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Research Article

SEASONAL VARIATIONS OF FRESH WATER ZOOPLANKTON FROM WELLINGTON LAKE, CUDDALORE DISTRICT OF TAMIL NADU, INDIA

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A B S T R A C T

The zooplankton populations play a vital role in food web, food chain in nutrient recycling and transfer of organic matter from primary producers to secondary consumers in freshwater. The seasonally variations of fresh water zooplankton were investigated from Wellington Lake, Cuddalore district of Tamil Nadu, India. The sampling was carried out from January 2016 to December 2016. In the present investigation, totally 24 species of zooplankton from 4 taxa were identified along with Rotifers (10), Copepods (9), Cladocera (4) and Ostrocoda (1). The rotifer was dominant groups of total zooplankton. The descending order of abundance in the various groups of zooplankton is as follows: Rotifers > Copepods > Cladocera > Ostrocoda. The maximum of population density was reported in post monsoon season and minimum was reported in monsoon season during the study period. It was concluded that the seasonally variations of fresh water zooplankton was also influenced by physicochemical parameters.

INTRODUCTION

Freshwater zooplankton plays an important role in ponds, lakes and reservoirs ecosystem of food chain and they are fundamental character in the significance of an aquatic ecosystem. (Manickam *et al.,* 2014). Zooplankton is small, floating or drifting and weakly swimming animals found in various water bodies. The various functional aspects of an aquatic system, such as food chains, food webs, energy flow and cycling of matter are influenced by the zooplankton members, which are important biotic components of an aquatic system (Sinha and Islam, 2002). They constitute an important link between primary producers and consumers of higher order in aquatic food web. Human demands on freshwater ecosystems have risen steeply over the past century leading to large and growing threats to biodiversity around the world (Dudgeon *et al*., 2006).

All the secondary production in aquatic ecosystems directly or indirectly relies on them. They play a major role in recycling nutrients as well as cycling energy within their respective environments. Freshwater zooplankton consists of mainly four major groups (Protozoa, Rotifer, two Orders of Crustacean viz., Cladocera and Copepoda). Most of the species occur in fresh or saline water and about 620 species are Currently known (Forro *et al.,* 2008).

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Their distribution is related with a complex of factors such as change of climatic conditions, physical and chemical parameters and vegetation cover (Neves *et al.,* 2003). They serve as bioindicators and are a reliable tool for determining the status of water pollution (Contreras *et al.,* 2009).

Thus zooplankton association, richness, abundance, seasonal variation and diversity can be used for the assessment of water quality and for pisciculture management practices. They are varying in contribution to total abundance and biomass depending on trophic status and predation by zooplanktonicvorous fish (Fernando, 2002). Zooplankton composition, distribution and movement are also influenced by physical and chemical characteristics of the ecosystem (Pinto-Coelho *et al*., 2005). In lakes, distinct differences between the composition and community dynamics of littoral and limnetic zooplankton may occur which necessitate separate evaluations (Matsumara and Tundisi, 2005). Zooplankton research became increasingly important in recent years since these floating organisms serve as a reproductive base for both marine and freshwater ecosystems.

In India, many of the lakes and reservoirs have been studied for the distribution, abundance and diversity of zooplankton. In Tamil Nadu limited works were carried out by Senthil Kumar and Sivakumar (2008); Rajagopal *et al.* (2010); Deenadayalamoorthy and Mazher Sultana (2011); Krishnamoorthy and Selvakumar (2012); Annalakshmi and Amsath (2012); Amsha Devi *et al.* (2013); Sivakami *et al.* (2013); Manickam *et al.* (2014); Suganthi *et al*. (2014) and Manickam *et al.* (2015). But, there is insufficient reference for the seasonal variations of zooplankton with respective

Wellington Lake, Cuddalore district, Tamil Nadu. Hence, in the present study an attempt was made to find out the variation of zooplankton according to season.

MATERIALS AND METHODS

Zooplankton samples were collected from Wellington Lake (Reservoir), Keezhachcheruvai (Latitude: 11° 20' 10" N; Longitude: 79° 32' 40" E), Tittagudi taluk, Cuddalore district of Tamil Nadu, India. They were collected from January 2016 to December 2016, at the time of morning hours 6.30 am to 8.30 am in the monthly intervals. The samples were filtered in 100 liters of water through the standard plankton net (No. 10, mesh size 148µm). The plankton samples were transferred to a plastic bottle and preserved in 5 % formalin solution. The preserved sample was transferred to laboratory. In the laboratory, the plankton samples were poured into a broad Petri dish and they were separated into different groups like Rotifers, Copepods, Cladocerans and Ostracodes under the binocular stereo zoom microscope using a fine pointed painting brush and a needle.

The quantitative and qualitative analysis of planktonic organisms was carried out using Sedgwick Rafter plankton counting cell (APHA, 2005). The diluted samples were thoroughly mixed and 1 ml of the sample was pipette out into the Sedgewick-Rafter counting chamber using a wide mouthed pipette for the enumeration. The number of zooplankton in 1 ml represents organisms per liter. The zooplankton was counted under a compound microscope and each species was recorded. The systematic identification of plankton was followed by Dhanapathi (2000) and Altaff (2004). Enumeration was carried out in the samples and mean value was calculated (Santhanam *et al.,* 1989). Zooplankton diversity indices were calculated the standard formula of Shannon and Weaver (1949) and Pielou (1966).

RESULTS

Seasonal variations, abundance and distribution of varies zooplanktonic forms observed in the study area during the present investigation. Totally 24 species of zooplankton from 4 taxa were identified from the study area. The Population density of zooplankton was ranged from 1347 to 3885 indi./l (mean 26 to 1748). The maximum was recorded Post monsoon season and Minimum in Monsoon season during the study period (Fig.1). The composition and community structure of zooplankton was observed and species belongs to diverse groups viz., 10 species of Rotifers, such as *Brachinous calyciflorus, B. bidentatus, B.falcatus, B. diversicornis, B. caudatus, B. forficula, Filinia longiseta, Trichocer caporcellus, Keratella cochlearis* and *K. tropica*, 9 species of Copepods, such as *Heliodiaptomus viduus*, *Neodiaptomus lindbergi*, *Cyclops strenuous*, *Eucyclops speratus*, *Mesocyclops cyclopoides, M. aspericornis, M. hyalinus*, *Nauplius sp.* and *Cyclops sp.*, 4 species Cladocera, such as *Daphnia magna, Daphnia Pulex, D. carinata and Moina sp.* and 1 species Ostrocoda such as *Cypris* sp. only was present during the study period. Among them *Brachinous calyciflorus* was dominant species of Rotifer groups in total zooplankton. The descending order of abundance the various groups of zooplankton is as follows: Rotifers > Copepods > Cladocera > Ostrocoda.

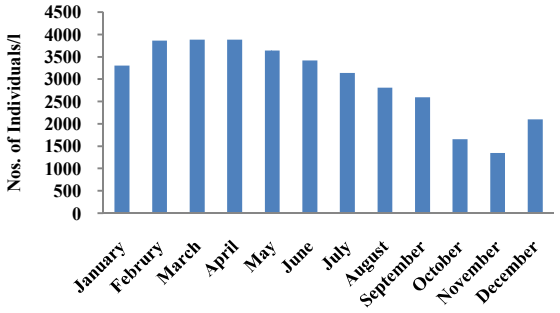

Fig 1 Monthly Variations of Zooplankton Population Density

The percentage composition of zooplankton, the rotifers were found to be the dominant group by constituting 45.10% from the total zooplankton groups. Copepods formed the second dominant group with a percentage contributing of 38.21% followed by Cladocera 16.83% and Ostrocoda 1.55% (Fig. 2). A monthly variation of zooplankton groups percentage composition was observed. The percentage composition of zooplankton was varied from 9 % to 26%. Maximum was reported during the post monsoon and minimum was reported in the monsoon season during the study period (Fig. 3).

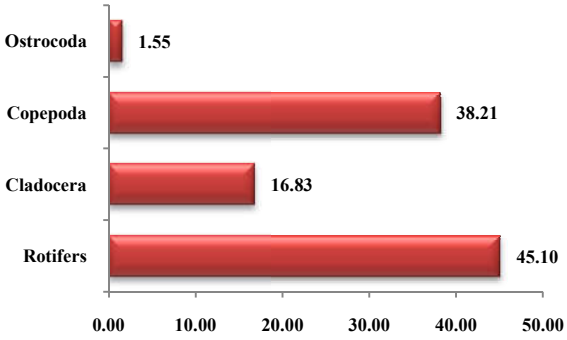

Fig 2 Percentage composition of zooplankton groups

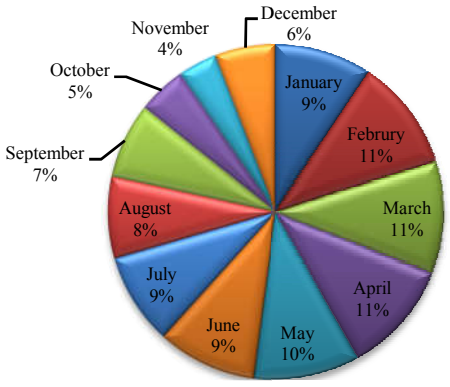

Fig 3 Monthly Variations of Zooplankton groups Percentage

Seasonally distribution and abundance of Zooplankton was investigated from the study period. Rotifers, copepods, Cladocerans and Ostracodes constitute the major groups of zooplankton, which occupy an intermediate position in the food web and mediate the transfer from lower to higher trophic levels. Rotifers are the most important soft bodied metazoans and they are living in the surface of the water. The variations of Rotifers was ranged from 429 to 1748 indi./l (Mean 1289). The maximum was distributed during post monsoon season and minimum was reported during monsoon season from the study period (Fig. 4).

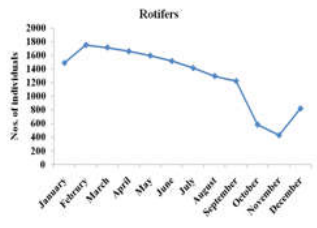

Fig 4 Monthly Distributions of Rotifers

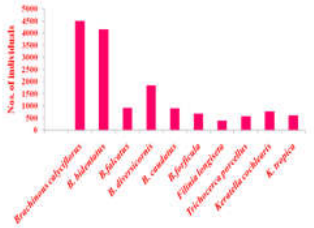

Fig 5 Rotifers species distribution

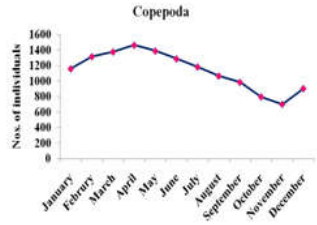

Fig 6 Monthly Distributions of Copepods

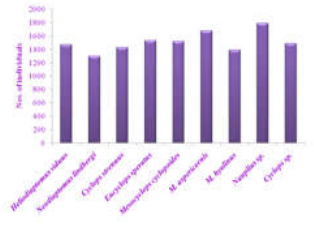

Fig 7 Copepods species Distributions

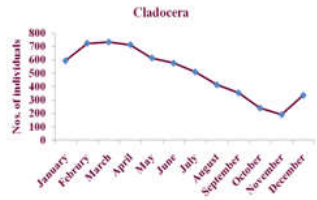

Fig 8 Monthly Distributions of Cladocera

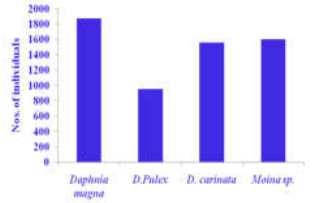

Fig 9 Cladocerans species Distribution

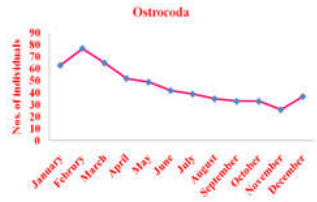

Fig 10 Monthly Distribution of Ostracodes

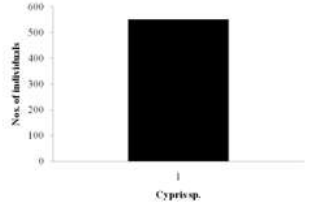

Fig 11 Ostracode species Distribution

The abundance of rotifer Species varied from 396 to 4515 indi./l. Among them the *Brachinous calyciflorus* was the most common and dominant species followed by other Rotifers species during the study period (Fig. 5).

The variations of copepods was ranged from 700 to 1462 indi./l (Mean 1135). The maximum was distributed during summer season and minimum was reported during the monsoon season (Fig. 6). The abundance of copepods Species varied from 1301 to 1794 indi./l. Among them the *Nauplius sp.* was the most common and dominant species followed by other copepods from the study period (Fig. 7).

The Cladocera was seasonally varied from 192 to 732 indi./l (Mean 500). The maximum was distributed in post monsoon season and minimum was reported during monsoon season (Fig. 8). The abundance of cladocera species varied from 954 to 1876 indi./l. Among, the *Daphnia magna* was the most common and dominant species followed by other Cladocera species from the study period (Fig. 9). The Ostrocoda was seasonally varied from 26 to 77 indi./l (Mean 46) during the study period. The maximum was distributed during post monsoon and minimum was reported during monsoon season. The *Cypris* sp. Only was present during the study period (Fig.10 & 11).

Diversity of Zooplankton

The diversity indices were calculated after transforming the zooplankton counts to their numbers per liter. The species diversity, richness and evenness were varied from 2.967 to 3.034 bits/indi, 0.9353 to 0.9461 and 0.9337 to 0.9547 respectively. The maximum was recorded during Monsoon season and the minimum was reported during Premonsoon season from the study area (Fig. 12).

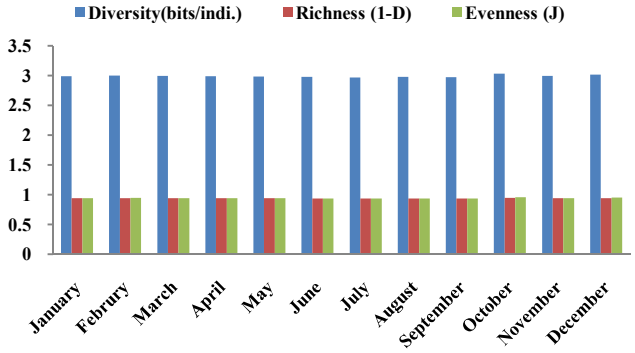

Fig 12 Diversity, Richness and Evenness of Zooplankton

DISCUSSION

The importance of the zooplankton is well recognized as these have vital part in food chain and play a key role in cycling of organic matter in an aquatic ecosystem. They form an integral part of the lentic community and contribute significantly, the biological productivity of the fresh water ecosystem (Wetzell, 2001). Occurrence of zooplankton species is great significance in freshwater habits. The abundance and diversity of zooplankton vary according to limnological features and the trophic status of freshwaters bodies (Jeppesen *et al.,* 2002). Totally 27 species was reported from Veeranam Lake (Krishnamoorthi and Selvakumar, 2012). 25 species were reported by Suganthi *et al.* (2014). 17 species was observed by Manoharan *et al.* (2015). 47 species was reported in Manickam *et al.* (2015). 40 species was investigated by Sivakami *et al.* (2015). In the present study, 24 zooplankton species were encountered in the study area with their taxonomical distribution as Rotifers (10), Copepods (9), Cladocera (4), and Ostrocoda (1) during the study period.

In the present study, the peak value of zooplankton during post monsoon might be due to optimal thermal, nutritional conditions, higher concentration of oxygen and presence of higher population of bacteria. Plankton depends on water quality remain on dead and decayed organisms and vegetation and shallowness of the lake water might have supported the increase the zooplankton density. Similar findings were observed by Jeyasingh (1997) Chittar reservoir, Soruba (2002) in some water bodies of Ariyalur and Krishnamoorthi and Selvakumar (2012) from Cuddalore district.

During the monsoon season, low zooplankton counts were recorded in the study area. It may be due to the fall in temperature, low penetration and the heavy water flow wash off the surface zooplankton were the reasons for the low density of zooplankton. The unsettled and disturbed conditions of the water column resulting from the rains and the heavy inflow and outflow retard the zooplankton production. In this result was suggested by earlier reporters from different regions

by Welch (1952), Trivedi *et al.* (2003) and Krishnamoorthi and Selvakumar (2012).

Rotifers showed numerical superiority over other groups of zooplankton. They are primary consumers feeding on various phytoplanktons. Rotifers have a versatile capacity to thrive in different environments and as such they usually dominate over other zooplankton communities reported by Krishnamoorthi and Selvakumar (2012). The present study showed that rotifers dominated of water body in terms of species richness and abundance. This finding is in accord with worked by Reckendorfer *et al.* (1999). Krishnamoorthi and Selvakumar (2012); and Suganthi *et al.* (2014) were reported that rotifers the dominant group in their study area. The high number of rotifers in freshwater ecosystem is due to their less specialized feeding habits, high fecundity and short developmental rates (Allan, 1976). In fact, this pattern is common in freshwater ecosystem such as lakes, ponds, rivers and streams (Neves *et al.*, 2003).

The abundance of rotifers is more or less governed by the interaction of number of physical, chemical and biological processes. They are playing a vital role in the trophic tiers of fresh water impoundments and they serve as living capsules of nutrition (Jeelani *et al.,* 2005). Manickam *et al.* (2012) were identified 13 species of rotifer perennial freshwater lake and reservoir of Dharmapuri District. Krishnamoorthi and Selvakumar (2012) were reported 7 species of rotifers. In the present findings 10 species was recorded from study area. Rotifers were investigated maximum during the post monsoon season and minimum was reported during monsoon.

Rotifer was ranked in first order of individuals. The abundance of rotifer may be attributed to its dependence on phytoplankton and detritus matter as food (Bazmi Shaukat Hussain *et al.,* 2011). This report was supported by earlier workers (Sivakumar and Altaff, 2004; Manickam *et al.,* 2012 and Suganthi *et al.,* 2014). The rotifer species of *Brachionus calyciflorus* was dominant and is considered to be a good indicator of eutrophication (Sampaio *et al.,* 2002). About 120 species of freshwater free-living copepods are known from India. The pioneer workers were identified 8 species of copepods was reported by Manickam *et al.* (2014). 4 species was reported by Krishnamoorthi and Selvakumar (2012), 9 species was recorded by Reeja Jose and Sanalkumar (2012), 8 species was reported by Suganthi *et al.* (2014). In the present study, 9 species of copepods was investigated. The lake rich in organic matter support higher number of cyclopoids, thus suggesting their preponderance in higher trophic state of water. Copepods ranked second in the order of dominance among the zooplankton fauna. They were found in maximum numbers during summer season and minimum was observed in monsoon season during the study period. Similar observation was made by previous worker in Krishnamoorthi and Selvakumar (2012). The peak value of copepods could be attributed the resulting of settling of rainwater and return of favorable condition. This decrease in the density of copepods may be due to environmental variation. So there exists seasonal fluctuation in the density of copepods population. Similar observation was early made by Suganthi *et al.,* (2014) and Manickam *et al.,* (2015). The copepoda constitute an essential link in the aquatic food chain.

There are about 600 species of freshwater cladocerans occurs in throughout the world (Korovhinsky, 1996). In India, 110 species have been recorded by Patil and Gouder (1989). 7 species of cladocera was reported by Manickam *et al.* (2012), 6 species was identified in Veeranam lake (Krishnamoorthi and Selvakumar, 2012), 4 species of Cladocera was reported during the present study in the study period. They are ranked third, in the order of dominance. Similarly observed by Krishnamoorthi and Selvakumar (2012), Manickam *et al.* (2012) and Suganthi *et al.* (2014). In terms of copepods, the abundance of nauplii was always higher than the adult stages (Zakaria *et al.,* 2007). This is probably due to the larger size of adult forms which increase the predation intensity compared to juvenile forms (Sampaio, 2002).

According to George (1966), the abundance of rotifers followed by cladocerans is an indication of the eutrophic nature of the water bodies. Cladocera comprised of water fleas is common occurrence in almost all the fresh water habitats. These represent an important link in the aquatic food chain and form the favorable food for both young, adult fishes and prawn larva. They constituted the peak in the post-monsoon. The maximum population of cladocera was reported during the study period could be attributed to favorable temperature and availability of food such as bacteria, nanoplankton and suspended detritus while in monsoon the factors like water temperature, dissolved oxygen, turbidity and transparency play an important role in controlling the diversity and density of Cladocera. This is agreeing with earlier reports by Edmondson (1965), Sivakumar and Altaff (2004), Manickam *et al.* (2012) and Krishnamoorthi and Selvakumar (2012).

This was observed maximum may be to high phytoplankton density. Similar observation was earlier workers by Santhanam and Perumal (2003). The decrease in the density of cladocerans may be due to seasonal variation suggested by Reeja Jose and Sanalkumar (2012). Cladocera and Copepoda were observed in lower species richness and abundance compared to Rotifera. This is due to the effects of size-selective predation by fish (Pankow, 1991) and the changes in chemical characteristics of the water condition (Medeiros and Arthington, 2008).

Ostracoda is commonly known as ‘mussel shrimp’ or ‘seed shirmps’ are small crustacean. The freshwater ostracods are usually smaller than a millimetre. They are found in a wide variety of aquatic habitats like lakes, pools, stream and especially shallow places where weeds or algae are abundant. Ostracoda is a free-swimming and occurs in freshwater stagnant pond, lake and reservoirs. They feed on a wide range of food stuffs including diatom, bacteria and detritus. Patil and Gouder (1989) were reported 7 species of Ostrocoda. Mathivanan *et al.* (2007) was also reported that the 5 to 8 species of ostacoda in lake and reservoir, Manickam *et al.* (2012) were identified 3 species from the Dharmapuri District but during the present study only one species was identified. Ostracoda population was ranked in fourth order of individuals in the present study.

It was understood that the various anthropogenic activities such as entry of agricultural runoffs (Insecticides and pesticides) from surrounding agricultural field seem to be the major cause of eutrophication. Therefore the continuous monitoring is essential for the conservation of this lake ecosystem. Among these zooplankton, Rotifers, Cladoceran, Copepods occurred commonly whereas, Ostrocoda and protozoa were recorded less frequently. Wilhm and Dorris

(1968) suggested that the increase in diversity is an indication of the healthier environmental condition and low diversity suggested fewer species dominance probably due to sewage environmental stress. The quantitative analysis of zooplankton was carried out in the wellington reservoir. Zooplankton density of these reservoir indicated variation in different species. Low density, moderate density and high density of the zooplankton in this reservoir can be correlated to high, moderate and low pollution in this reservoir (Suganthi *et al*., 2014).

The low diversity of the zooplankton in premonsoon season could be due to higher pollution and improper maintenance. The higher pollution due to domestic sewage, industrial pollutants and agricultural pollutants affect the water quality and diversity of the zooplankton. Hence there should be some remedial measures to prevent release of these pollutants to this reservoir, so that the native condition of this reservoir can be restored. High diversity of the zooplankton was recorded mainly in this reservoir as well as ecological condition. This reservoir has clear water due to least pollution. The chemical parameters of these ponds appear to be optimum and there is proper recirculation of nutrients leading to production of ecologically balanced food chains and food webs. These might be the reasons for occurrence of different species of Copepods, Cladocerans, Rotifers and Ostracods.

Plankton population on which the whole aquatic life depends directly or indirectly are largely governed by the interaction of a number of physical, chemical and biological conditions and tolerance to one or more of these conditions (Reid and Wood, 1976). The distribution and diversity of zooplankton depending upon the prevailing physico-chemical parameters of the environment; the rotifers were found to predominant groups which are the indicators of eutrophication and measures must be taken to minimize the water pollution by regulating human activities in watershed areas (Mathivanan *et al.,* 2007 and Manickam *et al.,* 2014).

SUMMARY AND CONCLUSION

The present study revealed that, the seasonal variations of freshwater zooplankton was made up of depending on the physico-chemical parameters prevailing in the environment. The qualitative analysis of zooplankton from aquatic ecosystems revealed the presence of four taxonomic groups: Rotifera, Cladocera, Copepoda, and Ostrocoda From those, rotifers are best represented as number of species diversity and abundance, followed by copepods in nauplius, copepodite and adult froms, cladocerans and ostracodes. The dominance of zooplankton species is highly variable in different types of water body according to nutrient levels, predator and other environmental factors which then affects the other biotic components of the ecosystems. In addition, the data generated from this investigation are being useful to the decision maker for the effective conservation and sustainable utilization of this water body. Due to protected conditions, this reservoir showed higher diversity of zooplankton. Further maintenance of the water quality supports production of many commercially important fishes. Additionally many of these Lake form important source of drinking water and irrigate agricultural fields. Hence the present study suggested protecting the fresh water lake in order to maintain their normal ecology and to get many benefits from them.

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