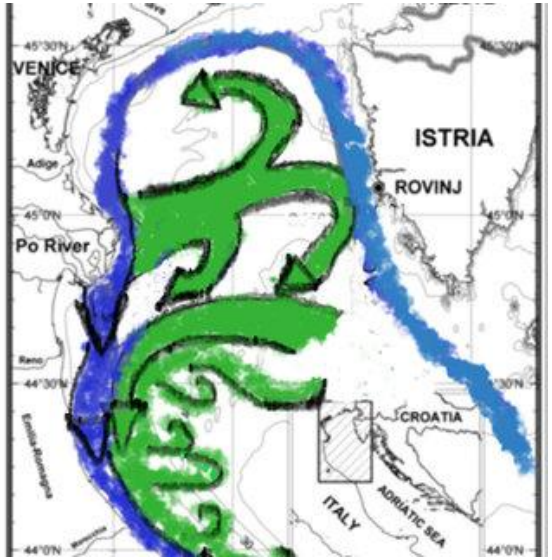
Long-term observations: the maximum abundances in 2020!

Its appearances have profound implications for the diversity of GZ and other zooplankton taxa.

2022-2023 Extremely low Po influx could have affected GZ food and circulation patterns that enable its spread, leading to an overall GZ minimum but the highest diversity.

2024 *M. leidyi* returned in high numbers, while other GZ were rare.

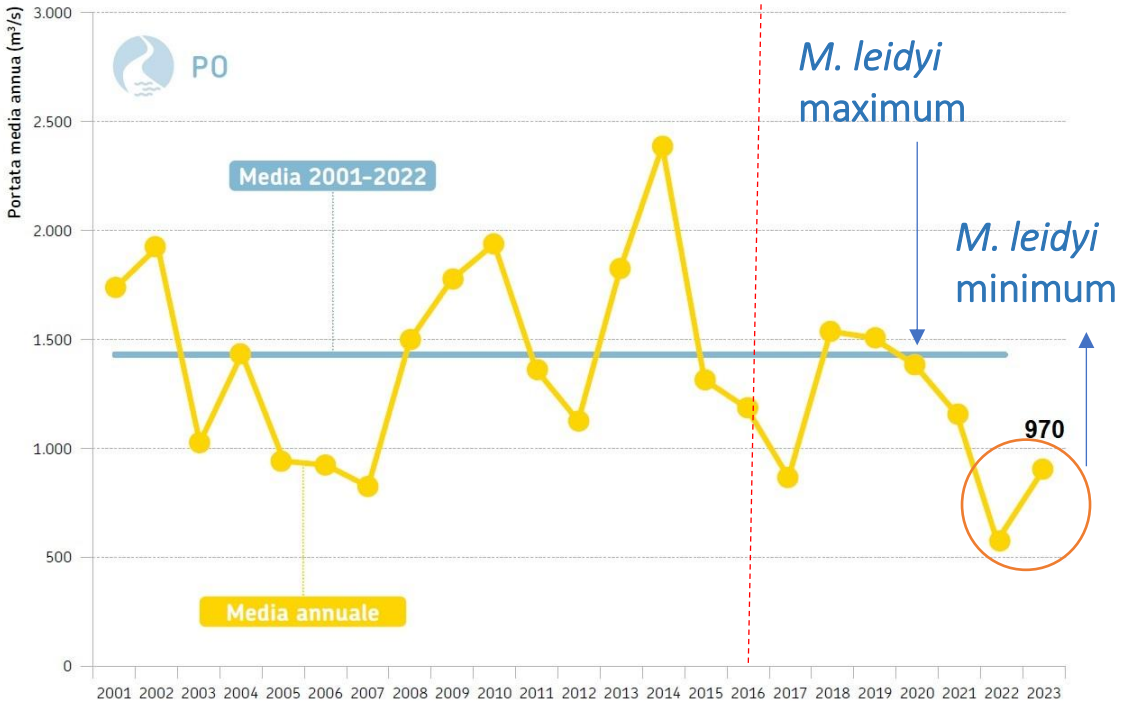




Water levels of Po River

The Po River discharge during the *M. leidyi* maximum in 2020 was much higher than during the *M. leidyi* minimum in 2022 and 2023.

We hypothesize that reduced spring and autumn influxes and a delay in the formation of a semi-enclosed N Adriatic circulation hampered the proliferation of *M. leidyi*.



Hydrologic data from: https://webbook.arpae.it/indicatore/Portata-dei-fiumi-00001/?espandi=grafici

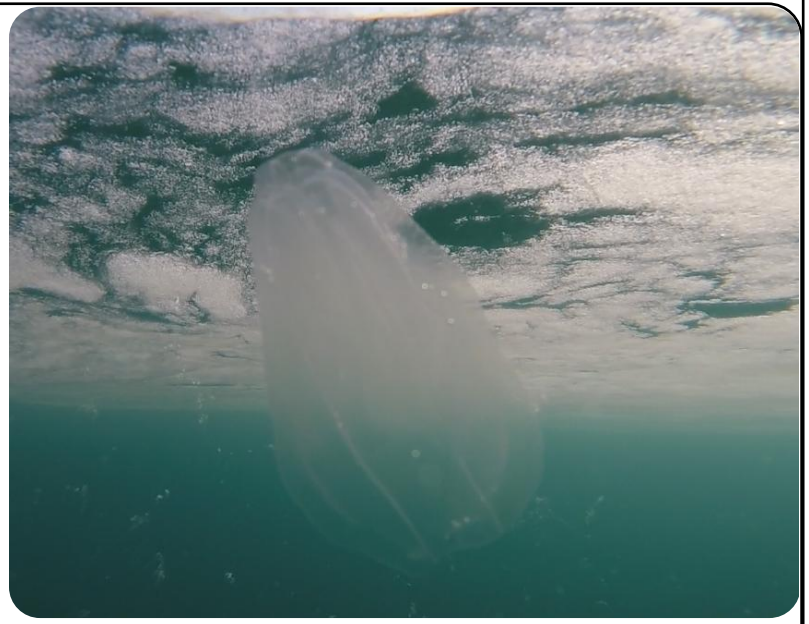
Striking contrast: Po River in 2022 vs 2024

2024: mucilage & blooms in N Adriatic

Late spring and summer: 3 mucilage events with *M. leidyi* presence.

Unlike in 2023, the intense Po River influx lowered surface salinity, and favorable circulation patterns allowed *M. leidyi to* spread eastwards.

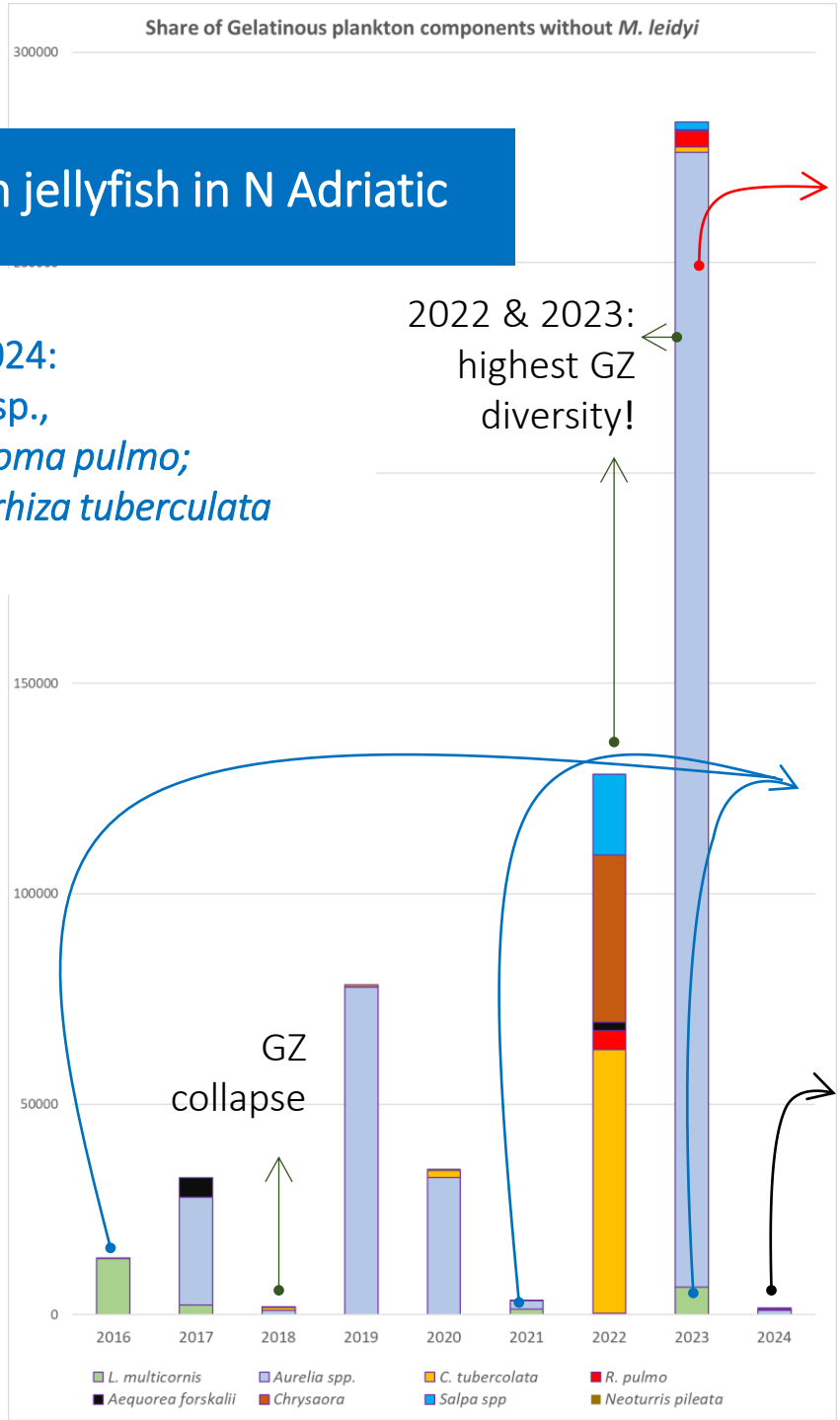
We hypothesize that the abundant Po River influx provided a good base for a recovery of the *M. leidyi* population after its collapse in 2023.



It is reasonable to conclude that the combined effect of the spread of an invasive GZ, mucilage, and extreme environmental conditions could adversely affect the ecosystem and the fish stocks in the N Adriatic.

The most common jellyfish in N Adriatic

2016-2024:
Aurelia sp.,
Rhyzostoma pulmo;
Cothylorhiza tuberculata



Collapse of *M. leidyi* and proliferation of *Aurelia* sp. (the 2nd most common GZ in N Adriatic after *M. leidyi*).

Autochtonous *Leucothea multicornis* (Ctenophora) was present regularly, especially in 2016, 2021, and 2023.

During the recovery of *M. leidyi,* other GZ collapsed.

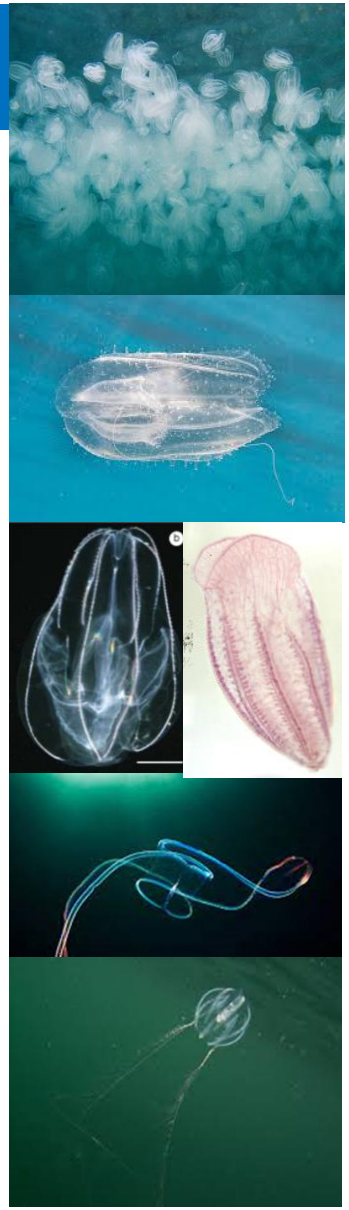
GZ Across Adriatic: S vs N

Apart from a short-term appearance in the Harbor of Ploče *M. leidyi* was not present in the central nor in southern Adriatic.

In the south, *L. multicornis* was the prevalent Ctenophora, albeit in low abundance.

Other autochthonous Ctenophora, such as *Bolinopsis vitrea*, *Cestum veneris*, *Pleurobrachia pileus*, and *Beroe forskalii*, are more common than in the north.

Overall, the GZ diversity indices are higher for the S vs N.



Jellyfish (Cnidaria) N vs S Adriatic

Aurelia sp., in the S, is generally a rare spring-occurring species in the area, except for its year-round presence at some micro-locations.

C. tuberculata is common in warmer months in the central Adriatic with a limited presence south.

R. pulmo was relatively common in the N and rare S.

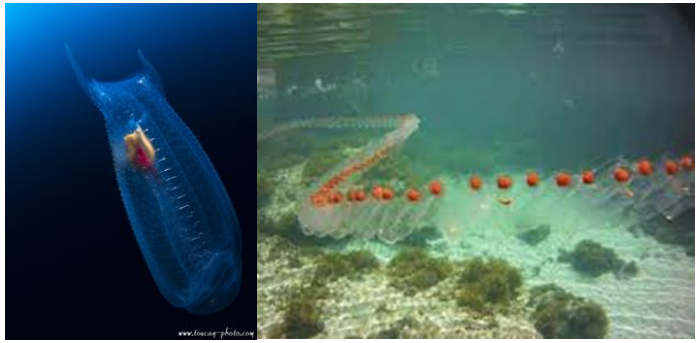
C. hysoscella is frequently found in N but rarely in S.

P. noctiluca used to be the dominant GZ in the 80s and was observed again in 2023 in N, while being present frequently in the S.

Pelagic tunicates – marginal component of GZ in N Adriatic

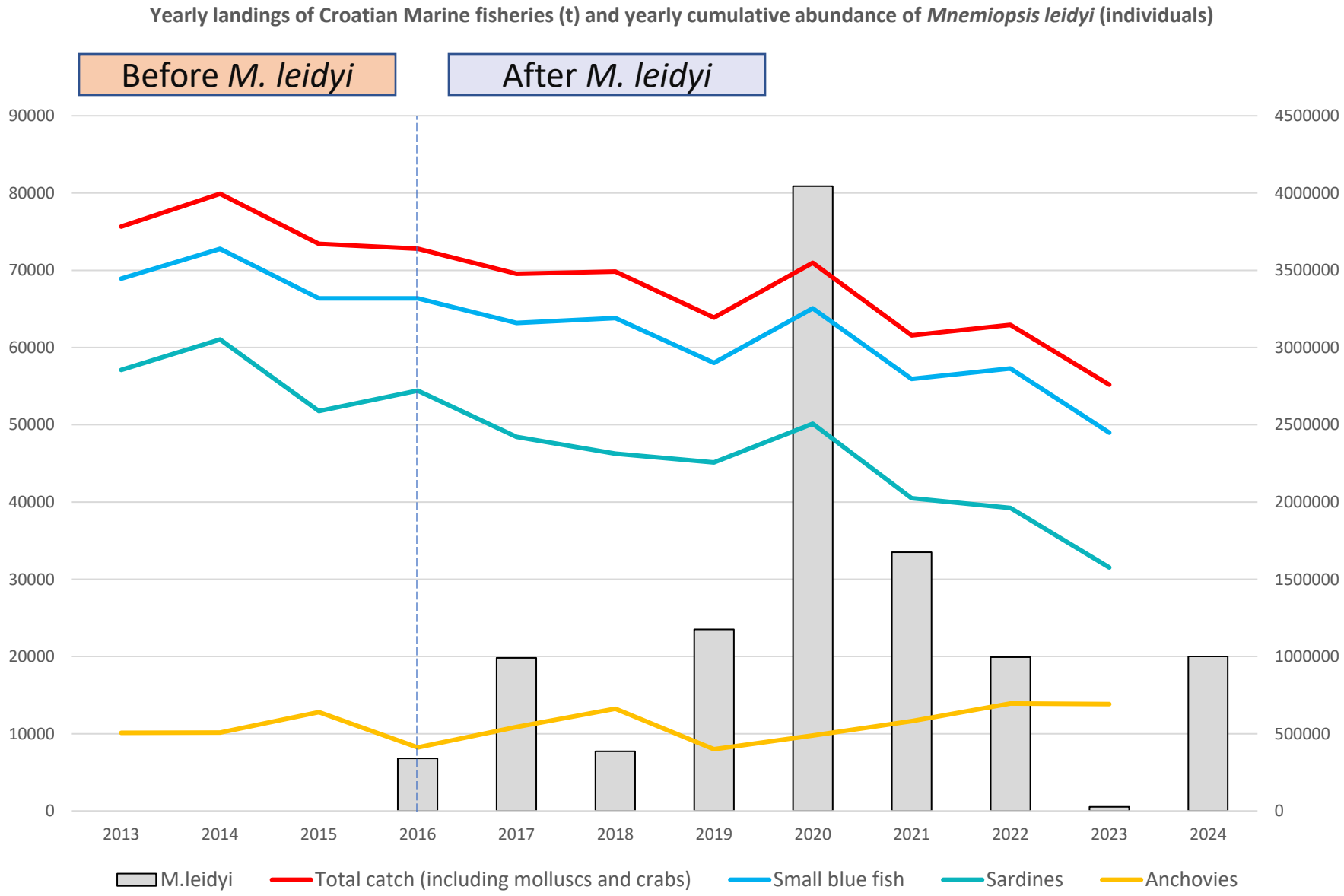
Different feeding patterns, e.g., filtration and diet consisting of protists and phytoplankton rather than zooplankton, are likely limiting their competition with other GZ and *M. leidyi*.

In the north, short-lasting chain-forming *Salpa* spp. represented the only encounters.



In contrast, in the south, *Salpa* spp. was more common along another autochthonous tunicate – *Thalia democratica*.

M. leidyi proliferation is followed by declines in total catches



https://podaci.dzs.hr/ Data provided by the Croatian institute for statistics

Conclusions

The results of the long-term monitoring (2016-2018) demonstrate that *M. leidyi* has and still is **profoundly changing** the ecosystems in the N Adriatic by dominating the GZ pelagic component of the food web in numbers, frequency of occurrences, bloom duration, and spatial coverage and shifting the 'common' autochthonous GZ blooming peak from spring to autumn, outside the pause in fishing, and overlapping with many small pelagic fish spawning times.

Other GZ (Cnidaria and Tunicata) showed accessory and incidental occurrences, except in 2023. Likely, the decline of *M. leidyi*, which followed after the low riverine influx, allowed competing taxa to thrive.

On the contrary, in the south, we observe more pristine GZ diversity, as oligotrophy appears suboptimal for *M. leidyi*.

In addition, in 2023, *P. noctiluca* reappeared in the north, possibly also due to the absence of food competitors such as *M. leidyi*.

Food for Thought

Gelatinous zooplankton thrives only when the more efficient food competitors – fish are removed from the food web. Should we consider different fishery pauses to allow for fish recovery, as more fish would also show some resistance to the trending 'jellification'?

M. ledyi is an efficient predator without its predators in the Adriatic. In the Black Sea, the accidental introduction of *Beroe ovata* stabilized the detrimental effects of *M. leidyi*'s predation. However, that also happened after an exceptionally long pause in fishing activities, and could have benefited from that too.

Would it be good to introduce a new species? Needless to say, *B. ovata* is another allochthonous species, and its response in the Adriatic can hardly be predicted. Moreover, it is a GZ that can excrete labile exudates that fuel the microbial loop rather than allowing the energy flow to higher trophic levels.

What about jellyfish bay-nets? In terms of fully pelagic self-fertilizing species such as *M. leidyi*, those can be of limited use (temporary solutions) or no use.

Could biotechnological advancements stimulate the GZ fisheries? Possibly! The blue-biotechnology is rapidly evolving, but GZ fisheries are still not a trend.

Other possible contributors to the decline of small pelagic fish in Northern Adriatic

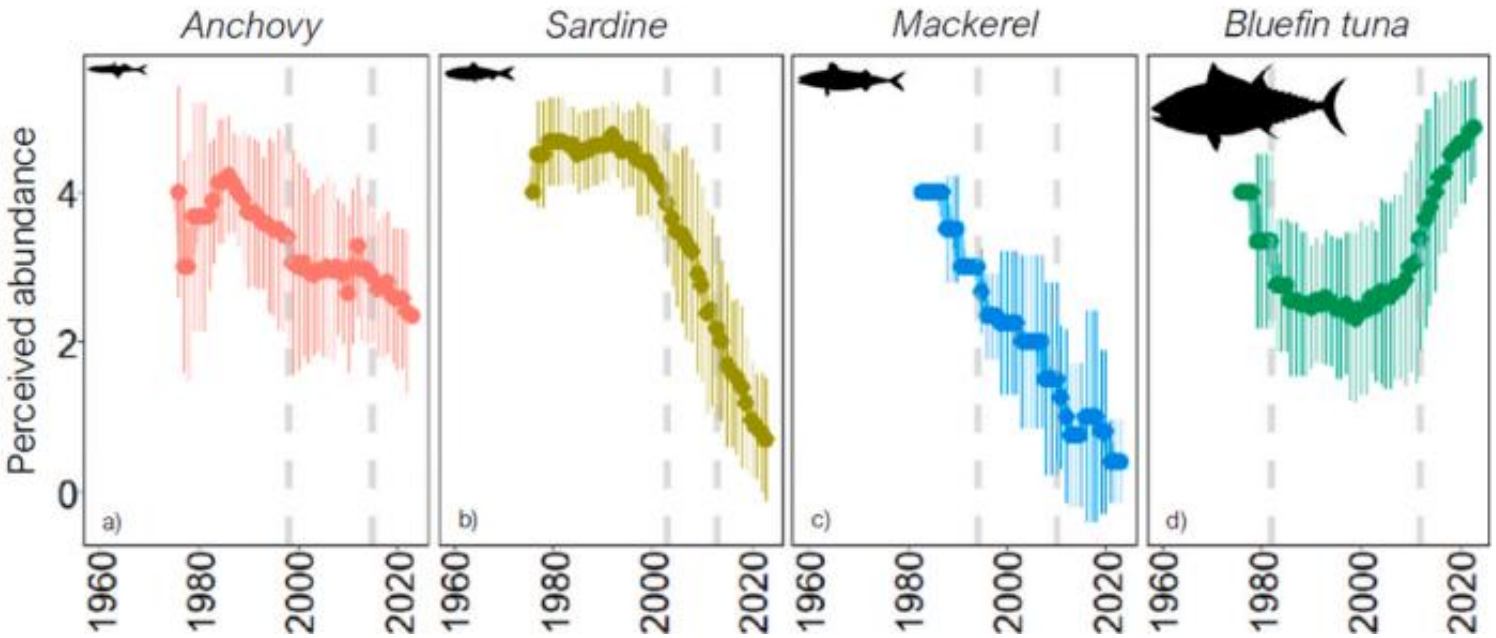
"What about the bottlenose dolphin and the Atlantic bluefin tuna?"

Marine mammals, like other predators, rarely if ever deplete prey stocks to critical levels, they may impede recovery of fish stocks depleted via overfishing!

BUT…

the impact is <u>two-fold</u>: they raise natural mortality and disrupt fishing by driving fish from the light, lowering apparent catch rates (statistics).

Thunnus thynnus



"(About tuna) Before there was little and now it is full to excess. Just the opposite of the sardine. At the beginning of the 2000s it was banned and then it started to increase until now. It doesn't let us fish and I think it eats what we are missing (Q interview 7)"

"And the tuna is the same, it wasn't caught before. There have always been, but now there are more, since 2011 or thereabouts it has gone up and there have started to be more or to interact more with us (Q interview 2)."

Miquel Ortega, Sara Mohamed Santamaria, Christos Zografos, Yesmina Mascarell-Rocher, Marta Coll, Valerio Sbragaglia (2025). Past, present and future of small-pelagic fisheries in the north-western Mediterranean Sea through fishers' perceptions. Marine Policy, 171: 106490

Thank you for your attention!

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