Jpn. J. Phycol. (Sôrui) **36**: 154–165, June 20, 1988

Spatial differences in *Cyclotella comta* populations in the Nishina-sanko Lakes, Nagano Prefecture, Japan

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MARUYAMA, K. 1988. Spatial differences in *Cyclotella comta* populations in the Nishina-sanko Lakes, Nagano Prefecture, Japan. Jpn. J. Phycol. **36**: 154–165.

The horizontal and seasonal variations in the cell size distribution and standing crops of *C. comta* populations on coastal surface water in the Nishina-sanko lakes were examined during 1972 and 1973. KOLMOGOROV-SMIRNOV two-sample test (KTT) in summer populations revealed that the subgroups have different distribution at 0.1, 0.5 and <0.1 per cent levels of significances in Lakes Aoki, Nakatsuna and Kizaki, respectively. The differences in population within each lake were, however, below that among lakes. The population in Lake Aoki exhibited a slight deviation from the normal trend and had a small size of location of distribution and higher cell density, while the case was the opposite in all the above aspects in Lake Kizaki. The populations in Lakes Nakatsuna and Aoki resembled each other in the form and location of distribution and the standing crop, because the water in Lake Aoki had direct effect upon the surface water in Lake Nakatsuna during summer. The cell size in summer populations in these three lakes was smallest as compared to that in other seasons. On the other hand, the standing crop, water temperature and electric conductivity were high.

*Key Index Words: Aoki Lake—cell size distributions—*Cyclotella comta*—horizontal changes—intraspecific variation—Kizaki Lake—local populations—Nakatsuna Lake—Nishina-sanko Lake—seasonal changes—spatial differences—standing crops.*

The plankton species flourish in open water bodies and often develop into blooms. Except a few situations, considerable inter- and intraspecific variations occur in their populations. The existence of intra-specific variation of plankton species has been suggested by KNUDSEN (1955 in ROUND, 1965), GUILLARD and RYTHER (1962), CARPENTER and GUILLARD (1971) and FISHER *et al.* (1973). The clones isolated by them may be part of a widespread population having a number of intergrading morphological and physiologiacl types, while the spatial differences and their expanses are still obscure (WIMPENNY, 1936, 1946, 1966; NAMIKI *et al.*, 1985) and not verified genetically.

Diatom *Cyclotella comta* (EHR.) KÜTZ. and its synonyms have been included in VAN LANDINGHAM (1969). The taxonomic position, the morphological biometrics, and ultrastructure of valves of this taxon have begun to receive some critical attention (PLANAS, 1972; LOWE, 1975; MAHOOD *et al.*, 1984; GENKAL, 1984). Fresh and slightly brackish water is the habitat of *C. comta* (AL-KAISI, 1974). *C. comta* exhibits one or two pulses in annual fluctuation (WEST and WEST, 1912; DORGELO *et al.*, 1981; FLIK, 1986) and appears in the latest diatom of phosphate-limited sequnece (DORGELO *et al.*, 1981; VAN DONK, 1984). Successional pathways in lakes of different trophic status are also generalized by RAYNOLDS (1984). The presence of this taxon indicates deep oligotrophic types of lakes (BRUGAM, 1983) and is found only in small numbers in mesotrophic lakes (HOLLAND and CLAFLIN, 1975; DORGELO *et al.*, 1981; JOHANSEN *et al.*, 1982; FLIK, 1986). In small manmade lakes rich

Table 1. The loccations, areas, and depths of the Nishina-sanko lakes (TANAKA, 1930; HORIE, 1956; HORIUCHI *et al.*, 1963)

Lake	Longitude	Latitude	Sea level (m)	Area (Km^2)	Maximum depth (m)	Mean depth (m)
Aoki	137°51′	36°37′	822	1.863	58.0	29.0
Nakatsuna	137°51′	36°36′	815	0.141	12.0	5.7
Kizaki	137°50′	36°33′	764	1.413	29.5	17.9

in nutrients, the cell number reaches 55×10^3/m*l* for *C. comta* and *C. stelligera* (TIEFENBRUNNER and ROTT, 1975).

The Nishina-sanko Lakes are situated in the east side of the Japan Alps. Mt. Sanozaka forms the watershed from where the Hime-kawa River flows to the north and the Nogu-gawa River in the Nishina-sanko valley southward. The locations, areas, and depths of the Nishina-sanko lakes are shown in Table 1 (TANAKA, 1930; HORIE, 1956; HORIUCHI *et al.*, 1963). Since 1954, the water depth in Lake Aoki has decreased markedly to a minimum depth of 37 m, because of the water-intake for the power plant. It would take about eight months to recover from a drop. Gradual decrease of transeparency from north to south in Lake Kizaki was also observed (HORIUCHI *et al.*, 1963). Lakes Aoki, Nakatsuna, and Kizaki have been defined as oligo-, eu-, and mesotrophic types, respectively by SAIJO (1956), YASUDA *et al.* (1975) and MAEDA and TOMIOKA (1977), while according to KITAGAWA (1973) Lakes Aoki and Kizaki belong to meso- and eutrophic types, respectively. *C. comta* group in the Nishina-sanko valley are described by HUSTEDT (1927), KAWAMURA (1928), SKVORTZOW (1936), KO-BAYASHI *et al.* (1971), and YASUDA *et al.* (1975).

Materials and Methods

Forty-one sampling stations were chosen along the shore, *viz.* 16 in Lake Aoki (Stations A1–A16), 10 in Lake Nakatsuna (Stations N1–N10), and 15 in Lake Kizaki (Stations K1–K15) (Figs. 1–3). Surface water samples were collected five times druing 1972–73 in 500 m*l* polyethylene bottles (November 4–5, 1972; December 10, 1972; January 3, April 2, and July 31 to August 1 or August 26, 1973). The pH and electric conductivity (EC) were measured by using both portable pH (Toa DM–1A) and EC (Toa CM–3M) meters.

For the estimation of the standing crops and cell size distributions, 30, 50, 100, 200 or 300 m*l* water samples were filtered through a membrane filter (Millipore RAWP 04700, 1.2 μm pore size and 47 mm diam.) reducing the pressure by using a miniature vacuum pump (Millipore XX61 00000), and cells on a filter fixed with a 10 per cent neutral formalin solution and stored in a petrislide (Millipore PD15 04700).

Population estimates were based on the cell counts of 10 to 70 block samples drawn at random from imaginary 910 occular quadrates and expressed as number of cells per m*l*. The means and the standard error of the means (SEM) were estimated. The diameter of the frustles were measured in 200 cells in each population by using a video-writer (FOR.A FVW300) connected to a computer (FM–11). The point and 95 per cent confidence interval of population means and medians, SEM, and the point and 90 per cent confidence interval of the standard deviation were estimated. KOLMOGOROV-SMIRNOV one sample test (KOT) for detecting the departure from normality, BARTLET's test (BT) for homogeneity of varinace, and KOLMOGOROV-SMIRNOV two sample test (KTT) for the detection of difference in form and location of distribution were also employed (BLISS, 1967; CAMPBELL, 1974).

Results

Environmental conditions: a. *Horizontal changes.* The water temperature, pH and EC of the surface water in Lake Aoki on July 31 are shown in Fig. 1. The water temperatures were 21.2 to 23.2°C, pH 6.8 to 7.4 (except 8.2 and 8.4 at stations 1 and 16 respectively), and EC between 31.0 and 33.0 μ mho/cm (except 38.0 μ mho/cm at station 16).

The water temperatures (°C) in Lake Nakatsuna were 12.5 to 12.6 (except 13.0 at station 6), 6.3 to 6.8 (except 5.7 at station 6), 3.3 to 3.7, 4.4 to 6.0, and 23.2 to 23.8 (except 21.7 and 24.4 at stations 6 and 7 respectively), on Nov. 4, Dec. 10, Jan. 3, Apr. 2, and Aug. 1, respectively (Fig. 1). The water temperatures were almost the same at fixed times, except slight deviation found at stations 6 and 7 and a contrast between east and west shores on April 2. The pH was 6.8 to 7.2, 6.8 to 7.4, and 6.2 to 8.0 on Nov. 4, Dec. 10 and Aug. 1, respectively. The pH on Aug. 1 largely depends on the station. In other seasons the values were fairly neutral. The EC (μ mho/cm) were 30.0 to 34.0, 27.5 to 29.0 (except 35.0 at station 6), 28.0 to 31.0 (except 41.0 at station 6), 29.0 to 34.0, and 35.5 to 38.0 (except 33.0 at station 6) at five different times. The EC were constant, although the value at station 6 deviated from the rest and fluctuated considerably on April 2. The Upper-Nogu-gawa River which flowed out from Lake Aoki drains into the station 6 in Lake Nakatsuna. The flow ceased from Dec. to July.

Fig. 1 also shows the situation in Lake Kizaki on August 26. The water temperatures were 25.3 to 26.8°C , pH 6.8 to 7.1 (except 6.4 at station 2), and EC 45.0 to 48.0 μ mho/cm (except 59.0 at station 2), which did not change with the station markedly except station 2.

Fig. 1 further shows the water temperature, pH, and EC at different times at the stations 10 and 12 in Lakes Aoki and Kizaki, respectively. The water temperatures (°C) were 12.6, 4.8, 5.9, and 21.6 on Nov. 5, Jan. 3, Apr. 2, and Jul. 31, respectively in Lake Aoki, and 12.9, 6.0, 7.1, and 25.5 on Nov. 5, Jan. 3, Apr. 2, and Aug. 26, respectively in Lake Kizaki. The pH was 7.6 and 6.8 on Nov. 5 and July 31, respectively in Lake Aoki, and 7.4 and 7.0 on Nov. 5 and Aug. 26, respectively in Lake Kizaki. The EC (μ mho/cm) at the same dates mentioned in the case of water temperature were 30.0, 26.0, 23.0, and 32.0 respectively in Lake Aoki, and 32.0, 27.0, 26.0, and 46.0 in Lake Kizaki. The water temperatures at Lake Nakatsuna at the same dates mentioned above were −0.1 to 0, −1.1 to −1.5, −1.5 to 0.1 and 1.6 to 2.2°C higher respectively than those in Lake Aoki. EC at the same dates were respectively 0 to 4.0, 2.0 to 5.0, 6.0 to 11.0, and 3.5 to 6.0 μ mho/cm higher in Lake Nakatsuna than those in Lake Aoki. The water temperatures at the same dates in Lake Kizaki was 0.3, 1.2 and 1.2°C higher than those of Lake Aoki. The EC in the same series were 2.0, 1.0, and 3.0 μ mho/cm higher in the former lake than those in the latter. As for the pH, there was no appreciable difference between these three lakes.

b. *Seasonal changes.* The seasonal changes of the water temperature, pH, and EC at stations 10 and 12 in Lakes Aoki and Kizaki, respectively, and all the stations in Lake Nakatsuna are shown in Fig. 1. In Lakes Aoki and Kizaki, the temperature dropped through Nov. to Jan. and rose through Apr. to Jul. or Aug., and the EC decreased from Nov. through Jan. to Apr. and increased in Jul. or Aug. In Lake Nakatsuna, situation of the temperature was similar to that in Lake Aoki. The pH remained unchanged except in Aug. and the EC was the minimum in Dec. and increased reaching a maximum in Aug.

Population density: a. *Horizontal changes.* Fig. 2 depicts the cell population at each station in Lake Aoki on July 31, showing a rather uniform number from 1155 ± 37 to 2139 ± 34 cells/m*l*. Relatively large num-

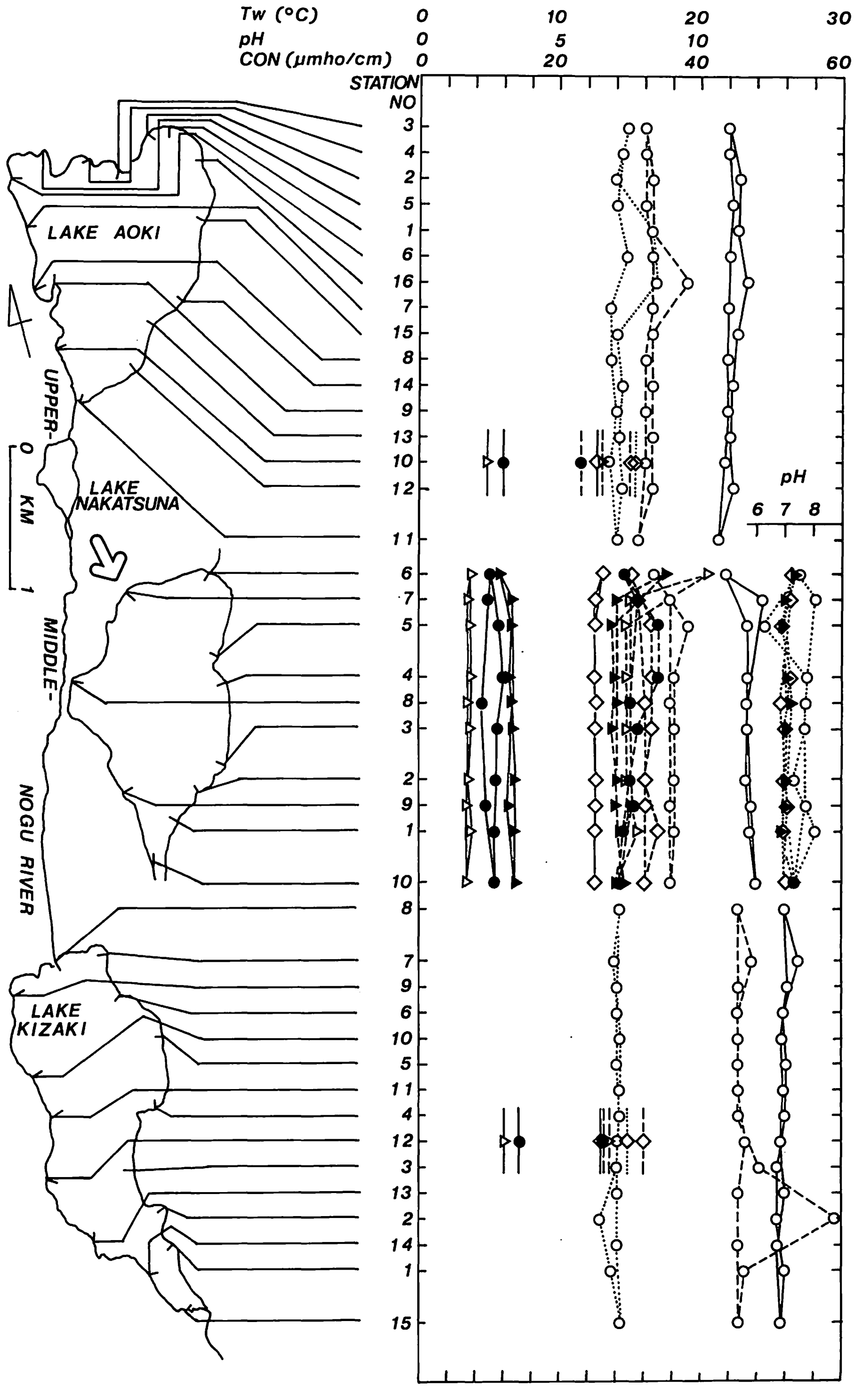

Fig. 1. Sampling locations and the horizontal and seasonal changes of the water temperature (solid line), pH value (dotted line), and electric conductivity (dashed line) of the surface water in the Nishinasanko lakes on November 4–5 (open diamond), December 10 (solid triangle), January 3 (open triangle), April 2 (solid circle), and July 31 to August 1 (Lakes Aoki and Nakatsuna) and August (Lake Kizaki) (open circle), 1972 to 1973.

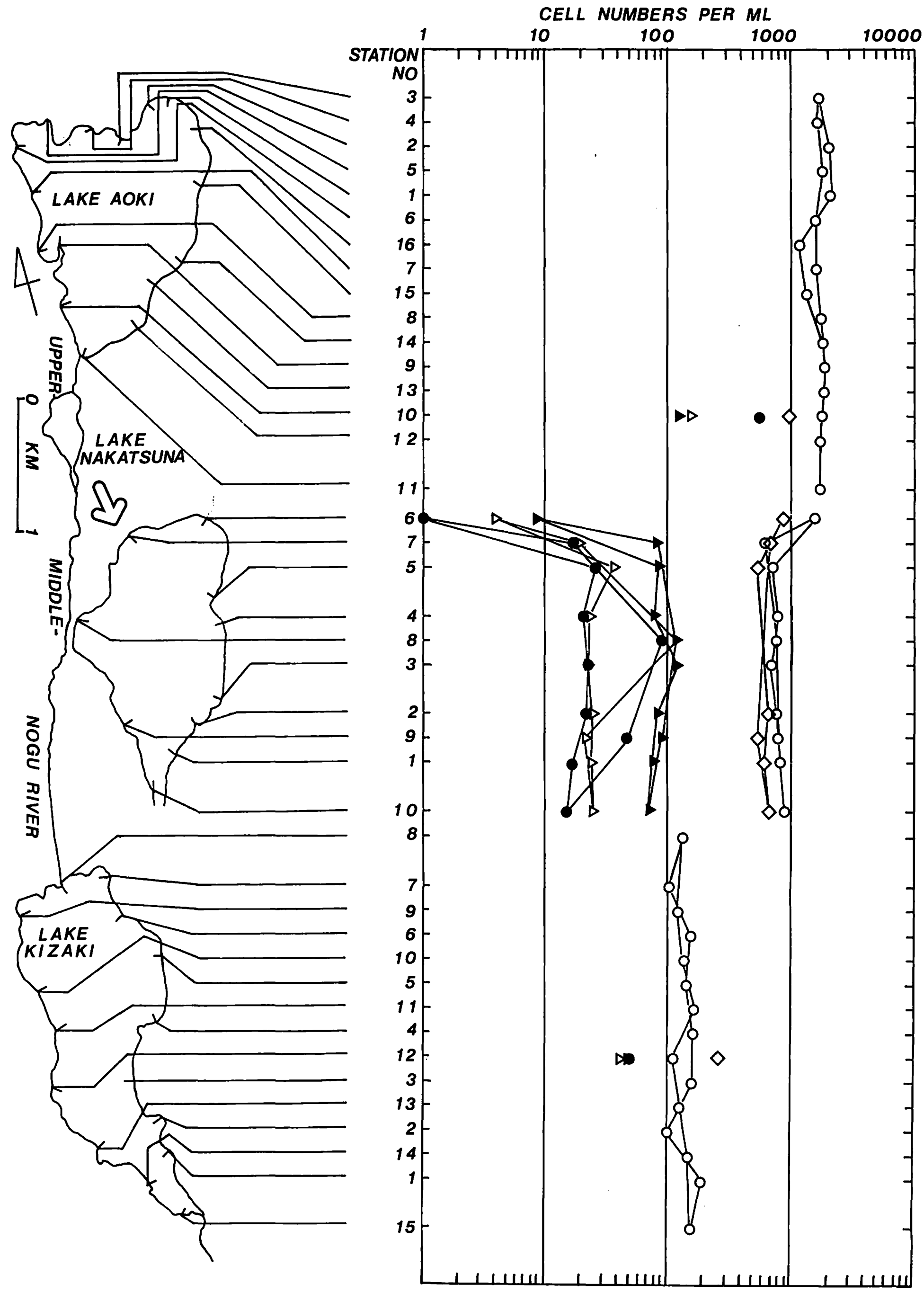

Fig. 2. Sampling locations and the horizontal and seasonal changes of the population density in surface water in the Nishina-sanko lakes on November 4–5 (open diamond), December 10 (solid triangle), January 3 (open triangle), April 2 (solid circle), and July 31 to August 1 (Lakes Aoki and Nakatsuna) and August 26 (Lake Kiazaki) (open circle), 1972 to 1973.

bers of cells (2088 and 2139 cells/m*l*) at stations 1 and 2 of north-northeastern shore, and small numbers (1155 and 1357 cells/m*l*) were observed at stations 16 and 15 of northeast-eastern.

The time-course of population density in Lake Nakatsuna is also shown in Fig. 2. At the five different sampling times, the cell numbers were 536 to 676 (655±23 at station 10)/m*l* (except 856 at station 6), 70 to 120 (70±3 at station 10)/m*l* (except 9 at station 6), 19 to 37 (25±2 at station 10)/m*l* (except 4 and 116 at stations 6 and 8 respectively), 15 to 26 (15±2 at station 10)/m*l* (except 1, 47 and 89 at stations 6, 8 and 9 respectively), and 624 to 891 (891±24 at station 10)/m*l* (except 1582 station 6). The cell number at station 6 deviated from the uniform number and increased in Nov. and Aug., but decreased in Dec., Jan. and Apr.. The Upper-Nogu-gawa River flowed out from Lake Aoki and drained into station 6 in Lake Nakatsuna, and the flow ceased from Dec. to July. Deviations were also toward large at stations 8 and 9 on April.

Fig. 2 also shows the situation in Lake Kizaki on August 26. The cell numbers in all stations ranged from 100±6 to 191±6/m*l*. The minimum and maximum numbers were observed at stations 1 and 2 respectively.

Fig. 2 also depicts the cell population at five different times of collection at stations 10 and 12 in the Lakes Aoki and Kizaki, respectively. The cell number per m*l* was 951±47, 123±5, 154±9, 545±29, and 1843±80 on Nov. 5, Dec. 10, Jan. 3, Apr. 2, and Jul. 31, respectively in Lake Aoki and 261±16, 49±3, 41±3, 50±5, and 111±6 on Nov. 5, Dec. 10, Jan. 3, Apr. 5, and Aug. 26, respectively in Lake Kizaki. The cell densities in Lake Kizaki at the same dates were respectively 690, 74, 113, and 495 cells/ml lower than those in Lake Aoki. At the same dates, the cell densities at Lake Nakatsuna were 257 to 415, 3 to 53, 117 to 135, 519 to 530, and 952 to 1219 cells/ml lower than those in Lake Aoki.

b. *Seasonal changes*. The seasonal changes in cell number at stations 10 and 12 in Lakes Aoki and Kizaki, respectively and at all the stations in Lake Nakatsuna can also be seen in Fig. 2. The population density in Lake Aoki decreased from Nov. to Dec.–Jan. and then increased through Apr., reaching a maximum of 1843 cells/m*l* on July. In Lake Kizaki, the density decreased from the maximum of 261 cells/m*l* in Nov. to Dec., Jan. and Apr. and then increased by Aug. In Lake Nakatsuna, the density decreased from Nov. through Dec. to Jan. and Apr., then increased and reached the maximum of 624 to 891 cells/m*l* on August.

Cell size distributions of the populations. a. *Horizontal changes*. The frequency distributions of living cell diameter of each population in Lake Aoki on Jul. 31 were different from each other in form, positive skew or symmetry, and location. KOT

Table 2. The observed largest differences of Kolmogorov-Smirnov one-sample test (KOT) for detecting the departure from nomality in the Nishina-sanko lakes in summer. In these cases the value for 5 per cent significance is 0.0964. If the difference exceeds this value the distributions cannot reasonably be regarded as normal.

Lake Aoki		Lake Nakatsuna		Lake Kizaki	
Station No.		Station No.		Station No.	
3	0.1001	6	0.0931	8	0.0612
4	0.0817	7	0.1142	9	0.0584
5	0.0957	8	0.1099	10	0.0604
6	0.0879	9	0.0877	11	0.0820
7	0.0999	10	0.1011	12	0.0638
8	0.0884	5	0.0711	13	0.0726
9	0.0629	4	0.0935	14	0.0603
10	0.0708	3	0.1439	15	0.0677
11	0.0642	2	0.1096	7	0.0497
2	0.0954	1	0.1037	6	0.0593
1	0.0762			5	0.0477
16	0.0622			4	0.0705
15	0.0749			3	0.0575
14	0.0656			2	0.0631
13	0.0777			1	0.0604
12	0.1003				

was used for detecting the departure from normality of the observed distribution. The largest value of the differences in each population are shown in Table 2. Since the observed differences exceed or are close to the value of 0.0964 for 5 per cent significance, the distributions cannot reasonably be regarded as normal at many stations. Thus it is inadequate to compare the population means. Fig. 3 expresses the point and interval estimates of population medians in Lake Aoki. The population medians and their 95 per cent confidence limits were 9.88 (9.59, 10.14) to 10.67 (10.41, 11.01) μm as shown in Fig. 3. The population medians increased in the following order: stations 2, 12, 5, 3, 1, 10, 13, 7, 15, 9, 11, 4, 6, 8, 14, and 16. Table 3 shows the values of KTT in Lake Aoki by combining the population medians of stations arranged in ascending order. The KTT values over 5 per cent level of significance are indicated by a quadrate. In this case, the populations at stations 7, 15, 11, 4, and 6 were the same as others; those at stations 13 and 9 were different from station 14 only; those at stations 5 and 3 were different than the populations at station 16. The population at station 1 was different from those of station 8 and station 16. The populations at stations 2, 12 and 10 were greatly different. The populations at stations 8, 14, and 16 had the highest population medians, ranging from 10.56 to 10.67. The difference in the distribution at 0.1 per cent level of significance was found by KTT between stations 2 and 16.

The frequency distributions of living cell diameter in Lake Nakatsuna on Aug. 1 were rather positively skewed. The observed values of KOT exceeded at stations 1–3, 7, 8 and 10 and most distributions differed from normal. The population medians and their 95 per cent confidence limits were 9.37 (9.07, 9.86) to 10.01 (9.63, 10.36) μm as shown in Fig. 3. The population medians in summer increased in the following order: station 8, 7, 10, 6, 3, 9, 2, 1, 4, and 5. The differences in the distribution at 0.5 per cent level of significance were recognized by KTT between the population at station 8 and that at station 2. The population medians (μm) in other seasons were 10.88 (10.65, 11.21) to 11.21 (10.66, 11.48) except 11.59 (11.21, 12.07) at station 6, 11.30 (10.97, 11.79) to 11.76 (11.32, 12.10), and 10.99 (10.67, 11.25) to 11.66 (11.42, 12.04) on Nov. 4, Dec. 10, and Jan. 3, respectively (Fig. 3).

The frequency distributions in Lake Kizaki on Aug. 26 were rather symmetric. The observed differences of KOT were lower than 0.0964 for 5 per cent significance and the distributions are hence normal. The BT for homogeneity of variance was taken in this case. The observed value was 61.720 and higher than 24.996 for 5 per cent probability, hence the comparison of population mean was not feasible here. The population medians and their 95 per cent confidence limits were 10.43 (10.26, 10.98) to 11.48 (11.21, 11.73) μm as shown in Fig. 3. The population medians increased in the order, stations 11, 4, 14, 13, 7, 15, 8, 10, 6, 9, 5, 3, 12, 1, and 2. The difference in the distribution at <0.1 per cent level of significance were determined by KTT. Small population medians were observed in stations 4, 14 and 15 and others having large ones were stations 14 and 2.

Fig. 3 also depicts the population medians at five different times at stations 10 and 12 in Lakes Aoki and Kizaki, respectively. The median (μm) was 11.44, 11.75, 11.27, 10.95, and 10.12 on Nov. 5, Dec. 10, Jan. 3, Apr. 2, and Jul. 31, respectively in Lake Aoki and 11.36, 12.28, 12.01, 11.61, and 10.97 on Nov. 5, Dec. 10, Jan. 3, Apr. 5, and Aug. 26, respectively in Lake Kizaki. The median at the same times in Lakes Kizaki was −0.08, 0.53, 0.74, and 0.66, higher than that in Lake Aoki. The downgrades, such as a head (μm) of 0.23 to 0.56, −0.01 to 0.45, −0.39 to 0.28, and 0.11 to 0.75 in the same series, were indicated in Lakes Nakatsuna and Aoki. In Lake Kizaki, the medians were higher in all

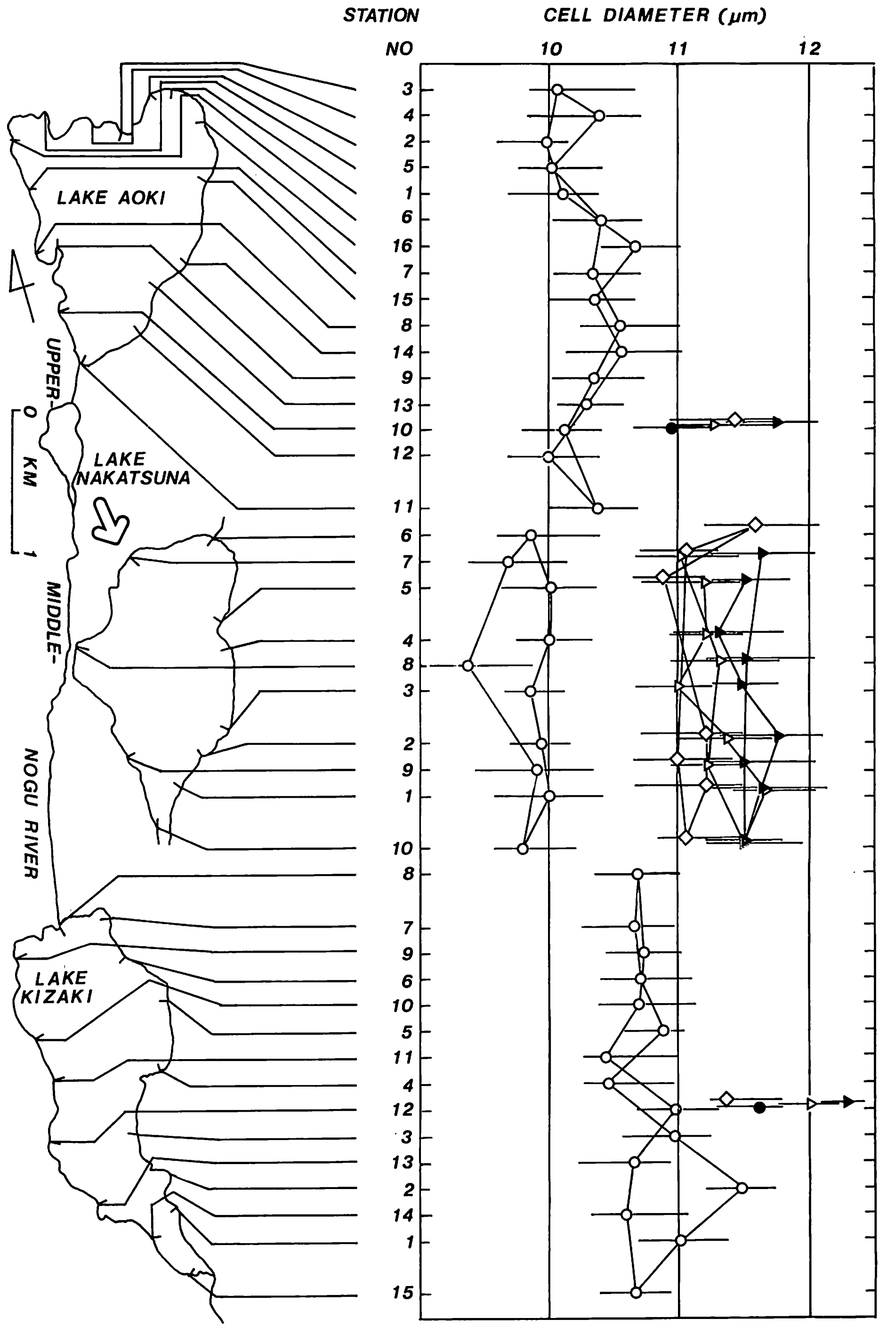

Fig. 3. Sampling locations and the horizontal and seasonal changes of the point and interval (bold line) estimates of population medians of cell diameter in the Nishina-sanko lakes on November 4–5 (open diamond), December 10 (solid triangle), January 3 (open triangle), April 2 (solid circle), and July 31 to August 1 (Lakes Aoki and Nakatsuna) and August 26 (Lake Kizaki) (open circle) from 1972 to 1973.

Table 3. The observed largest differences of KOLMOGOROV-SIMIRNOV two-sample test (KTT) in Lakes Aoki (upper), Nakatsuna (middle), and Kizaki (lower) in summer by combining the population medians of stations arranged in ascending order. In the present case the significance at 10, 5, 2.5, 1, 0.5 and 0.1 per cent level are 0.122, 0.136, 0.148, 0.163, 0.173 and 0.195, respectively. At various levels of significance two populations cannot reasonably be regarded as having the same distribution. The values over 5 percent level of significance are indicated by a quadrate.

ST	16	14	8	6	4	11	9	15	7	13	10	1	3	5	12
2	**.195**	**.175**	**.165**	.135	.125	.115	.120	.115	.120	.125	.060	.050	.095	.080	.070
12	**.180**	**.140**	**.140**	.105	.095	.085	.095	.090	.090	.090	.055	.050	.060	.095	
5	**.160**	.125	.135	.090	.090	.080	.090	.100	.130	.095	.110	.095	.090		
3	**.150**	.100	.120	.085	.055	.055	.085	.085	.075	.080	.075	.070			
1	**.170**	.135	**.150**	.105	.105	.090	.100	.115	.120	.080	.040				
10	**.185**	**.140**	**.140**	.115	.095	.080	.110	.110	.115	.075					
13	.130	**.145**	.130	.110	.105	.100	.065	.085	.120						
7	.110	.070	.065	.070	.055	.085	.120	.110							
15	.130	.120	.105	.085	.080	.070	.065								
9	.115	**.150**	.125	.090	.095	.080									
11	.135	.095	.085	.080	.050										
4	.120	.070	.110	.070											
6	.080	.075	.065												
8	.075	.065													
14	.095														

ST	5	4	1	2	9	3	6	10	7
8	.125	**.155**	.135	**.165**	.110	.135	**.150**	.130	.110
7	.080	.090	.075	.095	.065	.075	.080	.060	
10	.065	.075	.090	.080	.070	.055	.070		
6	.070	.055	.075	.065	.080	.070			
3	.060	.050	.080	.055	.060				
9	.050	.075	.085	.100					
2	.065	.045	.075						
1	.085	.060							
4	.055								

ST	2	1	12	3	5	9	6	10	8	15	7	13	14	4
11	**.220**	.115	.110	.090	.090	.070	.065	.070	.055	.120	.050	.075	.060	.055
4	**.215**	**.140**	.105	.090	.085	.075	.060	.070	.075	.135	.065	.055	.075	
14	**.200**	**.150**	.110	.105	.075	.080	.075	.095	.080	.080	.065	.100		
13	**.210**	.130	.100	.095	.085	.060	.065	.075	.075	**.160**	.090			
7	**.200**	.110	.115	.105	.070	.095	.055	.060	.055	.085				
15	**.230**	**.145**	**.165**	**.155**	.095	**.140**	.115	.115	.110					
8	**.185**	.095	.090	.075	.060	.080	.075	.050						
10	**.170**	.080	.080	.060	.050	.050	.060							
6	**.185**	.130	.095	.075	.060	.065								
9	**.185**	.120	.080	.065	.070									
5	**.175**	.105	.085	.080										
3	.130	.075	.050											
12	.125	.070												
1	.115													

Table 4. The population means and their 95 per cent confidence limis, the standard errors of the means (SEM), and the standard deviations (SD) and their 90 per cent confidence limits in the Nishina-sanko lakes in summer, 1973. Table 4 also shows the population minimum (MIN) and maximum (MAX) in summer.

	Cell diameter (μm)				
	Mean	SEM	SD	MIN	MAX
L. Aoki	10.22 (9.95, 10.49)	0.12	1.70(1.57, 1.85)	5.81	15.92
	−10.91(10.63, 11.19)	−0.15	−2.11(1.95, 2.31)	−7.41	−19.68
L. Nakatsuna	9.89 (9.62, 10.16)	0.13	1.80(1.99, 2.35)	6.15	15.59
	−10.35(10.16, 10.61)	−0.15	−2.15(1.99, 2.35)	−7.12	−19.75
L. Kizaki	10.65(10.37, 10.93)	0.12	1.59(1.47, 1.74)	6.29	14.93
	−11.47(11.22, 11.72)	−0.14	−2.05(1.89, 2.23)	−7.72	−23.79

seasons except Nov. compared with those in Lakes Aoki and Nakatsuna (except station 6).

Other estimates such as the population means and their 95 per cent confidence limits, the standard errors of the means, and the standard deviations and their 90 per cent confidence limits in three lakes in summer are shown in Table 4, which also shows the population minimum and maximum. The range of the valve diameter in the present study was 5.61 to 24.33 μm.

b. *Seasonal changes.* At all the stations in Lakes Aoki, Nakatsuna and Kizaki the population medians increased from Nov. to a maximum in Dec. or Jan., followed by a decrease to a minimum in summer (Fig. 3).

Discussion

A wide range of variation in the valve diameter exists among the different ecotypes of *C. comta*. The type species *C. comta* has been reported to have valves of 1/96‴ (Kützing, 1849), 15 to 50 μm (Hustedt, 1930), 8 to 16 μm (Planas, 1972) or 14 to 20 μm diam. (Al-Kaisi, 1974). The range is 9–17.5 μm (n=15) in var. *comta* and 21.2–53 μm (n=13) in var. *glabriuscula* (Genkal, 1984). *C. comta* var. *paucipunctata* Grun. from Lake Aoki is described by Hustedt (1927) and Skvortzow (1936). This variety differs markedly from the type species in its central area with scattered beads forming a star. Skvortzow (1936) described a new form of *C. comta* (f. *parva*) from Lake Kizaki, based on its smaller valve size of 4.2 to 6 μm, but this form is a synonym of the type (Van Landingham, 1969). The populations in the present study showed a range from 5.61 to 24.33 μm. The specimens in the Nishina-sanko valley are either a local population having small valve or the type recorded by Planas (1972), Al-Kaisi (1974) and Genkal (1984).

The population at station 16 in Lake Aoki showed structural and ecological peculiarities in the difference at low level of significance by KTT, the largest location of distribution, and the minimum population density. The water in this station also had maximum temperature, pH, and EC. In Lake Kizaki the population at station 2 has similar characteristics.

Although there was such a peculiar population in each lake, the difference in cell size distributions as well as in population densities and in environmental conditions within lakes were below that among lakes. In Lake Aoki, *C. comta* population on coastal surface water in summer was exhibited slight deviation from normal trend, smaller location of distribution and higher standing crop and it had a relatively low water temperature and EC, while it was the opposite in Lake Kizaki.

The form and location of cell size distribution in this diatom seemed to depend on the population density. The positive skew form, slight deviation from normality, and smaller location in distribution might be due to cell division specific to diatoms.

The existance of *C. comta* indicates deep, low phosphorus, high transparent (BRUGAM, 1983), oligotrophic (HOLLAND and CLAFLIN, 1975) types of lakes. As the lake became enriched *C. comta* decreased (LUND in HOLLAND and CLAFLIN, 1975). In the mesotrophic lake, the number of *C. comta* was low (DORGELO *et al.*, 1981; JOHANSEN *et al.*, 1982; VAN DONK and RINGELBERG, 1983; FLIK, 1986). Lakes Aoki and Kizaki correspond to the former and the latter, respectively.

A structural and ecological similarity was found between the populations in Lakes Nakatsuna and Aoki. The water in Lake Nakatsuna which is a small river-lake is affected considerably by Lake Aoki close to it (SAIJO, 1956). The water temperature was lowered by the inflow of water in summer (TANAKA, 1930). The water in Lake Kizaki registered the highest temperature among the three lakes in summer because the water stayed long in the large and long river-lake. The upper temperature limit might also influence the growth of *C. comta*, other than eutrofication.

Differences in population densities and in environmental conditions could be seen among the lakes. They are constant in large areas and unique in each lake, as against the structural differences in cell size ditsributions. *C. comta* seems to be sensitive to environmental condition. Abundance of the cells appears in a limited sphere such as deep oligotrophic lakes. This seems to be a general global pattern. But the direct relation between environmental condition and cell number as well as cell size cannot be fixed. The intraspecific variation of this taxon will become clear by further studies on its population dynamics in other lakes, mating frequency, fine structure and biochemical characters.

Acknowledgement

The author wishes to acknowledge Dr. G.S. VENKATARAMAN, Indian Agricultral Research Institute, for his critical reading of the manuscript.

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丸山 晃：仁科三湖における *Cyclotella comta* 集団の地域的な差異

1972-3年，仁科三湖の沿岸部41地点の表層水資料を用いて，*Cyclotella comta* 集団の細胞サイズ分布，現存量などの地域差と季節的変化が調べられた。細胞サイズは，三湖とも夏期に最小となる。KOLMOGOROV-SMIRNOVの二試料検定により，この小型集団には，青木，中綱，木崎三湖で，それぞれ有意水準0.1，0.5，<0.1%で，細胞サイズ分布の湖沼内差異が見出された。しかし，この湖沼内差異は，湖沼間差異を越えない。青木湖の集団は，細胞サイズ分布の正規性が低く，分布域が小さい側にあり，高い現存量をもつ。これに対して，木崎湖では，正規性の高い，大きい側にずれた，密度の著しく低い集団からなる。中綱湖の集団は，かなり青木の湖水の影響を受けているとみられ，分布の形と位置や現存量が似ている。*C. comta* をとりまく環境の湖沼内，湖沼間差についても言及される。（113 東京都文京区彌生1-1-1 東京大学応用微生物研究所）