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Determination of Benthic Soil Conditions Using Nematodes: Nematode Food Web Conditions of Fish Ponds in the Lincoln and Desha Counties of Arkansas

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Abstract

We determined the health status of similar channel catfish (*Ictalurus punctatus*) ponds in Lincoln and Desha counties of Arkansas, using the nematode soil food web condition as our reference point. Soil nematodes were categorized into colonizer-persister (cp) groups, based on their life course characteristics e.g sensitivity to environmental changes, body size, etc. These cp groups represent different components of the soil food web, which in turn were indicators of soil conditions. Benthic soil samples were collected at four week intervals over a 4-month period, from 6-ponds in each county. The nematodes were extracted according to standard methods and the recovered nematode taxa grouped according to their cp values. The product of each nematode taxon was determined (mean number of individuals x cp value) and the sum of all members of a cp group constituted the biomass produced by that cp group. Nematodes of the cp-3 and cp-4 groups dominated in biomass productivity in ponds for both counties. These groups of nematodes represent structured components of a food web and therefore a healthy ecosystem. Lincoln county ponds had higher cp-3 and cp-4 biomass likely due to slightly less acidic conditions while Desha county ponds had a greater biomass of plant-parasitic nematodes. It was also found that free-living nematodes tolerate more acidic conditions than plant-parasitic nematodes, though this could also be related to more root tissues. Nematode biomass calculations could be useful in determining benthic soil food web conditions, which may provide a simple way of assessing environmental conditions and changes in Arkansas catfish ponds.

Keywords: Arkansas; fish ponds; nematode soil food web; biomonitoring; benthic soil health status; biomass.

Introduction

Soil food webs and function

The sustained productivity of Arkansas catfish ponds is directly tied to managing and maintaining the health of these aquatic environments. Regular monitoring of pond conditions is essential for profitable catfish production. Nematodes are excellent indicators of changes in environmental conditions and in some cases they are useful determinants of environmental health. Therefore nematode guilds, used as indicators of food web conditions might be valuable in monitoring the ongoing health of ponds.

The many functions of soil food webs are defined in terms of key ecosystem processes (Ferris et al., 2001). These include environmental maintenance, detoxification of pollutants, and nutrient cycling. Different nematode guilds react differently to environmental perturbations. Consequently, there exist an enrichment food web, a basal food web and three levels of structured food webs. Depending on the food web type that dominates, the health status of the aquatic ecosystem can be inferred. Knowledge of the function of the soil food web in relation to the presence and abundance of its component organisms is a basic requirement for soil stewardship (Ferris et al. 2001).

Nematodes and Biomonitoring

Nematodes are extremely abundant in almost all environments. These primarily microscopic metazoans occupy all niches that provide an organic carbon source in aquatic and terrestrial environments. Nematodes vary in their sensitivity to pollutants and environmental disturbance and their value as bioindicators of environmental conditions has been recently summarized (Bongers and Ferris 1999). Nematodes are in all soil types, under all climatic conditions, and there is a clear relationship between structure and function. Nematodes are found both in pristine environments and under extremely polluted conditions. Their permeable cuticle provides direct contact with their microenvironment, and because they occupy key positions in soil food webs, nematodes respond rapidly to disturbance and enrichment.

Natural animal taxa are composed of species with varying degrees of morphological and functional similarity; the lower the hierarchical level of the taxon, the higher the similarity. Nematode species in monophyletic families generally have similar r- or K-selected and other life-history characteristics (Bongers and Ferris 1999). Consequently, species related at the family level exhibit similar responses to environmental perturbation (Bongers 1990).

For the purpose of biomonitoring, nematodes that are particularly sensitive to perturbation, such as those in the Dorylaimidae are considered K-strategists. They are large bodied, low fecundity persisters that are relatively pollution intolerant, and have relatively permeable cuticles. Conversely, those considered r-strategists such as members of the Rhabditidae are small bodied, high fecundity organisms with relatively impermeable cuticles. They are colonizers that are relatively pollutant tolerant, that favor food rich conditions (Bongers 1999). Within the two extremes of r- and K-strategists are intermediates (Johnson et al. 1974).

Based on feeding habits and life-history, families of nematodes can be ordered on a colonizer-persister (cp) scale ranging from one (early colonizers of new resources) to five (persisters in undisturbed habitats) (Bongers 1990). The colonizer-persister (cp) scale is therefore an assignment of soil and freshwater nematodes to a 1-5 linear scale according to their *r* and *K* characteristics (Ferris et al. 2001)

Definition of Terms: *Nematode Guild Indicators of Food Web Conditions*

Food webs represent complex interactions between organisms of different trophic groups and taxa. Using nematodes, three qualitative conditions of food webs have been described and their associated nematode indicator guilds indentified.

Enrichment food web: Food webs become enriched when disturbance occurs and resources become available due to organism mortality, turnover, or favorable shifts in the environment (Odum 1985). These cp-1 nematodes are small with short generation time. They are enrichment nematodes that form dauerlarvae, and are mainly bacterial feeders (Ba_1)

Basal food web: a food web that has been diminished due to stress, due to limitation of resources, adverse environmental conditions, or recent contamination. Nematode guilds present are those adapted to stress conditions and represent the cp-2 class of the MI (maturity index). They are predominantly bacterial scavengers (Ba_2) and fungal feeders (Fu_2). Both the Ba_2 and Fu_2 guilds are also present in all other food web classes and have been categorized as general opportunists (Bongers 1999). The MI is the weighted mean frequency of the cp classes (Bongers 1990). It expresses the proportional representation of nematode families as an index of environmental condition.

Structured Food webs: Food webs in which resources are abundant or where recovery from stress is occurring. Such webs are more specious than the basal condition and there are more trophic links and elements of community structure apparent (Ferris et al. 2001, Wardle and Yeates 1993, Wardle et al. 1995). With time, maturation and a lack of environmental perturbation, the degree of structure may increase as indicated by a continuum of nematode guilds that represent cp classes 3-5. Indicator guilds of rudimentary community structure are the larger bacterivore nematodes (Ba_3), larger fungivore nematodes (Fu_3) and small carnivore nematodes (Ca_2, Ca_3). With greater structure in the community, more links in the food web, nematode predation and multitrophic interactions occur (Ferris et al. 2001). The nematode indicators are large carnivore nematodes (Ca_4), smaller omnivore nematodes (Om_4), and the largest fungivore nematodes (Fu_4). Environmental stability and homeostasis results in the highest levels of community structure. Indicator guilds include the largest carnivore nematodes (Ca_5) and the larger omnivore nematodes (Om_5).

Plant parasitic nematodes are not included in the cp scale for environmental monitoring because their presence is dependent primarily on the root tissues of higher plants. However, plant parasitic nematode families are also arranged on the cp scale based on body size and other life characteristics and they constitute guilds $Pl_2 – Pl_5$ (Bongers 1990, Bongers and Korthals 1995, Bongers et al. 1997, Yeates 1994). Plant-parasitic nematode data collected and grouped into cp-values are eventually related to soil conditions, when transformed to biomass units.

Cp values and nematode body sizes

Nematodes of the family Rhabditidae tend to be relatively small (Bongers 1999, Bongers and Ferris 1999). Nematodes of this family are in the cp-1 group. The cp-2 group is composed of the smaller tylenchids, mainly feeding on epidermal cells; the fungal feeding aphelenchoids and anguinids, and the bacterial feeding cephalobids, plectids, and monhysterids (Bongers and Bongers 1998).

The cp-3 group of nematode is composed of the bacterial feeding teratocephalids, the Araolaimida and Chromadoria; the larger tylenchid nematodes that feed on deeper cell layers in the roots; the diphtherophorids, and the carnivorous tripylids (Bongers and Bongers 1998).

The cp-4 nematode group is comprised of small dorylaimids and large non-dorylaimds. This group is composed of larger carnivores, bacterial feeding Alaimidae and Bathyodontidae, the smaller dorylaimid nematodes, and the plant feeding trichodorids (Bongers and Bongers 1998).

The cp-5 nematode group is composed of the larger dorylaimid: omnivores, predators, and plant feeders. Nematodes of this group are of the largest body sizes (Ferris et al. 2001, Bongers and Bongers 1998)

From the above, it is clear that body size is one of the main factors taken into consideration during cp-scaling of nematodes. However, Bongers (1999) notes that body size is no objective criterion on which to scale nematodes from colonizers to persisters. There are small-sized persisters (Longidorella, Microdorylaimus, Dorydorella) which never exceed 1mm in length and never rich the length of the most extreme opportunists (e.g. members of the Rhabditidae, Panagrolaimidae and Diplogasteridae). Absolutes in biological structure, function, and behavior are rare if not non-existent, for any designated biological taxon. The small-sized persisters noted by Bongers (1999) could therefore be considered the exceptions as opposed to the rule. If a nematode sample excludes these exceptions then it is reasonable to assume that cp-scaling has an approximate relationship to the body size of the nematode.

Biomass is living tissue and the amount of biomass possessed by an organism is a measure of the amount of living tissue produced i.e., its productivity. A small bodied organism will produce less biomass as compared to a relatively larger organism. This is especially true when the organisms compared are of the same bio-architectural design, for example, nematodes versus nematodes, mites versus mites, etc, and also that these organisms are in the same ecological environment. Based on this, the success or abundance of a group of organisms could be measured based on the amount of biomass contributed to its microenvironment as opposed to its numerosity. The abundance of a nematode cp group could therefore be determined by measuring its biomass produced in its microenvironment.

Purpose of this Investigation

Pond fish farming is a major agricultural industry in Lincoln and Desha Counties in Arkansas as well as in many other counties of the state. Some of these ponds were established decades ago using varying management practices. While pond owners continue to harvest fish, it is difficult to predict the sustainability of production in these ponds. Sustained productivity of their farming enterprises is dependent on the healthiness of the ecosystem in which the fish are grown.

Nematode faunal diagrams have been proposed as a way of using nematode food web structure in determining environmental conditions (Ferris et al. 2001). Our main objective was to study the feasibility of using nematodes as bioindicators of the health status of fish ponds in Lincoln and Desha counties using nematode food web conditions as our indicators. We intend to use biomass units (*bu*) derived from food web structure and their cp values to determine the conditions of the fish ponds investigated. Biomass units will be calculated by multiplying the number of individuals in a cp-class times their cp-values.

Based on their cp values nematode food web types could be enriched (cp-1), basal (cp-2), rudimentary structured (cp-3), structured (cp-4), and stable structured (cp-5). Structured food webs are indicators of a healthy ecosystem. A dominance of any of the food web types enumerated above will therefore be an indication of the soil conditions. We determined the conditions of commercial fish ponds in two counties, based on these qualitative conditions of soil nematode food webs.

Materials and Methods

Study sites and fish farm management.

The fish ponds studied were located in Desha and Lincoln counties of Arkansas. These are neighboring counties, Lincoln being to the east of Desha. The Desha soils are described as mostly poorly drained, pH 6.6-7.3, and organic matter content of 0.5-4.0; while the Lincoln soils are mainly soils of loessial plains, poorly drained, with a slightly acidic pH, and organic matter content of 0.4-4.2 (Scott et al. 1998).

A total of 12 similar fish ponds were investigated six from each county. The selection of the ponds was based on permission by the farmers. The ponds were commercial channel catfish (*Ictalurus punctatus*) ponds of approximately 12 acres in surface area and an average of 4 ft in depth. All of the ponds are 10-20 years old. The ponds are not drained for harvest and so they are filled year round with fish. They are however, drained and reshaped every 5-7 years.

The management of the Desha ponds is intensive, stocking mixed sizes at about 10,000 fish/acre and feeding at over 100 lb/acre/d using 32% floating pellets during warm weather (above 21°C). Fish in these ponds were fed 12-times during the summer. The Lincoln county ponds though similarly managed were stocked at 8500 fish/acre and fed at a lower frequency of nine-times in the summer. In the winter, all the ponds are fed only during relatively warm periods.

Benthic soil sample collection and nematode extraction

Sampler design: Benthic soil samples were collected using a corer sampler of the authors' design. Basically, the sampler was a 1.5 m long PVC cylindrical tube with a core diameter of 8.5 cm and 30 cm from the distal end was perforated with drain holes. A 1.75 m long wooden plunger, with a PVC disk of diameter 8.2 cm attached at the proximal end, was used to remove the soil core from the tube. The sampler size was designed to fit clear, plastic screw top sample jars. With a 1.5 m height, the sampler can be used either from shore or from the water.

Benthic soil samples were collected from each pond for 4 months (December- March). The samples were collected at 4 week intervals. Four samples were collected from each pond during each sampling period, with one sample from each of the four corners of the pond. Samples were collected to a depth of 15-20 cm and 1.5 m away from the shore. There were therefore 4-composite samples for each pond, during each sampling period. The temperature of the soil samples was determined in the field and the pH in the laboratory.

In the laboratory, individual composite soil samples were homogenized and mixed. A 50 ml subsample was used for pH determination and 100 ml was used for recovery of nematodes. Nematodes were recovered using a combination of sieving, decanting and Baermann funnels. The sample for the nematode assay was suspended in 10 L of water. Clumps were dissolved by hand. The mixture of soil and water was stirred and left to settle for 30-50 seconds, then the supernatant was decanted through a 60 mesh sieve and the trapped debris was washed lightly into the filtrate. The collected filtrate was further stirred and left to settle for another 30-50 seconds and then the supernatant was decanted through a 400 µm mesh sieve. The soil retained on the 400 µm mesh sieve was transferred onto a Baermann funnel assemblage and incubated for 72 hr (Barker 1985). After the incubation period, 15 ml of each sample was tapped and the total number of nematodes was counted irrespective of guild or taxon. The sample was then concentrated by centrifugation and the supernatant removed except for 0.5 ml containing the concentration of nematodes. This was used to make a temporary slide, and the nematodes were identified to family, genus, and species where possible. At least 100 nematodes were identified from each temporary slide and this number adjusted to the total count for the sample obtained during the nematode quantification count (Ferris and Matute 2003).

Analysis of Data

With very few exceptions, cp-scaling of nematodes uses as one of its main criterion, the body size of the nematodes. Thus a cp-5 nematode is larger than a cp-3 nematode and a cp-1 nematode is smaller than a cp-4 nematode, etc. The exceptions noted by Bongers (1999), were not recorded in our investigation. We are proposing an alternate use of cp values that makes the following assumptions-a) the cp values assigned to nematode taxa are directly related to their body sizes, b) body sizes are related to and are a measure of biomass content i.e. amount of living tissue or matter, and c) that the dominant cp group in any ecosystem will produce the most biomass i.e. its productivity. For example, if cp-2 or stress tolerant nematodes produce the most biomass-then we conclude that the food web is stressed and therefore of poor health status, while on the other hand if cp-3-5 groups produce the most biomass, then we conclude that the food web is structured and there fore healthy and stable.

Biomass productivity was calculated by multiplying the cp value x the number of individuals in that cp group irrespective of guild or taxonomic designation. For example, if we recovered 257 individuals in a sample in the cp-3 group, then the cp-3 biomass productivity in that sample will be 3 x 257 = 771*bu* (biomass units).

We were interested only in using biomass measurements to compare cp groups and county ponds. Our interest was also focused on the overall picture, as opposed to pond to pond differences or time of sampling. The values used in calculating the biomass produced in Tables 1 and 2 were mean values. For example *Mesorhabditis* in Table 1, the 33.8 is the mean of 6-ponds and the mean of 4-sampling periods. The biomass productivity was calculated as 33.8 x 1 = 33.8 *bu*. The 33.8 was therefore the biomass contribution of this taxon in its microenvironment. The same reasoning was applied to all the other taxa.

Results

Biomass productivity and food web nature in Lincoln and Desha counties

The data collected for the Lincoln and Desha counties are presented in Tables 1 and 2. Each table is subdivided into 5-parts, each representing a nematode colonizer-persister (cp) group. Within each cp group, the biomass contributed by each nematode taxa is indicated, it's feeding guild, and food web designation (e.g. Ba_1). The total biomass productivity of each cp group and its percentage total are also indicated.

Sixteen nematode genera were recovered from Lincoln County ponds (Table 1). The nematodes from the cp-3 group contributed the most biomass, accounting for 37% of the total nematode biomass produced, and the cp-2 group nematode taxa contributed 33.9% of (Table 1), biomass produced in the Lincoln County fish ponds.

The nematode cp groups percentages in Table 1, includes nematodes that are sensitive to environmental changes for example the cp-1 group (enrichment nematodes) and the herbivores (Pl-dependent on root tissues). When these groups of nematodes (denoted as

Table 1: Mean number of nematodes per 100ml benthic soil samples from fish ponds in Lincoln County. The number of nematodes is means of 24 samples (samples collected at 4 week intervals from six ponds). The nematodes are grouped according to their colonizer-persister (cp) values. The biomass value of each genus is the product of its mean number and cp value.

Nematode family	Nematode taxa	Mean no.	cp value	Biomass productivity in biomass units *(bu)*	Response Guild*
Rhabditidae	*Rhabditella*	17.8	1	17.8	Ba_1
Rhabditidae	*Rhabditis*	29.4	1	29.4	Ba_1
Panagrolaimidae	*Panagrolaimus*	68.4	1	68.4	Ba_1
Rhabditidae	*Mesorhabditis*	33.8	1	33.8	Ba_1
Diplogasteridae	*Diplogaster*	18.5	1	18.5	Ba_1
Diplogasteridae	*Demaniella*	31.6	1	31.6	Ba_1
Part 1	6-Genera		subtotal	cp-1 = 199.5**	**8.3%**
Cephalobidae	*Cephalobus*	71.1	2	142.2	Ba_2
Cephalobidae	*Acrobeloides*	46.4	2	92.8	Ba_2
Tylenchidae	*Tylenchus*	99	2	198	Fu_2
Aphelenchoididae	*Aphelenchoides*	94.3	2	188.6	Fu_2
Tylenchidae	*Psilenchus*	99	2	198	Fu_2
Part 2	5-Genera		subtotal	cp-2 = 819.6	**33.9%**
Prismatolaimidae	*Prismatolaimus*	105.2	3	315.6	Ba_3
Pratylenchidae	*Pratylenchus*	17.5	3	52.5**	Pl_3
Part 3	2-Genera		subtotal	cp-3 = 368.1	**15.2%**
Dorylaimidae	*Timmus*	78.9	4	315.6	Om_4
Dorylaimidae	*Mesodorylaimus*	22	4	88	Om_4
Mononchidae	*Mylonchulus*	122.3	4	489.2	Ca_4
Part 4	3-Genera		subtotal	cp-4 = 892.8	**37%**
Longidoridae	*Xiphinema*	27.1	5	135.5**	Pl_5
Part 5	1-Genus		subtotal	cp-5 = 135.5	**5.6%**
Total	16-Genera			cp1-5 = 2415.5	

*Designation of nematode taxa according to feeding guilds and environmental sensitivity
** Excluded from environmental sensitivity considerations

** on Table 1) are excluded, we are left with the following biomass values: cp-2 = 819.6*bu* (40.4%), cp-3 = 315.6*bu* (15.6%), and cp-4 = 892.8*bu* (44%). Nematodes in the cp-3 and cp-4 groups (55.6% total) represent structured food webs as opposed to nematodes in the cp-2 group (40.4% total) that are indicators of a basal food web condition.

Thirteen nematode genera were recovered from the Desha county ponds and nematodes from the cp-5 group contributed the most biomass, accounting for 29% of total productivity (Table 2). The cp-4 group of nematodes made up 27.8% of the total biomass of nematodes.

The nematode biomass in the Desha County ponds includes both enrichment and plant-parasitic nematodes (Table 2). These nematode types, are normally excluded during environmental sensitivity considerations and when these groups (denoted as ** in Table 2) were excluded, we are left with the following biomass values: cp-2 = 154*bu* (24.1%), cp-3 = 150.3*bu* (23.5%), and cp-4 = 336*bu* (52.5%).

Nematodes in the cp-3 and cp-4 groups (76% total) represent structured food web conditions as opposed to the nematode taxa in the cp-2 group (24.1% total) that are indicators of basal food web conditions.

A qualitative and quantitative comparison of nematode taxa and biomass productivity in the Lincoln and Desha fish ponds

There was similarity in the history and construction of the Lincoln and Desha fish ponds. While their management was also similar, the Lincoln County ponds were less intensively stocked (8500 fish/acre), while the stocking rate was 10,000 fish/acre for the Desha County ponds. Also, the fish in the Lincoln County ponds were fed 9-times in the summer versus 12-times for the Desha County ponds.

a. ***pH***: For the duration of the investigation, the mean pH value for the Lincoln County was 5.3 and that for the Desha County 5.9.
b. ***Number of nematode taxa***: Up to 16 nematode genera were recovered from the Lincoln County ponds as compared to 13-genera from Desha County.
c. ***Total nematode biomass****:* Two times as much nematode biomass was produced in the Lincoln County ponds as compared to the Desha County ponds. Biomass productivity is the amount of living matter that nematodes produce in their microenvironments. The total biomass of the individual nematode taxa recovered from the Lincoln County ponds was 2415.5*bu* as compared to 1207.6*bu* for the Desha County ponds.
d. ***Environmentally sensitive nematode taxa****:* These are nematode taxa that respond to changes in their immediate microenvironments and therefore can be useful as indicators of benthic soil conditions. Three such groups of nematodes; cp-2, cp-3, and cp-4, were found in Lincoln and Desha County ponds. In our investigation, 5.3, 2.1, and 2.7 times greater total nematode biomass was produced in the Lincoln County ponds than in the Desha County ponds for the cp-2, cp-3, and cp-4 indicator nematode groups, respectively.
e. ***Herbivore Nematodes (Pl)****:* These are the plant parasitic nematodes whose presence is always associated with root tissues of higher plants. As a general rule, plant parasitic nematode genera are not included as indicators in environmental conditions studies. The two genera found in this investigation were *Pratylenchus* (Pl_3/cp-3) and *Xiphinema* (Pl_5/cp-5). *Xiphinema* was the only cp-5 group nematode recovered in this investigation. The total biomass for herbivorous nematodes was greater in Desha County than in Lincoln County ponds.

Discussion

Biomass productivity and the nature of the food web

For ponds in both the Lincoln and Desha counties, nematode taxa included members of all colonizer-persister (cp) groups from cp-1 to cp-5. This is evidence of a speciose food web with multitrophic linkages. In such food webs nematode predation and multitrophic interactions occur that results in environmental stability and homeostasis (Ferris et al. 2001).

Biomass productivity values were not based on the number of individuals per taxa but rather the 'actual' contribution to living matter in a community of biotic organisms. Thus we were able to determine what fraction of the total biomass in a nematode community was contributed by each group by determining the product of mean values of individual members and their cp values. We were therefore able to precisely indicate the biomass contribution of each cp group, which gives us a rough idea as to the nature and condition of the food web. For example in Lincoln County, the cp-1 nematode group constituted 8.3%, cp-2 group 33.9%, cp-3 group 15.2%, cp-4 group 37%,

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Table 2: Mean number of nematodes per 100ml benthic soil samples from fish ponds in Desha County. The numbers are means for 4 months from six ponds. The extracted nematodes are grouped according to their colonizer-persister (cp) values. The biomass value of each genus is the product of its mean number and cp value.

Nematode family	Nematode taxa	Mean no.	cp value	Biomass productivity in biomass units *(bu)*	Response Guild*
Rhabditidae	*Rhabditella*	26.8	1	26.8	Ba_1
Panagrolaimidae	*Panagrolaimus*	71.9	1	71.9	Ba_1
Rhabditidae	*Mesorhabditis*	22.7	1	22.7	Ba_1
Diplogasteridae	*Demaniella*	17	1	17	Ba_1
Part 1	4-Genera		subtotal	cp-1= 138.4**	**11.5%**
Cephalobidae	*Acrobeloides*	20.3	2	0.6	Ba_2
Aphelenchoididae	*Aphelenchoides*	32.4	2	64.8	Fu_2
Tylenchidae	*Psilenchus*	24.3	2	48.6	Fu_2
Part 2	3-Genera		subtotal	cp-2 = 154	**12.8%**
Prismatolaimidae	*Prismatolaimus*	50.1	3	150.3	Ba_3
Pratylenchidae	*Pratylenchus*	26.3	3	78.9**	Pl_3
Part 3	2-Genera		subtotal	cp-3 = 229.2	**19%**
Dorylaimidae	*Timmus*	40.4	4	161.6	Om_4
Dorylaimidae	*Mesodorylaimus*	21.3	4	85.2	Om_4
Mononchidae	*Mylonchulus*	22.3	4	89.2	Ca_4
Part 4	3-Genera		subtotal	cp-4 = 336	**27.8%**
Longidoridae	*Xiphinema*	70	5	350**	Pl_5
Part 5	1-Genus		subtotal	cp-5 = 350	**29%**
Total	13-Genera			cp 1-5 = 1207.6	

*Designation of nematode taxa according to feeding guilds and environmental sensitivity
** Excluded from environmental sensitivity considerations

and cp-5 group 5.6%. The bulk of the biomass was produced by cp 3-5, which are nematode guilds that indicate structured food webs and therefore stable environmental conditions.

Comparing Lincoln and Desha counties

The benthic soil samples of the Lincoln County fish ponds were slightly more acidic (pH 5.3) than the Desha ponds (pH 5.9). This difference is attributed to either fish pond management practices and (/or) their soil types. The Lincoln ponds were less intensively stocked and the fish fed at a lower frequency than the Desha ponds. Increased fish population density and increased fish feed introduced into the ponds may have increased the alkalinity of the ponds due to organic compounds.

The Lincoln County ponds had a greater number of nematode genera and higher biomass values than the Desha ponds, so it is possible that the more acidic conditions support higher nematode biomass productivity and greater nematode taxa diversity.

The nematode groups recovered in this investigation were cp-2, cp-3, and cp-4. A dominance of cp-2 nematodes indicates stress in the environment and possibly a polluted environment (Bongers 1990, Ferris et al. 2001), while a dominance of cp-3 and cp-4 nematodes is an indicator of increasing community structure, conditions that are associated with more healthy environmental conditions. In our study, the higher cp-3 and cp-4 biomass values in the Lincoln County ponds implies that the Lincoln County ponds are healthier than the Desha County ponds.

Herbivore nematodes are normally not included in environmental sensitivity considerations because their presence is always associated with root tissues of higher plants. In our investigation, the Desha County recorded higher herbivore biomass values than the Lincoln County ponds. This is attributed to greater plant root tissues and a lesser tolerance for acidic conditions by these plant-parasitic nematodes.

Conclusions

The ponds investigated in both counties appear to be healthy from an environmental perspective. Constant monitoring is however recommended to anticipate near or long term changes that could negatively affect fish production.

The acidity or alkalinity of fish ponds is affected by the fish stocking density and frequency of feeding among other factors. This in turn likely affects nematode abundance and community structure. Greater acidic conditions are favorable to the populations of free living nematodes, while lesser acidic conditions are favorable to herbivorous nematodes.

Calculating and using nematode diversity and biomass appears to have some promise in determining soil food web conditions and may provide a simple way of assessing environmental conditions and changes in commercial fish ponds in the Arkansas Delta.

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