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Reports on Aquatic Oligochaetes (Naididae) In Paddy Fields of Moodabidri Taluk, Dakshina Kannada, South India

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ABSTRACT

The objectives of the study was to record the occurrence and abundance of microdril earthworms in the paddy field in and around Moodabidri (Dakshina Kannada), south India. 74 submerged paddy fields were surveyed during October/ November 2011 and February /March 2012. Three species namely *Aulophorus vagus*, *Aulophorus furcata* and *Dero digitata* belonging to the family Naididae were reported in 12 paddy fields for the first time from India. *A. furcata* was recorded in 8 paddy fields, *D. digitata* was sampled in 6 paddy fields, where as *A. vagus* was found only in one paddy field. The diversity of naidid worms increased with algal abundance, rotting materials, natural manures, nitrate, phosphorus and potassium in the paddy fields indicating that the algal cover is a significant factor with respect to abundance of species studied. The very high density of naidid worms particularly *A. furcata* was found to be due to a budding occurred during favorable condition in submerged paddy fields. Sexual reproduction seems to be adopted in these worms in response to soil desiccation. Density of naidid worms was found to improve growth conditions in the paddy.

Keywords: Naidid, Oligochaeta, D.K. district, Algae, Rotting material.

1. Introduction

Aquatic oligochaetes (microscopic earthworms belong to Phylum: *Annelida* and Class: *Oligochaeta,* Family: Naididae) have been mainly studied in lakes [9, 10, 11]. Including aquatic oligochaeta, the macro-invertebrate community is an important trophic level in wetland systems, providing food for several wildlife species, such as fish and waterfowls [15]. They are a major component of the invertebrate fauna of submerged paddy soils [13]. Oligochaetes in paddy soils accelerate NH_4^+ and N release from overlying water and soils as well as PO_4^{3-} release [4]. Under laboratory conditions, aquatic oligochaetes promote nutrient mineralization and suppress weed germination [4]. Therefore, although the organisms are of small size, aquatic oligochaetes may play a substantial role in plant growth in paddy fields [5]. Recent papers have indicated that mineral and organic fertilizers, and other agricultural chemicals, affected the population of Oligochaeta in paddy soils; inorganic N fertilizer increased their population density [14], whereas compost and organic fertilizers increased oligochaete density to a greater extent than inorganic fertilizers [4]. Agricultural chemicals have bilateral effects showing an increase or decrease in numbers of oligochaetes [12]. When flooding paddies without using chemicals, the population density of aquatic oligochaetes was seven times higher than during conventional agriculture [3]. Tillage practice, which disturbs paddy soils physically, is an important soil management strategy, and is used in concert with fertilizers and other agricultural chemicals. The effect of tillage on the population density of oligochaetes has not been so far investigated. Almost all published papers are concerned with microdrils belonging to family Tubificidae, but very few with Naididae.

While tubificid worms reproduce sexually, most naidid worms reproduce asexually by rapid budding of zooids under favorable conditions [6, 7]. The asexual reproduction of naidid is seemed to be influenced by availability of aerated unpolluted water, organic rich conditions, suitable temperature and sunlight. The amounts of legumes applied were highly correlated with the population of *Dero dorsalis*, indicating that the weight of legume is a limiting factor with respect to carrying capacity [17].

Despite numerous laboratory tests, few studies have examined oligochaete population density, geographical distribution, species composition, and population dynamics in paddy fields [14]. Even though significance of megadril oligochaetes in paddy field is known since ancient times, the report of microdril oligochaetes in the paddy field is not available from India. Hence, the present study attempts to record the occurrence of microdrils in the selected paddy fields in and around Moodabidri (Dakshina Kannada), south India.

2. Materials and Methods
Moodabidri is located 31 kilometers northeast of Mangalore (13°4'11"N 74°59'50"E). The field survey was conducted in 74 paddy fields (PAD), from four villages in the Moodabidri Taluk: They included, Ervail (PAD; 1-25), Venur (PAD; 26-50), Puttigae (PAD; 51-65) and Gurupura (PAD; 66-74).The climate is tropical and in most months of the year, there is significant rainfall. There is only a short dry season and it is not very effective. The average annual temperature is s 26.6 °C. About 4530 mm of precipitation falls annually. The warmest month of the year is April-May, with an average temp. of 28.9 °C, and the lowest average temp. of the whole year (25.3 °C.) is in July-August. The sampling was done in the month of October/ November 2011 and February /March 2012 in the selected submerged paddy fields.

Fig 1: Paddy field-one of the sampling sites

Oligochaete populations were sampled in 3-4 different sites in each paddy field by collecting 10 cm^3 of water along with algae. The conditions of paddy fields like presence of natural manure, and chemical fertilizers were also observed. The bottles were labeled with date and the place of collections. The worms were not found in the paddy field with clear water. The algae were screened extensively and the moving worms were detected by naked eye. Worms were also found to be moving on the inner surface of the lid. After 2-3 hours these bottles were taken to the laboratory for the worm identification. Worms were collected using droppers and preserved in 4% formalin solution. Specimens were temporarily mounted using Amman's Lactophenol (Phenol, Lactic acid, Glycerol, and water in the ratio of 1:1:2:1). 2-4 specimens were placed on the slides containing two to three drops of medium and covered with cover slips.
The microdriles were observed and morphometric details were recorded. The microphotographs were taken under compound microscope. The species were identified by using the keys of Brinkhurst [1], and Naidu [8].

Water quality analysis was also done from the paddy field in which the microdriles were collected. Nitrate, Phosphorus and Potassium was analyzed using the standard titration method.

3. Results
Three species of microdril earthworms namely *Aulophorus furcatus* Muller, 1773, *Aulophorus vagus* Leidy, 1880. and *Dero digitata* Muller, 1773 were collected in different paddy fields having different physicochemical conditions. Of the 74 paddy fields surveyed only in 12 paddy fields (PAD-15; PAD-23; PAD-35; PAD-42; PAD-46; PAD-49; PAD-54; PAD-56; PAD-65; PAD-64; PAD-67; PAD-70;) these microdrils were present. The details are given in the Table.
The results on the physicochemical properties of the water sample collected from the paddy fields have shown the range as pH 6.8 to 7.2, the temp. 27 °C to 29 °C, the nitrate 0.6 to 2.34 mg/l, phosphate 3.5 to 7.5 mg/l, and potassium 0.9 to 4.8 mg/dl.

Aulophorus furcatus Muller, 1773
Aulophorus furcatus Muller, 1773; *Nais furcata* Müller, 1773, *Dero furcata,* Stieren, 1892; *Aulophorus furcatus* Stephenson, 1914; Michaelsen, 1933 ; Brinkhurst and Jamieson, 1971; *Dero (Aulophorus) furcatus* Sperber, 1948.
Diagnosis: Length: 4-20 mm; Segments: 45; Prostomium: bluntly triangular. Eyes are absent; *Setae*: dorsal setae begin in V segment, each bundle with one hair like setae of 140- 150 µm. long and one bifid needle setae, 50-54 µm long with distal nodules. Ventral setae 4-5 per bundle decreasing to 2 in the posterior, the 2 segment with median nodules; *Bronchial fossae:* posterior ends with 3-4 pairs of cylindrical gills and parallel palps.
World distributions: Cosmopolitan. Earlier reported from Kashmir (Naidu and Naidu, 1979), Europe and North America (Milligan, 1998).

Fig 2: ***Aulophorus furcatus***- Anterior region-regenerating

Fig 3: ***Aulophorus furcatus***- Posterior region

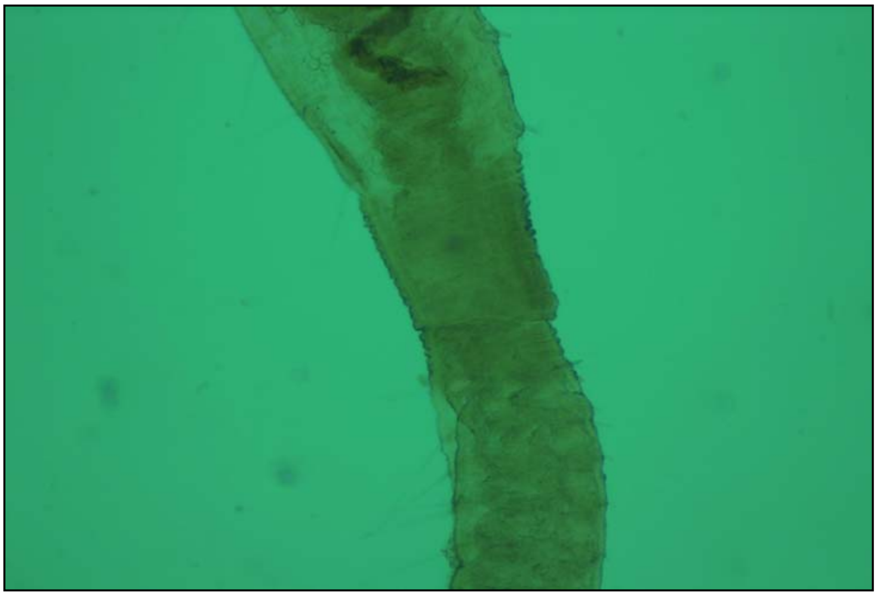


Fig 4: Budding zone- ***Aulophorus*** *furcata*

Aulophorus vagus **Leidy, 1880.**
Diagnosis: *Length*: 5-10 mm; *Segments*: 24-60. Dorsal chaetae present from segment VI, bundle composed of 1-3 hairs and 1-3 palmate needles. Ventral setae all bifid, those of II-V longer and straighter than rest with upper tooth up to 2 times the length of the lower, 7-14 per bundle; from VI upper tooth shorter and thinner than lower, 4-7 per bundle. *Bronchial fossae:* with one pair of small ventral gills and strongly diverging palps.
World distributions: Reported in Australia (Pinder, 2007).

Dero digitata Muller, 1773.
Dero digitata Muller, 1773; *Nais digitaa (coeca)* Muller, 1773; *Dero (D.) digitata* Sperber,1948.
Diagnosis: Length: 6.8 mm; *Segments*: 58; *Prostomium*: triangular, rounded at apex, without proboscis; Eyes are absent; *Color*: body without pigmentation; *Setae*: dorsal chaetae present from segment VI, each bundle consisting of one hair setae of 140- 150 µm. Long and one bifid needle setae 78-98 µm long . Ventrally, chaetae from segment II-V, 4-5 bifid chaeta, 160 µm long, with very long teeth, distal tooth slightly longer than proximal. Gills present, 3-4 pair, on last posterior segment without palps with bronchial fosses.
World distributions: Earlier reported from Washington (Smith, 1984). The species is found from the northeastern states and provinces south to Tennessee, then west to Kansas, Texas, and California, and then north to the southern tier of Canadian provinces. Recorded also from Europe and North America (Milligan, 1998), West Indies (Righi and Hamoui, 2002) and Netherland (Verdonschot *et al*., 2007).

Fig 5: *Dero digitata*-Anterior region

Fig 6: *Dero digitata*-Posterior region

Fig 7: *Aulophorus vagus*

4. Discussion

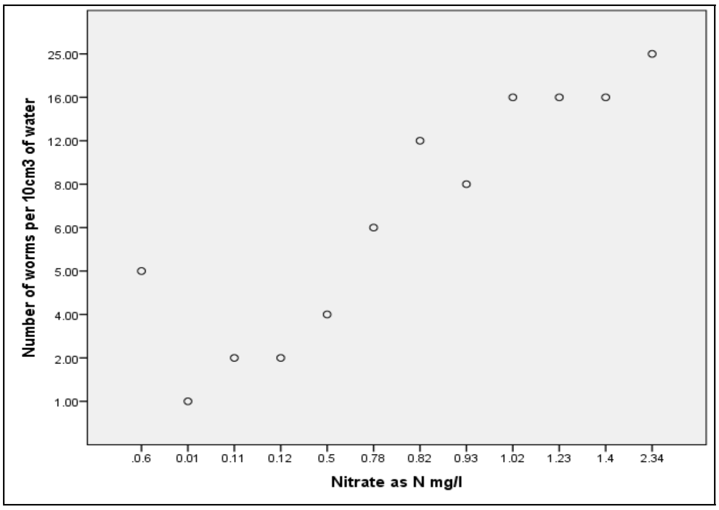
The species density in the paddy field showed positive correlation with nitrogen, phosphorous and potassium. This study confirms that the abundance of oligochaetes increases with the concentration of nitrate, phosphate and potassium in the paddy fields. Additions of mineral N stimulated the development of oligochaete populations [2]. The oligochaete abundance in water bodies was found to be influenced by availability of sunlight, algae, rotting observed with pH and temperature of water on the population density of naidid worms.

It is evident that there is rapid asexual reproduction in the submerged paddy field. Budding zones were detected in *A. furcata*. *A. vagus* is the first report from the India and was found only in one paddy field in a single tubular nest. Therefore, the present study reports that the density of aquatic oligochaetes would depend on simultaneous growth of algae and rotting materials which was materials. We could not find the microdril in paddy field where algae were scarce and farm yard manures were not added and pre-harvesting-dry paddy fields and treated with agricultural fertilizers and pesticides. Flood water management is the most important determinant of aquatic oligochaete population dynamics [14]. The decrease in population density caused by soil paddling can be reversed [16]. However, there was no significant correlation

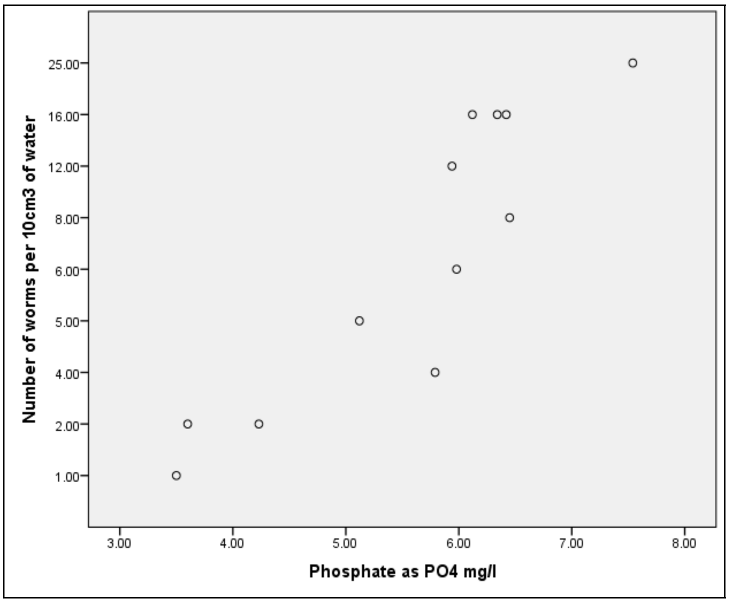
added to paddy field by means of farm yard manure. This directly signifies the biofarming in paddy cultivation in terms of long term sustainability and yield. The formation of a protective cocoon that could endure the period of stress would allow the population to recover once favorable environmental conditions return [7]. Most naidid worms reproduce asexually by budding zooids under favorable conditions [6].

Table 1: Distributions of oligochaetes in different conditions of paddy fields in the study area *Aulophorus furcatus* (Sp.A); *Aulophorus vagus* (Sp.B); *Dero digitata* (Sp. C)

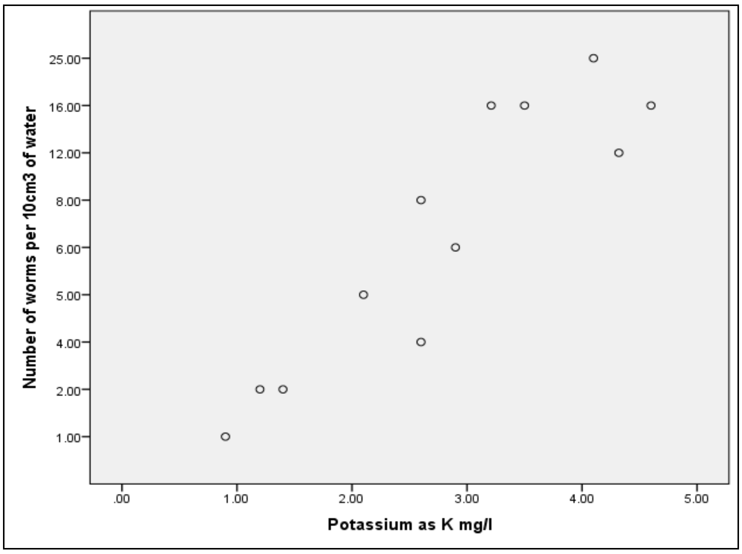
Paddy Fields	Natural manure	Algal cover
PAD-15		Sp. B
PAD-23		Sp. C
PAD-35		Sp.A; Sp.C
PAD-42		Sp.C; Sp.A
PAD-46		Sp.A
PAD-49	Sp.A	
PAD-54	Sp.A; Sp.C	
PAD-56	Sp.A	
PAD-65	Sp.A; Sp.C	
PAD-64		Sp.A
PAD-67		Sp.C
PAD-70		Sp.A



A. Graph showing the abundance of naidid worms in relation to the nitrate of the water sample.



B. Graph showing the abundance of naidid worms in relation to the phosphate of the water sample.



C. Graph showing the abundance of naidid worms in relation to the potassium of the water sample.

5. Conclusions

Research on aquatic oligochaetes in the paddy fields will contribute to a better understanding on the significance of organically farmed paddy fields and studying ecological risks of spraying agricultural chemicals. This study allows the assessment of ecological risks, for example, when non-target aquatic oligochaetes are lost as a result of use of agricultural fertilizers and pesticides. Further research is necessary to clarify the ecosystem function of aquatic oligochaetes in organic agriculture. This preliminary report further raises the scope for the study of crop yield in microdril rich paddy fields and laboratory techniques of microdril cultures. Due to short lived submerged condition of paddy field, the detection of asexual reproduction in the wet condition raises further scope to study its life cycle in other dry conditions of the same paddy field.

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