A neglected treasure of our waters

Why low trophic level fish are the future

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Introduction

Hunger is defined as when an individual has a physical discomfort due to the lack of obtaining sufficient and nutritious food, or the uncertainty that one will not be able to do so (Davis *et al.*, 1994). There are 854 million people in the world who are chronically or acutely malnourished due to hunger, and 2 billion people suffer from hidden hunger and micronutrient deficiencies (Sanchez *et al.*, 2005). How food is produced, delivered, marketed and sold are factors affecting what kind of food choices people take (Steptoe, *et al.*, 1995). The food that people in the western world consume does not necessarily contain the kind of nutrients one should have in one's body, which can lead to malnutrition (Spence *et al.*, 2016). While both the production and availability of food in total is increasing, the malnutrition and food security is dangerously low (Premanandh, 2011). These issues have been heeded in the United Nations 2030 Agenda for Sustainable Development, having appointed a specific sustainable development goal to 'End hunger, achieve food security and improved nutrition' (SDG 2), and thereby promoting agriculture to reach this goal (United Nations, 2015, pp. 15-16). However, as the population is growing, so is the demand for food and thereby demand of land area to produce the food (Wirsenius, 2010). This will be difficult to achieve in unison with SDG 15, which pleads for the protection and restoration of terrestrial ecosystems (United Nations, 2015, pp. 24-25). Keeping in mind that the ocean constitutes for 70 % of the earth surface, it would be a logical step to release some of the pressure on the land by using more of the ocean's resources, especially since only 2% of our overall calorie intake comes from the ocean (Lovelock, 2007; European Commission, 2017). There is a huge public interest towards seafood, due to its health benefits (Ackman, 1989) and also its sustainability (Smith *et al.*, 2010). The oceans are thus a good source of nutrition, but the global catch of wild fisheries has not increased for decades (FAO, 2018). With the world population predicted to reach 10 million before 2100 (Roser, 2020), it is critical that a sustainable solution to this issue is found in order to reach SDG 2. At the same time, we have to take heed of SDG 14, which deals with 'conserving and sustainable using the oceans, seas and marine resources for sustainable development' (United Nations, 2015, pp. 23, 24). We believe that changing our diet so it consists more of lower trophic level (LTL) fish species could be the answer.

Higher efficiency of lower trophic level species

The efficiency of eating LTL species is due to the roots of physics. LTL fish include herring, mackerel, sardine, anchovy and other small fishes. The Second Law of Thermodynamics demands that there be less available energy at higher trophic levels, because a lot of energy is lost in every level due to metabolism (respiration and heat production) and some more is lost due to inefficiencies in transferring the biomass produced (Brown *et al.*, 2004). The Lindeman efficiency estimates the transfer of energy between trophic levels at 10% and that the percentage loss of energy due to respiration is progressively greater for higher levels in the food chain (Lindeman, 1942). LTL species are often presented in a high abundance. Many of these small fishes are forage fish and they are mostly been used for fishmeal production to higher trophic levels, as livestock industries and aquaculture (Smith *et al.*, 2011). If these fishes were used as food, it would be a more sustainable use of the whole fish, and this again is great when it comes to the loss of energy in trophic levels (Smith *et al.*, 2011). This leads to the conclusion that harvesting small fish is most efficient because they have higher productivity per unit biomass than large fish (Kolding *et al.*, 2016). As an example, Peruvian anchovy contributes to 50 % of the production of fishmeal, and if this were used as a food source to the increasing population rather than food for bigger fishes it would help to reduce hunger and it may be easier to continue and promote fishing at LTL (Smith *et al.*, 2011).

Mesopelagic fish

Another option would be to introduce new fisheries of underutilised fish species, such as mesopelagic fish (Zhou *et al.*, 2015). Mesopelagic fish are small, LTL fishes found in the twilight zone (200m to 1000m depth) of all our oceans, with the dominating species being Lantern fish (*Myctophidae*) (Gjøsæter & Kawaguchi, 1980). There is no exact estimation of their total global biomass, but it is believed to be a magnitude over 1000 million tons (Irigoien *et al.*, 2014). The potential to fish more mesopelagic species is thus high and that raises the next question: why has this not yet happened? One reason is the lack of knowledge on the effect mesopelagic fish have on their environment and ecosystem. They are a key resource for higher trophic levels and play a vital part in the global carbon cycle (Potier *et al.*, 2017; Davison *et al.*, 2013). Nevertheless, there is simply not enough insight on how the harvesting of these fish would affect already existing fisheries or even the global climate (St John *et al.*, 2016). Furthermore, fishing mesopelagic species would be costly, due to the fish being located at a great depth and showing high trawl avoidance (St John *et al.*, 2016; Kaartvedt *et al.*, 2012). Gathering more information on the ecological role of the species and developing more adequate fishing gear is thus instrumental to make this fishery a possibility and to make sure it is conducted sustainably and does not collide with any of the targets of SDG 14.

Nutritional value

However, due to the high expenses of such a fishery, the profit, and thus demand, needs to be high as well. This brings us to another reason for the underutilisation of mesopelagic fish, which is one that concerns all LTL fish species. There is an overall disregard and distaste of small fish for human consumption, especially seen in the western world, that complicates the transition to LTL fish species in our diet (Zhou *et al.*, 2015). In many countries people associate fish from LTL as the poor man's fish, and that the fillet is the nutritional part of the fish. It is true that filleted muscle contains a big portion of important proteins, however many of the micronutrients from bones, head and viscera are lost (Reksten, 2019). One of the many benefits with LTL is their size. Often, they are small, and that makes it so that the whole fish can be easily consumed. They consist of some of the most important micronutrients like iron, calcium, zinc and vitamin A (Roos *et al*., 2007). These are crucial for good health, and development and growth in children (Kolding, 2019)**.** When comparing the nutritional value in small fish eaten whole with big fish processed into fillets, it is evident that small fish have more nutrients per weight then big fish (Reksten, 2019). Besides, research has shown that these fish have little environmental toxins (Reksten, 2019). A serious change in our relationship with small fish species is thus necessary and could be accomplished through good marketing and product development (Venugopal *et al.,* 1995), which will contribute to SDG 12.7 and 12.8 by promoting sustainable consumption and raising the awareness of the public on the matter (United Nations, 2015, pp. 22-23). This could open up the possibility of a new fishery in mesopelagic fish, as well as create an opportunity to utilise the bycatch of small pelagic fish that is still being regarded as discard in most fisheries (Venugopal *et al.*, 1995).

Conclusion

In a growing world where not the amount of food is the problem, but enough food with the necessary nutrients, low trophic level fish can be a key component to solve the growing demand. Less biomass is lost when remaining low on the food chain, and for the small mesopelagic fish, many are still unutilized. These fish have a huge potential as food for humans. Not only will the transition to LTL fish in our diet bring more food to the table, it will also increase the quality of the fish we eat. It will help us reach the Sustainable Development Goal 2, to end hunger and malnourishment in the world, while still using our oceans in a sustainable way and thus staying in line with SDG 14. To make this happen we will need a change of our view of LTL fish to make them a bigger part of our diet.

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