An experiment on geotaxis of pond planktons

by

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Diurnal vertical migration is commonly seen among many planktonic animals, both of fresh water and marine, especially among crustaceans.

Their reaction to the diurnal changes of light and ather enviromental conditions, stimuli to the movement of those animals through the nutrition they take during a day, and their internal activity periodicity may be the limiting factors to this vertical movement.

I have carried out an experiment on the diurnal vertical migration of planktons collected in some ponds in Mihara-gun, Hyogo Prefecture. In this paper the results are reported on the experiment of the geotaxis of 11 species of the planktons, viz. *Ceratium hirundinella* and *Dinobryon divergens* in Dinoflagellida, *Difflugia corona* in Rhizopoda, *Asplanchna priodonta, Filinia longiseta, Hexarthra mira, Keratella cochlearis* var. *tecta, Polyarthra trigla,* and *Trichocerca longiseta* in Rotatoria, *Diaphanosoma brachyrum* in Cladocera, and *Eodiaptomus japonicus* in Copepoda.

Method

A glass tube of 6.0cm in diameter and 80.0cm in length, filled with pond water and test animals was used in the experiment.

The content of the glass tube was divided into four sections, with transparent plastic screens, and an attention was payed for making the test animals possible to rotate and to move up and down through the screen during experiment.

Vertical distribution of the animals were observed after exposure to light for one hour.

The glass tube was stood vertically receiving 250 lux in light intensity by two 100W incandescent lamps at the distance of 1m. The experiment was arranged in four series: (1) geotaxis in diffuse light, of which intensity was 250 lux, (2) geotaxis in darkness, (3) that in comlined conditions of two kinds. The lower 2½ section of the glass tube was covered with a thick black paper and the remaining upper 1½ section was kept uncovered, and the upper 2½ section was covered with a thich black paper and the remaining lower 1½ section was exposed to diffuse light.

Immediately after the materials were collected from a pond, they were flowed into the glass tube for the experiment together with pond water which showed pH 7.0-7.4. The water temperature in the test tube was kept at 25.0-26.0 °C.

When the experiment as over, all the screens were closed tightly. Then the water containing the materials of each section, from I to IV, of the glass tube was sucked up with a siphon into sample bottles, then the animals contained in the water were filtered and their number was counted. The experiment was repeated three times and the mean value was brought into consideration.

Results

Table 1 shows the individual number of the species appeared in each section in the series of the experiment.

1) Geotaxis in diffuse light.

Positive geotaxis was observed in diffuse light in *Difflugia, Keratella, Diaphanosoma,* and*Eodiaptmus,* while *Asplanchna, Filinia,* and *Hexarthra* showed negatiae geotaxis. On the other hand, *Ceratium, Dinobryon, Polyarthra,* and *Trichocerca* showed uncertain reaction in respect of geotaxis.

2) Geotaxis in darkness.

Positive geotaxis was observed in *Ceratium, Difflugia, Asplanchna, Keratella, Trichocerca, Diaphanosoma,* and *Eodiaptomus,* Whereas negative reaction in respect of geotaxis was observed in *Dinobryon, Filinia, Hexarthra,* and *Polyarthra.*

3) Geotaxis in the case of upper 1½ section exposure to light.

Ceratium, Difflugia, Dinobryon, Asplanchna, Filinia,

Table I. Correlation between geotaxis and light intensity which pond planktons receive.

Species of plankton	Section / Number	Full exposure to light				Darkness				Upper 1½ section exposure to light				Lower 1½ section exposure to light			
		1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Ceratium hirundinella	I	1000	600	900	1200	700	900	1000	1100	2000	800	1100	3800	2300	2700	1500	1900
	II	1820	1200	1420	1153	1200	1600	1430	1250	100	1800	2400	2400	4400	3050	2100	1400
	III	2952	2820	2925	2870	1280	1420	1654	1391	1092	2340	2700	3200	3900	2950	1630	980
	Total	4772	4620	5245	5223	3180	3920	4084	3741	1892	4940	6200	9400	10600	8770	5230	4280
	%	24	24	26	26	22	26	27	25	8	22	28	42	37	30	18	15
Difflugia corona	I	23	22	36	41	28	29	72	40	30	49	55	80	10	47	52	58
	II	24	33	43	67	46	40	69	63	55	64	104	42	38	53	31	58
	III	41	69	87	150	24	18	33	57	23	42	79	63	27	47	53	46
	Total	88	124	166	258	98	87	174	160	108	155	238	185	125	147	136	162
	%	12	23	25	40	19	16	34	31	15	23	35	27	22	26	24	28
Dinobryon divergens	I	2255	1980	1080	2100	1540	1620	1044	1133	1249	1465	1624	1625	2453	1760	1980	1500
	II	1610	1360	1870	1350	1720	1590	1356	1405	1193	1289	1452	1491	3070	2640	2080	1420
	III	1550	1980	1710	1620	1478	1640	1261	1055	1250	1512	1469	1680	1960	2120	1650	1200
	Total	5415	5320	5380	5070	4738	4850	3661	3593	3692	4266	4545	4796	7483	6520	5610	4120
	%	26	25	25	24	28	29	22	21	22	24	26	28	32	28	23	17
Asplanchna priodonta	I	4	7	5	2	9	1	13	8	1	0	1	3	4	5	11	0
	II	2	3	4	1	1	2	5	6	0	5	8	12	5	5	20	13
	III	10	12	9	14	7	5	4	10	4	5	8	6	7	3	12	4
	Total	16	22	18	17	17	8	22	24	5	10	17	21	16	13	43	17
	%	22	30	25	23	24	11	31	34	9	19	32	40	18	15	48	19
Filinia longiseta	I	180	270	220	180	98	60	21	8	13	123	60	21	12	18	53	27
	II	119	151	105	97	252	176	92	21	40	163	104	24	22	68	84	14
	III	131	92	74	60	140	79	34	12	10	117	39	16	18	59	80	21
	Total	510	513	399	337	490	855	147	41	63	403	743	61	52	145	217	62
	%	30	30	21	19	32	56	9	3	5	32	59	4	11	31	45	13
Hexarthra mira	I	165	90	60	7	149	121	132	19	234	216	20	0	24	90	124	139
	II	96	64	57	28	217	183	161	37	108	153	64	19	120	190	161	120
	III	131	102	73	18	116	98	63	9	126	80	56	13	54	212	105	136
	Total	392	256	190	53	482	402	356	65	468	449	140	32	198	492	390	395
	%	44	29	21	6	37	31	27	5	43	41	13	3	14	33	26	27
Keratella cochlearis var. tecta	I	55	180	120	167	10	6	16	20	21	32	45	50	31	46	24	27
	II	39	76	91	132	24	21	48	64	14	40	28	45	28	30	20	16
	III	17	35	74	69	32	36	53	70	15	27	33	39	38	57	51	25
	Total	111	291	285	368	66	63	117	154	50	99	106	134	97	133	95	68
	%	11	28	27	34	17	16	29	38	13	25	27	35	25	34	24	17
Polyathra trigla	I	495	480	540	450	275	120	165	104	221	263	254	247	328	430	255	267
	II	146	132	119	123	183	168	159	137	162	274	224	246	484	375	260	283
	III	329	308	422	416	362	250	187	114	150	246	257	271	368	297	234	186
	Total	970	920	1081	989	820	538	511	355	533	783	735	764	1180	1102	749	836
	%	25	23	27	25	37	25	23	16	19	28	26	27	31	29	20	20
Trichocerca longiseta	I	16	14	13	15	16	13	18	18	12	9	1	1	15	14	17	19
	II	18	13	10	9	14	16	23	24	14	13	4	9	8	10	13	15
	III	13	14	11	18	16	11	14	19	19	14	7	3	19	15	9	13
	Total	47	41	34	42	46	40	55	61	45	36	12	13	42	39	39	47
	%	28	25	21	26	23	20	27	30	43	34	11	12	26	23	23	28
Diaphanosoma brachyrum	I	3	12	11	14	5	5	13	18	3	14	10	12	3	4	4	19
	II	2	5	7	10	0	8	22	26	7	20	26	39	0	5	0	29
	III	8	16	15	40	16	15	16	47	5	18	14	35	7	4	5	29
	Total	13	33	33	64	21	28	51	91	15	52	50	86	10	13	9	77
	%	9	23	23	45	11	15	27	47	7	26	25	42	9	12	8	71
Eodiaptomus japonicus	I	2	4	3	8	3	6	12	7	4	12	5	17	2	6	6	22
	II	9	12	12	27	2	4	36	26	7	20	21	19	11	3	6	12
	III	5	13	11	25	7	10	15	21	2	11	23	21	7	7	5	14
	Total	16	29	26	60	12	20	33	54	13	43	49	57	20	16	17	48
	%	12	22	20	46	10	17	28	45	8	27	30	35	20	16	17	47

Keratella, Polyarthra, Diaphanosoma, and *Eodiaptomus* showed positive geotaxis, while negative reaction was observed in *Hexarthra* and *Trichocerca.*

4) Geotaxis in the case of lower 1½ section exposure to light.

Hexarthra, Trichocerca, Diaphanosoma, and *Eodiaptomus* showed positive geotaxis, while *Ceratium, Dinobryon, Asplanchna, Filinia, Keratella,* and *Polyarthra* showed negative reaction. *Difflugia* was uncertain in respect of geotaxis.

Consideration

Regarding the geotaxis of zooplanktons, many papers have been Published up to the present by several workers such as Esterly (1907, 1917, 1919), Harper (1907), McGinnis (1911), Dice (1914), Fox (1925), Kikuchi (1938), and Motoda (1953).

Parker (1902), Dice (1914), Esterly (1919), and Kikuchi (1938) reported relationship between geotaxis and water temperature. Among them, Kikuchi (1938) also stated that no decided change in reaction with respect to geotaxis was seen in *Acanthodiaptomus* when it was brought to bright place from dark one and vice versa. Foxon (1940) reported that zooplanktons adapted to dark place are usually negative in geotaxis. Ewald (1910) found that zooplanktons put in glass bottles showed similar geotaxis to those in natural condition.

Motoda (1953) carried out experiments on photo and geotaxis useing various planaktonic crustaceans such as *Acanthodiaptomus, Daphnia, Bosmina,* and *Scapholoberis.* He observed that *Acanthodiaptomus,* both male and female, showed negtive geotaxis. *Daphnia* and *Bosmina* position reaction, and *Scapholoberis* negative reaction. Furthermore he observed that *Acanthodiaptomus* and *Daphnia* showed neutral in reaction, while *Scapholoberis* slightly positive geotaxis and *Bosmina* negative reaction.

As mentioned above, geotaxis of plankton is peculiar to the species. I observed *Diaphanosoma* showed close similarity in geotaxis to that of *Daphnia* and *Bosmina* as reported by Motoda. While *Eodiaptomus* showed evident positive geotaxis both in diffuse light and darkness, quite different from that in the case of *Acanthodiaptomus* as observed by the same writer.

As already mentioned in my previous paper (1967), *Difflugia, Diaphanosoma,* and *Eodiaptomus* mig-

Table 2. Geotaxis of pond planktons.

Species of plankton	Full exposure to light	Darkness	Upper 1½ section exposure to light	Lower 1½ section exposure to light
Ceratium	N	N	+ +	− −
Difflugia	+ +	+	+ +	+
Dinobryon	N	−	+	− −
Asplanchna	−	+	+ +	−
Filinia	−	− −	+ +	− −
Hexarthra	− −	− −	− −	+
Keratella	+ +	+ +	+ +	− −
Polyathra	N	− −	+	−
Trichocerca	−	+	− −	+
Diaphanosoma	+ +	+ +	+ +	+ +
Eodiaptomus	+ +	+ +	+ +	+ +

+ Positive geotaxis
− Negative geotaxis
N Neutral

rate distinctly up and down periodically during a day. *Ceratium, Dinobryon, Hexarthra* and *Keratella* also make fairly distinct migration, while *Asplanchna, Filinia, Polyarthra,* and *Trichocerca* are uncertain in respect of migration.

The results obtained from my experiment on geotaxis are given in Table 2. As is clear from this table, in *Ceratium, Dinobryon, Asplanchna, Filinia, Hexarthra, Keratella, Polyarthra,* and *Trichocerca* geotaxis is affected by the light intensity which the plankton receve, while in *Difflugia, Diaphanosome, Eodiaptomus* it is not influenced by the light intensity, though they make undoubtedly diurnal vertical migration under natural condition. This is in good accordance with Motoda's finding (1953) in both male and female of *Diaptomus, Daphnia,* and *Bosmina.* Thus geotaxis and phototaxis may play one of the important roles in the diurnal vertical migration of zooplanktons, and changes of environtal condition where they inhabit may sometimes regulate their feeding behavior.

Summary

An experiment has been carried out on the geotaxis of pond planktons. The results obtained are shown in Table 1-2. In *Ceratium, Dinobryon, Asplanchna, Filinia, Hexarthra, Keratella, Polyarthra,* and *Trichocerca,* the reaction in respect of geotaxis is controlled fairly well by the light intensity they receive. Neverthless, in *Difflugia, Diaphanosoma,* and *Eodiaptomus* no correlation between geotaxis and light intensity was found.

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