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POPULATION DYNAMICS OF ROTIFERS IN EPHEMERAL PONDS

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Abstract

In this study, rotifer population dynamics and the water quality of ephemeral ponds were investigated. Samples were collected monthly from thirty stations for 2 years from June 2006 to January 2008 for qualitative as well as quantitative purposes. A total of 52 taxa (49 species) have been recorded during the study period. The results obtained during the present study clearly demonstrate the richness and diversity of the rotifer species in the ephemeral ponds. The rotifer community showed seasonal and spatial variations in total number of species and their diversity.

Keywords: Rotifer density, diversity index, species richness and evenness, ephemeral ponds

INTRODUCTION

Aquatic ecosystems are closed or semi-closed, as the site of the study appears to be a finite and vulnerable resource threatened by catches in the environment [6], and are considered a siege of several bio-physico-chemical phenomenon. Ephemeral ponds are fairly small body of still water existing or continuing for a short time only but richness and uniqueness of species in these environments is still obvious. According to the topography, the soil and the climate of the area where they are located, temporary wetlands can be either seasonal, which alternate dry and wet phases in the same year, or episodic, which can persist without water for years until precipitations fill them again in a short time, and in which the duration of the hydro-period is variable [43] [8]. The size of these environments, which are widely distributed, can be of either a few square meters or hundreds of hectares [43] [30]. The depth of ephemeral ponds varies from few inches to about 10 feet or sometimes more. Ponds have less or no currents. These ponds are quite common on the sides of road and railway tracks where depressions are made due to removal of soil and mud. They are also found along embankments of rivers, streams and inside the forest. The organisms that inhabit them during the wet phases have adaptations that allow them to go through the dry phases. These adaptations include diapause or dormant stages [30][9], deposition of resting eggs, such as that observed in anostracans, notostracans, cladocerans and rotifers [17] [1] [23] [29], and the burial of individuals in the sediments, sometimes in larval stage, such as that observed in cyclopoid copepods [18] [28]. In recent years, the abundance and ecological importance of these ephemeral water bodies have drawn attention of the scientists in the monument of aquatic ecosystem throughout the world [43],[46]. Evaluation of factors controlling the distribution of zooplankton species is, by its central position and its dual control by resources and predation, a central point in the biological and ecological functioning of aquatic ecosystems, which must be taken into account in the context of the management of these environments through the manipulation of the food web [25]. The functioning of small water bodies differs from that of lakes in many respects, including the spatial and vertical distribution of physical-chemical parameters and also their biological features, although, in both types of reservoirs aquatic plants may play an important role in the structuring of freshwater communities [22]. H^- values express seasonal homogeneity in the species abundance of zooplankton community [45]. Fernandez-Rosado & Lucena, [16] have also mentioned the influence of environmental and biotic interactions on the composition, abundance and dynamics of zooplankton. Rogozin [27] stated that it is important to analyze the relationship between the tropic structure of the lake and the zooplankton community. Many permanent water bodies like rivers, lakes, reservoirs, etc. has been studied for rotifer diversity but the ephemeral ponds particular in Washim region have never been studied although they seem to shelter an interesting fauna and therefore, to identify groups of dominant rotifers and analyze their spatial distribution, diversity, richness and evenness to evaluate rotifers as biological component of ecosystem and to co-relate the species diversity, richness and evenness of the species with some physico-chemical parameters like temperature, conductivity, TDS, pH, dissolved oxygen and salinity, the present work was undertaken.

MATERIAL AND METHODS

Study Area- Washim Region: Washim is one of the districts of Maharashtra state. It is located at 19^0 36' N and 21^0 13' N latitude and 76^0 38' E longitude. It is 300-600 meter above the mean sea level. Washim was once known as *Vatsagulma*, the capital of the *Vatsagulma line of Vakataka dynasaty*. The region of district spreads over 5178 sq. km. Most of the district is hilly. The district has no mountains of importance but the ranges of the Ajantha hills, which formed a plateau. This plateau known as 'Balaghat' forms one of the great water shades in the country as the region to its north is dawned by the river Purna, in the western direction to the river Tapi while that situated on the plateau and to its south is trained by the river Painganga towards the east ultimately joining the Godavari. The average temperature of the district ranges from 10-45^0 C and the average rainfall ranges 750-1000 mm.

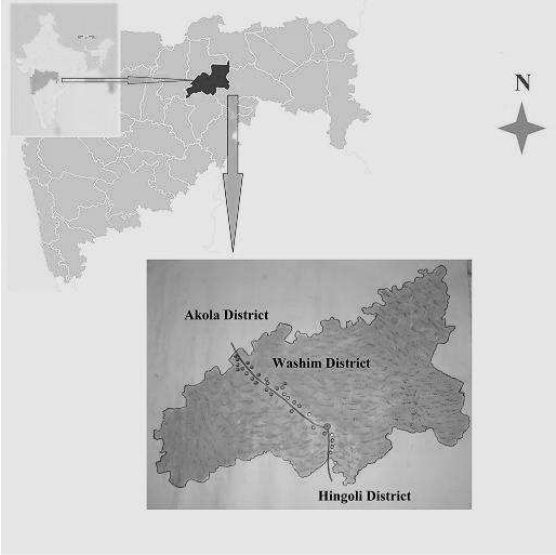

Figure 1: Map showing location of sampling sites.

30 ephemeral ponds lying along the roadside at State Highway No. 204 from Washim-Akola borderline (N 20.32759 E 76.94160) to Washim-Hingoli borderline (N 19.97625 E 77.14342) were fixed during the complete study of water chemistry and rotifer collection. The sampling stations were named as S_1, S_2, S_3, S_4,…… S_{30}. For qualitative and quantitative purpose, zooplankton samples were collected monthly in early morning hours i.e. from 8:00 a.m. to 12:00 noon for two years, June 2006 to January 2007 and June 2007 to January 2008 strictly following the "Standard Methods for Examination of Water and Wastewater, [2]. Rotifers were fixed in 4% formalin [12]. To preserve illoricate forms the samples were fixed by adding equal volume of hot water followed by 4% formalin. Few drops of glycerin were added for better preservation and to prevent evaporation of sample [11]. Few drops of detergent were added to prevent clumping of zooplankton [10]. For qualitative study of the preserved organisms, individual organisms were picked out with a fine pipette. Such pipettes of different opening size were prepared in the laboratory. A small glass tube (2-3 mm diameter) was drawn-out to fine point, the exact size being determined by the size range of the organisms to be handled. The other end of the tube is fitted with one inch length fitting tuber tubing which is closed at its other end by a short length of glass rod. Then specimens were put into 10% glycerin in a watch glass or a cavity slide and the water is allowed to evaporate, it left the object in pure glycerin. On another slide a small drop of pure glycerin was put at the centre and the material is transferred into pure glycerin. To observe live material, scanning lens of the compound microscope was used. Most specimens were found moving occasionally, giving views which were observed live on phase contrast microscope with attached photographic device, *Studio DC 10 plus*. These grabbed images with special effects such as contrast and brightness were adjusted to study more details of an organism. Their lucid drawings were prepared and measurements of the specimens were carried out by using oculometer scale. Some of the specimens were treated with 4% sodium hypochlorite to isolate the trophi [34]. Identification of the species was carried out referring standard literatures [15], [44], [3],[4],[5],[41],[21],[31],[39], [14], [37],[38]. Segers [37] is followed for the recent system of nomenclature of Rotifera and remarks on the distribution are made using Segers [32]. Estimation of rotifer density was made by counting 1 ml sub-sample of the well-mixed standard sample in a Sedgwick Rafter counting chamber. Online statistical analysis was carried out by http://www.easycalculation.com/statistics/standard-deviation.php, while Shannon-Weiner diversity index, species richness and evenness were calculated by using the formulae [36 and 24].

RESULTS AND DISCUSSION

The Rotifer communities of the ephemeral ponds in Washim region of Maharashtra revealed in all 49 species of 22 genera belonging to 14 families of 3 orders belonging to 2 subclasses and, hence, comprised about more than one- sixth of the known 340 species of Indian rotifera. Out of 25 families and 63 genera of Eurotatoria so far known from India [40], 14 families and 22 genera are recorded presently. Rotifers are chiefly fresh water forms and presence of these organisms in the abundance is related to suitable conditions for their survival [14]. According to Segers [32], all the recorded rotifer species in the present study are widely distributed around the world. A systematic list of the reported species is depicted in **Table 1.** The rotifer community showed variations in total number of species and their diversity in different months. [7] was able to find only eleven genera form some ephemeral wetlands of Southern Kerala and these genera are *Phiolodina, Trichocerca, Keratella, Cephalodella, Lecane, Lepadella, Monostyla, Platyas, Epiphanes, Dicranophorus* and *Conochilus.* In the present study, the genera like *Lepadella, Platyas, Dicranophorus* and *Conocellus* was totally absent. Such an instance was evident in Indian Museum Tank, Calcutta wherein rotifer species composition indicated 77.8 per cent dissimilarity [42] when compared with earlier study [35]. The qualitative abundance was lowest between the months December and January. As reported by Jyoti & Sehgal [20] and Haque *et al* [19], the periods of peak rotifer densities were accompanied by reduced number of species. Relative lower number of species during differences in community structure of rotifers in various ephemeral pond habitats might be attributed to temporal changes in their trophic status and presence of aquatic hydrophytes. Rotifer species diversity, richness and evenness of ephemeral ponds are depicted in **Table 2.**

In the present study, annual average density of rotifers ranged from 381 ± 44 to 571±31 individuals/L in 2006-07 while it ranged from 419 ±29 to 582 ± 52 individuals/L in 2007-08. Shannon-Wiener index (H') ranged between 0.689 ± 0.283 and 1.671 ± 0.670 during 2006-07 and it ranged from 0.817 ± 0.191 to 1.895 ± 0.548 in the year 2007-08 while the mean species richness index (R) of ephemeral ponds ranged between 0.41 ± 0.110 and 0.767 ± 0.103 during 2006-07 and 0.416 ± 0.141 to 0.739 ± 0.194 in the year 2007-08. One of the major features of the animal communities is their diversity that it is the number of species present and their numerical composition. Diversity is niche time stability dependent meaning if a large number of niches are available, higher diversity is found. Dash [13] reported that high value of Shannon's index (H') the greater is the planktonic diversity. Present findings are not corroborated with the findings of Rajagopal *et al.* [26] who found low value of Shannon's index during September and October at Chinnapperkovil and Nallanchettipatti ponds. The peak period of rotifer diversity was observed during monsoon period while a peak period of rotifer density was observed during the late winter months in both the years of investigation. Ascended values of diversity during rainy season may be attributed to inflow of waste water while its increased values during consecutive months may be due to accumulation of organic wastes and disappearance of fish predation in the ponds.

CONCLUSION

The number of recorded species is quite great, if we take into consideration small dimensions and depth of these ponds, as well as the significant changes happened under the anthropogenic pressure in these ponds. These water bodies may possess a varied rotifer fauna; therefore, these water bodies require more studies for rotifer fauna and a question arisen during this study that how do predators affect the community structure of rotifer communities? A regular study on the ephemeral ponds is hereby advised in order to understand the impact of predation, competition increased anthropogenic activities around these water bodies which will uncover many new, rare or endemic species.

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Table 1: A systematic list of Rotifer species recorded from various ephemeral ponds.

Sr. No.	Species
Family I :EPIPHINIDAE	
1.	*Epiphanes clavulata (*Ehrenberg, 1832)
Family II :BRACHIONIDAE	
2.	*Anuraeopsis fissa* (*A. coelata*) (Gosse, 1851)
3.	*Brachionus angularis* (Gosse, 1851)
4.	*Brachionus caudatus* (Barrios and Daday, 1894)
5.	*Brachionus diversicornis* (Daday, 1883)
6.	*Brachionus forticula f typicus-urawensis* (Sudzuki, 1955)
7.	*Brachionus calyciflorus* (Pallas, 1776)
8.	*Brachionus bidentata* (Anderson, 1889)
9.	*Brachionus durgae* (Dhanapathi, 1974)
10.	*Brachionus falcatus* (Zacharias, 1998)
11.	*Brachionus plicatilis* (Muller, 1786)
12.	*Brachionus quadridentatus* (Hermann, 1783)
13.	*Brachionus urceolaris* (Muller 1973)
14.	*Brachionus rubens* (Ehrenberg, 1838)
15.	*Plationus patuulus comb nov.* (Segers *et al.*, 1993)
16.	*Keratella cochlearis* (Gosse, 1851)
17.	*Keratella tropica* (Apstein, 1907; Berzing, 1955)
18.	*Keratella ticinensis*(Carlin,1943)
Family III: EUCHLANIDAE	
19.	*Euchlanis dialatata* (Ehrenberg, 1932)
20.	*Pseudoeuchlanis longipedis* (Dhanapathi, 1978)
Family IV: MYTILINIDAE	
21.	*Mytilina ventralis* (Ehrenberg, 1832)
Family V: LECANIDAE	
22.	*Lecane bidentata* (Dhanapathi, 1976)
23.	*Lecane lauterborni* (Hauer, 1924)
24.	*Lecane leontina* (Turner, 1892)
25.	*Lecane luna* (Muller, 1776)
26.	*Lecane papuana* (Murray, 1913)
27.	*Lecane (Monostyla) bulla* (Gosse, 1857)
28.	*Lecane (Monostyla) decipiens* (Murray, 1913)
29.	*Lecane (Monostyla) punctata* (Murray, 1913)
30.	*Lecane pyriformis* (Daday, 1905)
31.	*Lecane(Monostyla) quadridentata* (Ehrenberg, 1832)
Family VI: NOTOMMATIDAE	
32.	*Cepholodella forticula* (Ehrenberg, 1832)
33.	*Cephalodella gibba* (Ehrenberg, 1832)
34.	*Esophora anthadis* (Harring and Myers,1921)
Family VII: TRICHOCERCIDAE	
35.	*Trichocerca ruttneri* (Donner, 1953)
36.	*Trichocerca similis* (Wierzejski, 1893)
37.	*Trichocerca rattus* (Muller, 1776)
Family VIII: ASPLANCHNIDAE	
38.	*Asplanchna brightwelli* (Gosse, 1850)
39.	*Asplanchna sieboldi* (Leydig, 1854)
40.	*Asplanchnopus bhimavaramensis* (Dhanapathi, 1975)
Family IX: SYNCHAETIDAE	
41.	*Polyarthra indica* (Segers and Babu, 1999)
42.	*Synchaeta pectinata* (Ehrenberg, 1832)
Order 2: Gnesiotrocha	
Family X: HEXARTHRIDAE	
43.	*Hexarthra intermedia* (Wixneiwask, 1929)
Family XI: FILINIDAE	
44.	*Filinia longiseta* (Ehrenberg, 1834)
45.	*Filinia opoliensis* (Zacharias, 1898)
Family XII: TESTUDINELLIDAE	
46.	*Testudinella patina* (Herman,1783)
Family XIII: TROCHOSHAERIDAE	
47.	*Horaella brehmi* (Donner, 1949)
Subclass II: Bdelloida	
Family XIV :PHILODINIDAE	
48.	*Rotaria neptunia* (Erhenberg, 1832)
49.	*Philodina flaviceps* (Bryce, 1906)

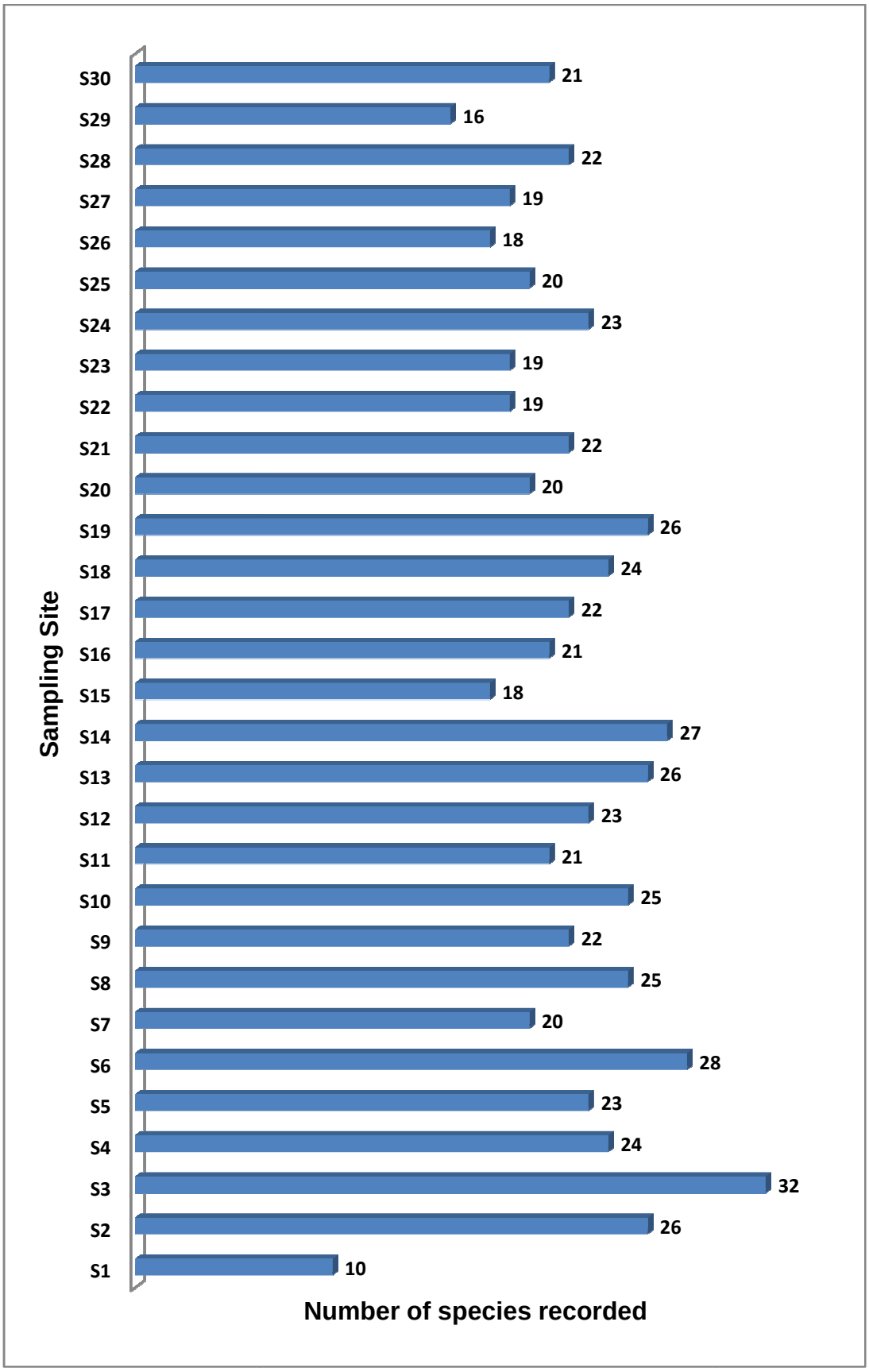

Figure 2: Bar diagrams showing overall number of rotifers species recorded form different ephemeral ponds during study period

Table 2: Rotifer species diversity, richness and evenness of ephemeral ponds (Mean ± S.D.)

Site ID	Shannon- Wiener Diversity Index (H')		Richness (R)		Evenness (e)	
	2007-08	2008-09	2007-08	2008-09	2007-08	2008-09
S_1	1.004 ± 0.33	0.853 ± 0.172	0.639 ± 0.218	0.668 ± 0.152	0.444 ± 0.052	0.608 ± 0.119
S_2	1.131 ± 0.332	0.948 ± 0.210	0.767 ± 0.103	0.680 ± 0.098	0.608 ± 0.110	0.593 ± 0.088
S_3	1.671 ± 0.670	1.895 ± 0.548	0.679 ± 0.227	0.711 ± 0.218	0.731 ± 0.140	0.735 ± 0.144
S_4	1.329 ± 0.412	1.278 ± 0.422	0.606 ± 0.170	0.492 ± 0.108	0.469 ± 0.116	0.485 ± 0.155
S_5	1.035 ± 0.503	1.126 ± 0.480	0.493 ± 0.211	0.602 ± 0.126	0.446 ± 0.156	0.494 ± 0.183
S_6	0.950 ± 0.493	0.886 ± 0.490	0.496 ± 0.144	0.505 ± 0.143	0.402 ± 0.160	0.527 ± 0.180
S_7	0.966 ± 0.251	0.918 ± 0.445	0.554 ± 0.157	0.564 ± 0.129	0.494 ± 0.175	0.423 ± 0.159
S_8	0.743 ± 0.338	0.838 ± 0.277	0.41 ± 0.110	0.420 ± 0.091	0.426 ± 0.111	0.472 ± 0.123
S_9	1.164 ± 0.351	0.835 ± 0.218	0.427 ± 0.220	0.416 ± 0.141	0.586 ± 0.152	0.629 ± 0.122
S_{10}	0.883 ± 0.327	0.890 ± 0.232	0.453 ± 0.134	0.510 ± 0.081	0.475 ± 0.190	0.508 ± 0.161
S_{11}	0.689 ± 0.283	0.858 ± 0.328	0.525 ± 0.167	0.480 ± 0.141	0.495 ± 0.233	0.446 ± 0.151
S_{12}	1.056 ± 0.348	0.999 ± 0.335	0.462 ± 0.167	0.483 ± 0.136	0.425 ± 0.119	0.456 ± 0.081
S_{13}	0.848 ± 0.158	0.980 ± 0.410	0.494 ± 0.125	0.534 ± 0.139	0.461 ± 0.186	0.475 ± 0.169
S_{14}	0.829 ± 0.218	0.817 ± 0.191	0.638 ± 0.063	0.625 ± 0.096	0.466 ± 0.141	0.489 ± 0.154
S_{15}	1.059 ± 0.388	0.974 ± 0.316	0.618 ± 0.159	0.564 ± 0.173	0.576 ± 0.159	0.559 ± 0.161
S_{16}	0.809 ± 0.098	1.046 ± 0.267	0.612 ± 0.090	0.739 ± 0.194	0.459 ± 0.147	0.549 ± 0.128
S_{17}	0.806 ± 0.184	0.82 ± 0.179	0.472 ± 0.111	0.526 ± 0.106	0.464 ± 0.144	0.504 ± 0.093
S_{18}	0.803 ± 0.305	0.837 ± 0.198	0.575 ± 0.109	0.544 ± 0.092	0.611 ± 0.131	0.529 ± 0.127
S_{19}	1.381 ± 0.560	1.377 ± 0.692	0.531 ± 0.101	0.557 ± 0.104	0.583 ± 0.158	0.582 ± 0.141
S_{20}	.839 ± 0.157	0.842 ± 0.147	0.637 ± 0.114	0.613 ± 0.097	0.506 ± 0.074	0.512 ± 0.100
S_{21}	0.904 ± 0.287	0.939 ± 0.298	0.590 ± 0.101	0.613 ± 0.092	0.575 ± 0.115	0.579 ± 0.085
S_{22}	1.032 ± 0.318	0.864 ± 0.244	0.519 ± 0.061	0.545 ± 0.064	0.668 ± 0.176	0.629 ± 0.127
S_{23}	1.227 ± 0.582	10.65 ± 0.412	0.691 ± 0.088	0.671 ± 0.110	0.635 ± 0.142	0.646 ± 0.116
S_{24}	0.822 ± 0.352	0.832 ± 0.345	0.495 ± 0.096	0.517 ± 0.092	0.459 ± 0.135	0.563 ± 0.143
S_{25}	0.944 ± 0.245	0.982 ± 0.320	0.531 ± 0.093	0.569 ± 0.056	0.566 ± 0.909	0.527 ± 0.040
S_{26}	1.074 ± 0.412	1.078 ± 0.319	0.622 ± 0.083	0.571 ± 0.037	0.517 ± 0.092	0.521 ± 0.049
S_{27}	1.024 ± 0.316	0.820 ± 0.101	0.561 ± 0.044	0.559 ± 0.039	0.449 ± 0.063	0.497 ± 0.072
S_{28}	0.876 ± 0.201	0.863 ± 0.099	0.59 ± 0.070	0.593 ± 0.064	0.588 ± 0.076	0.543 ± 0.057
S_{29}	0.856 ± 0.202	0.856 ± 0.204	0.543 ± 0.511	0.543 ± 0.051	0.544 ± 0.052	0.544 ± 0.052
S_{30}	0.819 ± 0.107	0.819 ± 0.107	0.623 ± 0.050	0.623 ± 0.050	0.594 ± 0.055	0.594 ± 0.055

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