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Taxonomic diversity in sewage nematodes of Aligarh, North India

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Abstract. A checklist is given of about 50 species of aquatic and semi-aquatic species of nematodes collected from sewage drains of Aligarh and adjoining districts, Uttar Pradesh, India.. The total nematode density as well as the species diversity varied in samples from the different localities. The relative counts of the different trophic groups revealed the abundance of the colonizer bacteriophagous species indicating decomposition to be the main energy channel in the perturbed and contaminated environment. The species diversity and the maturity index were markedly low in sewage waters compared to irrigation canal waters.

Keywords. Checklist, free-living nematodes, India, sewage, taxonomic diversity.

INTRODUCTION

Nematodes by nature are aquatic organisms. The incidence and prevalence of organisms reflect the nature and quality of the environment, hence, the existing nematode species and the resultant community structure differs in marine, brackish as well as freshwater habitats. Researchers have indicated that various nematode species respond differently to degradation of environmental quality and possess several attributes that make them useful ecological indicators (Samoiloff, 1987; Freckman, 1988; Gupta and Yeates, 1997; Neher and Campbell, 2001). Thus, the abundance of each species in the nematode community can be interpreted by ecological indices to assess the disturbance levels and decomposition pathways. Nematode community structure in polluted waters as studied by Beier and Traunspurger (2001) revealed important results on bioindicator species. Whereas nematodes serve as a nutrient source for invertebrates, small vertebrates and fungi, they consume largely bacteria in addition to some algae and fungi. The plant-parasitic nematodes in aquatic systems remain associated with aquatic plants or weeds although the impact of their parasitism on those plants is generally unknown. Keeping in view the scanty information on the aquatic group of nematodes with reference to Indian waters, this paper presents a checklist of nematodes associated with sewage and sewage water. The classification of nematodes followed in the checklist is a synthesis of those employed by Andrássy (1976, 1984) and Siddiqi (1980).

MATERIALS AND METHODS

Sewage samples collected from the drains of Aligarh and adjoining areas were categorized into two types, the sediment samples and the water samples. Sediment samples were collected from the shore as well as the bottom of water bodies using shovel or scoopers while water samples were collected in special steel containers. The samples were processed by modified Cobb's sieving and decantation technique and Baermann's funnel technique.

The freshly isolated nematodes were examined under the stereoscopic zoom microscope (SZX 12), for diagnosis at generic level and were assigned their respective trophic groups. Later the species status was confirmed by studying their permanent mounts after fixation by F:A fixative and dehydration in glycerine alcohol (95 parts 30% ethanol and 5 parts anhydrous glycerine). The individual species population and the total nematode counts were taken to evaluate trophic density, species diversity and maturity index. The nematodes collected from the shore and substratum sediments were recorded as semi-aquatic while the nematodes obtained from the open water zone were identified as aquatic species. Preliminary studies on community structure of sewage nematodes were made using the parameters: nematode density, trophic diversity, species diversity and maturity index.

$$\text{Mean Trophic Diversity} = \frac{\text{Total number of nematodes of a trophic group in samples}}{\text{Total number of samples collected}}$$

$$\text{Mean Specific Diversity} = \frac{\text{Total number of species in all samples}}{\text{Total number of samples collected}}$$

$$\text{Mean Density} = \frac{\text{Total number of nematodes in all samples}}{\text{Total number of samples collected}}$$

$$\text{Maturity Index (MI)} = \sum_{i=1}^{n} v(i) + f(i)$$

Where, $v(i)$= c-*p* value of taxon *i* given by Bongers (1990) and $f(i)$ the frequency of that taxon in a sample.

Table 1. List of nematodes recorded from the sewage waters of Aligarh and adjoining districts.

Order Tylenchida Thorne, 1949	
Family Hoplolaimidae Filipjev, 1934 (Wieser, 1953)	
Genus *Helicotylenchus* Steiner, 1945	
H. dihystera (Cobb, 1893) Sher,1961	Semi aquatic
Genus *Hoplolaimus* Daday,1905	
H. galeatus (Cobb, 1913) Thorne,1935	Semi aquatic
Family Hemicycliophoridae Skarbilovich, 1959 (Geraert, 1966)	
Genus *Hemicycliophora* de Man, 1921	
H. dhirendri Hussain and Khan, 1967	Semi aquatic
Genus *Hemicriconemoides* Chitwood and Birchfield, 1957	
H. mangiferae Siddiqi,1961	Semi aquatic
Order Aphelenchida Siddiqi, 1980	
Family Aphelenchoididae Skarbilovich, 1947 (Paramonov, 1953)	
Genus *Aphelenchoides* Fischer, 1894	
A. brevicaudatus Das,1960	Semi aquatic
Order Rhabditida Örley, 1880 (Chitwood, 1933)	
Family Rhabditidae Örley, 1880	
Genus *Teratorhabditis* (Osche, 1952) Dougherty, 1953	
T. synpapillata Sudhaus, 1985	Semi aquatic, aquatic
Genus *Mesorhabditis* Osche, 1952 (Dougherty, 1953)	
M. cranganorensis (Khera, 1968) Andrássy, 1983	Semi aquatic, aquatic
Genus *Diploscapter* Cobb, 1913	
D. coronata (Cobb, 1893) Cobb, 1913	Semi aquatic, aquatic

Family Cephalobidae Filipjev, 1934	
Genus *Acrobeles* Linstow, 1877	
A. thornei Heyns,1962	Semi aquatic, aquatic
Genus *Panagrellus* Thorne, 1938	
P. redivivus (Linnaeus, 1767) Goodey, 1945	Semi aquatic, aquatic
Family Diplogasteridae Micoletzky, 1922	
Genus *Acrostichus* Rahm,1928	
A. indicus (Suryawanshi, 1971) Andrássy, 1984	Aquatic
Genus *Diplogasteritus* Paramonov, 1952	
D. nudicapitatus (Steiner, 1914) Paramonov, 1952	Aquatic
Genus *Butlerius* Goodey, 1929	
B. butleri Goodey, 1929	Aquatic
Family Neodiplogasteridae Paramonov, 1952 (Andrássy, 1984)	
Genus *Mononchoides* Rahm, 1928	
M. fortidens Dassonville and Heyns, 1984	Aquatic
M. changi Goodrich, Hechler and Taylor, 1968	Aquatic
Genus *Fictor* Paramonov, 1952	
F. vorax (Goodey, 1929) Paramonov, 1952	Aquatic
Family Teratocephalidae Andrássy, 1958	
Genus *Euteratocephalus* Andrássy, 1958	
E. palustris (de Man, 1880) Andrássy, 1958	Semi aquatic

Order Araeolaimida De Coninck and Schuurmans Stekhoven, 1933

Family Leptolaimidae Oerley, 1880	
Genus *Chronogaster* Cobb, 1913	
C. neotypica Tahseen *et al.*, 1994	Semi aquatic
C. longicauda Heyns and Coomans, 1980	Aquatic
C. multispinata Heyns and Coomans, 1980	Aquatic
Family Plectidae Oerley, 1880	
Genus *Plectus* Bastian, 1865	
P. parietinus Bastian, 1865	Aquatic
P. parvus Bastian, 1865	Semi aquatic
Family Rhabdolaimidae Chitwood, 1951	
Genus *Rhabdolaimus* de Man, 1880	
R. terrestris de Man, 1880	Aquatic
R. sclerorectum Tahseen *et al.*, 2004	Aquatic

Order Chromadorida Chitwood, 1933

Family Cyatholaimidae Filipjev, 1918	
Genus *Achromadora* Cobb, 1913	
A. ruricola (De Man, 1880) Micoletzky, 1925	Aquatic

Order Monhysterida Schuurmans Stekhoven and De Coninck, 1933	
Family Monhysteridae de Man, 1876	
Genus *Monhystera* Bastian, 1865	
M. africana Andrássy, 1964	Aquatic
M. paludicola de Man, 1881	Aquatic
Genus *Eumonhystera* Andrássy, 1981	
E. similis (Bütschli, 1873) Andrássy, 1981	Aquatic
Genus *Monhystrella* Cobb, 1918	
M. paramacrura (Meyl, 1953) Andrássy, 1968	Aquatic
M. gracilis Khera, 1966	Semi aquatic
Order Enoplida Baird, 1853 (Chitwood, 1933)	
Family Tripylidae Örley, 1880	
Genus *Tripyla* Bastian, 1865	
T. glomerans Bastian, 1865 Andrássy (1970)	Aquatic
Genus *Tobrilus* Andrássy, 1959	
T. paludicola (Micoletzky, 1925) Andrássy, 1959	Aquatic
T. longus (Leidy, 1852) Andrássy, 1959	Aquatic
Family Prismatolaimidae Micoletzky, 1922	
Genus *Prismatolaimus*	
P. intermedius (Bütschli, 873) de Man, 1880	Aquatic
Family Ironidae de Man, 1876	
Genus *Ironus* Bastian, 1865	
I. longicaudatus de Man, 1884	Aquatic
I. tenuicaudatus de Man, 1876	Aquatic
Order Dorylaimida Pearse, 1942	
Family Dorylaimidae De Man, 1876	
Genus *Dorylaimus* Dujardin, 1845	
D. afghanicus Andrássy, 1960	Semi aquatic
D. stagnalis Dujardin, 1845	Aquatic
Genus *Mesodorylaimus* Andrássy, 1959	
M. bastiani (Bütschli, 1873) Andrássy, 1959	Semi aquatic
M. intermedius Dassonville and Heyns, 1984	Semi aquatic
Family Aporcelaimidae Heyns, 1965	
Genus *Aporcelaimellus* Heyns, 1965	
A. indicus Baqri and Khera,1975	Semi aquatic
A. coomansi Baqri and Khera,1975	Semi aquatic

Family Actinolaimidae Thorne, 1939	
Genus *Paractinolaimus* Meyl, 1957	
P. macrolaimus (de Man, 1880) Meyl, 1957	Aquatic
Family Belondiridae Thorne, 1939	
Genus *Oxydirus* Thorne, 1939	
O. gangeticus Siddiqi, 1966	Semi aquatic
Family Alaimidae Micoletzky, 1992	
Genus *Alaimus* de Man, 1880	
A. primitivus de Man, 1880	Semi aquatic
Order Mononchida Jairajpuri, 1969	
Family Mononchidae Filipjev, 1934	
Genus *Mononchus*, Bastian, 1865	
M. aquaticus Coetzee, 1968	Aquatic
Genus *Coomansus* Jairajpuri and Khan, 1977	
C. indicus Jairajpuri and Khan, 1977	Semi aquatic
Family Mylonchulidae Jairajpuri, 1969	
Genus *Mylonchulus* Cobb, 1916 (Altherr, 1953)	
M. minor (Cobb, 1893) Andrássy, 1958	Semi aquatic
Family Iotonchidae Jairajpuri, 1969	
Genus *Iotonchus* Cobb, 1916 (Pennak, 1953)	
I. longicaudatus Baqri *et al.*, 1978	Semi aquatic
I. indicus Jairajpuri, 1969	Semi aquatic

RESULTS

Fifty species of nematodes were identified from sewage waters of various localities of Aligarh and adjoining areas. The clean irrigation canal water, in contrast, showed an average of 80 nematode species with a greater generic and familial diversity. Five functional nematode trophic groups were identified based on morphological structures and modes of feeding such as herbivores or plant parasites, bacterivores, fungivores, omnivores and predators. Numerically, the bacterivores exceeded all other trophic groups in sewage waters (Fig.1). However, cephalobids were the most abundant group followed by rhabditids among the bacterial feeding nematodes. The total nematode density was greater in sewage as compared to relatively cleaner irrigation canal water (Fig. 2) but the species diversity was found to be nearly half of that observed in canal water (Fig. 3). The maturity index of sewage waters in different localities ranged between 0.8-1.2 (Fig. 4).

DISCUSSION

The fifty species of nematodes represented five trophic groups (Yeates *et al.,* 1993) in the sewage waters. A small fraction of the aquatic nematode fauna was plant parasitic that depended on primary producers i.e., aquatic plants or weeds. However, most of the nematode species were microbe grazing which have been reported to regulate the rates of decomposition (Seastedt, 1984; Trofymow and Coleman, 1982; Wasilewska *et al.*, 1975; Whitford *et al.*, 1982; Yeates and Coleman, 1982) and nutrient mineralization (Seastedt *et al.*, 1988; Sohlenius *et al.*, 1988). The relative abundance of the bacterivores particularly the cephalobs, the colonizers or "*r*-strategists" with low *c-p* values (1-2), indicated bacterial-based energy channels of decomposition as also observed by Bardgett *et al.* (2001). Increased bacterivore diversity was probably correlated with increased diversity of microbes and thus reflected the nature and quality of environment.The sewage waters showed high nematode density though species diversity was reasonably low and existed predominantly in microbial grazers. The high density may be correlated with a rise in population of select indicator species due to contamination. The low maturity index as also explained by Bongers (1990), Wasilewska (1995) and Bongers and Ferris (1999), indicated towards a disturbed and contaminated environment of sewage water bodies compared to irrigation canals.

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