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Review article

FREE-LIVING LIMNIC NEMAFAUNA OF ETHIOPIA: A REVIEW OF THE SPECIES REPORTED OUTSIDE THE RIFT VALLEY

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ABSTRACT: The available information on free-living limnic nematodes from Ethiopia is reviewed with special emphasis on those reported outside the Rift Valley, for which species are listed with their corresponding sites of occurrence. The families Monhysteridae, Dorylaimidae, and Tobrilidae comprise more than half of the total of 91 species hitherto reported from Ethiopia. Among 69 species reported outside the Rift Valley, a similar trend of dominance is observed. Of these, about a quarter of the species have never been reported out of their corresponding type localities (in Ethiopia). Most of the remaining are either cosmopolitan or have been reported earlier from Africa. The occurrence of the fifteen most widely distributed species is shown on maps. *Brevitobrilus graciloides* is the most widely distributed species. Studies on abundance and diversity, though limited, are also included.

Key words/phrases: Aquatic nematofauna, free-living nematodes, inland water bodies

INTRODUCTION

Nematodes are ubiquitous and numerically the most important animal group in benthic aquatic habitats (Platt and Warwick, 1980; Heip *et al.*, 1982; Heip *et al.*, 1985; Pennak, 1988; Traunspurger, 1992; 1996a; 1996b). The role of

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nematodes in aquatic ecosystems has been a subject of research for quite sometime and various workers have written reviews on the topic (Platt and Warwick, 1980; Heip *et al.*, 1982; Heip *et al.*, 1985). Their widespread nature and high density owe nematodes to the functional significance attached to them. Some of the most important roles attached to nematodes include being grazers on primary producers, facilitators of decomposition, predators and parasites, and their being food sources for other animals and being potential indicators of environmental pollution. Nevertheless, their importance is very much masked by their small size and as a result knowledge on their ecological roles is very incomplete, especially when compared to the parasitic forms.

This unfortunate fate is common to all aquatic nematodes, and especially to those inhabiting inland water bodies which have captivated even less attention of researchers than the marine forms (Pennak, 1988). Discussion on nematode ecology is lacking in most limnological treatises. The principal and singularly important reason for the dearth of knowledge on ecology and productivity of freshwater nematodes is the difficulty of their taxonomy (Wetzel, 1983). Although earlier works on aquatic nematodes concentrated on the taxonomy of the group, research done in more recent times is giving more and more emphasis to their ecological aspects.

Because of this lack of attention, the nematofauna of a vast part of the world's inland water bodies is still largely unknown. Moreover, what little taxonomical research that was done earlier, it was usually in the form of reports from short expeditions, hence limited in its spatial and temporal extent. This applies especially to nematofauna of the tropics. Consequently, we still are far from having a relatively complete understanding of the variation and the biogeography of most nematode species, genera or higher taxa involved, and all the more so with respect to the role they play in these particular ecosystems. An inventory of nematodes from inland water bodies, especially from the tropics, is badly needed.

At the global level, taxonomic studies on inland water bodies are strongly biased geographically because relatively complete studies or surveys are largely restricted to the temperate region. Except for those of South Africa, comprehensive African limnic nematodes, especially those of ancient lakes, are little known (Jacobs, 1984; Decraemer and Coomans, 1994). Moreover, information on ecology of nematodes from inland water bodies is entirely restricted to the temperate region (Biró, 1968; Zullini, 1974; 1976; Schiemer, 1978; Prejs, 1977; Eder and Krichengast, 1982; Prejs and Bernard, 1985; Prejs, 1986; 1987; Traunspurger, 1992; 1996a; 1996b). Due to the highly variable nature of inland water bodies, patterns and generalizations have not yet emerged from these nematological studies (Pennak, 1988).

Nematodes of Ethiopia are especially poorly known. Published works on Ethiopia free-living nematodes include those of Filipjev (1931), Zullini (1988), Tudorancea and Zullini (1989), Tudorancea *et al.* (1989), Tsalolikhin (1993; 1996), Eyualem Abebe (1996) Eyualem Abebe *et al.* (1998) and a series of papers by Eyualem Abebe and Coomans (1996 a, b, c, d, e, f; 1997a, b). The literature on Ethiopian nematode species reported from within the Rift Valley is reviewed elsewhere (Eyualem Abebe, submitted). This paper therefore complements the previous one by focusing on the distribution of free-living limnic nematodes from the sites outside the Ethiopian Rift Valley. Also, this review assesses the general distribution of the different species within all of Ethiopia. For a detail description of the major freshwater bodies in the country, the reader is referred to a recent and comprehensive review by Tudorancea *et al.* (1999).

COMPOSITION AND DISTRIBUTION OF NEMATOFAUNA

A total of 91 species belonging to seven orders, 24 families and 42 genera has been reported from Ethiopian limnic habitats. Of these, 69 species (*i.e.*, 76%) belonging to 20 families and 33 genera (*i.e.*, 79%) were found outside the Rift Valley (Appendix 1).

The nematofaunal composition of Ethiopian limnic habitats in general, and of sites outside the Rift Valley in particular, is typically fresh water. The families Monhysteridae, Dorylaimidae and Tobrilidae comprise more than half (54.1%) of the species recorded in Ethiopian limnic habitats, their contribution being 27.5%, 17.6% and 8.8%, respectively. The nematofauna outside the Rift Valley also follows a similar trend of dominance at the family level - Monhysteridae contributing 26.1%, Dorylaimidae 15.9% and Tobrilidae 7.1%. Out of the 20 families reported outside the Rift Valley, seven have not been reported so far from the chain of lakes in the Ethiopian Rift Valley (*i.e.*, Families Aphelenchidae (Fuchs, 1973) Steiner, 1949, Diplogasteridae Mikoletzky, 1922, Diploscapteridae Mikoletzky, 1922, Ethmolaimidae Filipjev and S. Stekhoven, 1941, Neodiplogasteridae Paramanov, 1952, Prismatolaimidae Mikoletzky, 1912, and Rhabditidae Örley, 1880). Four other families (Aphelenchoididae (Skarbilovich, 1947) Paramanov, 1953, Isolamiidae Timm, 1969, Nordiidae Jairajpuri and A. H. Siddiqi, 1964, Xyalidae Chitwood, 1951) are hitherto restricted to the Rift Valley, with no species being reported outside the Rift Valley.

Countrywide at the genus level the highest number of species, *i.e.*, nine has been recorded from each of the genera *Monhystera* and *Monhystrella* followed by *Eumonhystera*, *Dorylaimus*, *Ironus*, and *Laimydorus* with seven, six, four and four species, respectively. Most of the remaining reported genera are either mono-specifically represented or are represented by two species at most (Data not shown). In sites outside the Rift Valley the genus with the highest number of species is *Monhystera* with eight species followed by *Eumonhystera*, *Monhystrella* and *Laimydorus* each with six, four and four species, respectively (Appendix 1).

The list of families and genera from Ethiopian limnic habitats by and large fits within the list of free-living inland aquatic nematodes of Africa compiled by Jacobs (1984), Mononchidae, Neodiplogasteridae and Nordiidae being the only three families that were not included in Jacobs' list.

At the species level, nematofaunal composition of the sites outside the Rift Valley shows the presence of many newly reported species, these 16 new species amounting to a quarter of all the species reported hitherto from the sites. It is, however, not possible to comment on the possible endemicity of nematodes in these habitats, because inland aquatic habitats are little studied (Jacobs, 1984; Decraemer and Coomans, 1994). Therefore, such a discussion should await the generation of relevant data in this respect in the future. It is nevertheless important to note that among those species which have both been recorded in Ethiopia and elsewhere, many were reported from South Africa, a country with relatively well-studied inland aquatic habitats with respect to nematofauna. This suggests that the more we learn about our aquatic habitats in different countries, the fewer possibly endemic species we will find, and the wider the distribution map will become for most individual species that are currently restricted to a narrow range. Nevertheless, we should keep in mind that a few species may be truly endemic. For instance, since the description of *Monhystrella parvella* Filipjev, 1931 from a site within the Rift Valley in Ethiopia, this species has not been reported outside its type locality so far.

On the basis of current knowledge, *Brevitobrilus graciloides* is the species most widely distributed in Ethiopia followed by *Monhystera stagnalis, Tobrilus annettae, Ironus paludicola*, and *Tripyla glomerans*. All except *T. glomerans* were found mainly within the Ethiopian Rift Valley. Species widely found in sites outside the Rift Valley are *Mactinolaimus omercooperi, Achromadora inflata, Eumonhystera vulgaris*, and *Mnhystrella lepidura altherri* (Figs 1, 2 and 3).

B. graciloides is known to be widely distributed in east Africa, mainly in the East African Rift Valley. Moreover, a recent study (on nematofauna of Lake Tana and River Abbay) has shown that this species is also a denizen of sites outside the Rift. *T. glomerans* has been reported from the different corners of Africa, *Tobrilus annettea* and *I. paudicola* from the southern part of Africa, and *M. omercooperi* from west Africa. *E. vulgaris* and *M. lepidura altherri* are cosmopolitan while *M. stagnalis* is a species with a relatively narrow range of distribution (Jacobs, 1984; Tsalolikhin, 1996).

The sites studied outside the Rift Valley include both rivers and lakes. Most of the reported genera (19 genera) have both riverine (river dwelling) and lacustrine (lake dwelling) species, nine genera have only lacustrine and five genera only riverine species. Most of the exclusively lacustrine or exclusively riverine genera are represented by single species. Exceptions are *Chronogaster* and *Rhabdolaimus* from the former and *Prismatolaimus* and *Udonchus* from the latter. *Chronogaster* is a typically freshwater genus, whereas *Rhabdolaimus* is a genus with cosmopolitan species that also occur in terrestrial habitats. *Prismatolaimus* is a genus which is fairly atypical to freshwater, while *Udonchus* on the other hand contains species that have been associated with possible stressful environmental conditions (Schneider, 1937; Schiemer, 1978; Ocaña *et al.*, 1990; Ocaña, 1991).

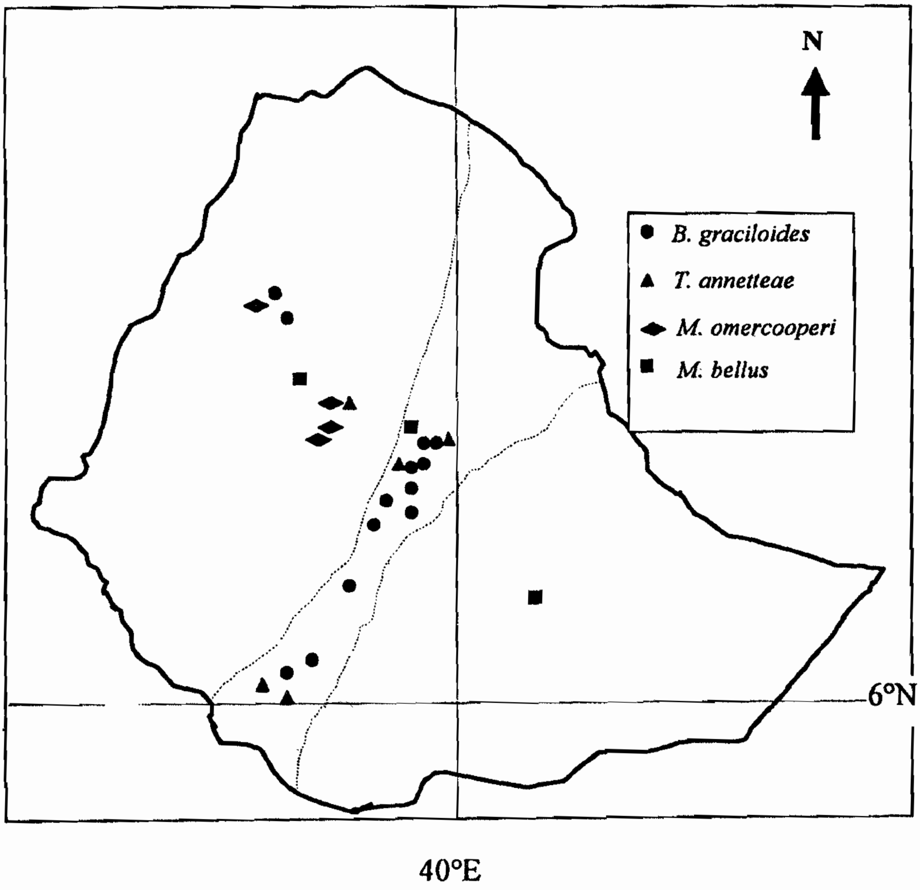

Fig. 1. **The distribution of *Brevitobrilus graciloides*, *Tobrilus annetteae*, *Mactinolaimus omercooperi* and *Mononchus bellus* in Ethiopia.**

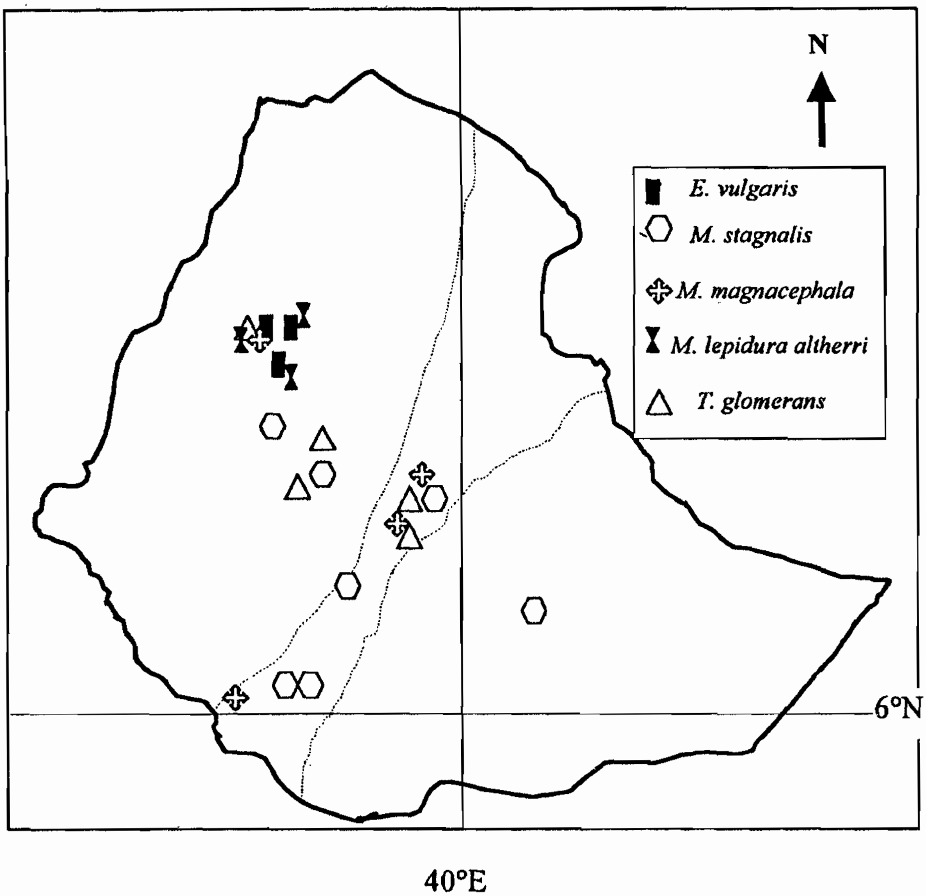

Fig. 2. The distribution of *Eumonhystera vulgaris*, *Monhystera stagnalis*, *Monhystera magnacephala*, *Monhystera lepidura altherri* and *Tripyla glomerans* in Ethiopia.

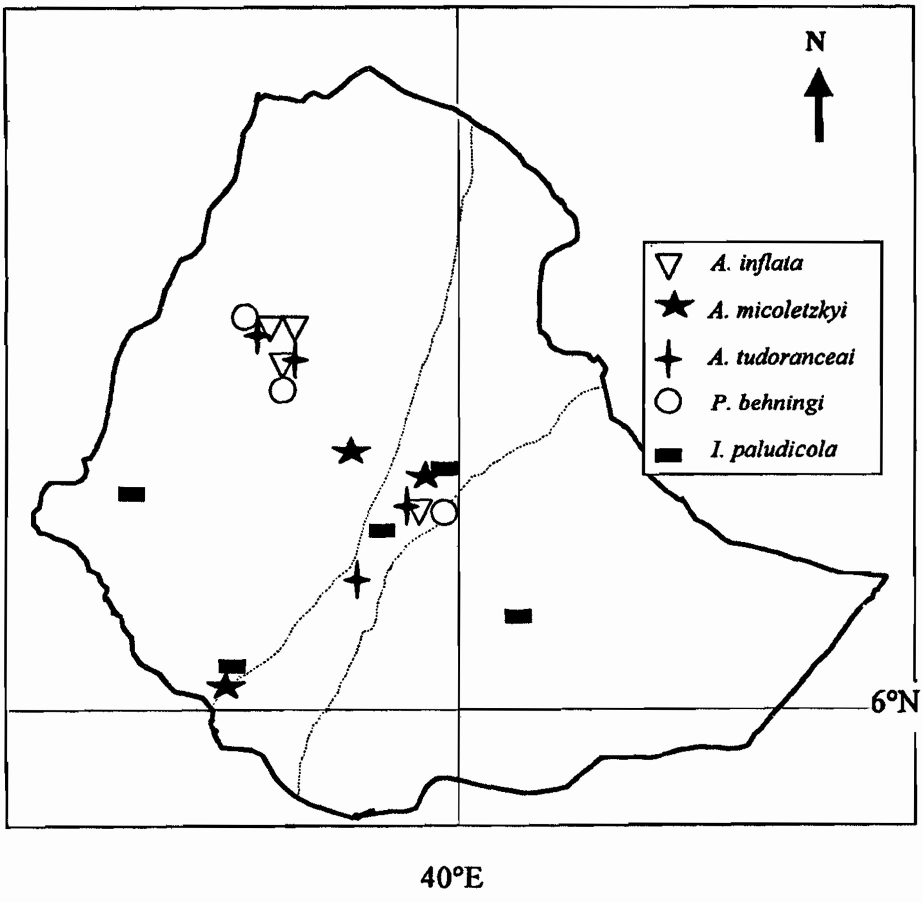

Fig. 3. The distribution of *Achromoadora inflata, Achromadora micoletzkyi, Aphanolaimus tudorancea* and *Paraphanolaimus behningi* in Ethiopia.

DIVERSITY

No comprehensive study on nematofaunal diversity in Ethiopia has been conducted hitherto on sites outside the rift system, except on L. Tana (Eyualem Abebe *et al.*, in press). The sampling schemes employed by various investigators involved also may complicate comparisons. The only uniformly readily available index to compare these sites is the numbers of species. But Soetaert and Heip (1990) stated that "mere species count does not cover all information present in the community, as it is not related to the way the individuals are divided among the species". Moreover, this index is the most sensitive to sample size. In some areas, the number of samples collected from each site has not even been clearly indicated. Therefore, comparison of diversity based merely on number of species would be misleading, and may bring more harm than good to our understanding of the nematofaunal assemblage. The extensive study on the nematofaunal diversity of L. Tana is being published separately. Here, I will only focus on the main findings.

In the L. Tana study, three locations were purposefully selected so as to bring various environmental factors into play. For each of the three locations (Gedero, Gelda, and Zegie) both horizontal and vertical distribution were assessed, taking water and sediment depth into consideration.

The overall nematofaunal diversity of L. Tana is comparable to that reported for oligotrophic and mesotrophic freshwater lakes elsewhere (Shannon-Wiener index H_T = 1.51–2.47 bits/ind.). Diversity showed variation over the five different communities identified. High mud content was related to low diversity. Hill's diversity numbers showed different trend in relation to sediment depth. N_0 (species number) decreases consistently with increasing sediment depth in all sites, whereas the other indices showed different trends in different sites. Most of the nematode diversity in L. Tana could be explained at the genus level (80–87%). Within genus diversity was low (13–20%).

Environmental uniformity created by strong wind action could possibly be the reason for the absence of difference in nematode composition over water depth at Gelda, an open site exposed to strong afternoon wind. The presence of a few dominant species characterized four of the five communities identified in the lake. Deposit feeders were most dominant in all communities (45–70%) followed by omnivore/predators (20–40%), and it is suggested that niche partitioning may be a driving force behind such a composition (Eyualem Abebe *et al.*, in press).

ABUNDANCE

Although temporal and spatial abundance of nematodes is known to vary horizontally (over localities and water depth) and vertically, only the studies on Lakes Arenguade, Kilote and Tana have hitherto addressed the abundance of nematofauna from inland water bodies of Ethiopia outside the Rift Valley (Tudorancea and Zullini, 1989; Eyualem Abebe *et al.*, in press). Also, although Tudorancea and Zullini (1989) studied the general nematofaunal abundance on Lakes Arenguade and Kilote, they did not consider vertical and horizontal variation of nematofauna within these lakes. For other studies, neither sample volume nor nematofaunal density was indicated. Therefore, the following comparison includes only these three sites, and even this comparison is difficult because of the different extraction methods employed.

Nematode density in L. Arenguade (51477 m^{-2}) is about half that of the location with the lowest density in L. Tana. This value, however, is about seven times more than the highest reported density value for rift valley lakes in Ethiopia (Tudorancea and Zullini, 1989). Lake Kilote on the other hand has a remarkably low nematode density (15 m^{-2}). However, the generally low estimates recorded by Tudorancea and Zullini (1989) from all the lakes they studied could simply be due to the extraction sieves, which had a 200 μm mesh net. The investigated depth of each lake could also be a major source of discrepancies in abundance values between studies (Traunspurger, 1996a). The ranges of studied depth were 0.5–11.0 m for L. Arenguade and 1.2–4.0 for L. Kilote in Tudorancea and Zullini (1989).

The nematofaunal density recorded for L. Tana is higher than any such value recorded in Ethiopia (91.0×10^3 – 504.7×10^3 m^{-2}) and is comparable to what has been reported for freshwater bodies elsewhere. Nematode density in various aquatic systems is in the range 90×10^3 – 944.0×10^3 m^{-2} for freshwater bodies (Traunspurger, 1996a).

In general information on free-living nematodes of Ethiopia from sites outside the Rift Valley is still meagre. Though Earlier studies produced relevant information on the distribution of the different species reported, more recent studies among the reviewed papers appear to indicate that some of the first impressions created by those pioneer studies are largely due to sampling artefacts.

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Appendix List of nematode species hitherto reported from seven lakes and eight rivers out of the Ethiopian Rift Valley. References: **1**, Filipjev (1931); **2**, Zullini (1988); **3**, Tudorancea and Zullini (1989); **4**, Eyualem Abebe and Coomans (1996a); **5**, Tsalolikhin (1996); **6**, Eyualem Abebe and Coomans (1996b); **7**, Eyualem Abebe and Coomans (1996d); **8**, Eyualem Abebe and Coomans (1996e); **9**, Eyualem Abebe and Coomans (1996f); **10**, Eyualem Abebe and Coomans (1997a); **11**, Eyualem Abebe (1996); **12**, Eyualem Abebe and Coomans (1997b); **13**, Eyualem Abebe and Coomans (1996c).

N°	Species	Sites														
		LT	LK	LA	LB	LHo	LHa	LZ	AR	GR	DDR	D-GR	AR	W-DR	B-AR	GR
	FAMILY ACHROMADORIDAE Gerlach & Reimann, 1973															
1.	*Achromadora inflata* Eyualem & Coomans, 1996	7							7	7						
2.	*A. micoletzkyi* (Stefanski, 1915) Van der Linde, 1938												5			
	FAMILY ACTINOLAIMIDAE (Thorne, 1939) Meyl, 1960															
3.	*Mactinolaimus omercooperi* Filipjev, 1931	5			5			1					5			
	FAMILY LEPTOLAIMIDAE Örley, 1880															
4.	*Anonchus coomansi* Eyualem, 1996	11							11							
5.	*Aphanolaimus tudoranceai* Zullini, 1988	11							11							
6.	*Paraphanolaimus behningi* Micoletzky, 1923	11							11							
7.	*Paraplectonema pedunculatum* (Hofmänner, 1913) Strand, 1934	11							11							

N°	Species	Sites														
		LT	LK	LA	LB	LHo	LHa	LZ	AR	GR	DDR	D-GR	AR	W-DR	B-AR	GR
	FAMILY APHELENCHIDAE (Fuchs, 1937) Steiner, 1949															
8.	*Aphelenchus abyssinicus* Filipjev, 1931				1											
	FAMILY TOBRILIDAE De Coninck, 1965															
9.	*Brevitobrilus graciloides* (Daday,1908) Tsalolikhin, 1983	10							10							
10.	*B. fesehai* Eyualem & Coomans, 1997	10														
11.	*B. tsalolikhini* Eyualem & Coomans, 1997	10														
12.	*Epitobrilus allophysis* (Steiner, 1919)											5		5		
13.	*E. setosus* (Altherr, 1963) Tsalolikhin, 1981	12														
14.	*Semitobrilus pellucidus* (Bastian, 1865)															1
15.	*Tobrilus annetteae* Jubert & Heyns, 1979												5			
	FAMILY CHRONOGASTERIDAE Gagarin, 1975															
16.	*Chronogaster getachewi* Eyualem & Coomans, 1996	8														
17.	*C. multispinatoides* Heyns & Coomans, 1984	8														
	FAMILY DORYLAIMIDAE de Man, 1876															
18.	*Chrysonema abyssinica* Filipjev, 1931							1								
19.	*Chr. thorni* Filipjev, 1931				1											
20.	*Dorylaimus flavomaculatus* (Linstow, 1876)										1					

N°	Species	Sites														
		LT	LK	LA	LB	LHo	LHa	LZ	AR	GR	DDR	D-GR	'AR	W-DR	B-AR	GR
21.	*D. stagnalis* Dujardín, 1845	12						1								
22.	*Ischiodorylaimus ugandanus* (Andrassy & Banage,) Andrassy, 1969	12														
23.	*Laimydorus flavomaculatus* (Linstow, 1876)										1					
24.	*L. gazella* Andrassy, 1970														5	
25.	*L. pseudostagnalis* (Micoletsky, 1972) Siddiqi, 1969	12														
26.	*L. ritae* Eyualem & Coomans, 1997	12														
27.	*Mesodorylaimus macrospiculum* Zullini, 1988		2													
28.	*M. bainsi* Basson & Heins, 1974													5		
	FAMILY DIPLOSCAPTERIDAE Micoletzky, 1922															
29.	*Diploscapter coronatus* (Cobb, 1893) Cobb, 1913	12														
	FAMILY ETHMOLAIMIDAE Filipjev & Stekhoven, 1941															
30.	*Ethmolaimus sp.*													5		
31.	*Ethmolaimus zullinii* Eyualem & Coomans, 1996	7														
	FAMILY MONHYSTERIDAE de Man, 1876															
32.	*Eumonhystera filiformis* (Bastian, 1865) Andrassy, 1981	13														
33.	*E. geraerti* Eyualem & Coomans, 1996								13							
34.	*E. mwerazii* (Meyl, 1957) Andrassy, 1981	13							13							

N°	Species	Sites														
		LT	LK	LA	LB	LHo	LHa	LZ	AR	GR	DDR	D-GR	AR	W-DR	B-AR	GR
35.	*E. pseudobulbosa* (Daday, 1896) Andrassy,1981	13														
36.	*E. sudanensis* Zeidan, Jacobs & Geraert, 1990											5	5			
37.	*E. vulgaris* (de Man, 1880) Andrassy,1981	13							13	13						
38.	*Monhystera deleyi* Eyualem & Coomans, 1996	4														
39.	*M.* cf. *zabaza* Joubert & Heyns, 1980	4														
40.	*M. magnacephala* Joubert & Heyns, 1980	5														
41.	*M. nubiae* Eyualem & Coomans, 1996	4														
42.	*M. shibrui* Eyualem & Coomans, 1996	4														
43.	*M. stagnalis* Bastian, 1865				5							5		5		
44.	*M. somereni* Allgén, 1952	4														
45.	*M. tanae* Eyualem & Coomans, 1996	4														
46.	*Monhystrella atteae* Eyualem & Coomans, 1996	6														
47.	*M. ethiopica* Eyualem & Coomans, 1996	6							6							
48.	*M. lepidura* altherri (Juget, 1969) Jacobs, 1987	6							6	6						
49.	*M. woitorum* Eyualem & Coomans, 1996	6														
	FAMILY IRONIDAE de Man, 1876															
50.	*Ironus ignavus* Bastian, 1865	10														
51.	*I. paludicola* Schneider, 1937													5	5	
52.	*I. sphincterus* Ebsary, 1985	10														

N°	Species	Sites														
		LT	LK	LA	LB	LHo	LHa	LZ	AR	GR	DDR	D-GR	AR	W-DR	B-AR	GR
	FAMILY NEODIPLOGASTERIDAE Paramonov, 1952															
53.	*Mononchoides longicauda* Rahm, 1928													5		
	FAMILY MONONCHIDAE Chitwood, 1937															
54.	*Mononchus truncatus* Bastian, 1865	12														
55.	*M. bellus* Andrássy, 1985											5		5		
	FAMILY DIPLOGASTERIDAE Micoletzky, 1922															
56.	*Paroigolaimella bernensis* (Steiner, 1914) Andrassy, 1958			3												
	FAMILY PLECTIDAE Örley, 1880															
57.	*Plectus galapagensis* De Ley & Coomans, 1994	8														
58.	*P. rhizophilus* de Man, 1880													5		
	FAMILY PRISMATOLAIMIDAE Micoletzky, 1912															
59.	*Prismatolaimus andrassyanus* Coomans & Mulk, 1980													5		
60.	*P. intermedius* (Bütschli, 1873) de Man, 1880												5			
61.	*P. matoni* Mulk & Coomans, 1979								8							
	FAMILY DESMODORIDAE Filipjev, 1922															
62.	*Prodesmodora nurta* Zullini, 1988	7														

N°	Species	Sites														
		LT	LK	LA	LB	LHo	LHa	LZ	AR	GR	DDR	D-GR	AR	W-DR	B-AR	GR
	FAMILY RHABDITIDAE Örley, 1880															
63.	*Rhabditoides stigmatus* (Steiner, 1930) Andrassy, 1984			3												
	FAMILY RHABDOLAIMIDAE Chitwood, 1951															
64.	*Rhabdolaimus aquaticus* de Man, 1880	9														
65.	*R.* cf. *Minor* Cobb, 1914	9														
66.	*R. terrestris* de Man, 1880	9														
67.	*Udonchus merhatibebi* Eyualem & Coomans, 1996								9							
68.	*U. tenuicaudatus* Eyualem & Coomans, 1996								9							
	FAMILY TRIPYLIDAE de Man, 1876															
69.	*Tripyla glomerans* Bastian, 1865	8						1					1			
	Total number of species from each site	42	1	2	5	1	1	4	14	3	2	4	6	9	2	2

LT, Lake Tana; LK, Lake Kilote; LA, Lake Arenguade; LB, Lake Bishoftu; LHo, Lake Horeso; LHa, Lake Harsadi; LZ, Lake Ziquala; AR, Abbay River; GR, Gelda River; DDR, Djem Djem River; D-GR, Duber-Gorfo River; AR, Akaki River; W-DR, Wabishebele-Dinke River; B-AR; Baro-Alvero River; GR, Guder River.