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A PRELIMINARY STUDY OF THE OLIGOCHAETES (ANNELIDA) IN A MATURE SPHAGNUM PEAT ON-SITE WASTEWATER TREATMENT SYSTEM

HARVASUKAMATOJEN ESIINTYMISESTÄ RAHKATURPEESTA VALMISTETUSSA JÄTEVEDEN SUODATTIMESSA

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The earthworms *Eisenia foetida* and *Lumbricus rubellus* and unidentified juveniles were recovered from a stable, *Sphagnum* peat on-site wastewater treatment system studied at Orono, Maine, U.S.A. over a 13 month period. The oligochaetes had a heterogeneous distribution in the filter although they did show a preference for the mid and upper layers. The temperature and pH regimes in the filter did not appear to influence the distribution of the worms.

Key words: peat, oligochaetes, Annelida, wastewater treatment

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INTRODUCTION

The microbiology of sewage and sewage treatment systems has been the subject of considerable study since the 1920's. The majority of these studies have centered on municiple systems such as the activated sludge or trickling filter processes (Curds & Hawkes 1975). These man-made ecosystems are kept in equilibrium by the component biota: bacteria, fungi, protista and a variety of invertebrates, notably oligochaetes, nematodes and arthropods, maintaining the system in an aerobic balance. A change in this balance frequently results in an impervious, bacterial slime layer forming which clogs the interstices and prevents the free passage of fluids through the trickling filter. This slime layer is either resistant to degredation by the bacteriovors or is synthesized faster than it can be degraded (Thomas et al. 1966). The importance of oligochaetes in the efficient operation of wastewater treatment systems by cropping the microorganisms is widely recognized (Solbe 1975, Harper et al. 1981, Hartenstein et. al. 1984).

Studies have largely ignored an alternative method of sewage treatment, the on-site soil adsorption system. A *Sphagnum* peat-based unit for treating domestic wastewater has been studied at the University of Maine since 1978 (see Brooks, 1980 to 1987). During this time the unit has performed efficiently and no clogging or anaerobic disfunction has occurred. This study was conducted to ascertain the oligochaete component in this unit as it is generally assumed that these worms are a prime factor in maintaining the microorganisms in balance.

MATERIALS AND METHODS

An on-site peat wastewater treatment system (Brooks et al. 1983) which has consistantly provided a high quality effluent was studied. Septic tank effluent was applied to the peat filter, 19 m long, 4.8 m wide and approximately 1 m deep, by gravity feed through three 10 cm diameter, perforated pipes and the treated effluent exited the system through an underdrain pipe for final disposal in the surrounding native soil.

Sample collection:

Cores, 5 cm in diameter, were extracted from along the midline of the filter system: A) 1 m from the influent end, B) mid point, and C) 1 m from the effluent end; and a 2,5 cm thick section was taken from each core at Level 1, 12 ± 4 cm, Level 2, 35 ± 5 cm and Level 3, 70 ± 5 cm below the surface. A set of nine sections was taken at 1800 ± 1 hours during the first week of each month from January 1984 to January 1985 inclusive. Each section was immediately placed in a polybag, stored at 5°C and sorted within the following three days. The temperature of each section was recorded prior to removal of the core using an Omega thermocouple temperature probe; a Cole-Palmer Digi-sense pH meter was used to determine pH of the sections immediately upon removal of the sections from the cores.

Sample examination:

Samples were carefully teased apart into fragments one fifth the size of the smallest oligochaete while being examined under a dissecting microscope at ×10 magnification. Fifteen small oligochaetes were abitarily selected from the total study collection and prepared for microscopical examination. The specimens were dehydrated in graded water: ethanol solutions, cleared in xylene, infiltrated in Canada Balsam and mounted on a microscope slide under a cover-glass. Gut contents were observed in each specimen and identified on the basis of the remaining hard parts i. e. cell walls.

The filter in the treatment system being studied was quite small in size and in constant domestic use, therefore the destruction which would accompany a scientifically desirable sampling regime could not be permitted. Inactivation of the system could have occurred if a larger sample size had been used to obtain earthworms, and at least three replicates had been collected per location; or if formaldehyde solution had been applied to the surface of the peat filter to assess earthworm population (Baker 1985). The fluid flow pattern could not be followed by using low concentrations of radioactive or fluorescent markers as peat readily adsorbs these materials, and higher concentrations would negatively affect the microbiological treatment of the applied wastewater.

RESULTS AND DISCUSSION

The numbers, locations and times of the oligochaetes recovered from the sections of peat are expressed in Table 1. Occasional specimens of the earthworms *Lumbricus rubellus* and *Eisenia foetida* were collected and measured from 5 to 10 cm long. Isolated cocoons were recovered from samples of peat and tentatively identified as those of *E. foetida* (Edwards & Lofty 1976), but the numbers were not recorded. The majority of oligochaetes obtained measured 1.5 to 2.0 cm long, and were all identified as juvenile (sexually immature) members of the Enchytraeidae. No explanation can be given for the apparent absence of juvenile lumbricids. The genitalia forms an important component in the taxonomic keys and so identification of the juvenile worms below family level was impossible.

Juvenile worms were present throughout the year and prefered Levels 1 and 2. Their distribution was shown to be highly heterogeneous, e. g. one record consisted of 107 specimens while the usual maximum number would be 20 and the expected number, where present, would be below 5. A microscopical examination of the juvenile worms showed that the alimentary canal always contained a substantial quantity of fungal hyphae and amorphous material which was interpreted as bacterial "gloea". This is consistant with the well established function of cropping the populations of microorganisms to keep them virile (Solbe 1975) and in particular with the observation on enchytraeids by Reynoldson (1939). The well fed juvenile worms were found in greater numbers than the mature worms in this study. This is again consistant with the observations on enchytraeid worms from the sewage bed study by Reynoldson (1947) and coniferous forest soil study by O'Connor (1958). Their explanation for this phenomenon is that most of the worms do not reach maturity. The earthworm population near the top of the filter, Level 1, was also influenced by regular, nightly foraging by racoons (*Pryrocyon lotor*) and skunks (*Mephitis mephitis*) when the surface of the filter was not frozen.

The temperature was recorded for each section over the study period and it varied from 0 °C to 25 °C at level 1 and from 1 °C to 20 °C at level 3. The over-all pH range was 3.5 to 6.2, although during the majority of the year the range was 4.0 to 5.3. However, neither the

Table 1: Number of immature enchytraeids and other oligochaetes found in samples collected at 1800 ± 1 hr, January 1984—January 1985.

Taulukko 1: Nuorten änkyrimatojen ja muiden harvasukumatojen määrä näytteissä tammikuusta 1984 tammikuuhun 1985. Näytteet kerätty 18.00 ± 1 tunnin aikana kolmesta kohtaa (A, B, C) ja kolmelta syvyydeltä (1, 2, 3) suodattimesta.

Site	*JAN*	*FEB*	*MAR*	*APR*	*MAY*	*JUN*	*JUL*	*AUG*	*SEP*	*OCT*	*NOV*	*DEC*	*JAN*
A1	1	0	0	0	2	0	7	14	19	0	0	0	0
B1	0	3	6	7	0	1	0	16	5	5	14	3	3+ 1 L.sp
C1	0	107	0	4+ 1 *L.r.*	0	0	6	1	2	2	3	2	6
A2	2	0	2	0	2	0	0	0	17+ 1 EW	0	4	2	13
B2	1	4	3	0	0	1	2	1	2	0	3	1	1+ 1 EW
C2	0	0	0	1	0	0	1	0	0	1 *E. f.*	2	0	0
A3	0	1	0	0	0	0	0	1	0	0	0	0	3
B3	1	1	0	0	0	0	0	0	0	0	1	1	0
C3	0	0	0	0	0	0	0	0	0	0	0	0	0

EW = earthworm, *kastemato*, *E. f.* = *Eisenia foetida*, *L.* sp. = *Lumbricus* sp., *L.* r. = *Lumbricus rubellus*

temperature nor the pH seemed to have any effect upon the distribution of the oligochaetes and the peat system remained efficient throughout the year.

CONCLUSIONS

The results from this study have shown that two species of earthworm and juveniles are present and that the populations have a heterogeneous distribution throughout the filter. The temperature and pH regimes monitored do not seem to have any influence on the distribution of the oligochaetes. Based on this preliminary study it will be possible to design a future study to obtain larger and replicate samples without imparing the efficiency of the system and for the oligochaetes to be extracted using the Baermam funnel method.

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TIIVISTELMÄ:

HARVASUKAMATOJEN ESIINTYMISESTÄ RAHKATURPEESTA VALMISTETUSSA JÄTEVEDEN SUODATTIMESSA

Työssä on tutkittu harvasukamatojen (Oligochaeta, Annelida) esiintymistä rahkaturpeesta valmistetussa jäteveden pien-suodattimessa yhden vuoden aikana. Suodattimen pituus on 19 m, leveys 4,8 m ja syvyys n. 1 m. Se on toiminut moitteettomasti vuodesta 1978 lähtien. Suodattimesta otettiin kerran kuussa näytteet yhdeksästä kohdasta: jäteveden tulo- ja lähtökohdista sekä keskeltä suodatinta kolmesta kerroksesta (12 ± 4 cm, 35 ± 5 cm ja 70 ± 5 cm pinnasta). Näytteet analysoitiin mikroskoopin alla (10× suurennos) ja niistä määritettiin harvasukumatojen (änkyrimadot ja kastemadot) määrät.

Suurin osa harvasukamadoista oli nuoria immatuureja. Niitä esiintyi läpi vuoden kuitenkin niin, että ne suosivat kahta ylintä kerrosta. Hyvin syöneitä immatuureja matoja löytyi selvästi enemmän kuin alkukypsyyden saavuttaneita, matuureja, matoja. Matojen ruoansulatuskanavista löydettiin aina melkoiset määrät sienirihmastoa ja bakteeriaineistoa.

Satunnaisesti tavattiin myös *Lumbricus rubellus* ja *Eisenia foetida* -lajien kastematoja. Myös niiden munia tavattiin, mutta niiden määrää ei laskettu. Jotta olisi saatu tarkka arvio kastematojen määrästä, olisi täytynyt kerätä suurempia näytteitä useimmin toistoin tai käyttää formaldehydiä suodattimien pintakerroksessa. Kumpaakaan ei voitu tehdä, koska suodatin oli jatkuvassa käytössä, eikä sen toimintaa voitu vaarantaa näytteiden otolla.

Näytteistä mitattiin myös lämpötila ja pH. Lämpötilä vaihteli 0—25 °C tasolla 1 ja 1—20 °C tasolla 3. pH:n vaihteluväli oli 3,5—6,2, ollen kuitenkin pääosan välillä 4,0—5,3. Lämpötilalla tai happamuudella ei todettu olevan vaikutusta harvasukamatojen esiintymiseen, ja suodatinsysteemi toimi läpi vuoden.

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