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Species Composition and Abundance of Aquatic Oligochaetes in Ihalagama Reservoir, a Shallow Perennial Minor Reservoir in Sri Lanka

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Abstract

Benthic oligochaetes were sampled from Ihalagama reservoir, Sri Lanka from May 1993 to April 1994 and examined together with the environmental characteristics of the reservoir. Oligochaete fauna in the reservoir was represented by two species of aelosomatids and eight species of naidids. The naidids, *Dero zeylanica*, *Pristina longiseta* and *Nais communius* were the dominant oligochaete species. Abundance of total oligochaetes was positively correlated with pH, dissolved oxygen and nitrate levels of the bottom water and silt content of the bottom sediment ($p < 0.05$). Nitrate levels of the bottom water showed significant positive correlations with the abundance of most of the oligochaete species than the other measured environmental parameter in the reservoir. Species composition and densities of oligochaetes and low levels of organic pollution indicative parameters of Ihalagama reservoir indicate that the reservoir has not been subjected to severe organic pollution in comparison to highly polluted water bodies in Sri Lanka.

Introduction

The composition and abundance of benthic organisms in water bodies are closely related to the quality of waters (Mackenthum 1966). Oligochaetes are one of the main invertebrate groups inhabiting the benthic sediments of the aquatic environments. Some aquatic oligochaete species, especially the tubificids tolerate eutrophy and organically polluted water and are used as biological indicators of water pollution (Brinkhurst 1969; Lobe & Space 1993; Milbrink 1994; Sarkka 1994). Aquatic oligochaetes also play ecologically important roles in the freshwater ecosystems especially as an agent of primary material exchange across sediment-water interface and as a food resource for a large number of predators including fish (Brinkhurst & Jamieson 1971).

Little information is available on the ecology of aquatic oligochaetes in inland water bodies of Sri Lanka (Costa *et al.* 1997, Weerasundara 1998). Ihalagama reservoir is a minor freshwater reservoir situated in the Western province of Sri Lanka [geographical coordinates L_7 (0.25-13.00)]. In the present study, the species composition and abundance of aquatic oligochaetes along with the environmental characteristics of Ihalagama reservoir, were investigated and the relationships between environmental variables and abundance of oligochaete species were examined.

Materials and methods

Site description and sampling stations

Ihalagama reservoir is a perennial reservoir of about 2 ha in extent. There is a bund on the west side which is build to retain the water draining from catchment area of the reservoir. The reservoir is used by villagers for irrigating paddy fields, washing and bathing. In the present study, three sampling stations (A, B, and C) were selected as shown in Fig. 1. Sampling station A is located close to the northern end of the bund. Sampling station B is near the south corner of the reservoir. Station C is located in the east side of the reservoir. Samples of bottom water and bottom sediments were collected from the sampling stations taking triplicates per station monthly from May, 1993 to April, 1994 from 0930 to 1330 hours.

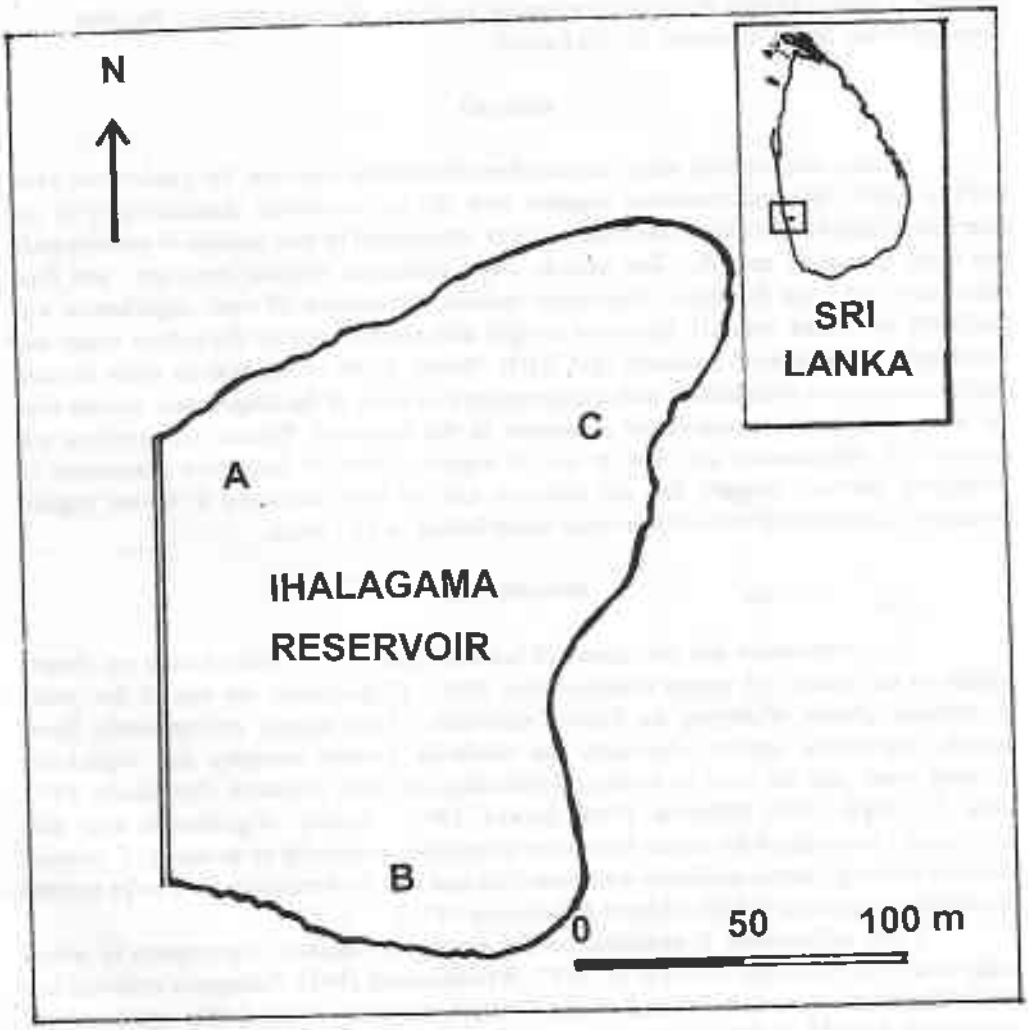

Fig. 1. The map of Ihalagama reservoir showing the location of sampling sites (A, B, and C). Inset shows the location of reservoir in Sri Lanka.

Sampling of oligochaetes and water analysis

Oligochaete fauna were sampled with a Peterson grab taking bottom sediments (0.025 m^2 sampling area) from three different places in each sampling station. Bottom sediments were brought to the laboratory and processed separately by gentle washing with a fine jet of water through a series of graded sieve as described by Costa *et al.* (1997). Oligochaetes were identified to the species level using taxonomic keys (Naidu 1961, 1962a, 1962b, 1962c, 1963; Brinkhurst & Jamieson 1971). Water samples were taken from the bottom of each sampling station using a Ruttner sampler. Temperature, pH and conductivity of bottom waters were measured using a Thermistor thermometer, WOC-2A model water quality checker (Yagamy Internationals, Japan) and a portable conductivity meter (Model 16300, Hach Company, USA) respectively. The dissolved oxygen concentration was determined using the Winkler method and biochemical oxygen demand for 5 days (BOD_5) was determined using an empirical test (Taras *et al.* 1971). Nitrate and phosphate concentrations in the bottom waters were measured colorimetrically using standard methods (Taras *et al.* 1971). Organic carbon content in bottom sediments and particle size analysis of bottom sediments were determined by the methods of Saxena (1990). Rainfall data of the area during the study period was obtained from the Meteorological Department, Colombo.

Statistical analysis

Oligochaete population densities in the sampling stations were compared by one-way analysis of variance (ANOVA) followed by Scheffe's test to determine station specific differences (Zar 1984). Physico-chemical characteristics in the sampling stations were also compared by ANOVA and Scheffe's test. Correlations between abundance of oligochaetes and environmental parameters were determined by Pearson's correlation coefficients. The statistical analysis was conducted using 'MICROSTAT' computer software package.

Results

In the present study, 10 species of aquatic oligochaetes were identified, 2 species belonging to the Family Aeolosomatidae and 8 species to the Family Naididae. The aelosomatids were represented by *Aeolosoma bengalense* and *Aeolosoma hemprichi*. Aeolosomatids also inhabited submerged macrophytes such as *Nelumbo* sp. in the reservoir. The naidid species found in the bottom sediments were *Allonais inaequalis, Allonais gwaliorensis, Dero indica, Dero sawayai, Dero zeylanica, Pristina longiseta, Pristina minuta and Nais communis*. The aeolosomatids were not sampled quantitatively due to nature of their highly fragile bodies. Densities of total oligochaetes (naidids) in the three sampling stations showed considerable fluctuations during the study period ranging from 376 individuals m^{-2} to 2928 individuals m^{-2} (Table 1). Mean density of total oligochaetes as well as the mean density of *Pristina minuta* were significantly lower in the sampling station B than that in other two stations. The density of *P. longiseta* was significantly higher in station C than the other stations. Mean densities of *D. zeylanica, P. longiseta and N. communis* were considerably high in the three sampling stations in comparison with the densities of other naidid species. However these species were not consistently dominant in the three sampling stations in each month of the study period. *D. sawayai* was the rarest naidid species and was not recorded from the station B during the study period.

Mean values of physico-chemical parameters of the bottom water, organic carbon content in the bottom sediment and particle size of the sediments of three stations of the reservoir during the study period are given in Table 2. Results show that the mean values of physico-

chemical characteristics of the three sampling stations were not significantly different from each other. However there were considerable fluctuations in some physico-chemical parameters of the bottom water in the three stations in the reservoir during the study period. Significant differences were found among the sampling stations with regard to organic carbon and particle size composition in the bottom sediments.

Table 1. Density* of littoral oligochaetes in the benthos of Ihalagama reservoir during May 1993 – April 1994.

Species	Density (Number of individuals m^{-2})		
	Station A	Station B	Station C
Total naidids	1422± 701^{a} (612-2815)	901± 358^{b}(376-1602)	1458± 716^{a}(804-2928)
Allonais inaequalis	148± 61^{a}(148-270)	111± 71^{a} (0-242)	234± 56^{a} (83-451)
Allonais gwaliorensis	71± 65^{a}(0-214)	41± 34^{a} (0-92)	65± 56^{a} (0-166)
Dero indica	117± 89^{a} (0-284)	60± 59^{a} (0-180)	108± 71^{a} (0-230)
Dero sawayai	11± 18^{a} (0-50)	0	4± 5^{a} (0-18)
Dero zeylanica	333± 186^{a} (65-686)	272± 164^{a} (0-579)	321± 154^{a} (167-745)
Pristina minuta	96± 89^{a} (0-363)	56± 57^{b} (0-164)	105± 139^{a} (0-512)
Pristina longiseta	278± 150^{a} (0-545)	223± 107^{a} (0-483)	388± 158^{b}(68-428)
Nais communis	368± 289^{a} (0-545)	219± 138^{a}(0-483)	233± 171^{a} (168-728)

*The results are presented as mean, standard deviation and ranges (n=36). In each row, means not followed by the same superscript are significantly different from each other (ANOVA, Scheffe's test, $P< 0.05$)

Table 2. *Physico-chemical characteristics of the bottom water and the bottom sediments of Ihalagama reservoir during May 1993 – April 1994.

Parameter	Station A	Station B	Station C
Bottom water			
Depth (cm)	51.5±5.6^{a}(37-58)	59.1±8.7^{a} (45-70)	56.7±13.2^{a} (29-78)
Temperature (^{0}C)	29.1±1.2^{a} (25.9-30.2)	28.6±1.3^{a} (25.6-30.2)	28.7±1.2^{a} (26.1-30)
Transparency	Full depth	Full depth	Full depth
Conductivity (μ mhos)	102± 9.8^{a} (90-110)	93 ± 7.1^{a} (85-110)	91± 6.5^{a} (75-100)
pH	6.3± 0.4^{a} (5.8-7.1)	6.3± 0.3^{a} (5.8-6.9)	6.2± 0.3^{a} (5.6-6.5)
Dissolved oxygen (mg l^{-1})	2.33±0.81^{a}(1.22-4.08)	1.83±0.92^{a}(0.82-4.08)	2.63±1.45^{a}(0.41-5.71)
BOD (mg l^{-1})	3.37±1.11^{a} (1.64-4.89)	2.99±1.11^{a}(1.22-5.44)	2.92±1.31^{a}(0.81-4.62)
NO_3^{-1} (mg l^{-1})	0.61±0.37^{a} (0.21-1.42)	0.39±0.23^{a}(0.17-0.77)	0.48±0.21^{a}(0.20-0.85)
PO_4^{-3}(mg l^{-1})	0.37±0.14^{a} (0.19-0.73)	0.47±0.30^{a}(0.19-1.26)	0.46±0.13^{a}(0.18-0.61)
Bottom sediments			
Organic carbon (%)	3.78± 0.9^{a} (2.10-6.38)	4.02± 1.0^{a} (2.21-5.93)	6.97± 0.9^{b} (5.15-8.92)
Coarse sand (%)	76.4± 3.1^{c} (71.3-81.1)	66.1± 3.6^{b} (60.1-71.5)	32.1± 1.4^{a} (30.4-34.2)
Fine sand (%)	15.5± 2.9^{a} (10.8-21.8)	28.2± 3.5^{b} (23.5-35.4)	48.7± 3.1^{c} (41.4-52.4)
Silt (%)	6.1± 1.5^{b} (4.0-8.4)	2.6± 1.1^{a} (1.2-4.9)	15.5± 2.1^{c} (13.9-19.5)
Clay (%)	2.1±0.7^{a} (1.1-3.5)	3.2± 1.3^{b} (1.7-6.5)	4.1± 0.8^{b} (2.9-5.5)

*The results are presented as mean and ranges (n=36). In each row, means not followed by the same superscript are significantly different from each other (ANOVA, Scheffe's test, $P < 0.05$)

Correlations of oligochaetes with physico-chemical parameters of the bottom water, characteristics of the bottom sediments in the reservoir are presented in Table 3. Correlations between environmental characteristics of the reservoir and abundance of *D. sawayai* were not determined as it was a rare species. Abundance of total Oligochaetes (naidids) showed significant positive correlations with pH, dissolved oxygen and nitrate levels of the bottom water and silt content of the bottom sediments. Abundance of *D. zeylanica* and *P. minuta* were positively correlated with the pH of the bottom water. Dissolved oxygen levels of the bottom water showed significant positive correlations with the abundance of *A. inaequalis* and *P. longiseta* whereas BOD_5 level was positively correlated with the abundance of *D. indica*. Nitrate levels of the bottom water showed positive correlations with *A. gwaliorensis*, *D. indica*, *D. zeylanica*, *P. minuta*, and *N. communis*. The other water quality parameters such as depth, temperature, conductivity, and phosphate levels of bottom water and rainfall did not show significant correlations ($p > 0.05$) with the abundance of total oligochaetes or any of the naidid species tested (Results not shown in the Table 3). Abundance of *A. inaequalis* and *P. longiseta* were positively correlated with high organic content and silt content in the bottom sediments.

Table 3. Pearson's correlation coefficients between abundance of naidid species and selected physico-chemical characteristics of Ihalagama reservoir. Values indicated by the asterisks are significant at 5% level. DO - Dissolved oxygen content; BOD_5 - Biochemical oxygen demand.

Species	pH	DO	BOD_5	nitrate	organic carbon	silt content
Total naidids	0.46*	0.35*	0.29	0.51*	0.24	0.32*
Allonais inaequalis	0.07	0.42*	0.07	0.05	0.35*	0.40*
Allonais gwaliorensis	0.13	,0.19	0.28	0.49*	0.10	0.21
Dero indica	0.25	0.13	0.41*	0.34*	0.04	0.21
Dero zeylanica	0.38*	0.11	0.26	0.33*	0.29	0.05
Pristina minuta	0.40*	0.21	0.12	0.39*	0.08	0.27
Pristina longiseta	0.15	0.45*	0.20	0.06	0.49*	0.49*
Nais communis	0.24	0.15	0.17	0.34*	0.02	0.14

Discussion

Ten species of aquatic oligochaetes representing two species of aeolosomatids and eight species of naidids were found to co-exist in Ihalagama reservoir. The naidid species, *Dero zeylanica*, *Pristina longiseta* and *Nais communis* were the most abundant oligochaete species. The species found in the Ihalagama reservoir have previously been recorded from several freshwater environments in Sri Lanka (Costa 1967; Fernando 1974; De Silva & de Silva 1984; Costa *et al.* 1997).

Species composition and density of oligochaetes in Ihalagama reservoir were found to be relatively low in comparison to the respective values in Beira Lake, an organically polluted, highly eutrophic inland water body in Sri Lanka. In Beira Lake, twenty two species of oligochaetes including 2 tubificid species and up to 23648 individuals m^{-2} of oligochaetes have been recorded recently (Costa *et al.* 1997). The tubificids, *Aulodrilus*

pigueti and *Limnodrilus hoffmeisteri* are considered as biological indicators of organic pollution and eutrophication (Brinkhurst 1969). These species have been recorded from highly polluted Beira Lake in Sri Lanka (Costa *et al.* 1997). However, not a single specimen of oligochaete belonging to the Family Tubificidae was recorded from Ihalagama reservoir during the study period. Costa *et al.* (1997) suggested that the naidids, *Aulophorus michaelseni*, and *Branchiodrilus semperi* may also be considered as biological indicator species of eutrophication and organic pollution. These two naidid species were not present in Ihalagama reservoir during the study period. The present study also found that organic pollution indicative parameters such as organic matter content of the bottom sediments and BOD_5 in the bottom water were relatively low indicating that the reservoir is not organically enriched in comparison to the highly polluted water bodies in Sri Lanka (Silva 1996; Costa *et al.* 1997).

Physico-chemical parameters of the bottom water of the reservoir did not show station specific variations. These values fall within the range for a tropical shallow man-made reservoir in Sri Lanka (Silva 1996). Physico-chemical characteristics of the reservoir affect the abundance and distribution of benthic organisms. In the present study, total oligochaete density was positively correlated with pH, dissolved oxygen and nitrate levels of the bottom water and silt content of the bottom sediments. However, analysis of correlations by species wise revealed that all oligochaete species do not equally respond to these environmental characteristics. BOD_5 level was positively correlated with abundance of *D. indica*. *A. inequalis* and *P. longesita* were the only species whose abundance was significantly correlated with organic carbon content and silt content of the bottom sediments implying that these species may prefer silty and organically enriched conditions. Of the total of 7 naidid species tested, abundance of 5 species was positively correlated with the nitrate levels of bottom water implying that these species prefer nitrate enriched water.

Absence of tubificid and naidid species which are indicative of organic pollution and low population densities of aquatic oligochaetes along with low values of the organic pollution indicative parameters indicate that the Ihalagama reservoir has not yet been subjected to severe organic pollution in comparison to highly polluted water bodies in Sri Lanka.

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