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MOLLUSCAN DIVERSITY IN DIFFERENT MICRO-HABITATS WITH REFERENCE TO AQUATIC VEGETATION IN LAKE VEERANAM TAMILNADU, SOUTHERN INDIA

K. Balasundaram[1, 2] and R. Nagarajan[1,*]

[1] PG and Research Department of Zoology and Wildlife Biology, A.V.C. College (Autonomous), Mannampandal – 609 305, Mayiladuthurai, Southern India

[2] Department of Microbiology, Shree Raghavendra Arts & Science College, Keezhamoongiladi-608 102, Chidambaram, Southern India.

Abstract:

We surveyed the molluscan species from January 2014 to March 2015 in lake Veeranam and the areas were divided into 'Vegetation Free Area' and 'Area with Vegetation' and in these two areas 12 different micro-habitats were identified. Totally 12 molluscan species were collected which were Villorita carbiculoides, Parreysia khadakvaslwensis, Lamellidens marginalis, Corbicula striatella, Polymesoda bengalensis, Indoplanorbis exustus, Bellamya bengalensis, Pila globosa, Stenothyra blanfordina, Thiara tuberculota, Lymnaea biacuminata and Cryptozona semirugata. They belong to five different orders viz., veneroida, trigoinoidea, basommitiophora, mesogastropoda and ariophantacea including nine families i.e. corbiculidae, unionoidae, bullininae, viviparidae, ampullariidae, stenothyridae, thiaridae, lymnaeidae and ariophantidae. Among the 12 molluscan species, the species Parreysia khadakvasiwensis and Lymnaea biacuminata were not observed in area with Pistia stratiotes (Pistia stratiotes micro-habitat) and the molluscan species Cryptozona semirugata was not observed in area with Cyperus sp. (Cyperus sp. micro-habitat). The molluscan species richness was maximum with 12 species in all the micro-habitats except 'Cyperus sp. micro-habitat' (11 species) and 'Pistia stratiotes micro-habitat' (10 species). From the observations it is seemed that the molluscan species Lymnaea biacuminata and Cryptozona semirugata avoided Pistia stratiotes micro-habitat and on the other hand the Parreysia khadakvaslwensis avoided the Cyperus sp. micro-habitat and reasons for the same need through investigation. Furthermore, this study indicated that although the lake Veeranam is infested considerably by aquatic weeds, it supports the molluscan diversity.

Keywords: *Aquatic vegetation, Diversity, Freshwater Molluscs, Micro-habitat, Veeranam lake*

Corresponding author:

K. Balasundaram,

PG and Research, Department of Zoology and Wildlife Biology,
A.V.C. College (Autonomous),
Mannampandal – 609 305, Mayiladuthurai,
Southern India
E-Mail: R.Nagarajan@ex.ac.uk

QR code

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INTRODUCTION:

Phylum mollusca have approximately around 93,000 recognized species which is making it the largest marine phylum. They are extremely diverse in tropical and temperate regions but can be found at all latitudes. The gastropods (snails) are by far the most numerous molluscs in terms of classified species, and account for 80% of the total number of classified molluscan species (Oehlmann and Schulte-Oehlmann, 2002). The current estimated number of mollusca could vary from 80,000 species to 1,35,000 species (Abott, 1989) and the total diversity possibly as high as 2, 00,000 species and second richest phylum with species richness (Strong et al., 2008). In toto, 5070 species of non-marine molluscs live in wild in India (Alfred, 1998). The global freshwater gastropod fauna is estimated at approximately 4,000 described species, however, the total number is probably 8,000 (Strong et al., 2008) with 213 species reported from India (Subba Rao, 1989).

The ecology of these organisms is considered to be influenced by density, diversity and distribution of macrophytes (Bronmark, 1985; Costil and Clement, 1996; Ofoezie, 1999), availability of food, competition, predator-prey interactions (Ofoezie, 1999, Nagarajan and Thiyagesan, 1996, 2006; Nagarajan et al. 2006, 2008). Clams and mussels have been an important food source for different organisms including man because of their high nutritive values (e.g. Creswell and McLay, 1990). Apart from this they act as parasite vectors, invasive species passive indicators of environmental degradation, etc. Since most of the bivalves are filter feeders they act as environmental cleaners and often indicate the environmental changes. Mollusca constitute an important part of ecosystem and play a critical role in maintaining aquatic ecosystem by recycling the nutrients and serve as main food for many aquatic creatures.

Aquatic vegetation plays an important role in structuring aquatic ecosystems (Meerhoff et al. 2003). Being the major primary producer in river and lake ecosystems, they provide food, foraging habitat and breeding places for aquatic organisms, maintaining the diversity and stability of aquatic organism assemblages (Agostinho et al., 2007; Thomaz et al., 2008; Balasundarm and Nagarajan, 2010). Further, in recent years the aquatic habitats are being infested with aquatic weeds which play significant role in aquatic ecosystems and contribute to the general fitness and diversity of a healthy aquatic ecosystem (Flint and Madsen, 1995) by acting as indicators for water quality and aiding in nutrient cycling (Carpenter and Lodge, 1986). Therefore, aquatic vegetation considerably increase habitat structural complexity, potentially change biotic and abiotic processes, and provide refuges against predators for aquatic organisms (Nagarajan and Thiyagesan, 1998; Miranda et al., 2000; Pelicice et al., 2005; Phiri et al., 2011) and from ecological point of view, stabilize bottom sediment, protect the shoreline from wave erosion, and serve as feeding and nesting habitat for waterfowl. These plants provide food, shelter and reproductive habitat or breeding ground for numerous fish and other aquatic animals (Lancer et al., 2002). There are considerable amount of research in assessing the relationship between aquatic vegetation and aquatic organisms in different aquatic habitats across lake, stream and marshes (Caffrey, 1993; Ferrer-Montano and Dibble. 2002; Wang et al., 2011). Therefore, we investigate the association between molluscan diversity and micro-habitat preference based on different species of aquatic vegetation.

STUDY AREA:

Veeranam Lake (11°20'10"N; 79°32'40"E) (formerly called as Veeranaaraayanapuram Lake) is located 14 kilometres south west of Chidambaram in Cuddalore district in the state of Tamil Nadu in South India and 1 kilometers from Sethiyathope. The lake has a catchments area of 25 km^2 (9.7$miles^2$) and the maximum length of the lake is 11.2 km and width is 4 km. The lake located 235 km from Chennai, India, is one of the water reservoirs from where water is planned to be supplied to Chennai. Veeranam Lake was created during Chola period in the tenth century, built from 1011 to 1037 AD and is a 16 km (10 mile) long dam in northern Tamil Nadu. Veeranam lake gets water from Kollidam via Vadavar river. Water released from the Mettur dam through Kollidam and Lower Anicut would also bring in sufficient inflow into the Veeranam Lake. The lake received sufficient inflow in April enabling supply to the city for three months with heavy rain in Western Ghats, the lake almost got its storage capacity as it received inflow from the Cauvery tributaries Bhavani and Amaravathi. The lake has a capacity to store about 1,465 mcft of water. Veeranam is second biggest lake of Tamil Nadu. The lake remains dry for the major part of the year. Their water is used for irrigation for about 70,000 acres. It is one of the source of Drinking water to Chennai and source of Agriculture water Distribution part of Cuddalore district (Fig. 1) (Balasundaram and Nagarajan, 2010).

MATERIALS AND METHODS:

Study Period

Different species of mollusca were collected from January 2014 to March 2015

Areas

The lake has diverse varieties of aquatic vegetation which showed variations in the pattern of distribution.

Based on the presence of vegetation the lake has been divided into two different areas.

Vegetation Free Area: The areas which do not have vegetation are considered in this category.

Area with Vegetation: The areas which have had vegetation are considered in this category.

Habitats

These two areas had wide variations in micro-habitat level and the molluscan species distribution also show varied spatial distribution. Hence, the area is further divided into micro-habitats based on the dominant substrate or vegetation species.

Micro-habitats of Vegetation Free Area

Pebbles micro-habitat: The area had various shapes and sizes of pebbles and the water level is shallow with a depth of 30-45cm

Muddy micro-habitat: The area is muddy in nature and the water level is shallow with a depth of 15-25cm

Silt soil micro-habitat: This area has silt soil substrate and water level is shallow with a depth up to 30cm

Micro-habitats of Area with Vegetation

Acacia* sp. *micro-habitat: There are water areas with trees of *Acacia* sp. in the lake with the inter space of 100m between the trees.

Ipomoea* sp. *micro-habitat: The *Ipomoea* sp. spread in the lake and the water depth of these areas would be 35–50cm.

Azolla* sp. *micro-habitat: The cluster of *Azolla* sp. float the surface of the lake where the water level is 2-5 feet.

Water hyacinth micro-habitat: The water hyacinths densely float on the water surface where the water level is 3-5 feet.

Cyperus* sp. *micro-habitat: There are places with shallow water depth upto 30cm in the lake with exposure of bottom surfaces. The *Cyperus* sp. grows on the exposed areas or in the shallow areas adjacent to the exposed areas.

Pistia stratiotes micro-habitat: The depth of water is very low the plants that grow in this area are partially submerged and partially floating

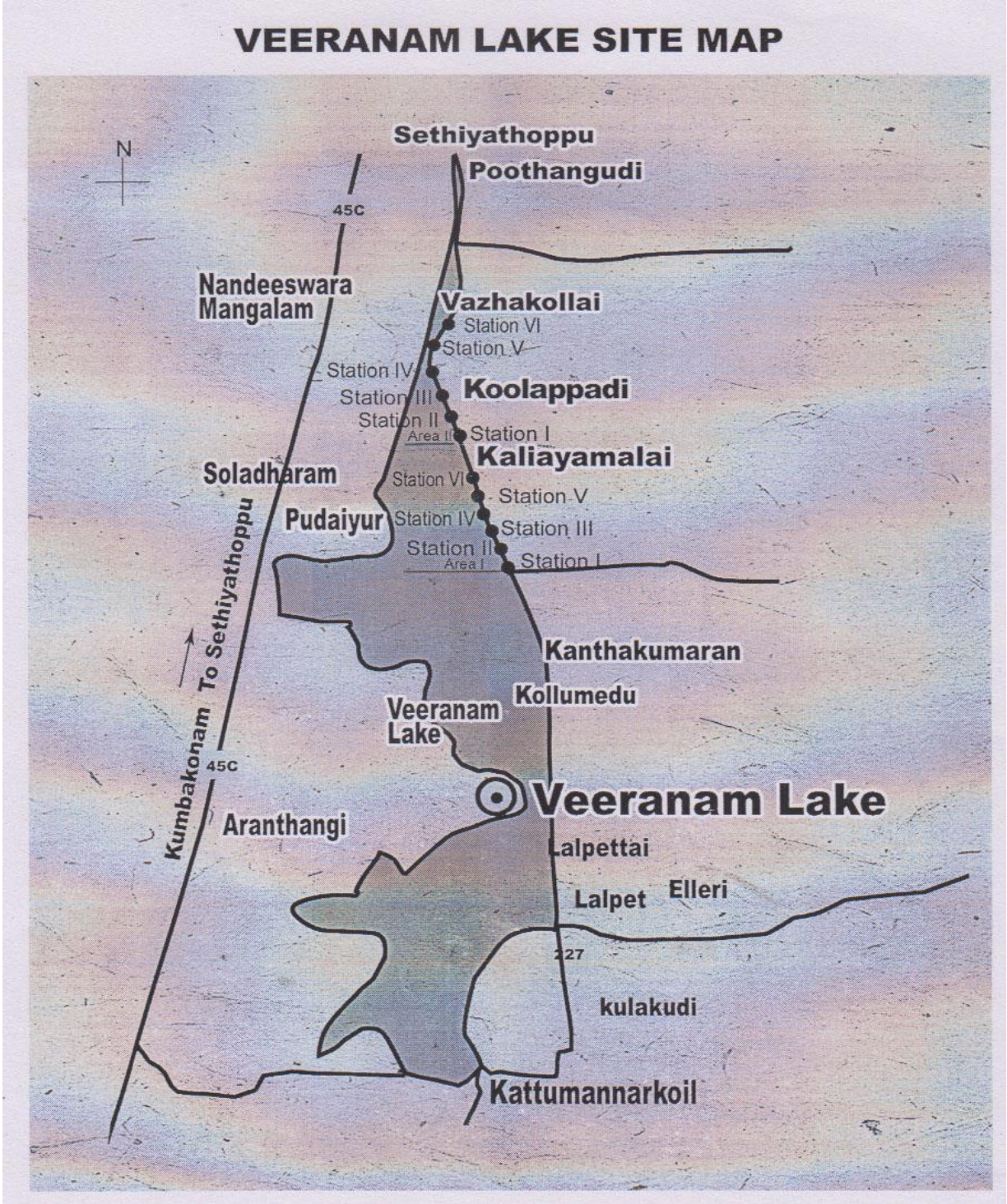
Prosopis juliflora micro-habitat: The areas adjacent to the lake banks show shallow slope gradient where the water depth gradually increases. The *Prosopis juliflora* plant invades upto water level 30cm on these areas.

Vallisneria* sp. *micro-habitat: Areas with water depth of 15-30 cm are infested with *Vallisneria* and floats around the area.

Hydrilla* sp. *micro-habitat: *Hydrilla* sp. grows from the bottom of the lake where the water level is 20 -30cm

Mollusca Collection

The surveys were made mostly in the morning and evening hours and also some time during day hours. Collections of mollusc were made by the methods of hand-picking, mostly from the edges and floor of the lake. In addition, the molluscs that were attached in the walls and plants were collected by hand. Molluscs were preserved with their shells (Sjoberg and Danell, 1981) in 5% formaldehyde (Strin, 1981).



RESULTS:

Species Composition

In the present investigation 12 molluscan species were collected during the study period. They were *Villorita carbiculoides, Parreysia khadakvaslwensis, Lamellidens marginalis, Corbicula striatella, Polymesoda bengalensis, Indoplanorbis exustus, Bellamya bengalensis, Pila globosa, Stenothyra*

blanfordina, Thiara tuberculota, Lymnaea biacuminata and *Cryptozona semirugata* (Plate 1). They belong to five different orders viz., veneroida, trigoinoidea, basommitiophora, mesogastropoda and ariophantacea including nine families i.e. corbiculidae, unionoidae, bullininae, viviparoidae, ampullariidae, stenothyridae, thiaridae, lymnaeidae and ariophantidae (Table 1).

Species Distribution in different micro-habitats

All the 12 species were recorded in all the three micro-habitats viz., Pebbles area, Muddy area and Silt soil area of 'Vegetation free area'. On the other hand, in micro-habitats of 'Area with vegetation', *Cyperus* sp. micro-habitat did not have the molluscan species *Parreysia khadakvaslwensis* and *Pistia stratiotes* micro-habitat did not have molluscan species *Lymnaea biacuminata* and *Cryptozona semirugata.* However, the molluscan species viz., *Lamellidens marginalis, Indoplanorbis exustus, Bellamya bengalensis, Villorita carbiculoides, Polymesoda bengalensis, Corbicula striatella, Indoplanorbis exustus, Pila globosa* and *Stenothyra blanfordina* were recorded in all 12 micro-habitats (Table 1). The molluscan species richness was maximum with all the 12 species in all the micro-habitats except *Cyperus* sp. micro-habitat and *Pistia stratiotes* micro-habitat (Table 1).

Plate – 1: Freshwater molluscan species found in different micro-habitats of 'Vegetation Free Area' and 'Area with Vegetation' of lake Veeranam, Tamil Nadu, Southern India

BIVALVES AND GASTROBODES SPECIES OCCURING IN VEERANAM LAKE

Villorita carbiculoids

Parreysia khadakvaslwensis

Lamellidens marginalis

Corbicula striatella

Polymesoda bengalensis

Indoplanorbis exustus

Bellamya bengalensis

Pila globosa

Stenothyra blafordina

Thiara tuberculota

Lymnaea biacuminata

Cryptozona semirugata

Habitat	Order: Veneroida	Trigoinoidea				Basommitiophora	Mesogastropoda					Ariophantacea	Species Richness
	Family: Corbiculidae	Unionoidae				Bullininae	Viviparoidae	Ampullaridae	Stenothyridae	Thiaridae	Lymnaeidae	Ariophantidae	
	Villorita carbiculoides	*Perreysia khadakva slwensis*	*Lamelliden marginalis*	*Corbicula striatella*	*Polymesoda bengalensis*	*Indoplanorbis exustus*	*Bellamya bengalensis*	*Pila globosa*	*Stenothyra blanfordina*	*Thiara tuberculota*	*Lymnaea biacuminata*	*Cryptozona semirugata*	
Vegetation Free Area													
Pebbles Area	√	√	√	√	√	√	√	√	√	√	√	√	12
Muddy area	√	√	√	√	√	√	√	√	√	√	√	√	12
Silt soil area	√	√	√	√	√	√	√	√	√	√	√	√	12
Area with Vegetation													
Acacia sp. Area	√	√	√	√	√	√	√	√	√	√	√	√	12
Ipomoea aquatica area	√	√	√	√	√	√	√	√	√	√	√	√	12
Azolla sp. Area	√	√	√	√	√	√	√	√	√	√	√	√	12
Water *hyacinth* area	√	√	√	√	√	√	√	√	√	√	√	√	12
Cyperus sp. area	√	X	√	√	√	√	√	√	√	√	√	√	11
Pistia stratiotes area	√	√	√	√	√	√	√	√	√	√	X	X	10
Prosopis juliflora area	√	√	√	√	√	√	√	√	√	√	√	√	12
Vallisneria sp. area	√	√	√	√	√	√	√	√	√	√	√	√	12
Hydrilla sp. Area	√	√	√	√	√	√	√	√	√	√	√	√	12
No. of Habitats	12	11	12	12	12	12	12	12	12	12	11	11	12

Table - 1: Molluscan species collected from different micro-habitats of vegetation free area and area with vegetation of lake Veeranam, Tamil Nadu, Southern India

DISCUSSION:

We collected totally 12 species of molluscs in 12 different micro-habitats of lake Veeranam based on the presence of aquatic vegetation. Earlier, Saravanakumar and Prabhakaran (2013) recorded a total of 67 plant species falling under 53 genera and spreading over 29 families in lake command area. Of the 67 species, the grass *Cynodon dactylon* was represented by highest number followed by *Cyperus rotundus* and *Ceratophyllum demersum*. Among the species highest frequency values were recorded for *Hydrilla verticillata* followed by *Typha domingensis* and *Eichhornia crassipes*. The highest Important Value Index (IVI) values were recorded for *Hydrilla verticillata* followed by *Eichhornia crassipes* and *Typha domingensis*. Thangadurai et al. (2012) classified the aquatic macrophytes of Veeranam based on morphological group viz., classified under floating (8), submerged (6), submerged anchored (3), floating leaved anchored (10) and emergent anchored (23). Bruyndoncx et al. (2002) opined that the alternation of aquatic and terrestrial phases in the marshes creates a diversity of micro-habitats. The difference between these humid, aquatic and dried out, terrestrial sampling sites and other factors like flooding frequency, micro-habitat, vegetation, water temperature, soil texture, presence of other organisms (e.g. birds) are expected to have an influence on the mollusc assemblages too. Although there were greater diversity in aquatic vegetation in Veeranam and the possibility for making micro-habitat classification, we restricted 12 micro-habitats based on the suitability and availability of molluscan species.

Among the 12 species, 9 species were recorded in all the micro-habitats, i.e. *Villorita carbiculoides, Lamellidens marginalis, Corbicula striatella, Polymesoda bengalensis, Indoplanorbis exustus, Bellamya bengalensis, Pila globosa, Stenothyra blanfordina,* and *Thiara tuberculota*. All these species belong to class gastropoda and bivalvia. Species of gastropoda are cosmopolitan in distribution in all terrestrial, freshwater and marine environments, including steppes, desserts, alpine mountains, polar regions, the deep sea and the pelagic and species of bivalvia is also cosmopolitan in distribution in all freshwater and marine environments from the eulittoral to the abyssal zone and from tropical to polar regions (Oehlmann and Schulte-Oehlmann, 2002). Leal (2002) emphasised that bivalves and gastropods can live in a highly diverse gamut of habitat conditions. Hence, these nine species would have distributed in all the 12 micro-habitats and are capable of living all micro-habitats and could be generalist in feeding as they mostly adopt filter feeding mechanism.

The molluscan species *Cryptozona semirugata* and *Lymnaea biacuminata* were not recorded in *Pistia stratiotes* micro-habitat and on the other hand the *Parreysia khadakvaslwensis* was not observed in *Cyperus* sp. micro-habitat.

Cryptozona semirugata is a species feeds on the crops which Shilpa (2013) assessed the incidence level of *Cryptozona semirugata* (Beck.) on major crops grown in different villages revealed that per cent plant damage and per cent leaf area consumption increased with increase in snail population. Balikai (1999) reported the incidence of snail, *Cryptozona semirugara* (Beck) at the Regional Research Station, Bijapur (Karnataka) during September-October 1998 and Giraddi et al. (1996) reported 30.6 and 25.4% damage to chilli and okra seedlings, respectively. Reddy and Puttaswamy (1984) recorded it pest of chilli seedlings in the nursery. From these literatures, it is inferred that *Cryprozona semirugara* prefers to feed the young plants and roots. As the *Pistia stratiotes* has thick leaves with bitter and pungent flavored (Tripathi et al., 2010), and hence *Cryptozona semirugata* would have avoided the *Pistia stratiotes* micro-habitat. *Lymnaea biacuminata* is a rare species and According to Budha et al. (2010) "there is very limited information on the distribution, occurrence, population, species threats and habitat of *Lymnaea biacuminata*. Its disparate distribution (Andhra Pradesh and Uttaranchal, India) requires investigation, and Subba Rao (1989) considered *Lymnaea biacuminata* a phenotypic variation of *Lymnaea acuminata f. rufescens*. It is therefore assessed as Data Deficient". *Cyperus* sp. contains phytochemical constituents of poly phenols, flavanol glycoside, saponin, essential oil and cardiac glycosides and hence *Parreysia khadakvaslwensis* would have avoided this micro-habitat.

Rajamanickam and Nagan (2016) emphasized that large reservoirs are affected by silt carried by the rivers from their large catchments whereas in rural lakes much of siltation occurs due to human activities such as agriculture and over grazing in their close vicinity. Invasive aquatic weeds, particularly exotic species such as water hyacinth, are among other factors responsible for rapid degradation of lakes. Finally, equally important contribution to the degradation of lakes are human alteration in hydrology (excessive water abstraction), shoreline modification through landfill or beautification measure that remove natural vegetation and in-lake activities (bathing, washing, idol immersion and disposal of religious offerings). CPCB (2001) found that anthropogenic activities (deforestation, agriculture, urban settlements and industries) have accelerated the aging process as increased amounts of sediments, nutrients and toxic substances enter lakes with the runoff.

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