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Vertical Distribution of the Lesion nematode: *Pratylenchus*species in Selected Turf Fields in Rivers State, Nigeria.

S. O. Nzeako,[1]H. O. Imafidor, [2]Ogwumba, E[3].andEzenwaka, C.O.[4]
[1,2,]*Department of Animal and Environmental Biology, University of Port Harcourt, P.M.B.5323,Choba, Rivers State, Nigeria.*
[3]*Department of Biological Sciences, Faculty of Science, Federal University of Otuoke,Bayelsa State, Nigeria.*

Abstract:*The vertical distribution of Pratylenchus species in ten (10) designated turf fields (Sites A- J) in Obio/Akpor L.G.A., Rivers State, Nigeria was determined using randomly collected soil samples. Collection of soil samples was achieved using a soil corerat depths of 0-5cm, 6-10cm and 11-15cm. The modified Baermann's method was used to extract nematodes from the soil samples. There was variability in depth related occurrence of nematodeshowever, abundance and species diversity was highest atthe 0-5cm depth and declined as depth increased (P>0.05). The study indicated that the rich content due to natural processes and the undisturbed status of the study sites influenced the vertical assemblage of Pratylenchus species at the depth range of 0-10cm. Specific parasitism sustained the population of specialist herbivores;P.thornei, P. branchurus and P. zae. However, P. penetrans and P. fallax occurred at relatively high populations at all depths indicating adaptation to variable ecological conditions. The undisturbed status of the turf fields influenced the species richness and the relatively even distribution of nematodes in the study. Trophic affiliation and specific biotrophyof Pratylenchus spp. influenced thevertical distribution, species abundance and richness of the wormsin the study.*

Keywords:*Vertical Distribution, Abundance and Species diversity, Specific parasitism, Specialist herbivores, Variable ecological conditions, Trophic affiliation.*

I. Introduction

Nematodes are well adaptedto both the aquatic and terrestrial ecosystems but their adverse effects are profound in the terrestrial environment where some of them are successful pests and parasites of animals and plants (Manzanilla-Lopez and Hunt, 2004). Their deleterious impacton field crops (cash and ornamentals) and stored farm products; yam and potato tubers etc. complement the scourge of *Plasmodium* spp. in perpetuating poverty in sub Saharan Africa (Addison, 2014, Eze*etal*., 2014, Nzeako*etal*., 2014 and 2015). Environmentally, nematodes assume a key position in the numerous ecosystem processes that stabilize both the aquatic and soil ecosystems (Sudhaus, 1981, Ferris, *etal*., 1996, Neher, 2000, Ferris and Matute, 2003 and Ferris *etal*.,2006).Amongst the ecosystem stabilizing processes nematodes are involved include;parasitism, energy dynamics, carbon mineralization and other nutrient cycles (Manzanilla-Lopez and Hunt, 2004). The ubiquitous nature of nematodes and their rapid response to disturbances in the environment accentuate their indicator value in relation to aquatic or soil biomes functioning (Goralczyk, 1998; Bongers and Ferris, 1999; Ekschmitt*etal*., 2001, Diemont*etal*., 2006).

Pratylenchus species of nematodesisareamong the few pathogenic migratory endo-phytoparasites that deplete the productivity of economically important crops in cultivation. This Genus of nematodescomprise relatively worms of moderate sizes typical of plant nematodes (less than 1mm), however, their migratory behaviour usually result in extensive damage of the root systems of crops (Corbett, 1973, Freckman, 1982, Sim,1990, Crow, 2012).*Pratylenchus*species of nematodeshave a wide host range worldwide and are not restricted by seasonality, crop cycle and soil type. Some species of the lesion nematode exhibit hydrobiosis in dead tissues that help them circumvent the biotrophic limitation that halts the reproductive potential of most endophytic nematodes (McSorley, 2003,Smiley, 2015).The feeding pattern of the parasite on plant tissues leaves characteristic rills of injuries (lesions) on the epidermal parts of the plants (Williams *et al*., 2002, McSorley, 2003). Chlorosis is a common aerial non-specific symptom ofnematodes whichhampers photosynthesis and fruitionin plants.Reduction in the leaf size and number are also key indicators of heavy infections of *Pratylenchus*Spp. in turf fields which resultto the characteristic patchy appearance of infected fields (Farsi, 1996, Tenuta and Ferris, 2004, Castillo and Vovlas, 2007,Nzeako*etal*., 2013, Smiley, 2015).

The evolving nature of the million dollar hospitality, sports and tourism industries have made the nurturing of extensive turf fields very aristocratic and a huge source of revenue to owners. The pivotal role nurtured turfs play in hospitality business, sports and entertainment industries cannot be over emphasized and any agents that deteriorates its integrity is view as an enemy. As obligate biotrophs, this genus of nematodes feed and multiply in plant tissues and the rhizosphereduring the rapid growing season which concedes with the wet, warm season in Nigeria. In the temperate regions, this active multiplication period falls within spring and fall(Moseley *et al*., 2014). Interestingly, *Pratylenchus* spp. of nematodes exhibit hydrobiosis in dead tissues or in dry conditions and experience enhanced multiplication at the return of favourable conditions (McSorley,2003, Smiley, 2015). This characteristic distinguishes *Pratylenchus* spp. from other nematode specialist herbivores.

The aetiology of disease in plant is multi-faceted,however, the establishment of nematodes in any plant is usually exploited by bacteria and fungi whose synergy aggravatesthe disease condition(Moseley *et al*., 2014).Although, nematode control alone cannot guarantee the perfect health of the turf grass but early diagnosis and elimination of risk factors that encourage plant parasitic nematodes'establishment will always reduce the incidences of opportunistic bacterial and fungal infections that aggravate disease condition in turf grass. It is obvious that temporal conditions always leave a toll oncrop growth and development, thus, influencing theirspatial distribution. However, the incidences of plant parasitic nematodes in Nigeria stem from myriads of factors such as; the misdiagnosis of nematode infestation in turf fields, poor cultural practices in agro-settings, unstable edaphic conditions and nutrient deficiencies (Moseley *et al.*, 2014).

The gross inadequacy in trained nematologistsand the errant negligence of nematological inputs in plant disease control programs in Nigeria is a lacuna that encourages the spread of nematodes in agro-systems. This negligence results in the apparent patchy and bald states of almost all economically important grassed fields in Nigeria. Aesthetically, bald appearances of turf fields in Nigeria constitute visual pollution and a sense of incompetence in management of natural resources on the part of those in authority.

In viewof the deleterious effects of plant parasitic nematodes especially*Pratylenchus* Spp. on turf fieldsand other agro-settings, thisstudy aims at determining the species diversity and vertical distribution of *Pratylenchus* species of nematodes in selected turf fields in Obio-Akpor Local Government Area of Rivers State, Nigeria.

II. Materials And Methods

Study Area and Sampling sites

The study area is within Obio/Akpor Local Government Area of Rivers State of Niger Delta, Nigeria which is within the metropolitan Port Harcourt city. The Local Government Area covers an area of 260km^2 with a population of 878, 890peopleaccording to the Nigeria National Census (2006). Geographically, Obio-Akpor is situated within latitude 4.83˚N and 6.99˚E.Ten designated sites sampled in the study area include; the Cricket Pitch: University of Port Harcourt- 4.899˚N and 6.918˚(Site A); the football field: Olobo Premier College, Choba-4.896˚N and 6.912˚E (Site B); the football field: State Primary School, Alakahia-4.887˚N and 6.926˚C (Site C); the football field: State Primary School, Rumuosi-4.883˚N and 6.941˚E (Site D); the football field: State Primary School, Rumuokoro-4.866˚N and 6.997˚N (Site E);the football field: State Primary School, Nkpolu Oroworukwo-4.807˚N and 6.988˚E designated (Site F); the main football field: Rivers State University of Science and Technology-4.803˚N and 6.986˚E(Site G); the football field: Rivers State College of Art and Science, Rumuola- 4.83˚N and 4.834˚ (Site H); the football field: State primary School, Ozuoba- 4.872˚N and 6.930˚ E (Site I) and the football field: State Primary School, Choba- 4.893˚N and 6.905˚ E;(Site J). None of the sites had a recent history of chemical fertilization or nematicide application.

Collection of Samples

The soil samples were collected randomly with the aid of a calibrated soil corer. The samples were collected from the designated sites at depths of 0-5cm, 5-10cm and 10-15cm respectively. The samples were put into properly labelled polythene bags to prevent dehydration. A total of 600 samples were collected, 60 from each location and were taken to the laboratory for extraction of nematodes.The samples from each site were combined and subdivided in five sets. Nematodes in the sets of soil samples were extracted using the modified Bearmann's extraction technique (Beaker *et al*., 1970; Nzeako*etal*., 2014) while identification was according to Goodey (1969) using the compound and stereoscopic microscope.

Data Analysis

Data was analysed using Analysis ofVariance (ANOVA) while the ShannonWiener Diversity Index was used toanalyse nematodes community dynamics.

III. Results

The ten study areas yielded a total of three hundred and fifty nine (359) nematodes of the genus *Pratylenchus* belonging to 10 different species (Table 1.). Out of these 43 (12.0%) nematodes extracted from site A were five (5) *Pratylenchus*species. Site B had a total 31(8.6%)nematodesbelonging to five *Pratylenchus*species. Site C yielded a total of 34 (9.5%) nematodes comprising four different *Pratylenchus*species. A total of 40 (11.1%) nematodeswere obtained from site D containing five different *Pratylenchus* species. In site E, seven *Pratylenchus* species were obtained from a total of 39 (10.9%). A total of twenty 24 (6.7%)nematodes were seen in site F comprising six (6) *Pratylenchus*species. In site G, five

*Pratylenchus*species were recovered from a total of 46 (12.8%). The 29(8.1%) nematodesobtained from site H constituted five *Pratylenchus*species. Site I had a total of 38 (10.7%) nematodes comprising five species while site J had four species of *Pratylenchus* out of the 35 (9.7%) worms were extracted (Figure 1).

Table 1.,Overall population of *Pratylenchus* species in the sampled Sites

Nematode diversity	Overall population of Pratylenchus Spp. in the sample Areas (%)										Population density (%)
	Site A	Site B	Site C	Site D	Site E	Site F	Site G	Site H	Site I	Site J	
P. brachyurus	7(16.3)	0	0	0	8(20.5)	0	2(4.3)	7(24.1)	0	0	24(6.7)
P. crenatus	0	0	0	19(47.5)	7(17.9)	0	0	0	0	0	26(7.2)
P. fallax	2(4.7)	12(38.7)	4(11.8)	8(20.0)	5(12.8)	1(4.2)	13(28.3)	9(31.0)	17(44.7)	11(31.4)	82(22.8)
P. goodeyi	0	4(12.9)	0	0	0	4(16.7)	0	2(6.9)	0	0	10(2.8)
P. minutus	0	0	6(17.6)	0	0	0	0	0	4(10.5)	0	10(2.8)
P. neglectus	0	9(29.0)	0	0	4(10.3)	0	10(21.7)	0	6(15.8)	0	29(8.1)
P. penetrans	18(41.9)	0	8(23.5)	2(5.0)	8(20.5)	3(12.5)	2(4.3)	3(10.3)	0	5(14.3)	49(13.6)
P. scribneri	6(13.9)	2(6.5)	0	7(17.5)	4(10.3)	5(20.8)	0	0	6(15.8)	9(25.7)	39(10.9)
P. thornei	10(23.3)	4(12.9)	0	0	0	7(29.2)	0	0	0	0	21(5.8)
P. zeae	0	0	16(47.1)	4(10.0)	3(7.7)	4(16.7)	19(41.3)	8(27.6)	5(13.2)	10(28.6)	59(16.4)
Total (%)	43(12.0)	31(8.6)	34(9.5)	40(11.1)	39(10.9)	24(6.7)	46(12.8)	29(8.1)	38(10.6)	35(9.7)	359

Table 2., Depth related occurrence of *Pratylenchus* Spp. and species diversity

Nematode diversity	Depth related occurrence of *Pratylenchus* Species (%)			Population density (%)
	5-10	10-15	15-20	
P. brachyurus	17(39.5)	14(32.6)	12(27.9)	43(11.97)
P. crenatus	18(5.8)	7(19.3)	6(19.3)	31(8.63)
P. fallax	19(55.9)	8(23.5)	7(20.6)	34(9.47)
P. goodeyi	20(50.0)	9(22.5)	11(27.5)	40(11.14)
P. minutus	16(41.0)	15(38.5)	8(20.5)	39(10.86)
P. neglectus	14(58.3)	5(20.8)	5(20.8)	24(8.61)
P. penetrans	22(47.8)	12(26.1)	12(26.3)	46(12.81)
P. scribneri	15(51.7)	12(41.4)	2(6.9)	29(8.07)
P. thornei	16(42.1)	15(39.5)	7(18.4)	38(10.58)
P. zeae	12(34.3)	12(34.3)	11(31.4)	35(9.74)
Total (%)	169(47.07)	109(30.36)	81(22.56)	359

Depth related Density and Diversity

There was great variability in depth related occurrence in the study. However, depth related density in the study showed that the 77.43% of the nematodes occurred at depth range of 0-10cm with the 0-5cm (Figures, 2-5) depth having the highest density of nematode which declined as depth increased in the study (Table 2). The study revealed that vertical distribution in the study was statically significant ($P<0.05$).The study showed high species richness and diversity with ten (10) species recorded from all sites (Figure 5). However, the depth related prevalence varied with the 0-5cm depth having all species, the 5-10cm having 8 species while 9 species were recovered from the 10-15cm core depth (Figures 2-4.). Relative abundance of the nematodes species showed that that *P. penetrans*46(12.81%) was more abundant at in the study followed by *P.brachyurus* 43(11.97%),P.goodeyi40(11.44%)andP.minuta39(10.86%)(Table2)

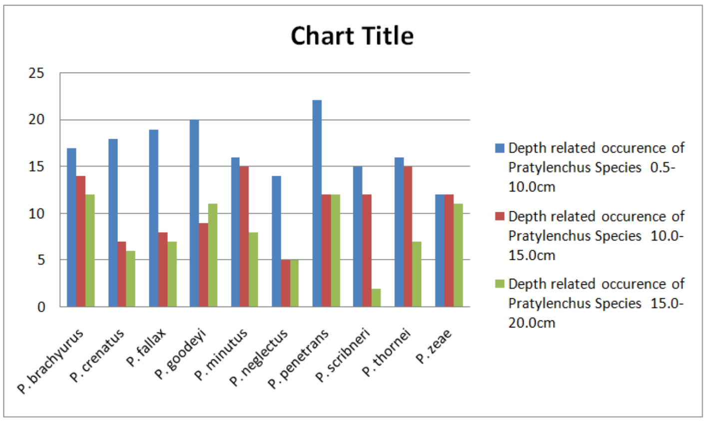

Figure 1., Depth related prevalence in the study

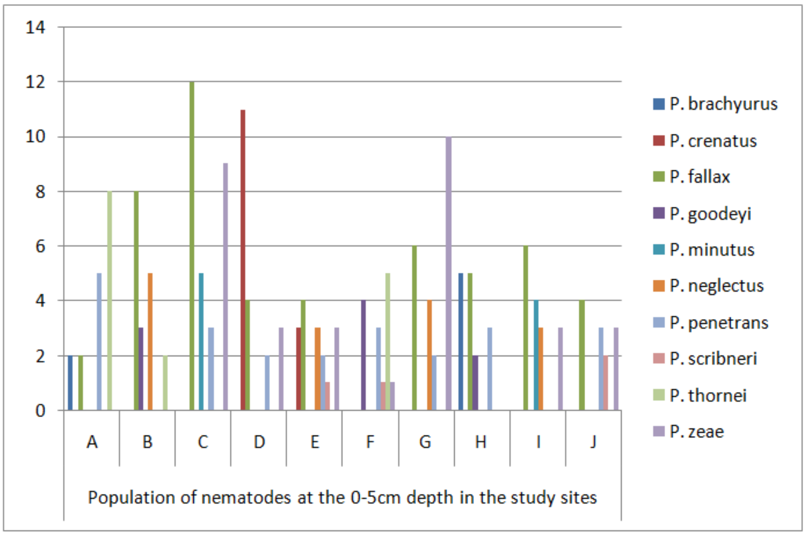

Figure 2., Variability in nematode population at the 0-5cm depth

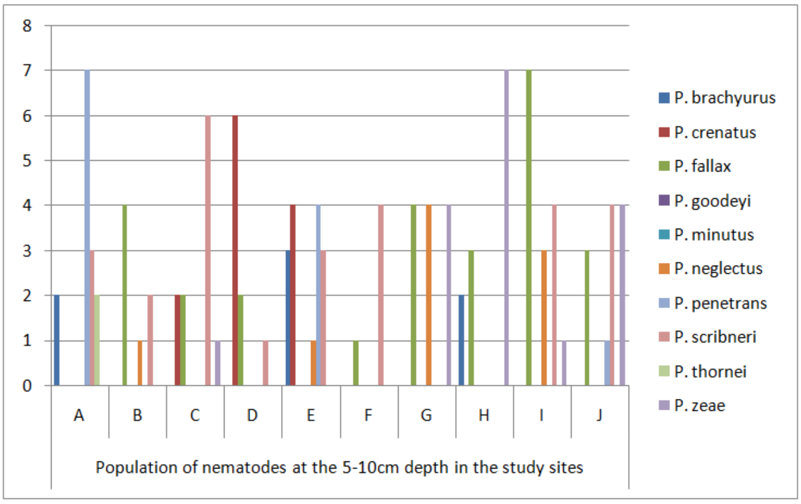

Figure 3., Variability in nematode population at 5-10cm dept

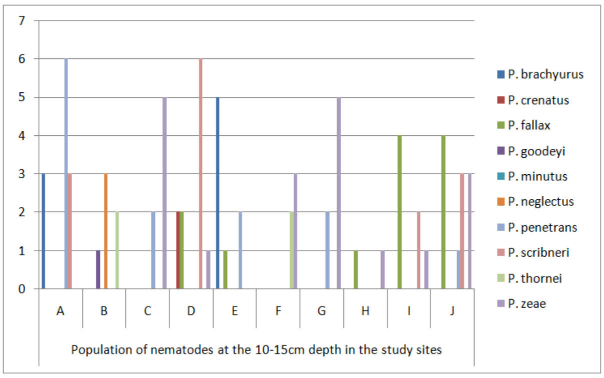

Figure 4., Variability in Nematode Population at the 10-15cm depth.

The Species richness in the study was high, however, the site specific diversity showed that site E had the highest richness (7); followed by site G (6). Sites C and J had the lowest species diversity (4 each) while the remaining sites had species richness of 5. The study showed even distribution of nematodes as Species evenness (E) of the various study sites ranged from 0.84-0.96 (Figure 5.). This pattern of species dynamics was associated to the undisturbed status of the fields sampled which encouraged the build-up of *Pratylenchus* species. This observation also supported the postulations of Nakamato*etal*., (2006) andNzeako*etal*., (2014) who stated that systems that turn the soil continuously without adequate replacement of soil organic matter bring about reduction in the densities soil meiofauna. In this context even though, the fields were relatively undisturbed in terms of cultivation, the natural enrichment was inadequate as it solely depended on natural defoliation.

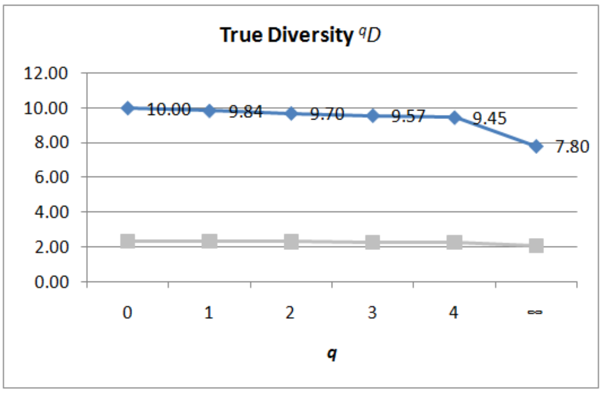

Figure 5., The Diversity indices showing the population dynamics *Pratylenchus* Spp. in the study.

IV. Discussion

In this study a total of 169*Pratylenchus* species occurred at the 0-5cm depth; 109 from the 5-10cm depth and 81 from the 10-15cm depth. This showed a progressive decline in abundance and diversity of *Pratylenchus*species as depth increased in all the study sites; a pattern which was not statistically significant (P<0.05). The variability in vertical distribution of nematodes in the study wasattributed to the stimulatory influence of the root exudates on the*Pratylenchus* species juveniles and humus enriched top soil (Table 2). The pattern of nematode assemblage in the study indicates the close association trophic affiliation have in the distribution of soil nematode meiofauna (Nzeako*et al*., 2014).Although, no strategic soil enrichment was administered on the study sites, their undisturbed status ensured that litter accumulation and mineralization processes consistently enriched the top soil thus accounting for the 77.43% of recovered nematodes(Table 2).Amongst the recovered *Pratylenchus* species the specialist feeders and strong biotrophs assemblages occurred within the 0-15cm depth range as observed in the populations of *P.goodeyi*, *P.brachyurus* , *P. thornei* and *P. zea*.The concentration of specialist herbivores at this trophic level indicates enrichment pulse which supports the build-up of*Pratylenchus* spp. and others colonizer nematodes which are outside the scopeof this study(Sudhaus 1981, Ferris *etal*., 1996, Ferris and Matute, 2003, Ferris and Bongers, 2006).

In this study, *Pratylenchus* species abundance and species diversity seemed to be influenced by undisturbed status of the fields. Agricultural practices such as tilling and cropping were out of the myriad of anthropogenic activities considered since the fields were play grounds or lawns groomed for recreation, sports and aesthetics. However the spatial distribution in terms of vertical spread was strongly associated with the soil organic constitution at specific study sites (Bongers*et al*., 1991, McSorley, 2003, Smiley, 2015) not ruling out the physic-chemical parameters of the specific sites.

The study revealed that the variability in *Pratylenchus*species community composition observed in the various study sites were intrinsically connected with cultural practice at the respective sites. In this context, site E had relatively the highest *Pratylenchus* species, not specifically due to the high organic composition of the soil but perhaps due to the diversity in the vegetation. The disparity in the *Pratylenchus* species richness in relation to specific study areas underscored the impact of anthropogenic influences on flora and fauna integrity in a habitat. The study revealed the fallow or undisturbed status of the turf influenced abundance and species richnessof the *Pratylenchus* species. Vertical distribution of the parasites in the various study sites and at theconsidered depths were greatly influenced by the endemic vegetation and anthropogenic disturbances (sports, agriculture e.t.c.) irrespective of the ambient physicochemical characteristics (Latour and Reiling, 1993, Rushton etal., 2004 and Breureetal., 2005). According to Muldera, (2005), the *Pratylenchu*s species in the study displayed increased ecosystem stability due to poor management of the habitats. Ferris etal., (2001), stated that the enrichment opportunistic nematodes respond positively to disturbances at any level of the environmental quality making them very important indicators of soil fertility and not pollution indicators (Muldera 2005). However, the stable vegetation sustained the nutrient status of the fields but not an enrichment pulse. It is observed that enrichment pulses stimulate heterotrophic succession where time related organismal changes occur based on prevailing biotic factors, trophic affiliation, life course dynamics and prevailing environmental conditions (Sudaus 1981, Ferris and Matute,2003, Ferris *et al*., 2006)

V. Conclusion

The decline in *Pratylenchus*species and abundance in relation to depth in the study is associated with nutritional affiliations of the *Pratylenchus*species, the degree of anthropogenic interference and the physiological characteristics of the parasites i.e. hydrobiosis in dead tissues. Species richness and evenness were greatly impacted by the relative absence of disturbances such as tillage hence allowing the fields to lie fallow in most cases and in turn influencing the abundance of specialist herbivores such *Pratylenchus* species with great host specificityvertically.

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