Reports on the prevalence of benthic harmful algae in the Red Sea coast – Potential bioindicators for Climate Change

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Introduction

▪The Red Sea is a meridionally elongated semi enclosed, narrow basin with a distance of about 2000 km covering a surface area of 458,620 Km^2 (Rasul and Stewart, 2015).

▪It is scientifically clear that the unique ecohydrography of the Red Sea renders it very important for ecological studies in which phytoplankton biomass and biodiversity are closely governed by surface circulation and wind systems (Kurten, et al. 2015). Dinoflagellate distribution is associated with environmental conditions which classify it into of the four regions (Fig. 1)

Impact of Climate Change

Despite its environmental extremities, the Red sea large marine ecosystem has also being characterized as a fast warming water body since the past decades (mid-90's) (Raitsos et al., 2013; Fine, et al., 2019) attributing to ecological changes such as reef destruction (coral bleaching) and emergence of macroalgae (macrophyte) fauna and their associates including harmful dinoflagellates (Fig. 1; Table 1) associated with toxicity and/or bloom formations in the region (Catania et al., 2017; (Chinain et al., 2021)).

Conclusion

The overall static mode of life renders benthic dinoflagellates as bioindicators of climate change. The lingering environmental changes (increasing sea temperature and eutrophication) might attribute to the ongoing ecological disturbances which ought lead to prevalence of both planktonic and mainly benthic species of dinoflagellates associated with bloom formation and/or toxicity that have been reported from different coastal waters of the Red sea.

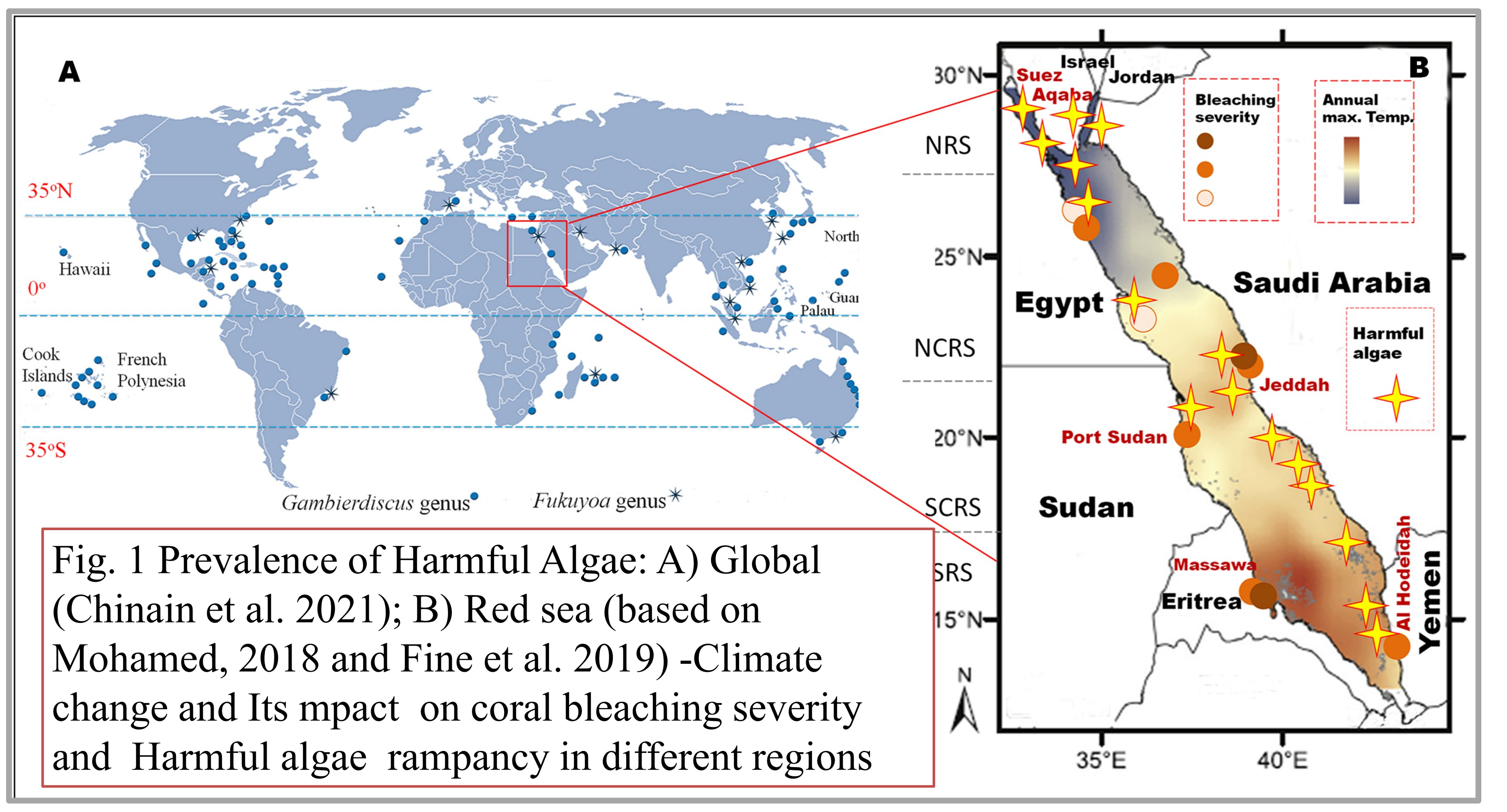

Fig. 1 Prevalence of Harmful Algae: A) Global (Chinain et al. 2021); B) Red sea (based on Mohamed, 2018 and Fine et al. 2019) -Climate change and Its mpact on coral bleaching severity and Harmful algae rampancy in different regions

Prevalence Of Harmful Algae

▪Currently out of the 395 taxa and 66 genera of dinoflagellates reported from the Red sea, more than a 106 dinoflagellates encompassing both benthic and planktonic modes of life have been reported in recent literatures (Fig. 1) (Mohamed, 2018; Prabowo and Agusti 2019) which signals rampancy of threats along the regions of the Red Sea.

▪Such reports of dinoflagellates include the well known benthic genera of *Gambierdiscus* and its assemblages such such *Ostreopsis* and *Prorocentrum* which attribute toxin associated with ciguatera fish Poisoning among and their counterpart planktonic species such as bloom forming toxigenic species of *Alexandrium*, *Dinophysis* , etc (Fig. 1) which are associated with other deadly mass fish killing impacts and human health (Prabowo and Agusti 2019).

Table 1 Environmental conditions and abundance of specific Benthic harmful algae associated with Ciguatera (CFP) reported from the Red sea.

Genus	Environmental conditions	Local bloom/toxicity incidence	*max Algal conc. (cells L^{-1})	*Potential harmful effects	References
Coolia spp.	23.06 - 32.60 °C 38.49 - 41.42 psu	NA	NA	NA	Prabowo & Agusti (2019)
Fukuyoa spp.		NA	NA	Ciguatoxin	Saburova *et al.* (2013)
Gambierdiscus belizeanus	29.3- 39 °C 28.9-38.4 psu	inshore reefs (Saudi Arabia)	120 cells g^{-1} algae	Palytoxin , Ciguatoxin, High biomass	Saburova et al. (2013), Catania et al. (2017)
Ostreopsis spp.	24-25 °C 40 psu	NA	143 ± 45 g^{-1} algae	High biomass, Ovatoxin	Catania et al. (2017), Prabowo & Agusti (2019)
Prorocentrum spp.	26 °C - 34 °C 35 – 39 psu	Al Salif coast, Al Hodeidah coast (Yemen;), *Gulf of Suez (Egypt),S Jeddah coast (Saudi Arabia)	1.81×10^3	Okadaic acid, DSP, Palytoxin, High biomass (hypoxia)	Alkawri (2016)

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