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Role of Marine Algal Compounds in Early Brain Development

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ABSTRACT

Bioactive substances are related to many benefits regarding health, which include antioxidants, anti-inflammatory, and antimicrobial properties. It is revealed through this research that supplementation of DHA enhances majorly the cognitive development. In studies of animals, the rats are exposed to DHA at the time of lactation, and gestation. On DHA, the major focus presence is noticed in this regard, and on the other side, smaller subsets examine other bioactive compound effects that are found in marine algae. It includes antioxidants and EPA. In the form of primary producers, to the global production of oxygen, the contribution made by them, and also serve in the form of a marine food web foundational components. Despite major findings, in the design of this research the variability, and outcomes emphasize the standard protocols of research requirements. It is reported through many types of research that, the markers are reduced through these compounds of oxidative damage in human trials, and animal models.

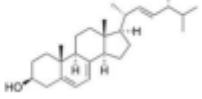
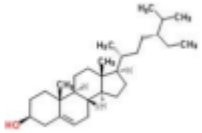
Keywords- DHA, EPA, oxygen, animals, antimicrobial, anti-inflammatory, subsets, variability.

I. INTRODUCTION

The Marine algal compounds include antioxidants, polyunsaturated fatty acids, or PUFAs, and bioactive peptides. These have generated attention for their major role in the early development of the brain. From different marine algae, these compounds are derived, which play a major role in synaptogenesis, neurogenesis, and overall cognitive functions. With increasing neurodevelopmental disorder incidence, understanding the nutritional contribution of marine algae at the time of major periods of development might offer insights into therapeutic interventions, and preventive strategies. A review of the present literature on marine algae compounds, their implications, and their action mechanism for the early development of the brain is going to be done through this report.

II. LITERATURE REVIEW

2.1 Significance of Nutrition of Marine Algal Compounds

Name	Main sources	Structure
Ergostérol	*Chlamydomonas reinhardtii*	
Clionasterol	*Spirulina*	

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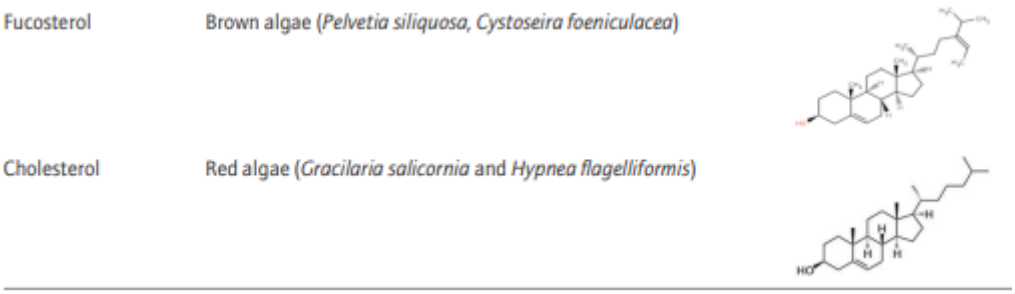

Figure 1: Structure of some sterols found in seafood
(Source: Hamed *et al.* 2015)

According to Hamed *et al.* (2015), marine organisms are recognized majorly in the form of a major source of unique bioactive compounds. These contribute majorly to global biodiversity. Comprising majorly half of the species of the earth, seas, and ocean demonstrates an untapped reservoir of major applications in the sector of food and beneficial natural molecules (Hamed *et al.* 2015). This present research by the author highlights the functional properties of compounds of seafood, which include peptides, proteins, fatty acids, amino acids, sterols, polysaccharides, phenolic compounds, oligosaccharides, minerals, vitamins, and Photosynthetic pigments.

Bioactive substances are related to many benefits regarding health, which include antioxidants, anti-inflammatory, and antimicrobial properties. An example regarding it is omega-3 fatty acids in fish that are found, are documented well for their cardiovascular benefits, and on the other side, polysaccharides from algae are recognized for their potential in immune support, and gut health. In addition to that, phenolic compounds exhibit major effects in combating chronic diseases, and oxidative stress majorly.

2.2 Action mechanism

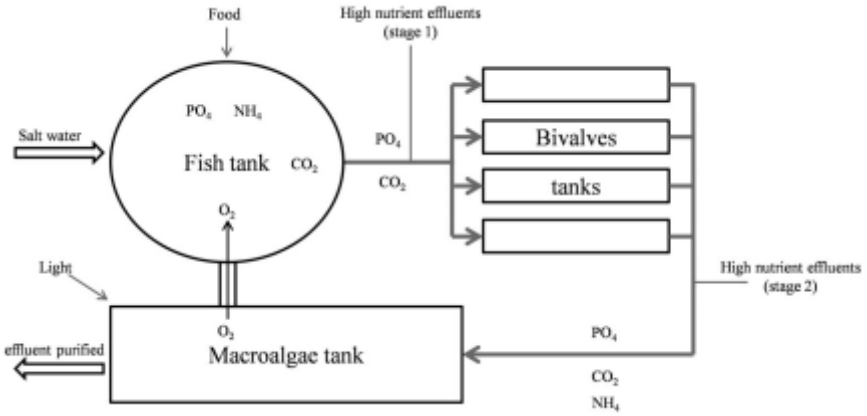

Figure 2: Illustration of IMTA system
(Source: Caryalho and Pereira, 2014)

According to Caryalho and Pereira (2014), marine algae plays a major role in the ecosystem, and a wealth of opportunities are offered by it for biotechnological applications throughout different industries. In the form of primary producers, to the global production of oxygen, the contribution made by them, and also serve in the form of a marine food web foundational components. Their diverse composition of biochemical, which include vitamins, polysaccharides, proteins, and antioxidants positions them in the form of an important resource for the cosmetics, pharmaceutical, and food sectors.

In aquaculture, macroalgae, and marine microalgae are important for the quality of water enhancement, and fist larval nutrition (Caryalho and Pereira, 2014). This leads to healthier production of fish. Compounds named β-carotene from microalgae are majorly used in the form of supplements, and additives of food because of their antioxidant properties. Beyond food, the content of rich fatty acid of microalgae makes them ideal candidates for producing biofuel, converting it into bioethanol, and biodiesel.

In addition to that, the therapeutic potential of algae is major, and their extracts exhibit antiviral, antimicrobial, and anticancer properties. This makes them appealing for the development of pharmaceuticals. In cosmetics, the qualities of skin benefit, and hydrating enhances the effectiveness of the product. In the form of a promising agent, algae are also present for bioremediation, which addresses pollution in water through mental accumulation, and nutrient uptake.

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2.3 Clinical evidence and studies

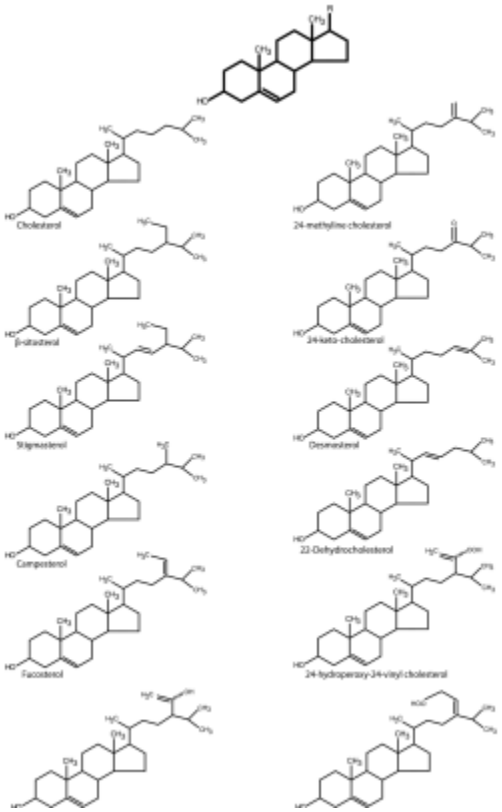

Figure 3: Chemical structure of diverse Phytosterols in the marine algae
(Source: Hannan *et al.* 2020)

According to Hannan *et al.* (2020), in the form of a major source, the presence of Marine algae is noticed, which have functional lipid compounds with diverse benefits for health. The synthesizing is done through this review through this present research by the author on the effects of pharmaceuticals in terms of algal sterols (Hannan *et al.* 2020). This highlights their role in the activity of antioxidants, anti-inflammatory responses, major protective effects, and cholesterol homeostasis against conditions named obesity, and Alzheimer.

2.4 Neurodevelopmental Disorders Implications

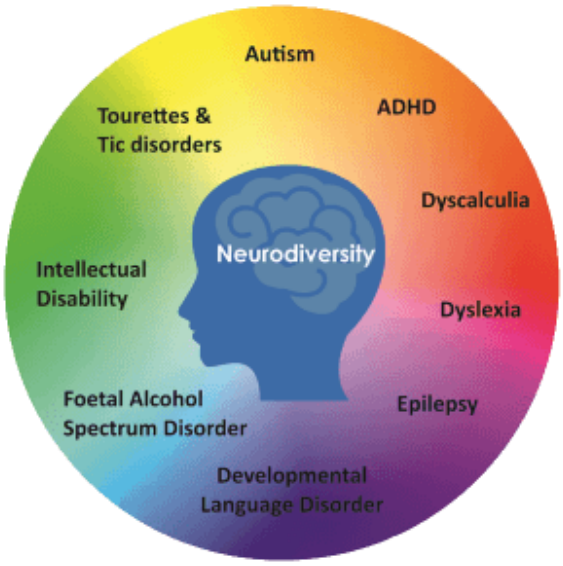

Figure 4: Neurodevelopmental Disorders Implications
(Source: https://www.structural-learning.net)

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According to Uljarevic *et al.* (2016), communication, and language are important for the development of children, specifically for those with neurodevelopmental disorders. A systematic review of 50 research shows that multilingualism does not generally hinder social development, or linguistic, in these children (Uljarevic *et al.* 2016). On the other side, some research indicates major benefits, specifically for social functioning, and communication in children with Autism Spectrum Disorder.

III. METHODS

3.1 Literature search strategy

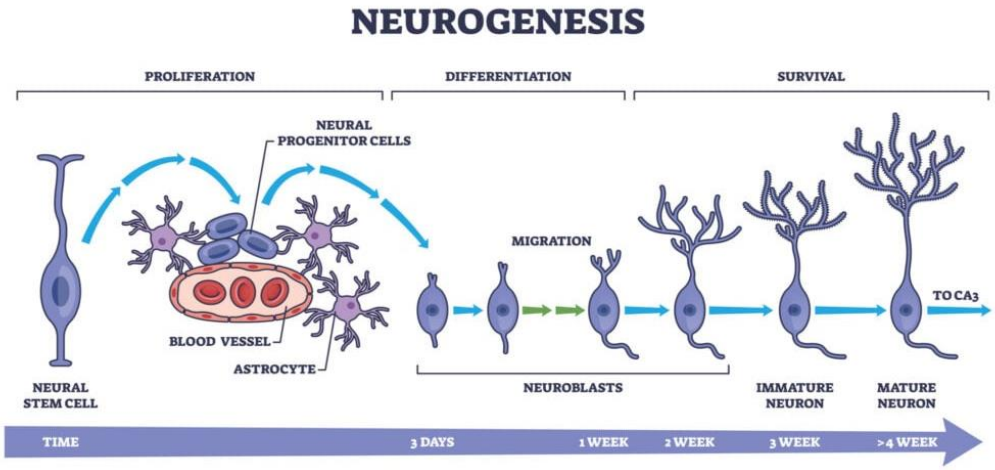

Figure 5: Neurogenesis
(Source: https://www.simplypsychology.net)

The literature that is already present, depending on the literature, the review is going to be synthesized on the role of marine algae compounds in the development of the brain through analysis systematically the peer-reviewed research that is published in scientific journals. The databases named Scopus, and Pubmed were utilized for appropriate articles gathering that were published up to 2000 (Stewart 2010). The keywords present in this regard, are the development of the brain, marine alga, neurogenesis, DHA, and cognitive function.

3.2 Selection of study

In research, criteria of inclusion are focused, through which algal compounds' impact is investigated in the early neurodevelopmental phase in both human subjects and animal models. The inclusion of the studies is done if they investigated the algal compounds' impact on the early development of the brain in human subjects, or animal models (Cornish *et al.* 2017). The articles are encompassed through the criteria of inclusion that are not focused on neurodevelopmental outcomes, or the absence of peer review. The screening of every study is done depending on the abstracts, and titles that are by the full-text review are followed for eligibility to ensure the criteria that are defined.

3.3 Extraction of data

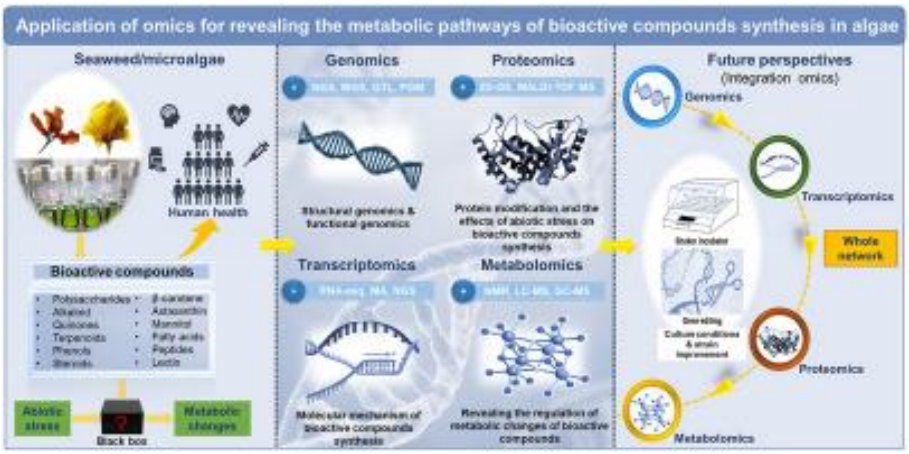

Figure 6: Algae compounds
(Source: https://www.sciencedirect.net)

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The extraction of the information is done regarding the design of the study, major findings, and used methodologies. Major data that were extracted, include design of the study, and algal compounds studies type (Shalaby *et al.* 2011). Particular outcomes that are measured are also included in the outcomes that were extracted. This includes behavioral tests, cognitive assessment, and biochemical markers regarding the neurodevelopmental phase.

3.4 Assessment of Quality

The importance of statistical analysis is noticed in this regard, and they were assessed for their overall quality, and the robustness of the evidence. These are rated through the established guidelines used for systematic reviews.

3.5 Thematic analysis

In addition to that, the thematic analysis is done for the common themes identification with the literature gaps, specifically focusing on the marine algal compounds' impact on different development of the brain aspect. This includes neurogenesis, cognitive functions, and outcomes of behavior.

IV. RESULTS

4.1 Overview of the research included

From the review, it is found that the inclusion criteria are met by 35 studies, which include both human trials and animal models (Souza *et al.* 2017). The studies are differentiated in design, which includes randomized controlled trials, observational studies, and cohort studies. On DHA, the major focus presence is noticed in this regard, and on the other side, smaller subsets examine other bioactive compound effects that are found in marine algae. It includes antioxidants and EPA.

4.2 Major Findings on DHA

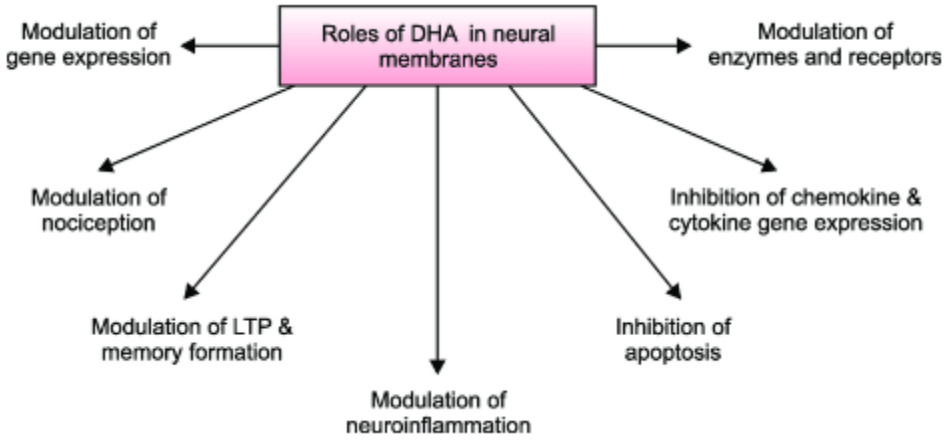

Figure 7: DHA roles in the brain
(Source: https://www.researchgate.net)

Majorly, 20 researches focused on DHA and its effects on cognitive development. In animal models, supplementation of DHA was linked to memory, and learning enhancement that is by improved hippocampal function is supported. It is revealed through this research that supplementation of DHA enhances majorly the cognitive development. In studies of animals, the rats are exposed to DHA at the time of lactation, and gestation (Hannan *et al.* 2013). These displays improved memory, and spatial learning, as by increased synaptic density, and maze tests are evidence in the hippocampus. These findings are corroborated through human studies. In this regard, the children's, whose mothers with DHA are supplemented at the time of pregnancy, scored higher on standardized tests measuring non-verbal, and verbal intelligence. Moreover, in the span of attention, and executive function, the improvements were noticed in infants, who are receiving DHA at the time of early infancy.

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4.3 Antioxidants effects

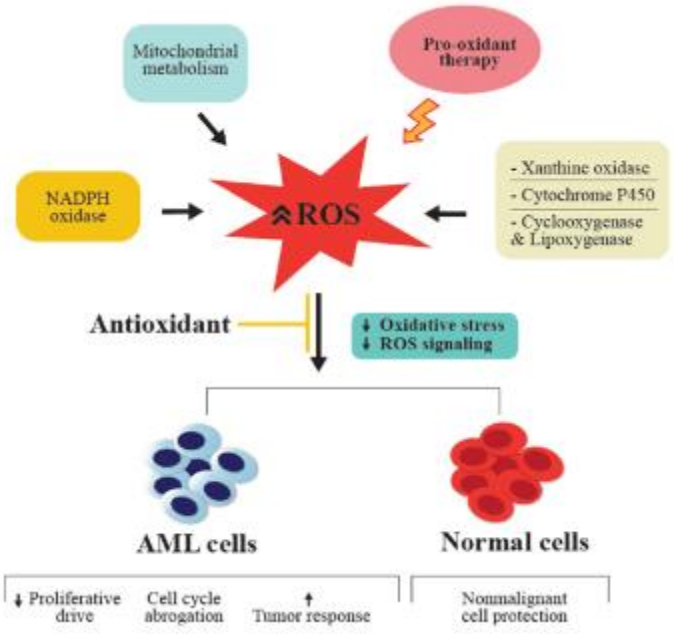

Figure 8: Antioxidants effects
(Source: https://www.researchgate.net)

In addition to that, beneficial effects are reported by 10 studies regarding antioxidants from marine algae on oxidative state markers reduction in the development of brains. From marine algae, antioxidants are derived. This includes flavonoids, and carotenoids, which were found to play a major role in oxidative stress mitigation at the time of development of the brain (Nova *et al.* 2020). It is reported through many types of research that, the markers are reduced through these compounds of oxidative damage in human trials, and animal models. An example of it is, the demonstration done through research that, with legal antioxidants, the supplementation led to malondialdehyde decreased levels. It is a lipid peroxidation market, which indicates reduced oxidative stress, and improved neuronal health.

4.4 Human studies clinical outcomes

It is indicated through human studies that maternal DHA intake is correlated with improved neurodevelopmental outcomes. In this regard, the major effect size is revealed for cognitive enhancements. From human studies, clinical outcomes highlighted major cognitive improvements that are related to marine algal supplementation. Specifically, with ADHD, or diagnosed attention deficit hyperactivity, the children who are present demonstrate enhanced scores regarding behavior and reduced hyperactivity after supplementation of DHA. In this regard, quantification is done regarding improvements, through the use of the validated behavioral scales. This indicates the major algal compounds in addressing neurodevelopmental disorders.

4.5 Limitations and Variability

Variability, however, in methodologies is the limitations that are commonly present. The findings highlight the importance of marine algal compounds to influence positively the early development of the brain. Despite major findings, in the design of this study, the variability presented challenges in results synthesizing, Differences in supplemental dosages, and tools of measurement were commonly present in this regard. Some research, for instance, utilizes low doses of DHA. On the other side, higher amounts are applied, which complicates comparisons. In addition to that, long-term follow-up is absent in many studies, which limits insights into the major effects of supplementation.

V. DISCUSSION

The hypothesis is supported by the evidence that algal compounds, specifically DHA, are important for optimal development of the brain at the time of early life stages. The mechanisms by which these compounds exert their effects through functional, and structural roles in neuronal shifts underscores their nutrition importance (Fernando *et al.* 2016). Despite major findings, in the design of this research the variability, and outcomes emphasize the standard protocols of research requirements. Longitudinal research exploring the effects in long-term of algal supplementation, or cognitive function is warranted specifically.

The present literature, moreover, indicates a strong correlation between cognitive enhancements, and marine algal compounds. This stays, casual, and it is an important question. The future research aims to elucidate the mechanisms

through which these compounds influence the development of brain. This majorly leads to targeted interventions of nutrition for at-risk populations.

VI. FUTURE DIRECTIONS

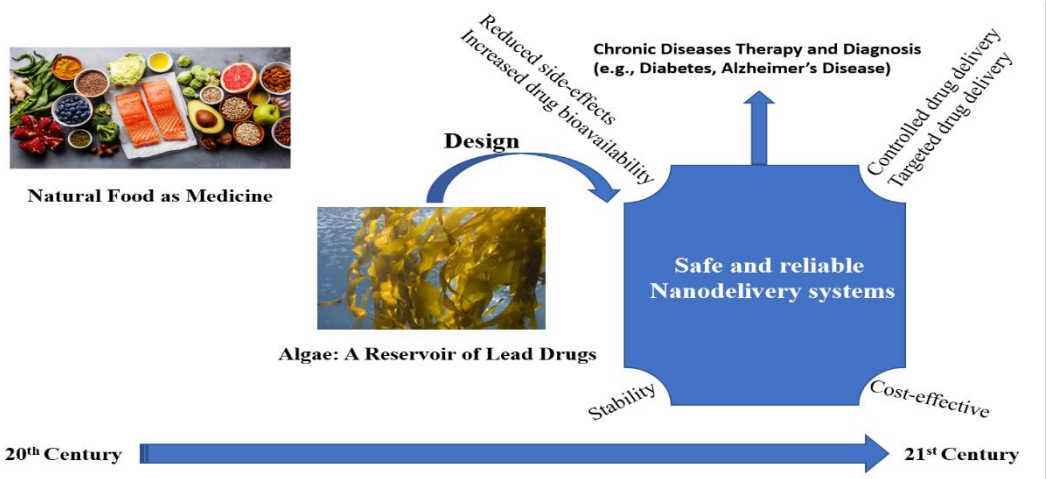

Figure 9: Marine Algae Derive Bioactive Compounds
(Source: https://www.mdpi.net)

It is needed that future research must focus on elucidating the optimal dosage, and supplementation of marine algal time in diverse populations. This includes at risk-groups, investigating synergistic effects of different algal compounds with the traditional strategies of nutrition, and can provide major insights for neurodevelopmental health into dietary interventions (Villa and Gerwick, 2010). Furthermore, the impact of environmental factors in the exploration of algal nutrient profiles might enhance the understanding of their efficacy and bioavailability. Through disciplines in collaborative studies, neuroscience, public health, and nutrition are important for the translation of the findings into therapeutical options, and practical dietary guidelines. This approach is interdisciplinary and can lead to evidence-based recommendations development for incorporating into diets, the marine algal compounds. In this regard, it is aimed to improve overall health of the brain and cognitive outcomes.

VII. CONCLUSION

From the discussion above, the conclusion is made that, a major potential is held by marine algal compounds in the early development of brain support. Antioxidants and important fatty acids-rich composition underscore the nutritional importance in cognitive function and neurogenesis. On the other side, research that exists already highlights their beneficial effects. In this regard, the importance of further studies is majorly noticed for the establishment of clear guidelines for supplementation. As nutrition's role understanding in the neurodevelopmental phase continues to change, in this regard, a major role might be played by marine algal compounds in the healthy development of brain promotion, and neurodevelopmental disorders prevention.

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