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Determination of Oxygen, Carbon Dioxide and pH of Dal Lake Kashmir

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Abstract
In a 5-month experiment on Dal Lake kashmir, Water temperature (10.4e10.6(C), pH (7.2e7.4) and oxygen concentration (8e10 mg l_1) were similar among other sites with little difference. Concentration of total ammonia nitrogen (TAN) was similar among groups for the first half of the experiment (0.3e0.4), but during the last month it was 0.6, 1.3, and 1.5 mg l_1 in Groups1, 2, and 3, respectively. There was a negative correlation (r2 ¼ 0.48, n ¼ 36) between relative growth rate and TAN, suggesting that ammonia may have been a limiting factor in there circulating system. The apparent threshold limit of TAN for reduced growth wasapproximately1 mg l_1.

Keywords: ammonia, CO2, nitrate, nitrite, oxygen, pH

1. Introduction
The valley of Kashmir is a land of lakes, rivers, springs and fast running streams. The important ones being the Wullar Lake, the enchanting Dal Lake, The Manasbal lake, The Anchar lake, The Nigeen lake, The Jhelum river, Snow fed streams like the Sind stream, The Lidder, The Erin and The Madumati. Other important streams include Hirpora, Hambiara stream, Naristan stream, Lam stream, Aripal stream, Chandriara, Shilon Stream, Budkul Stream, Watal Ara Stream, Khrew Stream, Wuyun Stream, Mohand Ara Stream, and Romeshi Stream in district Pulwama. Sukhnag, Dudh Ganga and Shallinga in district Budgam and Pohru, Kishanganga, Nallah Kehmil, Nallah Lolab, Nallah Kallaroos, Machil Nallah Bata Maji, Nallah Qazinag, Talri Nallah, Mawar and Dringyari in district Kupwara.

The fresh water bodies, whether lotic or lentic provide a great seasonal diversity in their physical, chemical and biological conditions from season to season. The vast stretches of inland waters support many and varied forms of fresh water life including fish. Water in the water bodies of Kashmir is cold, crystal clear and provide habitat for peculiar type of fish fauna. Fishes being one of the most important protein constituents of diet. In fact 62-68% people of the valley obtain their protein from this source. The fish fauna in the valley is peculiar in having the dominance of *Schizothorax*. Because of the geographical barriers the *Schizothorax* group has evolved a number of endemic species in the valley. *Schizothorax* is commonly known as “Snow Trout” because it inhabits the snow fed streams and rivers of Kashmir valley where temperature ranges from 10-18°c. It is a delicate fish which loves cold, well oxygenated and pollution free waters.

Table 1. Temperature (T, (C), oxygen (O2, mgl_1), pH, and total suspended matter (TSM, mg l_1) at various sites.

		Group 1			Group 2			Group 3		
		Site 1	site 2	site 3	site 4	site 5	site 6	site 7	site 8	site 9
T (8:00e9:00)	N	126	126	126	126	126	126	126	126	126
	Mean	10.4	10.4	10.4	10.5	10.6	10.5	10.6	10.6	10.6
	S.D.	1.5	1.6	1.6	1.3	1.3	1.3	1.3	1.3	1.4
O2 (8:00e9:00)	N	133	133	133	133	133	133	133	133	133
	Mean	10.3	9.1	9.7	8.9	8.9	8.8	7.9	8.5	8.5
	S.D.	2.7	2.0	2.7	0.8	0.8	0.8	0.9	1.1	1.2
O2 (16:00e17:00)	N	37	37	37	37	37	37	37	37	37
	Mean	10.4	8.3	8.4	8.5	8.6	8.2	7.4	8.2	8.0
	S.D.	3.4	1.4	1.8	1.0	0.7	0.8	1.0	1.4	1.3
PH (16:00e17:00)	N	40	40	40	40	40	40	40	40	4
	Mean	7.3	7.5	7.4	7.3	7.4	7.3	7.2	7.2	7.
	S.D.	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.4
TSM (8:00e10:00)	N	3	3	3	3	3	3	3	3	3
	Mean	3.8	3.9	4.5	3.4	3.6	4.5	4.2	4.1	4.1
	S.D.	1.1	0.1	1.0	1.1	1.4	2.0	0.9	1.4	1.4

The mean temperature was only slightly lower in Group1 (10.4(C) than in the other two groups (10.6(C) (Table 3).The mean oxygen concentration measured in the morning than in Group 2 (8.9 mg l_1, 99% saturation) and in-Group 3 (8.3 mg l_1, 93% saturation). Owing to the slow flow rate of running water water in Group 1, it was difficult to regulate the oxygen concentration in those tanks, resulting in a more variable concentration than in the tanks that were part of their circulating system. The mean oxygen values from late afternoon were slightly lower than the morning values:9.0 (100% saturation), 8.4 (94% saturation), and 7.9 mg l_1(88% saturation) for Groups 1, 2, and 3,respectively (Table 3).There was only a minor difference in mean pH between the groups: 7.4, 7.3, and 7.2 for Groups 1, 2, and 3, respectively (Table 3).Total suspended matter was low in all tanks(2e7 mg l_1) (Table 3).On the first two sampling dates, total ammonia nitrogen(TAN) was low and similar for all three groups,0.3 mg l_1, but the difference between groups increased in the three final sampling dates (Figure 3a). The highest mean values measured on the fourth sampling date (15May) were 0.7, 1.4, and 1.6 mg l_1 in Groups 1, 2, and 3,respectively.The TAN concentrations were slightly lower on the final sampling date(June 3). The average of the measurements from 15 May and 3 June was used to represent the TAN during the final growth period (8 May to 11 June):0.6, 1.3, and1.5 mg l_1 in Groups 1, 2, and 3, respectively. The concentration of nitrite was always much lower in Group 1 than in Groups 2 and 3, but no difference existed between Groups 2 and 3 (Figure 3b). In all the groups, there was a rapid increase in nitrite concentration with time, reaching a peak on the third sampling date, followed by a decline. The concentration of nitrate always remained low in Group 1 (<0.2 mg N l_1), but was high in Groups 2 and 3on the first three sampling dates (4.7 mg Nl_1), followed by gradual decline until the end of the experiment (Figure 3c).The high concentration of nitrate in the recirculation system relative to TAN and nitrite suggests that the two profilers were functioning reasonably well. In the flow-through system, almost no nitrate was produced, but there was a substantial amount of nitrite produced, perhaps by bacteria living on the surface of the rearing tanks, aided by the long residence time of the water (471 min) (Bjo¨rnsson, 2004) [7]. The large increase in TAN and the large decrease in the concentration of nitrite and nitrate during the latter part of the study (Figure 3) may have been caused by a reduction in the efficiency of the biofilters (perhaps due to excessive cleaning). Concentration of CO2 increased with time in all three groups (Figure 3d), mainly because of an increase in fish biomass. CO2 was lowest in Group 1 (from 3.6 to 8.7 mg l_1) and highest in-Group 3 (from 7.5 to 13.4 mg l_1).There was a highly significant negative correlation (r2 ¼ 0.48, n ¼ 36, p < 0.001) between relative growth rate and TAN, ranging from 0.2 to 1.6 mg l_1 (Figure 4).The relationship suggests that Schizothorax niger are sensitive to ammonia concentrations above 0.7 mg N l_1. However, the threshold limit for reduced growth must be somewhat higher, since these were morning values, which must below than evening values (Burel *et al.*, 1996) [14]. In the regression analysis, only values from growth periods 2e5were used (Table 2b), since no water samples were taken during the first growth period. There was also a significant negative correlation between relative growth rate and nitrite concentration (r2 ¼ 0.27, n ¼ 36, p < 0.01).

2. Discussion

Poor water quality may have resulted in lower mean weight in the recirculation system (Groups 2and 3), than in the flow-through system (Group 1). This was true even in the first growth period, when stocking density in the high density group was still low (15 kg m_3). Ammonia concentration was not measured during the first growth period, but it may have been high in Groups 2 and 3, while the bio filters were starting up. Furthermore, there was not a significantly lower mean body weight in the high density group than in the low density group in the recirculation system until the conclusion of the experiment, when stocking density in Group 3 had reached 48 kg m_3. During the length of the experiment, the mean weight gain was only10.2% lower in Group 3 than in Group 2. As total ammonia nitrogen (TAN) in the final growth period was 11.9% lower in Group 2 than in Group 3, it is possible that this slight difference in growth rate was caused by a difference in water quality rather than stocking density. Over the course of the experiment, the gain in mean weight was 22.3% lower in Group 2 than in Group1. Presumably, this was caused by a difference in water quality, perhaps as result of the difference in TAN which, in the final growth period, were 0.6, 1.3, and1.5 mg l_1 in Groups1, 2, and 3, respectively. All water samples were taken in the morning, just before the first-feeding, and as a result of the daily feeding routines, all measurements of nutrients must be minimum values (Burel *et al.*, 1996) [14]. Diurnal changes in TAN were not measured in this experiment. However, in similar experiment with Schizothorax niger in high-quality running water (W¼ 160 g, T ¼7.1(C, pH ¼ 7.2, feeding times: 9:30e10:30 and 15:30e16:30), TAN was lowest (0.406 mg l_1) at 12:00 and highest (0.587 mg l_1) at 24:00 (unpublished results). Thus, it is likely that the midnight TAN values in the final growth period may have been approximately 0.9, 1.9, and 2.2 mg l_1 in Groups1, 2, and 3, respectively. The negative correlation between relative growth rate and TAN indicates that ammonia concentration may have been a limiting factor of growth in the study. As the diurnal changes in TAN were not measured, it is not possible to estimate with great accuracy the threshold limit for reduced growth from the present results, but it may have been close to 1 mg l_1 TAN, which corresponds to about0.003 mg NH3-N l_1 at 10.5(C and pH 7.2 (Bower and Bid well, 1978; Spotte, 1979; Johansson and Wedborg, 1980). A truly safe, maximum acceptable concentration of un-ionized, or of total ammonia, for fish culture systems is not known (Meade, 1985). However, as general rule, warm-water fish are more tolerant of ammonia toxicity than coldwater fish, and freshwater fish are more tolerant than saltwater fish (Timmons *et al.*, 2002) [45]. For trout, it has been recommended that TAN be kept below 1 mg l_1inrecirculating systems (Timmons *et al.*, 2002) [45].

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