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Correspondence

Response to "More surprises in the global greenhouse: Human health impacts form recent toxic marine aerosol formulations, due to centennial alterations or world-wide coastal food webs"

The review article "More surprises in the global greenhouse: Human health impacts from recent toxic marine aerosol formations, due to centennial alterations of world-wide coastal food webs", presented by Walsh et al. (2017) in Marine Pollution Bulletin, attempts to link environmental changes with harmful algal blooms (HABs) and human health impacts around the world. On several occasions, the links/claims presented by the authors appear exaggerated given the evidence, and in other cases, are factually inaccurate. Our scientific community strongly supports research that links HABs and human health. However, we find that the claims in Walsh et al. (2017) are unsupported by rigorous, or in some cases, any scientific investigation. In this correspondence, we present certain examples which we feel require further investigation by the co-authors prior to being presented in this review article.

There are certain statements regarding HABs within the introduction that do not appear to be supported by the evidence presented. On occasions, the readers are directed to figures or tables for evidence which in turn lack relevant references to substantiate the claims in the text. The self-referential approach coupled with presenting arguments by assertion give the illusion of a factual review while crucial evidence needed to support the conclusions drawn is simply not presented. The following texts from the review are used as examples, which are far from exhaustive; which we feel require relevant citations for factual correction, prior to deriving associations.

"*A resident of Brisbane died from ciguatera, after eating sawtooth barracuda Sphyraena punamiae in 2008 (Hamilton et al., 2010), of presumed Gambierdiscus lapillus origins (Kretzschmar et al., 2017). Before this recent event, the last recorded case of Australian ciguatera was again in Brisbane during 1967* (Clark and Whitwell)."

The aforementioned statement from the review requires further clarification, as the origins of the suspected ciguatera toxins responsible for toxicity in the barracuda sample were never investigated. The *Gambierdiscus* species, *G. lapillus* was only recently published by Kretzschmar et al. (2017), and its toxicity is yet to be confirmed. Furthermore, there are ~20–100 reported cases of ciguatera annually in Australia, and this has been extensively documented in various studies previously e.g. Lewis (2006).

"*Like Gulf Stream poleward exports of barracuda and ciguatera into the SAB, southward movements of the EAC also led to appearances of Gambierdisucs carpenteri off southern New South Wales in 2013* (Kohli et al., 2014)."

Kohli et al. (2014) did not make claims regarding the southward movement and appearance of *G. carpenteri* in southern NSW due to the intensification of the EAC. In fact, it cannot be said with certainty if the appearance of *G. carpenteri* is a new phenomenon or if its colonisation in the southern NSW estuaries has occurred earlier in geological time. This ecological hypothesis is currently under investigation. Furthermore, the range expansion of ciguatera is not necessarily linked to the range expansion of *Gambierdiscus,* but more suggestive of the habitat shift of the vector species carrying ciguatoxins.

"*In Sydney, the frequency of childhood asthma concurrently increased ten-fold, from 2.7% in 1952 to 28.5–30.0% during 1991–1993 (Solomon, 1958; Pearce et al., 1993; Robertson et al., 1998). Such a toxic HAB stimulus of malign human pulmonary events followed both overfishing-induced trophic cascades and anthropogenic coral bleachings (Hughes, 1994; Hughes et al., 2003), as well as the increments of local dust-fed, bottom-up diazotroph nutrient sources from the interior deserts.*"

This paragraph is not substantiated with accurate evidence. There is no confirmation, to our knowledge, which links an increase in childhood asthma as a consequence of a "toxic HAB stimulus" in Australia, and there is no evidence to link asthma/HABs/overfishing-induced 'trophic cascades' and anthropogenic coral bleaching events in Australia as suggested by the authors. In fact, the references provided do not substantiate these claims in any way.

"*But, small HABs prevailed on the WFS during this decade of 1955–1965, before onset (Fig. 3) of a trophic cascade on both sides of the GOM (Walsh and Steidinger, 2001; Walsh et al., 2011). Subsequently, between 1967 and 2011, increased HAB onshore wind-borne aerosol fluxes of halides and DOC-transported organic neurotoxins amounted to ~48% of annual carbon sequestration by ungrazed WFS HABs (Walsh et al., 2016). Incremental prevalence of asthma also occurred within downstream Indiana, from 4.9% in 1966 to 11.0% in 2003 (Arbeiter, 1967; Akinbami et al., 2009).*"

To support the assertion that HABs were present during the decade of 1955–65, the reader is referred to Fig. 3, pp. 11 of the review article. This figure is an estimate of chlorophyll measurements from satellite data. While the figure provides an estimate of phytoplankton abundance based on the images, it cannot be used to elucidate the species or genera present and hence does not substantiate that harmful algal bloom forming organisms were present. The authors then continued by basing a 'trophic cascade' on this unsubstantiated HAB presence, followed by alluding to neurotoxic aerosols and finally presenting an increase in the asthma report rate in an adjacent state. Thus, in our opinion, the conclusion is based on over

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interpretation at best.

> "*During that two-year event, which began in September 1994 and ended by May 1996, until another HAB started in September 1997, a total of 238 manatees, ~10% of the Florida population, died from inhaling HABs. Such continued aerial imports of marine poisons were reflected in 2007 as part of recorded human asthma hospitalization rates over the SE United States, with corollary deposition of co-travelling total mercury aerosols in surface soils (Fig. 2) since 1965* (Walsh et al., 2015)."

The aforementioned paragraph from the review describes the decline of the Florida manatee population as a direct result of the inhalation of HABs. Further evidence of this is not supplied. The authors then seek to establish a link between manatee deaths from 1994 to 96 to the human asthma hospitalization rate in the south eastern USA in 2007, by drawing on the co-travel deposits of mercury aerosols in surface soils, referring to Fig. 2, pp. 11. This figure is simply a map of the soil mercury deposits in the USA, and does not supply references or an argument for the mercury deposition being indicative of marine HAB aerosols. The reader is directed at Walsh et al. (2015) for clarification. This reference mentions the co-travelling of mercury with HAB toxins in the following excerpt from Walsh et al. (2015); "*Accordingly, similar to facilitations of halide exits from the seas within other DOC matrices via bursting bubbles (Woodcock, 1948; Duce et al., 1963; Blanchard, 1975), co-traveling HAB brevetoxins and ostreocins may have aided sea–air exchange of Hg compounds, once a trophic cascade had begun*."

Here, the possibility of co-travelling of mercury with some HAB toxins is mentioned under the specific condition of a 'trophic cascade'. This hypothesis has apparently not been tested in, or since, their previous publication referenced, yet it is presented as a given and established link resulting in asthma hospitalizations by the authors.

> "*Consequently, ~15% of total world-wide annual asthma trigger responses (Table 2), i.e. amounting to ~45 million adjacent humans during 2004, were due to marine brevetoxin and palytoxin organic poisons in aerosol forms of initial coastal dinoflagellate origins*."

The authors extrapolated certain evidence and claimed that 15% of global asthma triggers, i.e. 45 million people, were due to brevetoxin and palytoxin. The reader is then directed to Table 2, pp. 12 for evidence. This table lacks information regarding the sites for which asthma rates are reported, the hair sample based mercury poisoning data or the sample sizes for any of these entries. When reading the caption, it becomes clear that the percentage of asthma triggers attributed to HABs is simply the fraction that was not attributed to dust, chemical pollutants etc. The inability to identify all the asthma triggers does not automatically accredit these to a HAB origin and constitutes an alarmist extrapolation.

> "*These causal interactions were reflected in greater global (Fig. 4) HAB abundances and associated breathing attacks among sea-side children and adults during 258 multi-decadal surveys of asthma prevalence during mainly the International Study of Asthma and Allergies in Childhood [ISAAC] program*."

Further global links between asthma and HABs are drawn within the text, where the reader is directed to Fig. 4, pp. 13. The figure caption, rather than explaining the links drawn by the authors, simply re-states the authors' position that the link exists without providing references. While circular, the argument is hardly substantiated.

> "*Like G. lapillus, G. carpenteri, and G. yasumotoi (Rhodes et al., 2013), the other extant, but aerosolized, dinoflagellate HABs of Ostreopsis siamensis (Rhodes et al., 2000; Chang et al., 2000) and Karenia papilionacea, K. selliformis, K. brevisulcata, and K. bidigitata (Haywood et al., 2004) would have drifted polewards within the EAC*."

The authors' claim of aerosolized toxins due to blooms of *Ostreopsis siamensis* occurring in Australia is unsupported by scientific evidence, as toxic aerosols related to *Ostreopsis* blooms have only ever been reported in relation to *O.* cf. *ovata* blooms in the Mediterranean basin (Ciminiello et al., 2014).

The authors' claim of the poleward expansion of *O. siamensis* in Australia is unsupported by data. Verma et al. (2016) showed that *Ostreopsis* spp. were present consistently in temperate southern-eastern Australia from 2005 and 2015, suggesting that *Ostreopsis* spp. were established in the region, rather than being reintroduced from tropical Queensland via the East Australian Current. *Ostreopsis* spp. were more abundant during warmer months (Verma et al., 2016). Similar observations have also been reported from New Zealand, as *Ostreopsis* cf. *siamensis* has been found regularly throughout the austral summer season (Rhodes, 2011). Previous studies have presented the role of temperature in regulating *Ostreopsis* blooms (Mangialajo et al., 2008; Mangialajo et al., 2011; Shears and Ross, 2009); however, a positive correlation between temperature and *Ostreopsis* blooms has not yet been clearly shown (Accoroni et al., 2011).

In summary, the misrepresentation of scientific literature in Walsh et al. (2017) is likely to create confusion amidst the readers and we strongly urge to verify supporting evidence when considering the facts represented in this manuscript.

References

Accoroni, S., Romagnoli, T., Colombo, F., Pennesi, C., Di Camillo, C.G., Marini, M., Battocchi, C., Ciminiello, P., Dell'Aversano, C., Iacovo, E.D., 2011. *Ostreopsis* cf. *ovata* bloom in the northern Adriatic Sea during summer 2009: ecology, molecular characterization and toxin profile. Mar. Pollut. Bull. 62 (11), 2512–2519.

Akinbami, L.J., Moorman, J.E., Garbe, P.L., Sondik, E.J., 2009. Status of childhood asthma in the United States, 1980–2007. Pediatrics 123, S131–S145.

Arbeiter, H.I., 1967. How prevalent is allergy among United States children? A survey of findings in the Munster (Indiana) school system. Clin. Pediatr. 6, 140–142.

Blanchard, D.C., 1975. Bubble scavenging and the water-to-air transfer of organic material in the sea. Adv. Chem. 145, 360–387.

Chang, F.H., Shimizu, Y., Hay, B., Stewart, R., Mackay, G., Tasker, R., 2000. Three recently recorded *Ostreopsis* spp. (Dinophyceae) in New Zealand: Temporal and regional distribution from 1995 to 1997. N. Z. J. Mar. Freshw. Res. 34, 29–39.

Ciminiello, P., Dell'Aversano, C., Iacovo, E.D., Fattorusso, E., Forino, M., Tartaglione, L., Benedettini, G., Onorari, M., Serena, F., Battocchi, C., 2014. First finding of *Ostreopsis* cf. *ovata* toxins in marine aerosols. Environ. Sci. Technol. 48 (6), 3532–3540.

Duce, R.A., Wasson, J.T., Winchester, J.W., Burns, F., 1963. Atmospheric iodine, bromine, and chlorine. J. Geophys. Res. 68, 3943–3947.

Hamilton, B., Whittle, N., Shaw, G., Eaglesham, G., Moore, M.R., Lewis, R.J., 2010. Human fatality associated with ciguatoxin contaminated fish. Toxicon 56, 668–673.

Haywood, A.J., Steidinger, K.A., Truby, E.W., Bergquist, P.R., Bergquist, P.L., Adamson, J., Mackenzie, L., 2004. Comparativemorphology and molecular phylogenetic analysis of three new species of the genus Karenia (Dinophyceae) from New Zealand. J. Phycol. 40, 165–179.

Hughes, T.P., 1994. Catastrophes, phase shifts, and large-scale degradation of a Caribbean coral reef. Science 265, 1547–1551.

Hughes, T.P., Baird, A.H., Bellwood, D.R., Card, M., Connolly, S.R., Folke, C., Grosberg, R., Hoegh-Guldberg, O., Jackson, J.B.C., Kleypas, J., Lough, J.M., Marshall, P., Nyström, M., Palumbi, S.R., Pandolfi, J.M., Rosen, B., Roughgarden, J., 2003. Climate change, human impacts, and the resilience of coral reefs. Science 301, 929–933.

Kohli, G.S., Murray, S.A., Neilan, B.A., Rhodes, L.L., Harwood, D.T., Smith, K.F., Meyer, L., Capper, A., Brett, S., Hallegraeff, G.M., 2014. High abundance of the potentially maitotoxic dinoflagellate *Gambierdiscus carpenteri* in temperate waters of New South Wales, Australia. Harmful Algae 39, 134–145.

Kretzschmar, A.L., Verma, A., Harwood, T., Hoppenrath, M., Murray, S., 2017. Characterization of *Gambierdiscus lapillus* sp. nov.(Gonyaulacales, Dinophyceae): a new toxic dinoflagellate from the Great Barrier Reef (Australia). J. Phycol. 53 (2), 283–297.

Lewis, R.J., 2006. Ciguatera: Australian perspectives on a global problem. Toxicon 48 (7), 799–809.
Mangialajo, L., Bertolotto, R., Cattaneo-Vietti, R., Chiantore, M., Grillo, C., Lemee, R., Melchiorre, N., Moretto, P., Povero, P., Ruggieri, N., 2008. The toxic benthic dinoflagellate *Ostreopsis ovata*: quantification of proliferation along the coastline of Genoa, Italy. Mar. Pollut. Bull. 56 (6), 1209–1214.
Mangialajo, L., Ganzin, N., Accoroni, S., Asnaghi, V., Blanfuné, A., Cabrini, M., Cattaneo-Vietti, R., Chavanon, F., Chiantore, M., Cohu, S., 2011. Trends in *Ostreopsis* proliferation along the Northern Mediterranean coasts. Toxicon 57 (3), 408–420.
Pearce, N., Weiland, S., Keil, U., Langridge, P., Anderson, H.R., Strachan, D., Bauman, A., Young, L., Gluyas, P., Ruffin, D., Crane, J., Beasley, R., 1993. Self-reported prevalence of asthma symptoms in children in Australia, England, Germany and New Zealand: an international comparison using the ISAAC protocol. Eur. Respir. J. 6, 1455–1461.
Rhodes, L., 2011. World-wide occurrence of the toxic dinoflagellate genus *Ostreopsis* Schmidt. Toxicon 57 (3), 400–407.
Rhodes, L., Adamson, J., Suzuki, T., Briggs, L., Garthwaite, I., 2000. Toxic marine epiphytic dinoflagellates, *Ostreopsis siamensis* and *Coolia monotis* (Dinophyceae), in New Zealand. N. Z. J. Mar. Freshw. Res. 34, 371–383.
Rhodes, L., Gimenez Papiol, G., Smith, K., Harwood, T., 2013. *Gambierdiscus* cf. *yasumotoi* (Dinophyceae) isolated from New Zealand's sub-tropical northern coastal waters. N. Z. J. Mar. Freshw. Res. 48, 303–310.
Robertson, C.F., Dalton, M.F., Peat, J.K., Haby, M.M., Bauman, A., Kennedy, J.D., Landau, L.I., 1998. Asthma and other atopic diseases in Australian children. Med. J. Aust. 168, 434–438.
Shears, N.T., Ross, P.M., 2009. Blooms of benthic dinoflagellates of the genus *Ostreopsis*; an increasing and ecologically important phenomenon on temperate reefs in New Zealand and worldwide. Harmful Algae 8 (6), 916–925.
Solomon, N.S., 1958. A study of results obtained at the asthma clinic. Med. J. Aust. 45, 592–595.
Verma, A., Hoppenrath, M., Harwood, T., Brett, S., Rhodes, L., Murray, S., 2016. Molecular phylogeny, morphology and toxigenicity of *Ostreopsis* cf. *siamensis* (Dinophyceae) from temperate south-east Australia. Phycol. Res. 64 (3), 146–159.
Walsh, J.J., Steidinger, K.A., 2001. Saharan dust and Florida red tides: the cyanophyte connection. J. Geophys. Res. 106, 11597–11612.
Walsh, J.J., Tomas, C.R., Steidinger, K.A., Lenes, J.M., Chen, F.R., Weisberg, R.H., Zheng, L., Landsberg, J.H., Vargo, G.A., Heil, C.A., 2011. Imprudent fishing harvests and consequent trophic cascades on the West Florida shelf over the last half century: a harbinger of increased human deaths from paralytic shellfish poisoning along the southeastern United States, in response to oligotrophication? Cont. Shelf Res. 31, 891–911.
Walsh, J.J., Lenes, J.M., Darrow, B.P., Parks, A.A., Weisberg, R.H., Zheng, L., Hu, C., Barnes, B.B., Daly, K.L., Shin, S.I., Brooks, G.R., Jeffrey, W.H., Snyder, R.A., Hollander, D., 2015. A simulation analysis of the plankton fate of the Deepwater Horizon oil spills. Cont. Shelf Res. 107, 50–68.
Walsh, J.J., Lenes, J.M., Darrow, B., Parks, A., Weisberg, R.H., 2016. Impacts of combined overfishing and oil spills on the plankton trophodynamics of the West Florida shelf over the last half century of 1965–2011: a two dimensional simulation analysis. Cont. Shelf Res. 116, 54–73.
Walsh, J.J., Lenes, J.M., Weisberg, R.H., Zheng, L., Hu, C., Fanning, K.A., Snyder, R., Smith, J., 2017. More surprises in the global greenhouse: Human health impacts from recent toxic marine aerosol formations, due to centennial alterations of world-wide coastal food webs. Mar. Pollut. Bull. 116 (1), 9–40.
Woodcock, A.H., 1948. Note concerning human respiratory irritation associated with high concentrations of plankton and mass mortality of marine organisms. J. Mar. Res. 7, 59–62.

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