NEMATODE FAUNA OF COSTA RICAN PROTECTED AREAS

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ABSTRACT

Esquivel, A. 2003. Nematode fauna of Costa Rican protected areas. Nematropica 33:131-145.

The Instituto Nacional de Biodiversidad (INBio), in collaboration with the Nematology Laboratory at Universidad Nacional (U.N.A) of Costa Rica, conducted a nematode inventory of Costa Rican wild lands. Hundreds of samples were randomly collected for nematode analyses and thousands of specimens were permanently mounted on Cobb slides. A total of 74 families, 231 genera and 105 species has been detected so far. Dorylaimida was the dominant order both in number of specimens and genera, while the least dominant orders were Aphelenchida, Monhysterida and Desmocolecida. Some nematodes were widely distributed across all microhabitats, others appeared be restricted to a specific microhabitat or ecosystem. Basic and advanced reports regarding nematode inventory in Costa Rican protected areas can be requested through the web page of INBio (*http://atta.inbio.ac.cr*).

Key words: biodiversity, conservation areas, inventory, nematodes, survey.

RESUMEN

Esquivel, A. 2003. Nematofauna de las áreas protegidas de Costa Rica. Nematropica 33:131-145.

El Instituto Nacional de Biodiversidad (INBio) en colaboración con el laboratorio de nematología de la Universidad Nacional (U.N.A), llevó a cabo el inventario de nematodos en áreas protegidas de Costa Rica. Cientos de muestras fueron colectadas al azar para análisis nematológicos y miles de especimenes fueron montados permanentemente en laminillas de Cobb. Un total de 74 familias, 231 géneros y 105 especies han sido detectados. Dorylaimida fue el orden dominante, tanto en número especimenes como en géneros identificados, mientras que los menos representados fueron Aphelenchida, Monhysterida y Desmocolecida. Algunos géneros se encontraron ampliamente distribuidos, mientras que otros se encontraron restringidos a ciertos microhabitats o ecosistemas. Reportes básicos y avanzados relacionados al inventario de la nematofauna en áreas protegidas de Costa Rica, pueden ser accesados a través de la página web de INBio (*http://atta.inbio.ac.cr*).

Palabras clave: áreas de conservación, estudio, biodiversidad, inventario, nematodos.

INTRODUCTION

The vast number of taxa unknown to science is particularly severe for nematodes, with only an estimated of 3% of the world's species studied and described (Barker *et al.*, 1994). A recent review of the literature by Boag and Yeates (1998) regarding nematode diversity, stressed the critical lack of information in tropical areas.

Costa Rica, a neotropical country has an estimated 4% of the world's biodiversity (Obando, 2002). However, in the past, groups such as nematodes were practically ignored and unrecorded in all biodiversity studies. The National Biodiversity Institute (INBio), responsible for developing and executing a national biodiversity inventory of the country, initiated in 1998 the nematode inventory in conservation areas of Costa Rica. The project was carried out with the cooperation of the Nematology Department of the Universidad Nacional (U.N.A) until December 2002.

This scientific effort had the following goals: 1) explore the nematode diversity in protected areas of Costa Rica, 2) create a nematode reference collection for Costa Rica, 3) create an infrastructure for nematode taxonomy and ecology, and 4) integrate scientific experts in the identification process. The goals of this paper are to disseminate the current knowledge of nematode diversity of Costa Rica and to stimulate the interests of taxonomist to work with the Costa Rican collection.

MATERIALS AND METHODS

The nematode inventory was carried out with major emphasis on conservation areas of Costa Rica (Fig. 1). Hundreds of samples were randomly collected through a variety of ecosystems (i.e., dry forest, wet lands, evergreen forest, moist and very moist forest, cloud forest, tropical rain forest and paramo) along an altitudinal range of 0 to 3820 m above sea level (highest mountain in Costa Rica). Many kinds of

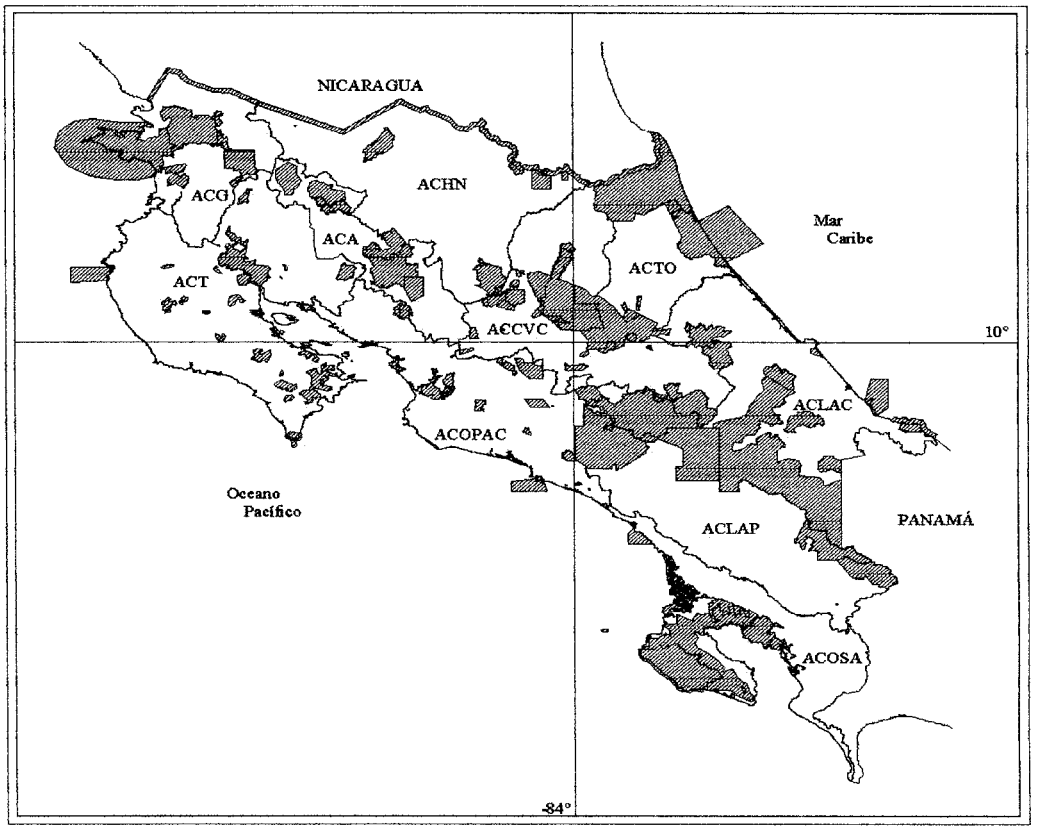

Fig. 1. Conservation Areas (CA) in Costa Rica, where the nematode inventory were conducted. They are Tempisque (ACT), Guanacaste (ACG), Arenal (ACA), Huetar Norte (ACHN), Cordillera Volcánica Central (ACCVC), Tortuguero (ACTO), Pacífico Central (ACOPAC), La Amistad Pacífico (ACLAP), La Amistad Caribe (ACLAC)., Osa (ACOSA) and Marina Isla del Coco (ACMIC) (not included in the map). Protected areas are marked by dark zones on the map and include national parks, biological reserves, wildlife refuges, protected zones, forestry reserves and wetlands.

samples for nematode analyses were collected: soil, fresh water sediments, mosses, sediments from caves, sand, water inside bromeliads, epiphytic plants, decaying wood, decaying leaves, lichens, mushrooms, insect nests, rotten fruits, bark, hot water sediments, aquatic plants, organic matter, and animal dung. Soil, freshwater sediments, decaying leaves, and mosses were most frequently represented. Each sampling site was referenced with a geographic positioning system (GPS) personal navigator to develop future maps of species distributions.

According to the type of substrate, samples of about 200-300 g were obtained with different tools (i.e, shovel, auger, knife) and techniques (i.e, digging, scraping, cutting and sieving). Each sample was deposited in a plastic bag with all necessary field information. The samples were maintained in insulated containers during transportation and before processing.

The samples were soaked for some hours and processed either by Cobb's modified decanting and sieving method or by means of an Oostenbrink elutriator (s'Jacob and van Bezooijen, 1984). The nematodes isolated were fixed with hot 4% formaldehyde and transferred to pure glycerin (Seinhorst, 1959). Under the dissecting microscope, nematodes from each sample were sorted out by size and shape. Adult nematodes were permanently mounted on Cobb's slides using the paraffin wax ring method (de Maeseneer and d'Herde, 1963). The nematode identification process was possible with the cooperation, training and stimulus given by international taxonomists. For classification, the nematodes were listed according with Siddiqi (2000) for the Tylenchida, Hunt (1993) for the Aphelenchida, Jairajpuri and Ahmad (1992) for the Dorylaimida, and Andrassy (1999) for the majority of the remaining taxa. *Thalassogenus* was placed in Thalassogeneridae following Loof and Zullini (2000b).

All the nematodes of the collection are linked through a bar code system that enable one to obtain information related with the specimen, e.g., where, when, how and who collected and identified the specimen. Type of substrate, number of specimens, sex, altitude, geographic coordinates and site description, were also registered. The specimens included in this study are deposited in the reference collection of UNA.

RESULTS

A total of 15,322 nematodes were identified in this study, of which 472 were identified to order, 4,028 to family, 9,742 to genus and 1,080 to species. A total of 74 families, 231 genera, 105 species have been detected so far. Two genera and 14 species are new to science (Table 1).

The nematodes listed below are distributed as follows: Dorylaimida (43.6%), Araeolamida (12.7%), Mononchida (11.1%), Enoplida (10.2%), Rhabditida (9.9%), Tylenchida (7.2%), Chromadorida (2.3%), Aphelenchida (1.8%), and Monhysterida (1.3%). Dorylaimida showed a clear dominance both in the number of specimens and the identified genera. On the other hand, only one specimen of Desmocolecida was found in the samples.

Some nematodes were widely distributed across all microhabitats, but others appeared to be confined to a specific microhabitat or ecosystem. For some genus several unidentified species were detected (Table 1). The massive amount of information obtained in this survey could not be placed in a single comprehensive table. Therefore, details regarding the nematode inventory are available through the website (*http://atta.inbio.ac.cr*), where basic and advanced reports can be requested.

Table 1. Families, genera and species detected during the nematode inventory in Costa Rican pro tected areas.

Family	Genera	Species	
Alirhabditidae	Alirhabditis	sp.	
Brevibuccidae	Brevibucca	sp.	
Bunonematidae	Bunonema	sp.	
	Pterygorhabditis	sp.	
	Rhodolaimus	sp.	
	Rhodonema	sp.	
Cephalobidae	Acrobeles	spp.	
	Acrobeloides	sp.	
	Cephalobus	spp.	
	Cervidellus	sp.	
	Eucephalobus	sp.	
	Heterocephalobellus	sp.	
	Heterocephalobus	sp.	
	Teratolobus	sp.	
Chambersiellidae	Diastolaimus	croca	(Masey, 1963) Andrássy, 1984
	Geraldius	backeri	(Sanwal, 1957) Sanwal, 1971
	Macrolaimus	sp.	
	Tricirronema	tentaculatum	Siddiqi, 1993
	Trualaimus	sp.	
	Trualaimus	culeatus	Andrássy, 2001
Cylindrocorporidae	Goodeyus	sp.	
Diplogasteridae	Demaniella	sp.	
	Diplogasteritus	sp.	
	Monobutlerius	sp.	
Diplogasteroididae	Rhabdontolaimus	sp.	
Diploscapteridae	Diploscapter	sp.	
Myolaimidae	Myolaimus	sp.	
Neodiplogasteridae	Mononchoides	spp.	
	Pristionchus	sp.	
Odontopharyngidae	Zullinius	sp.	
Odontorhabditidae	Cephaloboides	sp.	
	Diploscapteroides	sp.	
	Odontorhabditis	sp.	
Panagrolaimidae	Panagrolaimus	sp.	
Pseudodiplogasteroididae	Pseudodiplogasteroides	sp.	

Table 1. (Continued) Families, genera and species detected during the nematode inventory in Costa Rican pro tected areas.

Family	Genera	Species	
Rhabditidae	Caenorhabditis	sp.	
	Cuticularia	oxycerca	(de Man, 1895) Andrássy, 1983
	Mesorhabditis	spp.	
	Pellioditis	sp.	
	Rhabditella	sp.	
	Rhabditella	muscicola	Andrássy, 1986
	Rhabditis	spp.	
	Rhabpanus	sp.	
	Stomachorhabditis	sp.	
Teratocephalidae	Euteratocephalus	sp.	
	Metateratocephalus	sp.	
	Teratocephalus	spp.	
	Teratocephalus	costatus	Andrássy, *1958*
	Teratocephalus	terrestris	(Bütschli, 1873) de Man, 1876
Steinernematidae	Steinernema	sp.	
Anguinidae	Ditylenchus	sp.	
Criconematidae	Discocriconemella	spp.	
	Hemicriconemoides	sp.	
	Mesocriconema	sp.	
	Ogma	sp.	
	Xenocriconemella	sp.	
Ecphyadophoridae	Ecphyadophora	sp.	
Hemicycliophoridae	Hemicycliophora	sp.	
Heteroderidae	Heterodera	sp.	
Hoplolaimidae	Helicotylenchus	spp.	
	Rotylenchus	spp.	
Neotylenchidae	Deladenus	sp.	
Paratylenchidae	Gracilacus	sp.	
Pratylenchidae	Hirschmanniella	sp.	
Telotylenchidae	Tylenchorhynchus	sp.	
Tylenchidae	Coslenchus	sp.	
	Filenchus	sp.	
	Lelenchus	sp.	
	Malenchus	sp.	
	Psilenchus	sp.	

Table 1. (Continued) Families, genera and species detected during the nematode inventory in Costa Rican pro tected areas.

Family	Genera	Species	
	Tylenchus	sp.	
Aphelenchidae	Aphelenchus	sp.	
Aphelenchoididae	Aphelenchoides	spp.	
	Laimaphelenchus	sp.	
Seinuridae	Seinura	sp.	
Entaphelenchidae	Praecocilenchus	sp.	
Monhysteridae	Eumonhystera	sp.	
	Geomonhystera	spp.	
	Monhystera	spp.	
Desmocolecidae	Desmoscolex	sp.	
Cylindrolaimidae	Cylindrolaimus	sp.	
	Domorganus	sp.	
Halaphanolaimidae	Anonchus	sp.	
	Anonchus	n. sp.	see Zullini *et al.*, 2002
	Aphanolaimus	spp.	
	Aphanolaimus	coomansi	Tsalolichin, 1988
	Aphanolaimus	fuegoensis	Raski & Coomans, 1990
	Aphanolaimus	furcifer	Andrássy, 1989
	Paraphanolaimus	sp.	
Leptolaimidae	Chronogaster	spp.	
	Chronogaster	cameroonensis	Heyns & Coomans, 1984
	Chronogaster	n. sp.	see Zullini *et al.*, 2002
	Chronogaster	jankiewiczi	Winiszewska, 1997
	Chronogaster	multispinatoides	Heyns & Coomans, 1984
	Chronogaster	serrulata	Loof, 1973
	Paraplectonema	sp.	
	Paraplectonema	n. sp.	see Zullini *et al.*, 2002
Plectidae	Anaplectus	spp.	
	Anaplectus	granulosus	(Bastian, 1865) De Coninck & Schuurmans Stekhoven, 1933
	Anaplectus	octo	Zullini, 1973
	Ceratoplectus	sp.	
	Ceratoplectus	assimilis	Bütschli, 1873
	Ceratoplectus	armatus	Bütschli, 1873
	Chiloplectus	sp.	

Table 1. (Continued) Families, genera and species detected during the nematode inventory in Costa Rican pro tected areas.

Family	Genera	Species	
	Plectus	spp.	
	Plectus	acuminatus	Bastian, 1865
	Plectus	aquatilis	Andrássy, 1985
	Plectus	elongatus	Maggenti, 1961
	Plectus	exinocaudatus	Truskova, 1976
	Plectus	geophilus	de Man, 1880
	Plectus	indicus	Khera, 1972
	Plectus	intermedius	Cobb, 1893
	Plectus	longicaudatus	Bütschli, 1873
	Plectus	parvus	Bastian, 1865
	Plectus	patagonicus	de Man, 1904
	Tylocephalus	spp.	
	Tylocephalus	auriculatus	(Bütschli, 1873) Anderson, 1966
	Wilsonema	spp.	
	Wilsonema	otophorum	(de Man, 1880) Cobb, 1913
	Wilsonema	schuurmansstekhoveni	(De Coninck, 1931) Zell, 1985
Rhabdolaimidae	Rhabdolaimus	spp.	
	Rhabdolaimus	terrestris	de Man, 1880
	Sinanema	sp.	
Cyatholaimidae	Achromadora	spp.	
	Achromadora	micoletzkyi	(Stefanski, 1915) Van Der Linde, 1938
	Achromadora	pseudomicoletzkyi	Van Der Linde, 1938
	Ethmolaimus	sp.	
Hypodontolaimidae	Chromadorita	sp.	
Metachromadoridae	Prodesmodora	sp.	
Alaimidae	Alaimus	sp.	
	Paramphidelus	sp.	
	Paramphidelus	dolichurus	(de Man, 1876)
Cryptonchidae	Aulolaimus	sp.	
	Cryptonchus	sp.	
Ironidae	Ironus	sp.	
	Ironus	ignavus	Bastian, 1865
	Ironus	longicaudatus	de Man, 1884

Table 1. (Continued) Families, genera and species detected during the nematode inventory in Costa Rican pro tected areas.

Family	Genera	Species	
	Ironus	luci	Andrássy, 1956
	Ironus	paludicola	Schneider, 1937
Onchulidae	Mononchulus	sp.	
	Mononchulus	nodicaudatus	(Daday, 1899) Schneider, 1937
	Onchulus	sp.	
	Onchulus	longicaudatus	Cobb, 1920
	Stenonchulus	sp.	
Oxystominidae	Bastiania	sp.	
	Odontolaimus	sp.	
Prismatolaimidae	Prismatolaimus	sp.	
	Prismatolaimus	dolichurus	de Man, 1880
	Prismatolaimus	matoni	Mulk & Coomans, 1979
Thalassogeneridae	Thalassogenus	sp.	
	Thalassogenus	n. sp.	see Loof & Zullini, 2000b
Tobrilidae	Tobrilus	spp.	
Tripylidae	Tripyla	spp.	
	Tripylella	spp.	
	Tripylella	intermedia	Bütschli, 1873
	Tripylina	spp.	
	Tripylina	arenicola	(de Man, 1880) Brzeski, 1963
	Tripylina	sheri	Brzeski, 1963
	Trischistoma	sp.	
	Trischistoma	monohystera	(de Man, 1880)
	Udonchus	sp.	
Anatonchidae	Anatonchus	sp.	
	Doronchus	sp.	
	Iotonchus	spp.	
	Iotonchus	brachylaimus	Cobb, 1917
	Iotonchus	tenuidentatus	(Kreis, 1924) Goodey, 1951
	Iotonchus	trichurus	Cobb, 1917
	Miconchus	spp.	
	Miconchus	digiturus	(Cobb, 1893) Andrássy, 1958
	Miconchus	n. sp	see Zullini *et al.*, 2002
	Mulveyellus	monhystera	(Cobb, 1917) Siddiqi, 1984
	Mulveyellus	spp.	

Table 1. (Continued) Families, genera and species detected during the nematode inventory in Costa Rican pro tected areas.

Family	Genera	Species	
	Paracrassibucca	paucidentata	(Lordello, 1970) Jairajpuri & Khan, 1982
	Paracrassibucca	sp.	
	Promiconchus	sp.	
Mononchidae	Actus	spp.	
	Clarkus	spp.	
	Cobbonchus	coetzeeae	Andrássy, 1970
	Cobbonchus	spp.	
	Comiconchus	sp.	
	Coomansus	spp.	
	Coomansus	parvus	(de Man, 1880) Jairajpuri & Khan, 1977
	Coomansus	zschokkei	(Menzel, 1913) Loof & Winiszewska-Slipinska, 1993
	Mononchus	spp.	
	Mononchus	aquaticus	Coetzee, 1968
	Mononchus	n. sp.	see Zullini *et al.*, 2002
	Mononchus	truncatus	Bastian, 1865
	Mononchus	tunbridgensis	Bastian, 1865
	Prionchulus	spp.	
	Prionchulus	muscorum	(Dujardin, 1845) Cobb, 1916
	Prionchulus	punctatus	Cobb, 1917
	Sporonchulus	sp.	
Mylonchulidae	Mylonchulus	spp.	
	Mylonchulus	brachyuris	Bütschli, 1873
	Mylonchulus	contractus	Jairajpuri, 1970
	Mylonchulus	hawaiiensis	(Cassidy, 1931) Goodey, 1951
	Mylonchulus	obtusicaudatus	(von Daday, 1899) Cobb, 1916
	Mylonchulus	parabrachyuris	(Thorne, 1924) Schneider, 1939
	Mylonchulus	sigmaturus	Cobb, 1917
Actinolaimidae	Brasilaimus	spp.	
	Brasilaimus	n. sp.	see Loof & Zullini, 2000
	Brasilaimus	bryophilus	(Hunt, 1978) n. comb
	Brasilaimus	memorabilis	(Andrássy, 1968) n. comb.
	Brasilaimus	subaquilus	Lordello & Zamith, 1957
	Brasilaimus	n. sp.	see Loof & Zullini, 2000

Table 1. (Continued) Families, genera and species detected during the nematode inventory in Costa Rican pro tected areas.

Family	Genera	Species	
	Egtitus	sp.	
	Neoactinolaimus	sp.	
	Paractinolaimus	sp.	
	Practinocephalus	sp.	
	Practinocephalus	secundus	Andrássy, 1986
	Trachactinolaimus	sp.	
	Westindicus	sp.	
Aporcelaimidae	Aporcelaimellus	spp.	
	Aporcelaimellus	kikereensis	Bagri & Coomans, 1973
	Aporcelaimellus	obtusicaudatus	(Bastian, 1865) Altherr, 1968
	Aporcelaimellus	gerlachi	(Meyl, 1956) Heyns, 1965
	Aporcelaimium	sp.	
	Aporcelaimus	sp.	
	Makatinus	sp.	
	Sectonema	sp.	
	Takamangai	sp.	
	Torumanawa	sp.	
Aulolaimoididae	Adenolaimus	sp.	
Belondiridae	Amphibelondira	sp.	
	Anchobelondira	sp.	
	Axodorylaimellus	sp	
	Axonchium	spp.	
	Axonchium	labiatum	Thorne, 1939
	Belondira	spp.	
	Belondira	tenuidens	Thorne, 1964
	Belondirella	sp.	
	Dorylaimellus	spp	
	Metaxonchium	micans	(Thorne, 1939) Andrássy 1996
	Oxibelondira	sp.	
	Oxydirus	spp.	
	Oxydirus	tenuicaudatus	Thorne, 1964
	Oxydirus	tropicus	Thorne, 1964
	Paraoxydirus	sp.	
	Qudsiella	sp.	
Carcharolaimidae	Carcharolaimus	sp.	

Table 1. (Continued) Families, genera and species detected during the nematode inventory in Costa Rican pro tected areas.

Family	Genera	Species	
	Caribenema	sp.	
Dorylaimidae	Afrodorylaimus	sp.	
	Amphidorylaimus	sp.	
	Coomansinema	spp.	
	Dorylaimus	sp.	
	Idiodorylaimus	sp.	
	Idiodorylaimus	annulatus	(von Daday, 1905) Andrássy, 1969
	Lagenonema	sp.	
	Laimydorus	spp.	
	Mesodorylaimus	spp.	
	Mesodorylaimus	mexicanus	Zullini, 1973
	Minidorylaimus	sp.	
	Opisthodorylaimus	spp.	
	Prodorylaimus	spp.	
	Prodorylaimus	obesus	Ahmad & Jairajpuri, 1982
Leptonchidae	Basirotyleptus	sp.	
	Caveonchus	sp.	
	Caveonchus	saccatus	(Goseco, Ferris & Ferris, 1981) Siddiqi, 1982
	Doryllium	sp.	
	Funaria	sp.	
	Funaria	acuta	(Zullini, 1973) Goseco & Ferris, 1976
	Meylis	sp.	
	Meylis	dicephalus	(Yeates, 1967) Goseco, Ferris & Ferris, 1974)
	Proleptonchus	sp.	
	Punctoleptus	sp.	
	Sclerostylus	sp.	
	Sclerostylus	xiphinemoides	(Monteiro, 1970) Goseco, Ferris & Ferris, 1981
	Tylencholaimellus	sp.	
	Tyleptus	sp.	
	Tyleptus	n. sp.	see Loof & Zullini, 2000
	Zetalaimus	sp.	

Table 1. (Continued) Families, genera and species detected during the nematode inventory in Costa Rican pro tected areas.

Family	Genera	Species	
Longidoridae	Longidorus	sp.	
Mydonomidae	Dorylaimoides	sp.	
Nordiidae	Actinolaimoides	spp.	
	Dorydorella	sp.	
	Echinodorus	sp.	
	Longidorella	sp.	
	Oriverutus	sp.	
	Oriverutus	asaccatus	(Dhanachand & Jairajpuri, 1980) Ahmad & Jairajpuri, 1987
Nygellidae	Nygellus	sp.	
Nygolaimellidae	Aporcelaimoides	sp.	
	Scapidens	sp.	
Nygolaimidae	Afronygus	sp.	
	Clavicaudoides	sp.	
	Laevides	sp.	
	Nygolaimium	sp.	
	Nygolaimus	spp.	
	Paranygolaimus	sp.	
	Paravulvus	sp.	
	Paravulvus	hartingii	(de Man, 1880) Thorne, 1974
Qudsianematidae	Allodorylaimus	spp.	
	Baqriella	sp.	
	Chrysonemoides	sp.	
	Discolaimium	sp.	
	Discolaimoides	sp.	
	Discolaimus	spp.	
	Epidorylaimus	spp.	
	Eudorylaimus	spp.	
	Eudorylaimus	carteri	Bastian, 1865
	n. gen	—	see Loof & Zullini, 2000
	Inbionema	n. sp.	see Loof & Zullini, 2000
	Labronema	spp.	
	Labronemella	sp.	
	Lordellonema	sp.	
	Microdorylaimus	sp.	

Table 1. (Continued) Families, genera and species detected during the nematode inventory in Costa Rican pro tected areas.

Family	Genera	Species	
	Mylodiscus	sp.	
	Pachydorylaimus	spp.	
	n. gen	—	see Loof & Zullini, 2000
	Pachydorylaimus	n. sp.	see Loof & Zullini, 2000
	Parapalus	n. sp.	see Loof & Zullini, 2000
	Sicorinema	sp.	
	Sicorinema	n. sp.	see Loof & Zullini, 2000
	Talanema	sp.	
	Thonus	sp.	
	Thorniosa	sp.	
Trachypleurosidae	Trachypleurosum	sp.	
Tylencholaimidae	Chitwoodius	sp.	
	Discomyctus	sp.	
	Rostrulium	sp.	
	Tantunema	sp.	
	Tylencholaimus	spp.	
	Vanderlindia	sp.	
	Xiphinemella	n. sp	see Loof & Zullini, 2000
Xiphinematidae	Xiphinema	spp.	
	Xiphinema	brasiliense	Lordello, 1951
	Xiphinema	ensiculiferum	(Cobb, 1893) Thorne, 1937
Diphtherophoridae	Diphtherophora	sp.	
Trichodoridae	Trichodorus	sp.	
Mermithidae	Gastromermis	sp.	
	Hydromermis	sp.	

DISCUSSION

For the first time a comprehensive nematode survey was conducted in protected areas of Costa Rica. Between 1998 and 2002, new genera and species and many re-descriptions have been published (Vinciguerra *et al.*, 1999; Loof and Zullini 2000a, 2000b; Esquivel 2000; Zullini *et al.*, 2002a; Zullini *et al.*, 2002b; Holovachov *et al.*, 2003). More than two hundred known genera have been recorded as well many nematode species. The number of specimens collected, the few taxonomists involved, and the presence of nematodes that are difficult to identify, are the main reasons why only 71% of the entire material included in this research has been identified at least to genus level. However, in spite of the taxonomic impediment, this

survey contributes to our knowledge of tropical nematode diversity.

Various procedural factors probably affect the results. The extraction method, may not have been optimal in all the cases due to the great variability of analysed substrates, and the possibility exist that some taxa were inadvertently missed. Certainly the richness of genera and species would be higher if all specimens mounted had been identified. Much taxonomic work is still necessary, as only about 7% of the collection was identified to species level.

The information compiled in this research has limited value for revealing important conclusions about nematode community structure in the ecosystems sampled. However, the great number of collected dorylaimids could be indicative of nematode community structure in undisturbed tropical environments. According to some authors (Jonson *et al.*, 1974; Zullini and Peretti, 1986; Bongers, 1990), dorylaimids are considered K-strategists in the broad sense, being very sensitive to disturbance. Our results could be partially explained by taking into account that most of the samples were collected from natural ecosystems with little or no human alteration.

The most diverse nematode order found in the rainy forest of the Korup National Park, Cameroun, was Dorylaimida (42%) (Price and Siddiqi, 1994). In our study, dorylaimids comprised almost half of collected nematodes (43.6%) and had the greatest richness of genera. The diversity of genera found in this study is one the greatest reported so far in tropical areas.

The information reported here should be very useful in the understanding of nematode communities as bioindicators (Bongers, 1990; Bongers, 1999; Bongers and Ferris, 1999; Yeates and Bongers, 1999). The taxonomic knowledge of families, genera and species is the basis for the future implementation of ecological studies on nematodes in tropical ecosystems. Costa Rica has highly valued protected areas, and efforts to understand their biological richness is a key element for preserving our natural patrimony for future generations.

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LITERATURED CITED

ANDRASSY, I. 1984. Klasse Nematoda (Ordnungen Monhysterida, Desmocolecida, Araeolaimida, Chromadorida, Rhabditida). Stuttgart, Gustav Fisher Verlag. 509 pp.

ANDRASSY, I. 1986. Fifteen new nematode species from the southern hemisphere. Acta Zoologica Hungarica 32:1-33.

ANDRASSY, I. 1989. Six new nematode species from South America. Acta Zoologica Hungarica 35:1-16.

ANDRASSY, I. 1993 A taxonomy survey of the family Mononchidae (Nematoda). Acta Zoologica Hungarica 39:13-60.

ANDRASSY, I. 1993. A taxonomy survey of the family Anatonchidae (Nematoda). Opuscula Zoologica Budapest 26:9-52.

ANDRASSY, I. 1999. A census of genera and subgenera of free-living nematodes. Journal of nematode morphology and systematics 2:45-68.

BARKER, K. R., R. S. HUSSEY., L. R. KRUSBERG., G. W. BIRD., R. A. DUNN., H. FERRIS., V. R. FERRIS., D. W. FRECKMAN., C. J. GABRIEL., P. S. GREWAL., A. E. MACGUIDWIN., D. L. RIDDLE., P. A. ROBERTS, and D. P. SCHMITT. 1994. Plant and Soil Nematodes: Social Impact and Focus for the Future. Journal of Nematology 26:127-137.

BOAG, B., and G. W. YEATES. 1998. Soil nematode biodiversity in terrestrial ecosystems. Biodiversity and Conservation 7:617-630.

BONGERS, T. 1990. The maturity index: an ecological measure of environmental disturbance based on nematode species composition. Oecologia 83:14-19.

BONGERS, T. 1999. The Maturity Index, the evolution of nematode life history traits, adaptive radiation and cp-scaling. Plant and Soil 2:13-22.

BONGERS, T., and H. FERRIS. 1999. Nematode community structure as a bioindicator in environmental monitoring. Trends in Ecology and Evolution 14:224-228.

BRZESKI, M. W., and G. WINISZEWSKA-SLIPINSKA. 1993. Taxonomy of Tripylidae (Nematoda: Enoplida). Nematologica 39:12-52.

De MAESENEER, J., and J. D'HERDE 1963. Méthodes utilisées pour l´etude des anguillules libres du sol. Revue de l´ Agriculture Bruxelles 16:441-447.

ESQUIVEL, A. 2000. First finding of *Aphanolaimus coomansi* male (Tsalolichin, 1988) in tropical areas. Nematropica 30:161-166.

GOODEY, T. 1963. Soil and Freshwater Nematodes. Second edition, revised and rewritten by J. B. Goodey. London: Methuen & Co. Ltd. 544 pp.

HUNT, D. J. 1993. Aphelenchida, Longidoridae and Tricodoridae: Their Systematics and Bionomics. CAB International. Wallingford Oxon OX10 8DE. UK. 352 pp.

HOLOVACHOV, O., A. ESQUIVEL, and T. BONGERS. 2003. Free-living nematodes from natural reserves in Costa Rica. 4 Cephalobina. Nematology 5:1-15.

JACOB, J. J´S., and J. V. BEZOOIJEN 1984. A manual for practical work in nematology. Wageningen Agricultural University. The Netherlands.

JAIRAJPURI, M. S., and W. AHMAD 1992. Dorylaimida. Free-living, Predacious and Plant-parasitic nematodes. Brill, Leiden. 458 pp.

JOHNSON, S. R., J. M. FERRIS, and V. R. FERRIS. 1974. Nematode community structure of forest woodlots. III. Ordinations of Taxonomic groups and biomass. Journal of Nematology 6:118-126.

LOOF, P. A. A., and M. LUC. 1990. A revised polytomous key for the identification of species of the genus Xiphinema Cobb, 1913 (Nematoda: Longidoridae) with exclusion of the X. americanum-group. Systematic Parasitology 16:35-66.

LOOF, P. A. A., and A. ZULLINI. 2000a. Freeliving nematodes from natural reserves in Costa Rica. 1: Dorylaimina. Nematology 2:605-633.

LOOF, P. A. A., and A. ZULLINI. 2000b. A new sp.ecies of the genus Thalassogenus Andrássy, 1973 and the systematic position of the genus (Nematoda: Oncholaimina). Annales Zoologici (Warszawa) 50:263-266.

OBANDO, V. 2002. Biodiversidad en Costa Rica. Estado del conocimiento y gestión. Santo Domingo de Heredia, Costa Rica. Instituto Nacional de Biodiversidad. 250 pp.

PRICE, N. S., and M. R. SIDDIQI. 1994. Rainforest Nematodes with particular reference to Korup National Park, Cameroon. Afro.Asia Journal of Nematology 4:117-128.

RASKI, D. J., and A. V. COOMANS. 1990. Five new species of Aphanolaimus (Nemata: Araeolaimida) with a key to species. Nematologica 36:22-54.

SEINHORST, J. W. 1959. A rapid method for the transfer of nematodes from fixative to anhydreous glycerin. Nematologica 4:67-69.

SIDDIQI, M. R. 2000. Tylenchida. Parasites of plants and insects. 2nd edition. CAB International. Wallingford Oxon OX10 8DE. UK. 833 pp.

TSALOLICHIN, S. J. 1988. Tropical nematodes – new and rare species. Trudy zoologicheskoi Instituta. Akademii Nauk SSSR. 180:59-67.

VINCIGUERRA, M. T., A. ZULLINI., and A. R. MONTEIRO. 1999. The genus Brasilaimus Lordello and Zamith, 1957 (Actinolaimida, Nematoda). Journal of Nematode Morphology and Systematics 2:23-33.

YEATES, G. W., and T. BONGERS. 1999. Nematode diversity in agroecosystems. Agriculture, Ecosystems and Environment 74:133-135.

ZULLINI, A., P. A. A., LOOF, and T. BONGERS. 2002a. Free-living nematodes from nature reserves in Costa Rica. 2. Mononchina. Nematology 4:1-23.

ZULLINI, A., P. A. A., LOOF, and T. BONGERS. 2002b. Free-living nematodes from nature reserves in Costa Rica. 3. Araeolaimida. Nematology 4:709-724.

ZULLINI, A., and E. PERETTI. 1986. Lead pollution and moss-inhabiting nematodes of an industrial area. Water, Air and Soil Pollution 27:403-410.

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