FINAL REPORT

COMPARISON BETWEEN THE SENSITIVITY OF ENCHYTRAEIDS AND LUMBRICIDAE TO CHEMICALS, IN PARTICULAR PLANT PROTECTION PRODUCTS

A Report to EFSA

CFT/EFSA/PPR/2008/01
Lot 3

Nicholas Jarratt and Helen Thompson[1]

Environmental Risk Assessment Team,
Environmental Risk Programme,
The Food and Environment Research Agency
York YO41 1LZ
UK

August 2009

[1]Tel 44 1904 462515; Fax 44 1094 462111; email Helen.Thompson@fera.gsi.gov.uk

1. SUMMARY

1. Lumbricidae and Enchytraeidae are members of Oligochaeta in the phylum Annelida. Both are common in agricultural soil and usually inhabit the upper layers of soil and are therefore exposed to pesticides. Enchytraeidae are a family of small (1-40 mm) oligochaete worms distributed worldwide in a variety of habitats. Enchytraeids are often found in soils where earthworms are scarce (the opposite is rare).
2. *Eisenia fetida,* a Lumbricidae species, is recommended in various guidelines (OECD, ISO) as a standard test organism for the terrestrial environment. However, *E. fetida*, is not a true soil living earthworms and occurs almost exclusively in compost heaps. Therefore soil-dwelling species of the genus *Enchytraeus* could be a more suitable alternative because they are ecologically more relevant.
3. Species of the genus *Enchytraeus* also offer practical advantages as test organisms as they are easy to handle and breed. The most commonly used (and recommended in the OECD guideline) is *Enchytraeus albidus*. For the enchytraeids the test duration is 4-6 weeks, depending on the *Enchytraeus* species used, compared with the 8 weeks (20 weeks, including synchronization time) used in the earthworm test; smaller amounts of soil are necessary, and there is minimal experimentation between start and evaluation of the test, making the test less expensive. However, before a change in testing species can be recommended there is a need to assess the relative sensitivity of the two families.
4. The set of search terms was selected to identify suitable literature on the toxicity of organic chemicals to Enchytraeidae and Lumbricidae and databases searched for the study. In addition EFSA's Pesticide Risk Assessment Peer Review (PRAPeR) published draft risk assessments were searched for existing data. The database was searched for duplicates which were removed and the cleaned database transferred to EndNote. The literature was evaluated systematically and the criteria for including or excluding the references stated. All studies that were identified as potentially useful were evaluated to assess their reliability. Reliability covered the inherent quality of the test relating to the test methodology and the way the performance and results of the test were described.
5. Of particular concern for Enchytraeids and Lumbricidae is the effect of soil structure and pH on the results of studies and therefore where available for non-standard tests this was reported and only directly comparable data used. The comparable data were identified based on similarity of soil type tested and endpoint once the validity was established.
6. The information from previous reports and the review of 'new' literature was combined to provide an overview of the toxicity of chemicals in Enchytraeidae and compared with Lumbricidae.
7. Where population level data, e.g. from terrestrial model ecosystems (TMEs) or field studies were available and valid the information were collated separately as supporting data and compared.

8. The data for chemicals tested in both Enchytraeid and Lumbricid species in similar soil types were extracted and summarized. Based on the comparable data the most sensitive Enchytraeid species were compared with the most sensitive Lumbricid species for each chemical for which both were reported. This comparison was made for the acute LC50, the reproduction NOEC and the reproduction EC50. Comparison of the sensitivity of Enchytraeids and Lumbricidae between chemicals was difficult because the tests are not comparable in their duration, the lifecycle length varies between species and therefore affects exposure, and/or soil type differs between chemicals tested which can affect the results.
9. The variation between Enchtryaeids and Lumbricids is greatest in the acute toxicity data where the Enchtryaeids are generally less sensitive; there is less variation in the reproduction EC50 (comparison of NOECs is less reliable as it is dependent on the study design particularly in doses selected). This confirms the suggestion by Amorim et al, (2005, 4 (reference number in Appendix 4)) that on the basis of limited data sets there is no consistent difference in the sensitivity between Enchytraeids and Lumbricidae. The Enchytraieds showed up to 6 fold less sensitivity based on acute toxicity (Abamectin) and 3 fold less sensitivity based on reproduction (benomyl).
10. As an alternative measure of toxicity avoidance behaviour was considered. Currently the number of pesticides tested is too limited to draw firm conclusions on the relative sensitivity of the avoidance response of Enchytraeidae and Lumbricidae.
11. There is only one chemical for which directly comparable data are available for TME studies. Based on abundance of the selected families the data suggest that the overall sensitivity is similar but within this a particular genus may be affected as was the case for the Enchytraeid *Fridericia*.
12. Based on current data there are no consistent differences in the sensitivity between Lumbricidae and Enchytraeidae in the laboratory or from the very limited semi-field/field data. Based on acute toxicity the Lumbricidae appear more sensitive whereas the families are similar in sensitivity when the endpoint is reproduction. The specific properties of the test item also play a role with no consistent differences between endpoints in relative sensitivity.
13. Enchytraeid species are taxonomically close to earthworms and some studies reported similar sensitivity of these species (Rombke and Moser, 2002, 23). However results from this study are in accordance with other studies reporting lower sensitivity of enchytraeid species to some chemicals (Bezchlebova, 2007 121).

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2. INTRODUCTION

Lumbricids and enchytraeids are members of Oligochaeta in the phylum Annelida. These soil-inhabiting species play a key role in decomposition and soil forming processes and live in close contact with the soil pore water. Both of these animal groups are common in agricultural soil. In addition they both usually inhabit the upper layers of soil and are therefore exposed to pesticides. Lumbricids (or earthworms) are also called megadriles (or big worms), as opposed to the microdiles (or small worms) in the family Enchytraeidae (or potworms). The Lumbricidae are characterized by having a multilayered clitellum (which is much more obvious than the single-layered one of the microdriles), a vascular system with true capillaries, and male pores behind the female pores. Earthworms are ubiquitously distributed and also play a major role in the breakdown of organic matter and the release of nutrients in terrestrial ecosystems.

Enchytraeidae are a family of small (1-40 mm) oligochaete worms distributed worldwide in a variety of habitats. Enchytraeids are often found in soils where earthworms are scarce (the opposite is rare).

For Lumbricidae species *Eisenia fetida* are recommended in various guidelines as a standard test organism for the terrestrial environment. However, species of the genus *Enchytraeus* could be a more suitable alternative because they are ecologically more relevant than *E. fetida*, which are not true soil living earthworms and occur almost exclusively in compost heaps. Species of the genus *Enchytraeus* offer practical advantages as test organisms as they are easy to handle and breed. The most commonly used (and recommended in the OECD guideline) is *Enchytraeus albidus*. For the enchytraeids the test duration is 4-6 weeks, depending on the *Enchytraeus* species used, compared with the 8 weeks (20 weeks, including synchronization time) used in the earthworm test; smaller amounts of soil are necessary, and there is minimal experimentation between start and evaluation of the test, making the test less expensive. However, the relative sensitivity of the two families needs to be assessed.

Examples of Enchytraeidae species include:
Enchytraeus albidus
Cognettia sphagnetorum
Enchytraeus crypticus
Enchytraeus coronatus
Friderica ratzeli
Enchytraeus buchholzi

Examples of Lumbricidae species include:
Eisenia fetida
Eisenia andrei
Lumbricus terrestris
Aporrectodea caliginosa

Lumbricus rubellus
Aporrectodea tuberculata
Allobophora chlorotica
Dendrobaena rubida
Apporectodea longa
Aporrectodea rosea
Octolasium lacteum
Eisenia veneta

This review considers state-of-the-knowledge on the sensitivity of Enchytraeids and Lumbricidae to chemicals, in particular plant protection products, through a search of information from scientific literature, reports and other documents. The review covered both mortality (LD50, NOEC) and reproduction data (EC_x, NOEC) from laboratory studies and any available data for avoidance studies, terrestrial model ecosystems (TMEs) or field studies. The review was aimed at plant protection products but also included other organic chemicals, e.g. veterinary medicines, where these provided relevant data on relative sensitivity.

3. METHODS

The set of search terms selected and databases searched for the study are shown in Appendix 3. All search results are fully documented in Appendix 4. In addition EFSA's Pesticide Risk Assessment Peer Review (PRAPeR) published draft risk assessments were searched for existing data. The database was searched for duplicates which were removed and the cleaned database transferred to EndNote. The literature was evaluated systematically and the criteria for including or excluding the references stated (see Appendix 4). All studies that were identified as potentially useful were evaluated to assess their reliability. Reliability covered the inherent quality of the test relating to the test methodology and the way the performance and results of the test were described.

The criteria used for assessing reliability of toxicity data were based on those described in the EU Technical Guidance Document (2003), namely:

- A complete test report is available or the test has been described in sufficient detail and the test procedure is in accordance with generally accepted standards (e.g. OECD) – this only applied to EFSA PRAPeR data.
- The validity of the data cannot be fully established or the test method differs in some respects from the guidelines and the generally accepted scientific standards. In these cases expert judgement will be used to determine whether the results are suitable or whether they are regarded as not valid: Expert judgement had to be applied to the majority (>90%) of the literature identified.
- It is clearly evident that the data are not valid because critical pieces of information are not available and cannot be sourced retrospectively (e.g. if it is not possible to establish the identity of the test substance). These data are likely to be

inappropriate for standard setting although they may be used to steer future testing requirements.

Of particular concern for Enchytraeids and Lumbricidae is the effect of soil structure and pH on the results of studies and therefore where available for non-standard tests this is reported and only directly comparable data used.

The information from previous reports and the review of 'new' literature was combined to provide an overview of: the toxicity of chemicals in Enchytraeidae and compared with Lumbricidae**.** The complete extracted data set is shown in Appendix 2. Where population level data, e.g. from terrestrial model ecosystems (TMEs) or field studies were available and valid the information were collated separately as supporting data and compared.

The correlation of available toxicity (LC50/EC50) data were assessed between Enchytraeids and Lumbricidae. The data available were too limited to allow comparison according to chemical type. In particular the toxicity of plant protection products was interrogated to determine whether the assumption that the toxicity of these types of chemicals to Enchytraeids and Lumbricidae is similar can be supported and therefore data from either family may be used in risk assessment.

4. RESULTS

The comparable data are shown in Appendix 1 and summarised in Table 2 with the complete data set extracted shown in Appendix 2. The data which could be compared were identified based on similarity of soil type tested and endpoint once the validity was established.

4.1 Factors influencing the comparability of toxicity data for Enchytraeidae and Lumbricidae

The primary endpoints considered were the LC50 following acute exposure and the NOEC and EC50 for reproduction following chronic exposure. It is important to consider both acute and chronic exposure as the differences between lethal and sublethal toxicities of chemicals can vary considerably, depending on the mode of action of the chemical tested. (Van Gestel et al, 1992, 26)

The toxicity of plant protection products to soil dwelling organisms is a function of the physiochemical properties of the substance and of the soil (Van Gestel & Ma, 1988, 129) as well as the compounds metabolic fate in the organism (Hartnik et al, 2008, 101). Thus there were a number of factors regarding the comparability of data generated during toxicity testing which came to the fore during the assessment of the literature. These included:

Formulation tested (variability in product formulations, including concentrations of active and inert ingredients); in some cases the active ingredient was tested

Chemical persistence: both the properties of the chemical and microbial activity of the soil affect this
Mode of action: The ability of an organism to metabolise a compound affects the toxicity of the compound to the organism. Rapid metabolism results in lower concentrations in the tissue and target sites and therefore lower acute toxicity. However, resulting metabolites may have sublethal effects (Hartnik & Styrishave, 2008 101)

Test substrate (physiological properties): Soil ecotoxicology studies are usually performed in standard soils, such as OECD artificial soil or LUFA, a natural soil. When assessing the toxic effects in the environment, soil properties and microbial activity may be different from those in standard soils, which might lead to a different exposure situation for the test species.

Test duration: this affects the duration of exposure and is related to the life cycle for reproduction tests.

Identity of the test organism: the length of the reproductive phase affects the length of exposure (Pokarzhevskii et al 2003 119)

Culture strength: Amorim et al (2008, 2) noted intra-specific variability in terms of sensitivity towards chemicals when doing avoidance tests with phenmedipham on *E. albidus*. The only difference between the tests was the batch of *E. albidus* used.

Endpoint: Reproduction is generally the most sensitive endpoint whilst mortality is the least sensitive endpoint. Some chemicals do not affect mortality but have significant effects on reproduction (large acute/chronic ratios). NOECs, due to their high dependence on test design and variability, are generally an unsatisfactory measure of “no toxicity” for regulatory purposes and make comparisons between species difficult.

4.1.1 Test methods

Soil properties (e.g. pH, organic matter content and soil texture) have a strong influence on bioavailability, bioaccumulation and toxicity as well as on organism behaviour and viability. Therefore where possible this review concentrates on toxicity data obtained from test following standardised testing methods or from tests using similar methods and comparable test items and substrates.

Organisation for Economic Co-operation and Development (OECD) Guidelines

Test No. 207: Earthworm, Acute Toxicity Tests
Test No. 220: Enchytraeid Reproduction Test.
Test No. 222: Earthworm Reproduction Test (*Eisenia fetida / Eisenia andrei*)

International Standards for Business, Government and Society (ISO) Guidelines

ISO 11268-1:1993: Soil quality -- Effects of pollutants on earthworms (*Eisenia fetida*) Part 1: Determination of acute toxicity using artificial soil substrate.

ISO 16387:2004 : Soil quality -- Effects of pollutants on Enchytraeidae (*Enchytraeus* sp.) Determination of effects on reproduction and survival

ISO 17512-1:2008: Soil quality -- Avoidance test for determining the quality of soils and effects of chemicals on behaviour -- Part 1: Test with earthworms (*Eisenia fetida* and *Eisenia andrei*)

4.1.2 Effects of test soil type

One of the major factors that should be considered in assessing the risk of pesticides to the environment is the variability in the bioavailability of chemicals which is significantly affected by soil type. It has been shown that acute toxicity can vary by more than two orders of magnitude depending on the composition of the artificial soil used (Lock et al, 2000, 152 & 2001, 153). This may explain the observed variability in the toxicity data reported in the literature even for the same species (Appendix 2).

Artificial soil has been developed in order to provide a medium that makes it possible to achieve repeatable and comparable results from toxicity tests. However several disadvantages occur. The physiochemical and biological properties of artificial soil differ much from those of natural soils, which alter the true toxicity of the chemical in the environment. It should also be borne in mind that the test soil can also have detrimental effects on worm-health masking any affects of the chemical tested. Toxicity tests should be carried out using optimum conditions for the species being tested and test species are usually chosen for their ease of use rather than their relevance. Stress caused by sub optimal conditions (soil type, pH, soil moisture etc.) may mask adverse effects of the chemical and make comparison invalid. Sub-lethal endpoints, e.g. reproduction, are particularly sensitive to unfavourable conditions.

Not only do test organisms show a preference for certain soil properties (Amorim et al 2005 3, Amorim et al 2005 4, Kolar et al 2008 15) but soil type also affects toxicity (Amorim et al 2008 1, Amorim et al 2005 3, Amorim et al 2005 4, Kolar et al 2008 15, Kula and Larink 1997 60, Ellis et al 2007 84, Hartnik and Styrishave 2008 101) and compounds sorption plays a major role in the bioavailability and toxicity for soil organisms (Hartnik and Styrishave 2008 101) (Table 1). LUFA 2.2 is the most suitable test soil for enchytraeids but unsuitable for Eisenia species (Amorim et al 2005 4, Kolar et al 2008 15, Garcia 2004 79 cited by Garcia et al 2008 28). Control performance (reproduction) of earthworms in LUFA 2.2 was poor particularly for cocoon production and hatching (Kula & Larink 1997, 60). Although control survival was good, they suffered from a lack of food in the low organic sandy soil, resulting in weight loss and poor reproductive performance. In faeces the earthworms showed good control performance (survival & reproduction) (Kolar et al 2008, 15).

Lumbricidae can also be affected by low pH. Spurgeon & Hopkins (1996, 51) reported *Eisenia fetida* survival was not affected by soil pH, but at a pH of 4 cocoon production was reduced.

Enchytraeid species show a preference for specific soil properties. Some natural soils were clearly avoided by the enchytraeids. Control performance (survival & reproduction) of the enchytraeids in LUFA 2.2 was good and met validity criteria. However, in faeces the enchytraeids showed a better reproduction than in the soil (Kolar et al 2008, 15). Survival and reproduction of *E. crypticus* were lowest in clayey soil and the highest in the humus sandy soil (Martikainen, 1995 19). Although in some of the cases this could be explained by low pH or possibly high clay content the reasons for rejection and preference for other soils were not so obvious (Amorim et al 2005, 4). Enchytraeids have been shown to have a high sensitivity to changes in soil parameters and are mainly affected by low pH. pH can act as a stress agent at chronic levels, causing a decrease in reproductive performance of *E. albidus.* At a pH 4.5, low numbers of juveniles were produced in the controls (Amorim et al 2005 3, Amorim et al 1999, 5). Huhta (1984, 88) reported that pH may exert an indirect effect on enchytraeids affecting the microbial community in the soil and the quality of the soil organic matter. This may explain the poor reproductive performance in the sandy soils where pH was < 5.1. (Kuperman et al, 1999 17).

Low pH and high clay levels also caused stress to enchytraeids in avoidance tests (Amorim et al 2008 1). When tests were carried out in sandy and loamy field soils, effects occurred at lower concentrations compared with artificial soils (Amorim et al 2008 2).

Dermal exposure to a chemical via the soil pore water is thought to be the main route of exposure for soil dwelling organism. As a result it has been suggested that toxic responses of chemicals to soil dwelling organisms should be based on soil pore water concentrations, rather than the total concentration in the soil (Hartnik et al (2008, 12). In soils with high organic matter content, hydrophobic pesticides bind more strongly to soil particles than in soils with lower organic matter contents, and consequently, the pore water will have lower pesticide concentrations. Sverdrup et al (2002, 102) demonstrated that for pesticides with a Log $K_{ow} < 5$, the main route of uptake for soil dwelling organisms was from the soil pore water. Based on this hypothesis it should be possible to predict the toxicity of a compound based on its concentration in the pore water. However, low pore water concentrations don't necessarily result in lower bioaccumulation. Hydrophobic pesticides (high octanol/water partition coefficient, Log K_{ow}) are preferentially distributed to hydrophobic soil compartments (e.g. soil organic matter) while hydrophilic chemicals (low partition coefficient) are preferentially distributed to hydrophilic soil compartments (e.g. the soil pore water). However, hydrophobic pesticides, generally are also lipophilic and therefore have a high bio-concentration factor (partition coefficient between earthworm and water). Adsorption strongly influences bioavailability and bioaccumulation and for organic pesticides is correlated to hydrophobicity and the organic content of the soil (Van Gestel & Ma, 1988, 129).

For hydrophobic compounds (e.g. alpha-cypermethrin) that are strongly adsorbed to the soils organic matter, only a small fraction is available in soil water, therefore the main route of exposure is via ingestion. Hartnik et al, (2008, 12), found that soil-ingesting organisms *Enchytraeus crypticus* and *Eisenia fetida* were more sensitive to alpha-cypermethrin compared to the soil dwelling organisms *Folsomia candida* and *Helix aspersa*. However, not all differences in bioaccumulation between compounds can be attributed to differences in adsorption characteristics. Differences in the metabolic fate of the compounds might also be important (Hartnik et al, 2008, 101). Therefore the contribution of each route of uptake to acute and chronic toxicity and differences between soil-dwelling organisms needs to be more fully understood before predictions can be made reliably.

A number of authors (Amorim et al (2002, 112 & 113, 2005, 3 & 4 and 2008, 2), Martikainen, (1995, 19), Belfroid and Sijm (1998, 75), Kuperman et al (2006, 16) & Garcia (2004, 79) have shown that using OECD artificial soil can result in higher effect concentration values compared to natural soil e.g. LUFA soils. OECD artificial soils have high organic matter contents, therefore they are thought to reduce the bioavailability of chemicals compared to natural soils (e.g. LUFA 2.2). As a result, the chemical is less avoided or more unequally distributed in the soil and may lead to underestimations of the toxicity of chemicals in comparison to natural soils. However, Gestel & Ma, (1988, 129) based on the pore water theory above they reported that by correcting for adsorption by converting the LC50 values to concentrations in soil solution the differences between two test soils could be corrected. They concluded that for earthworms the toxicity and bioaccumulation and, therefore the bioavailability are dependant on the concentration in soil solution and can be predicted using adsorption coefficients.

Soil properties were shown to influence carbendazim sorption and therefore toxicity to *E. fetida*. Carbendazim sorption was influenced by pH and OM content with the greatest adsorption occurring in high OM (20%) and low pH (pH 4.5) soils. Decreased adsorption was associated with OM (2%) and high pH (pH 9) (Ellis et al, 2007 84). Clay type (kalonite & bentonite) also influences carbendazim toxicity to *E. fetida*. This may be attributed to limited adsorption of carbenadazim by kalonite clay, resulting in a greater concentration of bio available carbendazim (Ellis et al, 2007 84).

The influence of the type of soil substrate on the toxicity of chlorpyrifos and chloracetamide depends on the chemical concerned (Ma & Bodt 1993, 18) Chlorpyrifos was shown to be more toxic to *L. rubellus* than *E fetida* when tested in OECD soil whereas the opposite was true for chloracetamide. Dimethoate has been reported to degrade slower in artificial soil compared to a natural soil and may therefore actually increase toxicity Martikainen (1996, 19). This may be due to the limited number and diversity of microbes in artificial soil.

Considerably higher uptake of pesticides in earthworms was reported from the test soil with lower organic matter content (Hartnik & Styrishave, 2008 101). In soils with low organic matter content, hydrophobic pesticides (e.g. alpha cypermethrin and chlofenvinphos) bind less strongly to soil particles than in soils with high organic matter content, and consequently, the pore water will have higher pesticide concentrations.

Enchytraeids also showed considerable differences in their sensitivity towards chemicals in different test soils. Using reproduction as an endpoint it was reported that the respective soil could change phenmedipham EC_{50} values by a factor of 3 in *E. albidus* and by a factor of 14 in *E. luxuriosus*. Based on EC_{50} values the lowest toxicity was found in OECD test soil (Amorim et al 2005 3). This demonstrates how important the test substrate is for the environmental risk assessment of chemicals (Amorim et al 2005 3). Enchytraeids show a much greater sensitivity to abamectin and doramectin in faeces compared to LUFA 2.2 standard soil which may be explained by an increased intake through ingestion (Kolar et al 2008,15). Differences of sensitivity to Lindane were also observed between the different soil types. The toxicity of Lindane to Enchytraeids was higher in natural soils in comparison to artificial soils and was attributed to lower levels of organic matter in comparison to the artificial soil (Amorim et al 1999,5). Inappropriate test substrates can also have sensitising effects following chemical exposure (Kolar et al 2008,15).

It can be seen from the above discussion that soil type is an important issue when discussing which species can be used for risk assessment and the influence on the data generated. In this review care has been taken to identify those data using equivalent soil substrates to ensure data is as comparable as possible.

Table 1. Soil properties & influence on toxicity

Soil properties	Effects	Ref ID
Organic matter	Toxicity of Lindane to enchytraeids was higher in natural soils with low organic matter levels.	1, 3, 5
	A decrease in organic matter correlates to a reduction in reproduction for enchytraeids.	1, 3, 19
	High organic matter content and therefore high adsorptive capacity for hydrophobic chemicals may be responsible underestimations of toxicity in OECD soils	4, 15, 19, 74, 75
	There is a positive correlation between organic matter and LC_{50} values	85
	Chemical adsorption can increase with increasing organic matter	84, 101
	Bioavailability and toxicity of hydrophobic compounds decreases with increasing organic matter content in the soil.	60, 101
Clay	Enchytraeids avoid soils with high clay contents	1, 3
	High clay levels in soils can act as a stressor to enchytraeid reproduction	1, 3, 4
	Clay type influences toxicity. Different clays have different adsorption properties.	84
Moisture	May increase or decrease toxicity	3, 19
pH	Low pH (<5) can act as a stressor to reproduction to both enchytraeids and earthworms.	1, 3, 4, 5, 10, 15, 51, 76, 88
	Enchytraeids avoid soils with low pH (<5)	1
	pH might exert an indirect effect, affecting the microbial community in the soil and the quality of the soil organic matter.	88
	Chemical adsorption can increase with decreasing pH	84

4.2 Comparison of sensitivity

The data for chemicals tested in both Enchytraeidae and Lumbricidae in similar soil types were extracted and the data are summarized in Table 2. Based on the data in Table 2 the most sensitive Enchytraeidae were compared with the most sensitive Lumbricid species for each chemical for which both were reported (differences in species sensitivity are discussed below). This comparison was made for the acute LC50, the reproduction NOEC and the reproduction EC50 and the results are shown in Figure 1. The one-to-one line is also shown on each figure to show the distribution around the line. Even when soil types are comparable between the tests it remains difficult to directly compare the sensitivity of Enchytraeidae and Lumbricidae between chemicals because the tests are not comparable in their duration, the lifecycle length varies between species and therefore affects exposure, or soil type differs between chemicals tested. However, the distribution of the toxicity data for the LC50 and reproduction EC50 (there were insufficient comparable NOEC data available) are shown in Figure 2.

The variation between Enchtryaeidae and Lumbricidae is greatest in the acute toxicity data where the the most sensitive Enchtryaeidae are generally less sensitive than the most sensitive Lumbricidae; there is less variation in the reproduction EC50 (comparison of NOECs is less reliable as it is dependent on the study design particularly in doses selected). This confirms the suggestion by Amorim et al, (2005, 4) that on the basis of limited data sets there is no consistent difference in the sensitivity between Enchytraeidae and Lumbricidae. The relative sensitivity of Enchytraeidae when compared to Lumbricidae species varies greatly from chemical to chemical and between endpoints (Table 2 and Figure 2). A factor of 5 fold difference was taken as the threshold for a difference in sensitivity to allow for within family species differences. The distribution of the sensitivity by chemical is shown in Figure 3 and Table 4 for the Enchytraeidae and Lumbricidae and Figure 4 shows differences in the scale of the variation between the acute and reproductive endpoints. The most sensitive Enchytraiedae showed up to 6 fold less sensitivity based on acute toxicity (Abamectin) and 3 fold less sensitivity based on reproduction (benomyl). These observed differences in sensitivity may be related to differences in exposure, intrinsic activity, detoxification systems, specificity of receptor and/or subtle differences in the mode of toxic action (Hartnik et al 2008, 12).

There are significant differences between species concerning how toxic substances may affect their life history parameters (Somogyi et al, 2007, 25) and reproduction is a more sensitive endpoint than mortality. Therefore reproduction tests seem to be a more useful method for testing chemicals. If a change in test species were to be recommended then this is supported by the similarity in sensitivity of the reproduction EC50 for Enchytraeidae and Lumbricidae in the literature although the dataset is limited.

Avoidance behaviour has been used as an alternative measure of toxicity (Table 3). Amorim et al (2005, 4 & 2008, 2) reported that *E. albidus* is less sensitive than *E. fetida* or *E. andrei* to most of the chemicals they tested. It is not known whether the lower sensitivity of *E. albidus* is species specific or whether Enchytraeidae in general react less to chemical repellents. Currently the number of pesticides tested is too limited (Table 2 and Figure 2) to draw firm conclusions on the relative sensitivity of the avoidance response of Enchytraeidae and Lumbricidae.

Table 2 Summary of comparable data based on similar soil types and test duration (OECD soil unless otherwise stated)

Compound	Species	Mortality (mg /kg)		Reproduction (mg /kg)			Reference
		NOEC	LC50	NOEC	EC10	EC50	
Chloracetamide	*E. abidus*	-	4	-	-	-	65
	E. fetida	20	24 - 41	-	-	-	18, 62
	L. rubellus	36	48	-	-	-	18
	E. veneta	36	58	-	-	-	18
Malathion	*E. albidus*	-	-	-	-	9.8	17
	E. fetida	-	58 -70	-	-	16	17, EFSA
Lindane	*E. albidus*	-	107 – 200	10	3.3	9.7	5, 34,
	E. fetida	-	59 - 165	10-18	7.7 – 22.5	10 – 35.8	34, 44, 63, 85
	P. posthuma	-	40	-	-	-	86
Alpha-cypermethrin	*E. crypticus*	-	31.4*	2.5*	1*	4.9*	12
	E. fetida	-	762 –1000*	8*	1.6 –2.6*	31 – 43*	12, 101
Dimethoate	*E. crypticus*	8.1	-	8.1	-	-	19
	E. fetida	-	84.5 - 207	5	-	-	EFSA, 60
	E. andrei	-	-	2.5	-	-	60
	A. tuberculata	27	56	-	-	-	19
	A. rosea	-	89	-	-	-	19
	A. caliginosa	-	179	-	-	-	60
	A. chlorotica	-	191	-	-	-	60
Benomyl	*E. albidus*	-	22 – 25.7	-	-	5	65, 122
	E. andrei	-	6 -19	1	-	1.6	26, 63
	E. fetida	-	22 - 27	1	-	1.6	28, 44, 62
Benomyl *1	*E. albidus*	-	1.8	-	-	-	4
	E. fetida	2.0	14.6	0.32	-	1.0	28, 70,
Carbendazim	*E. albidus*	-	3.6 – 5.9	0.68 – 3.74	0.26 –1.14	1.4– 3.67	16, 23, 50, 119
	E. coronatus	-	>321.8	10.2	4.3	14.1	83
	E .crypticus	-	-	18	-	44	16, 119
	E. buchholzi	-	-	2.7	-	-	50

	E. andrei	-	5.7	-	-	2.9	26
	E. fetida	1.9	5.8 – 9.3	0.1 – 2.0	-	2.7	50, 77, 79, 84

Compound	Species	Mortality (mg /kg)		Reproduction (mg /kg)			Reference
		NOEC	LC50	NOEC	EC10	EC50	
Phenmedipham	*E. albidus*	-	>100	-	-	46.0 – 52.5	3, 16
	E. luxuriosus	-	118	-		44 – 44.5	3, 16
	E. andrei	-	129	<1.6	-	52.0	26
	E. fetida	-	244	-	-	-	Pesticide Properties Database
Phenmedipham [*1]	*E. albidus*	-	49.8 – 56.6	-	-	24 - 31	3, 4, 16, 122
	E. luxuriosus	-	51.0 –51.3	-	-	22	3, 16
	E . crypticus	-	74.8	-	-	36.9	4
Pentachlorophenol	*E. abidus*	-	136	-	-	-	65
	E. andrei	-	75.1 – 83.0	-	-	-	129, 150
	E. fetida	-	68.9 – 75.1		-	-	62, 134
	L. rubellus	-	362	-	-	-	150
Toxaphene	*E. albidus*	620	-	620	-	-	93
	E. crypticus	620	-	620	-	-	93
	E. fetida	248	-	15.5	-	54.5	93
Abamectin [*1]	*E. crypticus*	-	111	8.0	-	38	15
	E. andrei	-	16.5 - 18	9.8	-	-	15, EFSA
Abamectin [*2]	*E. albidus*	50	-	10	12.7	23.7	9
	E. fetida	5	>5	< 0.25	0.06	0.39	9
Doramectin [*1]	*E. crypticus*	-	>300	100	-	170	15
	E. andrei	-	228	8.4	-	-	15
Pyrene [*2]	*E. crypticus*	-	>2300	18	11	42	137
	E. veneta	-	155	-	-	-	102

Fluoranthene[*2]	*E. crypticus*	-	>2500	38	15	61	137
	E. veneta	-	416	-	-	-	102
Phenanthrene[*2]	*E. crypticus*	-	>2000	34	40	87	137
	E. veneta	-	134	-	-	-	102
Fluorene[*2]	*E. crypticus*	-	1600	27	25	55	137
	E. veneta	-	69	-	-	-	102
Compound	Species	Mortality (mg /kg)		Reproduction (mg /kg)			Reference
		NOEC	LC50	NOEC	EC10	EC50	
Carbazole[*2]	*E. crypticus*	-	>2100	34	19	52	137
	E. veneta	-	106	-	-	-	102
Dibenzofuran[*2]	*E. crypticus*	-	400	62	36	130	137
	E. veneta	-	78	-	-	-	102
Acridine[*2]	*E. crypticus*	-	3600	570	310	1500	137
	E. veneta	-	863	-	-	-	102
Parathion	*E. albidus*	-	124	-	-	-	151
	E. fetida	-	135 - >180	56	-	68	26,151
4-Nitrophenol	*E. albidus*	-	40.5 - 55	10 – 46.7	5.13 – 8.55	37.1 - 37.4	23, 50, 119
	E. crypticus	-	121.6	-	-	-	119
	E. buchholzi	-	-	5.6	-	-	50
	E. coronatus	-	-	0.32	0.25	7.6	83
	E. fetida	-	38	-	-	-	99
	E. eugeniae	-	40	-	-	-	99
	A. tuberculate	-	56	-	-	-	99
	P. excavatus	-	44	-	-	-	99
Short Chain Chlorinated Paraffin	*E. albidus*	1000	-	3000	-	6027	121
	E. crypticus	600	-	6000	-	7809	121
	E. fetida	1000	-	1000	-	2849	121
Quinoline	*E. crypticus*	-	2093	-	253	990	92
	E. fetida	-	1993	-	1641	1948	92
Acridine	*E. crypticus*	-	2610	-	666	1412	92

	E. fetida	-	>2500	-	451	1460	92
Phenazine	*E. crypticus*	-	2488	-	787	1073	92
	E. fetida	-	2018	-	372	649	92
1,10-Phenanthroline	*E. crypticus*	-	1692	-	379	796	92
	E. fetida	-	-	-	787	1033	92

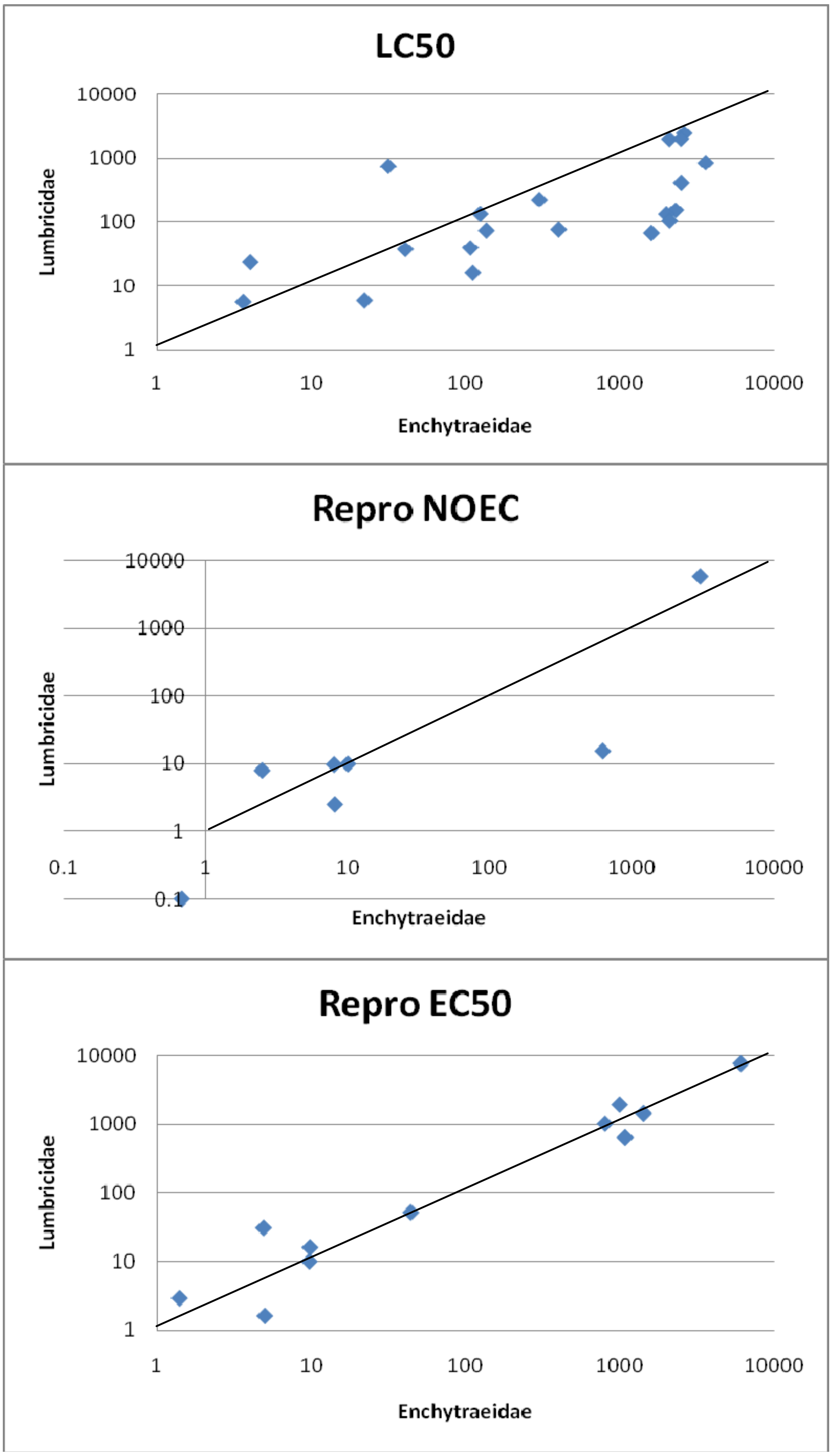
* Comparable Natural Soils
*1 LUFA Soil
*2 Sandy Loam

Table 3 Comparison of avoidance data

Compound	Species	Avoidance (mg /kg) EC50	Reference
Dimethoate	*E. albidus*	58.3	2, 81
	E. andrei	50.1	71
Benomyl	*E. albidus*	> 32	4
	E. andrei	<1	71
	E. fetida	28.2	28
Benomyl*1	*E. albidus*	46.8	4
	E. fetida	1.6	28
Carbendazim	*E. albidus*	>32	4
	E. andrei	< 1	71
	E. fetida	127.4	28
Carbendazim*1	*E. albidus*	7.6 – 8.0	2, 4, 82
	E. fetida	7.1	28
Phenmedipham *1	*E. albidus*	7.0 –57.7	2, 4
	E. crypticus	20	4

* Comparable Natural Soils
*1LUFA Soil
*2 Sandy Loam

Figure 1 Comparison of toxicity data (mg ai/kg soil) generated using comparable soil types for the most sensitive species of Enchytraeidae and Lumbricidae shown in Tables 2 and 3 (line shows one-to-one relationship)



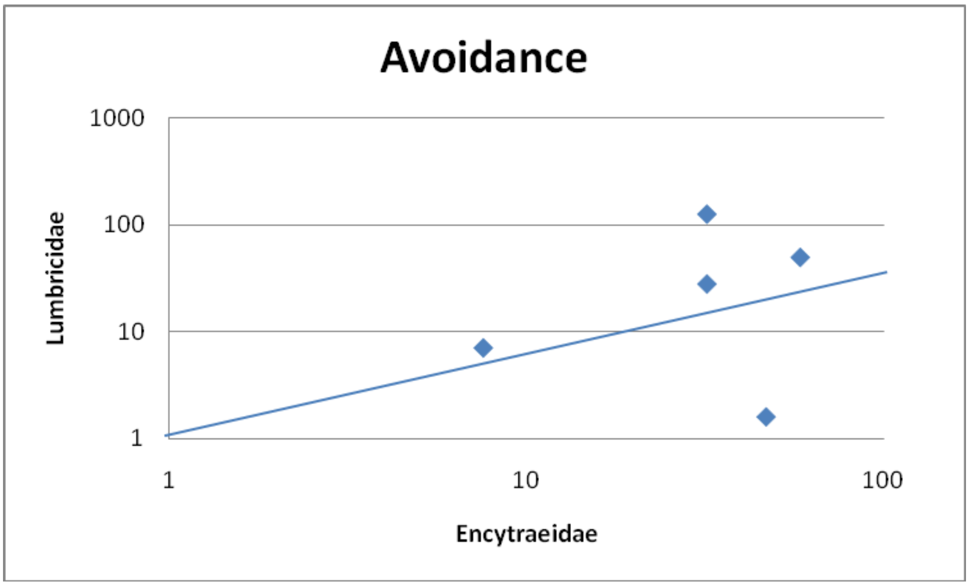

Avoidance
1000
100
10
1
Lumbricidae
1
10
100
Encytraeidae

Figure 2. Distribution of toxicity data (most sensitive species) within comparable data based on an order of magnitude scale

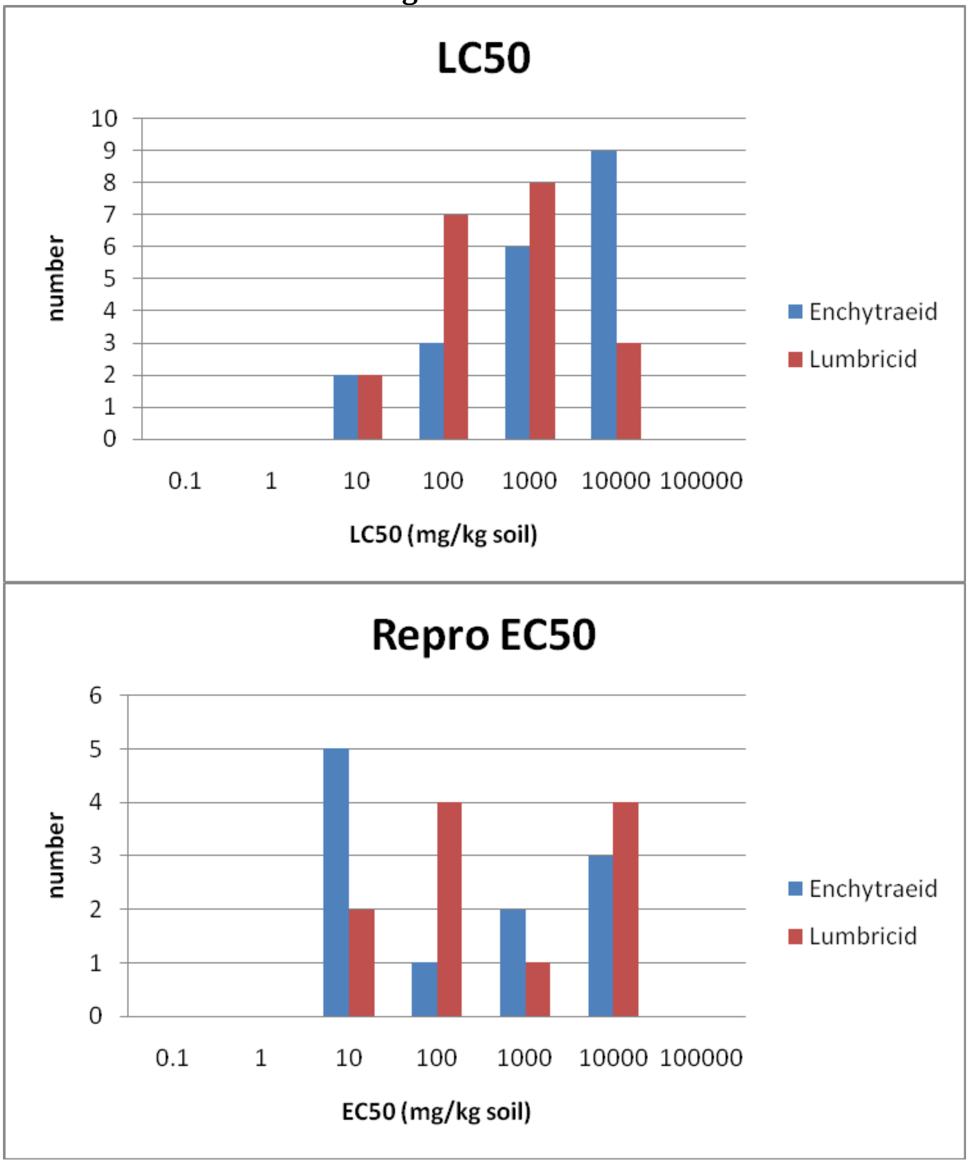


Figure 3 Comparison of relative sensitivity of most sensitive Enchytraeidae and most sensitive Lumbricidae on a chemical by chemical basis for acute and reproduction tests

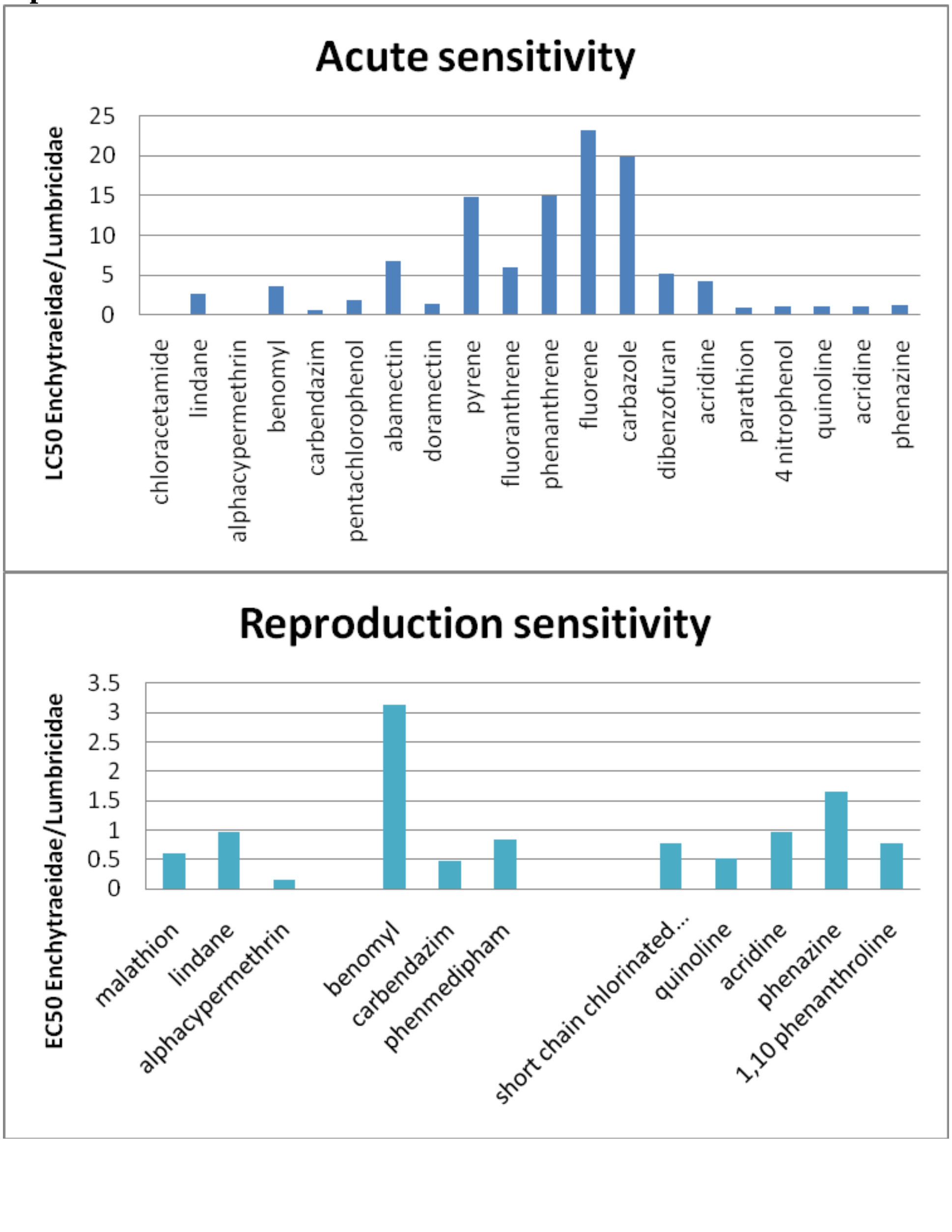


Figure 4 Distribution of the relative sensitivity of most sensitive Enchytraeidae compared with most sensitive Lumbricidae based on LC50 for acute toxicity and EC50 for reproduction

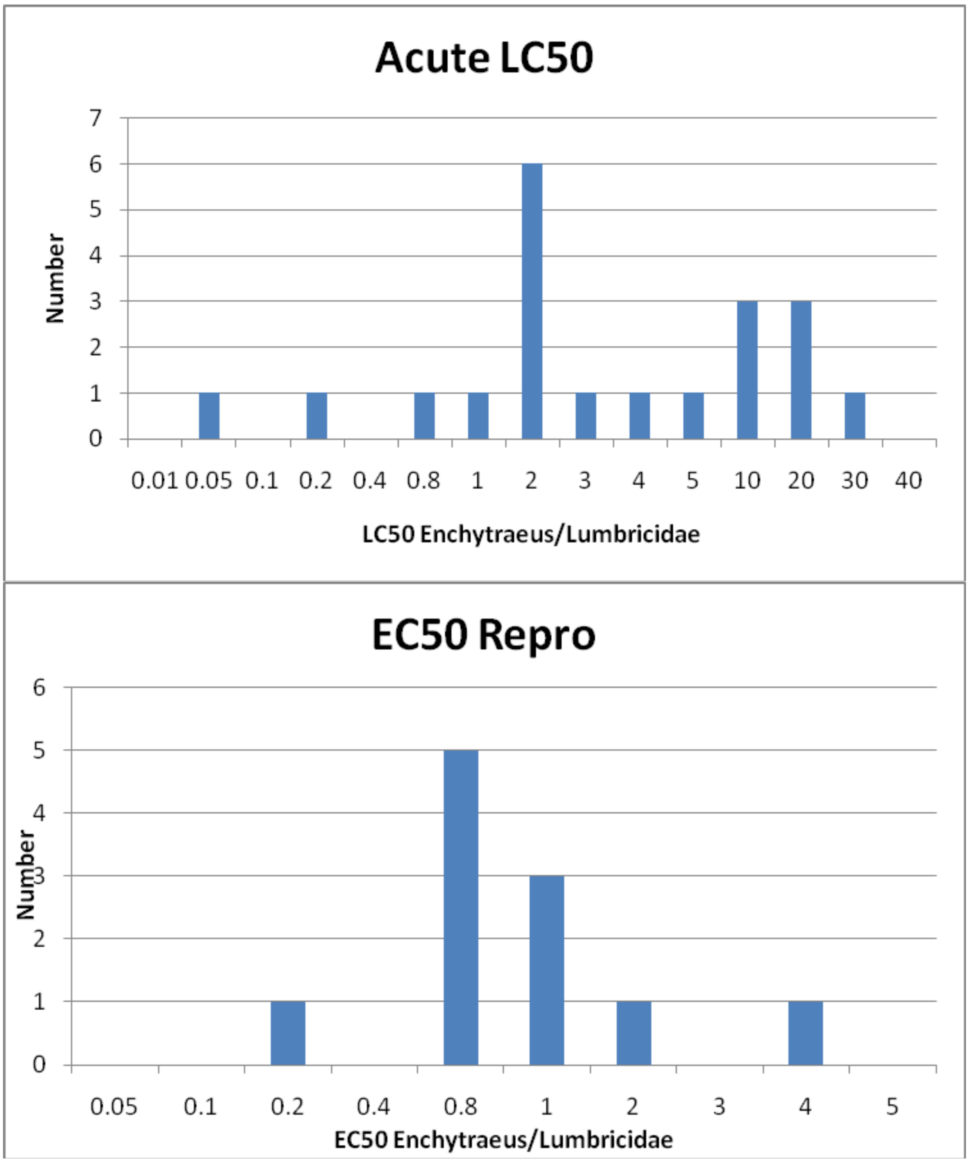


Table 4 Chemical by chemical comparison of relative sensitivity based on most sensitive species

Acute toxicity (E-enchytraeids; L- Lumbricids)

Less sensitive (E >5 fold more than L)	Same sensitivity (within 5 fold)	More sensitive (E >5 fold less than L)
Abamectin Pyrene Fluoranthrene Phenanthrene Fluorene Carbazole Dibenzofuran	Lindane Benomyl Carbendazim Phenmedipham Pentachlorophenol Doramectin Acridine Short chain chlorinated paraffin Parathion 4-Nitrophenol Quinoline Acridine Phenazine	Chloracetamide Alphacypermethrin

Repro toxicity NOEC

Less sensitive (E >5 fold more than L)	Same sensitivity (within 5 fold)	More sensitive (E >5 fold less than L)
Toxaphene Doramectin	Lindane Alphacypermethrin Dimethoate Carbendazim Abamectin Short chain chlorinated paraffin Acridine Phenazine	Quinoline

Repro toxicity EC50

Less sensitive (E >5 fold more than L)	Same sensitivity (within 5 fold)	More sensitive (E >5 fold less than L)
Abamectin	Malathion Lindane Benomyl Carbendazim Phenmedipham Short chain chlorinated paraffin Quinoline Acridine Phenazine 1,10 Phenanthroline	Alphacypermethrin

The sensitivity of the endpoint used (particularly reproduction and avoidance) varies between species and test item (Table 4). Reproduction was shown to be a most sensitive endpoint for Enchytraeids (Amorim et al 2008 2, Amorim et al 2005 3); Van Gestel et al (1992, 26) also reported reproduction to be the most sensitive endpoint for *E. andrei.* There may be a different mode of action for acute and chronic toxicity (Amorim et al 2008 2, Amorim et al 2005 3 & 4, Diao et al 2007 9, Vangestel et al 1992 26, Kula and Larink 1997 60, Hartnik and Styrishave 2008 101). Avoidance could be as sensitive as reproduction or in the same magnitude of mortality (Amorim et al 2008 2).

Similar sensitivities

Rombke (1989 65) reported earthworms and enchytraeids to be similarly sensitive to chemicals and the comparison presented here suggest that for the majority of plant protection products this holds true. A detailed comparison of enchytraeid and earthworm sensitivity to carbendazim and 4-nitrophenol under comparable exposure conditions show that even with one genus differences in sensitivity can occur. On the other hand the overall range of sensitivities of oligochaetes to one endpoint is usually quite similar (Rombke & Moser, 2002, 23).

Lower sensitivity of Enchytraeidae

There are a number of compounds where the sensitivity of the Enchytraeids is lower particularly where mortality is the endpoint, including the plant protection product abamectin. Enchytraeid species tested were rather insensitive to toxaphene when compared to *E. fetida* (Bezchlebova et al, 2007 93). Reproduction, but not mortality, was sensitive to toxaphene exposure in the earthworm test but neither acute nor chronic endpoints of enchytraeids were affected (Bezchlebova et al, 2007 93). Toxaphene has a specific mode of action, which might explain the high variation in species response to toxic effects (Vaal et al, 1997, 128).

When comparing earthworm and enchytraeid avoidance tests, Amorim et al (2008 2) reported *E. albidus* was less sensitive than *E. fetida* and *E. andrei* to most of the chemicals tested.

Higher sensitivity of Enchytraeidae
There were a small number of compounds for which the Enchytraeids were more sensitive than Lumbricids (Table 4) with the only pesticide represented being alpha-cypermethrin.

4.3 Species differences

Differences in ecological strategy, life cycle history and or exposure routes make the comparison of organisms difficult (Bezchlebova, 2007 121). In addition Vaal et al, (1997 128) reported that the toxic effects of chemicals with non-specific mode of action showed lower variations among species response than those with a specific mode of action. Some species differences can be attributed to the lifecycle of the species and the persistence of the chemical. Carbendazim was reported to affect both adult and juveniles stages of *E albidus*, whereas nitrophenol affected only adult stages. This was attributed to the persistence of the chemicals in the soil and the life cycle duration of the organism (Pokarzhevskii et al, 2002 119). *E. albidus* has a life cycle of 56 days whilst carbendazim has a half-life of 230 day. Carbendazim affected both adult and juvenile stages of *E albidus* but nitrophenol which almost entirely degrades within 30 days affected only adult stages with no noticeable effect on reproduction (Pokarzhevskii et al, 2002 119). *E. crypticus* has a life cycle of 30 days and both its adult and juvenile stages were affected by both chemicals although adult *E. crypticus* were more tolerant to the toxicant (Pokarzhevskii et al, 2002 119).

Collado et al, (1999 50) reported that *E albidus and, E bulchholzi/ minutus* did not appear to differ in sensitivity to phenmedipham. However, *E. luxuriosus* adults seem to be more sensitive than *E.albidus* adults in avoidance tests (Amorim et al 2008 2). It is not known whether the low sensitivity of *E. albidus* is species specific or whether enchytraeids in general react less to chemical repellents. Pokarzhevskii et al (2002 119) reported that *E. crypticus* appears more tolerant to toxicants when compared to *E albidus.* Table 2 shows that the variation in reproduction EC50 of the Enchytraeidae to the same chemical. The EC50 for carbendazim ranges from 1.4 mg/kg in *E. albidus* to 44 mg/kg for *E. crypticus* whereas for 4-nitrophenol *E coronatus* (EC50 7.6 mg/kg) was far more sensitive than *E albidus* (EC50 37.1 mg/kg)

Ma & Bodt (1993, 18) reported that the sensitivity of earthworms to chlorpyrifos (Appendix 1) showed a striking correspondence with the taxonomical classification. *Lumbricus* species were the most sensitive followed by *Aporrectodea*, with *Eisenia* species being the least sensitive. However they also demonstrated that species differences in sensitivity are not a general phenomenon and can be chemical specific. LC50 values of chloracetamide for *L. rubellus* (previously the most sensitive species) were similar to that of *E. fetida* (one of the least sensitive species). It was concluded that physiological factors are involved, which would render certain taxonomic species or genera more tolerant or sensitive than others.

4.4 Terrestrial Model Ecosystems and Field Studies

There is only one chemical for which directly comparable data are available for TME studies. Carbendazim was selected as a model pesticide for use in a large scale ring test of the TME approach and field validation by Moser et al (2004 48). They showed that following application to TMEs the EC50 for abundance of the genus of Enchytraeidae *Fridericia* was affected by carbendazim between 0.7 and 18.6 kg/ha in cores taken from 4 different sites but neither *Achaeta* nor *Enchtryaeus* were affected. Decreases in the overall enchytraeid abundance the EC50 ranged from 0.5-28.4 kg ai/ha and for number of species from 7.2-87.4 kg ai/ha. In field studies conducted on two of the same sites as the soil cores were extracted the EC50 for Enchytraeid abundance ranged for 2.5-11.7 kg ai/ha and for the number of species from 20.6-21.4 kg ai/ha. In parallel studies on earthworms Rombke et al (2004, 136) reported the EC50 of carbendazim on abundance of earthworms as 2.04-26.5 kg ai/ha in TMEs and 11.5-49 in field studies and for biomass as 1.02 - 8.57 kg ai/ha in TMEs and 8.7-34.6 in field studies. Based on abundance of the selected families this would suggest that the overall sensitivity is similar but within this a particular genus may be affected as was the case for the Enchytraeid *Fridericia*.

5. CONCLUSIONS

Based on current data there are no consistent differences in the sensitivity between Lumbricidae and Enchytraeidae in the laboratory or from the very limited semi-field/field data. Based on acute toxicity the Lumbricidae appear more sensitive whereas the families are similar in sensitivity when the endpoint is reproduction. The specific properties of the test item also play a role with no consistent differences between endpoints in relative sensitivity. Enchytraeids were the least sensitive species tested with abamectin (Diao et al 2007, 9). *E. crypticus* were found to be the most sensitive organisms when considering effects on reproduction (Hartnik et al 2008 12)

The reproduction of *E. fetida* was shown to be a highly sensitive endpoint for the toxicity testing of organic chemicals. However, mortality was shown to have a low sensitivity (Bezchlebova, 2007 121).

Enchytraeid species are taxonomically close to earthworms and some studies reported similar sensitivity of these species (Rombke and Moser, 2002, 23). However results from this study are in accordance with other studies reporting lower sensitivity of enchytraeid species to some chemicals (Bezchlebova, 2007 121).

Appendix 1 Comparable data

1.1 Chlorpyrifos

Class of pesticide	Sub class	Log K_{ow}	Soil DT_{50} Lab @ 20ºC	Targeted system/process	Mode of action
Organophosphorus Insecticide	**Pyridine Organothiophosphate**	4.7	2.5	Nervous System	Cholinesterase inhibitor

Summary Of Literature Data On The Acute Toxicity Of Chlorpyrifos

Organism	Soil type	Test duration (days)	Mortality		Reference
			LC_{50} mg/kg	NOEC mg/kg	
A.caliginosa	OECD	14	755	486	Ma et al (1993, 18)
A. longa			778	486	
E. fetida			1077	486	
E.veneta			1174	875	
L. rubellus			129	83	
L. terrestris			458	270	

Note: Edwards and Bohen (1992, 144) found most of the OPs were not very toxic to *E. fetida*, because they are unable to convert OP insecticides into their more toxic oxon metabolite.

Summary Of Literature Data On The Chronic Toxicity Of Chlorpyrifos

Species	Soil type	Test duration (days)	Survival		References
			NOEC mg /kg	EC_{50} mg /kg	
L. rubellus	Sandy soil	14	4.6	9.5	Ma et al (1993, 18)
E. veneta			49	121	

1.2 Chloracetamide

Summary Of Literature Data On The Acute Toxicity Of Chloracetamide

Species	Soil type	Test duration (days)	Mortality		Reference
			LC_{50} mg /kg	NOEC mg /kg	
E. albidus	OECD or Similar	28	4	-	Rombke(1989, 65)
E. fetida		28	24	-	Heimbach, 1984, 62)
		14	20 -80	-	OECD 207
		14	41	20	Ma et al (1993, 18)
E. veneta			58	36	
L. rubellus			48	36	

1.3 Malathion

Class of pesticide	**Sub class**	**Log K_{ow}**	**Soil DT_{50} Lab @ 20ºC**	**Targeted system/process**	**Mode of action**
Organophosphorus Insecticide	Aliphatic Organothiophosphate	2.75	0.18 d	Nervous System	Cholinesterase inhibitor

Summary Of Literature Data On The Acute Toxicity Of Malathion

Species	Soil type	Test duration (days)	Survival		References
			LOEC mg /kg	LC_{50} mg /kg	
E. albidus	OECD	14	**23**	**-**	Kuperman et al (1999, 17)
E. fetida			75	70	
				58	EFSA Draft assessment report

Summary Of Literature Data On The chronic Toxicity Of Malathion

Species	Soil type	Test duration (days)	Reproduction		References
			LOEC mg /kg	EC_{50} mg /kg	
E. albidus	OECD	42	**7.8**	9.8	Kuperman et al (1999, 17)
E. fetida		21	18	16	

Enchytraeid species *E. albidus* showed higher sensitivity to Malathion than the earthworm *E. fetida*

1.4 Parathion

Class of pesticide	**Sub class**	**Log K_{ow}**	**Soil DT_{50} Lab @ 20ºC**	**Targeted system/process**	**Mode of action**
Organophosphate		3.83	14	Nervous System	Cholinesterase inhibitor

Summary Of Literature Data On Acute Toxicity Of Parathion

Species	Soil type	Duration	LC50 mg/kg	Reference
E. andrei	OECD	21	>180	Van Gestel at al (1992, 26)
L. terrestris	Buss bedding	42	44	Cathey (1982, 104)
A. chlorotica	Sandy soil	7	80	Fayolle (1979, 141)
E fetida	OECD	28	135	Rombke et al (1994 151)
E albidus	OECD	42	124	Rombke et al (1994 151)

1.5 Lindane

Class of pesticide	**Sub class**	**Log K_{ow}**	**Targeted system/process**	**Mode of action**
Organochlorine Insecticide	Cyclodiene	3.5	Nervous System	GABA-gated chloride channel antagonist

Summary Of Literature Data On The Acute Toxicity Of Lindane

Organism	Test soil	Test duration (Days)	Mortality LC_{50} mg/kg	References
E. fetida	OECD or Similar	14	165	Lock et al (2002, 34)
			162.1	Shi et al (2007, 85)
			136	Haque & Ebing (1983, 44)
			59	Heimbach (1985, 63)
P. posthuma			40.4	Hans et al (1990, 86)
E. albidus			107	Lock et al (2002, 34)
			200	Amorim et al (1999, 5)

Chronic toxicity data of Lindane

Organism	Test soil	Test Duration (days)	Reproduction				References
			NOEC mg/kg	LOEC mg/kg	EC10 mg/kg	EC_{50} mg/kg	
E. fetida	OECD or Similar	21	10 - 18	18 -32	7.7 – 22.5	10 - 32	Lock et al (2002, 34)
E. albidus		42	10	18	3.3	9.7	
		42		6.1			Amorim et al (1999, 5)

Despite its relatively low acute toxicity, Lindane has a profound chronic toxicity towards soil living organisms.

1.6 Alpha-cypermethrin

Class of pesticide	**Log K_{ow}**	**Targeted system/process**	**Mode of action**
Pyrethroid Insecticide	6.94	Nervous System	Sodium channel modulator

Summary Of Literature Data On The Acute Toxicity Of Alpha-cypermethrin

Species	Soil type	Test duration (days)	Survival	Reference
			LC_{50} mg /kg	
E. fetida	Sandy Loam	28	>1000	Hartnik et al (2008, 101)
			762	Hartnik et al (2008, 12)
E. crypticus			31.4	

Summary Of Literature Data On The Chronic Toxicity Of Alpha-cypermethrin

Species	Soil type	Test duration (days)	Reproduction			Reference
			EC_{10} mg/ kg	EC_{50} mg/ kg	NOEC mg/ kg	
E. fetida	Sandy Loam	28	2.6	43	5.0	Hartnik et al (2008, 101)
			1.57	31	<4.65	Hartnik et al (2008, 12)
E. crypticus			0.99	4.91	2.51	

ACRs (ACR = LC_{50}/ NOEC)

E. fetida = 200 (Hartnik et al, 2008, 101)
E. fetida = 164 (Hartnik et al, 2008, 12)
E. crypticus = 12.5 (Hartnik et al, 2008, 12)

The sensitivity of the enchytraeid, E. *crypticus* to alpha cypermethrin was higher than that of the earthworm *E. fetida*. Interspecies differences in sub lethal sensitivity are probably caused by differences in uptake mechanisms and detoxification systems.

The acute chronic ratio for the *E. fetida* was higher than 200 and indicates a different mode of toxic action for acute and chronic toxicity. It is known that ACRs can be particularly high for compounds that are effectively metabolised by organisms and where one or more metabolites exert sub lethal effects on the test organism (Roex et al, 2000, 148). For organisms unable to excrete a certain metabolite, it is possible that it may reach concentrations that cause sublethal toxic effects.

The average ACR for a narcotic acting compound is 10 (Roex et al, 2000, 148). For these compounds the mode of action between lethal and sublethal toxicity is presumably similar and the parent compound most likely causes the toxic effect and not the metabolite that is produced during chronic exposure.

1.7 Dimethoate

Class of pesticide	**Log K_{ow}**	**Targeted system/process**	**Mode of action**
Organophosphorus Insecticide	0.7	Nervous System	Cholinesterase inhibitor

Summary Of Literature Data On Acute Toxicity Of Dimethoate

Species	Soil type	Test duration (days)	Mortality (mg kg)			Reference
			NOEC	LC_{10}	LC_{50}	
E. fetida	OECD or Similar	14	-	-	84.5	EFSA Draft assessment report
			-	-	207	Kula & Larink (1997, 60)
A. caliginosa			-	-	179	
A. chlorotica			-	-	191	
A. rosea			-	-	89	
A. tuberculata			27	19.9	56	Martikainen (1996, 19)
E. crypticus		89	8.1	-	-	

Species	Soil type	Test duration (days)	Mortality (mg /kg)			Reference
			NOEC	LC_{10}	LC_{50}	
E. fetida	LUFA 2.2	14	-	-	98	Kula & Larink (1997, 60)
A. caliginosa			-	-	47	
A. chlorotica			-	-	316	
A. rosea			-	-	13	

Summary Of Literature Data On Chronic Toxicity Of Dimethoate

Species	Soil type	Test duration (days)	Biomass (mg/kg)			Reference
			NOEC	LOEC	EC_{50}	
E. fetida	OECD or Similar	56	<5.2	-	-	EFSA Draft assessment report
		28	5.0	7.5	-	Kula & Larink (1997, 60)
E. andrei		28	2.5	5.0		
E. crypticus		89	8.1			Martikainen (1996, 19)

Summary Of Literature Data On Chronic Toxicity Of Dimethoate

Species	Soil type	Test duration (days)	Reproduction (mg /kg)			Reference
			NOEC	LC_{10}	LC_{50}	
E. fetida	OECD or Similar	28	5.0	7.5	-	Kula & Larink (1997, 60)
E. andrei		28	2.5	5.0	-	
E. crypticus		89	8.1	-	-	Martikainen (1996, 19)

Species	Test duration (days)	Immobility	References
		EC_{50} mg /l	
E. fetida	4	780	Ronday & Houx (1996, 80)
E. buchholzi	4	340	
E. albidus	4	1400	

Summary Of Literature Data On Effects Of Dimethoate On Avoidance Behaviour

Species	Soil type	Test duration (days)	Avoidance (mg ai/kg)	Reference
			EC_{50}	
E. albidus	OECD or Similar	2	58.3	Amorim et al (2008, 2)
E. andrei		2	50.1	Loureiro et al (2005, 71)

1.8 Benomyl

Summary Of Literature Data On The Acute Toxicity Of Benomyl

Species	Soil type	Test duration (days)	Survival LC50 mg /kg	Reference
E. andrei	OECD or Similar	21	6	Van Gestel at al (1992, 26)
		42	5.7	
		14	19	Heimbach (1985, 63)
E. fetida		14	27	Haque & Ebing (1983, 44)
		14	22	Garcia (2004, 79 see 28)
		28	22	Heimbach (1984, 62)
E. albidus		-	25.7	Amorium et al (2005, 122)
		28	22	Rombke (1989, 65)

Species	Soil type	Test duration (days)	Survival LC50 mg /kg	Reference
E. fetida	LUFA 2.2	14	14.6	Rombke et al (2007, 70)
		14	14.6	Garcia (2004, 79)
E. albidus		28	1.8	Rombke (1989)

Summary Of Literature Data On Chronic (Reproduction) Toxicity Of Benomyl

Species	Soil type	Duration	EC50 mg/kg	NOEC mg/kg	Reference
E. andrei	OECD or Similar	42	1.6	1	Van Gestel at al (1992, 26)
E. fetida		28	1.6	1.0	Garcia (2004, 79 see 28)
E. albidus		-	5	-	Amorium et al (2005, 122)

Summary Of Literature Data On Effects Of Benomyl On Avoidance Behaviour

Species	Soil type	Test duration (days)	Avoidance (mg ai/kg)		Reference
			EC_{50}	NOEC	
E. andrei	OECD or Similar	2	<1		Loureiro et al (2005, 71)
E. fetida		2	28.2	3.2	Garcia et al (2008, 28)
E. albidus		2	>32		Amorim et al (2005, 4)

Species	Soil type	Test duration (days)	Avoidance (mg ai/kg)		Reference
			EC_{50}	NOEC	
E. fetida	LUFA 2.2	2	1.6	<1.0	Garcia et al (2008, 28)
E. albidus	LUFA 2.2	2	46.8		Amorim et al (2005, 4)

1.9 Carbendazim

Class of pesticide	Sub class	Log K_{ow}	Soil DT_{50} Lab @ 20°C	Targeted system/process	Mode of action
Fungicide	Benzimidazole	1.38	260	Mitosis	Inhibition of mitosis and cell division.

Summary Of Literature Data On The Acute Toxicity Of Carbendazim

Organism	Soil type	Test Duration Days	LC_{50} mg/kg	Reference
E. fetida	OECD or Similar	14	9.3	Vonk et al (1986, 77)
		14	5.8	Garcia (2004, 79 see 28)
		14	8	Ellis et al, (2007, 84)
E. andrei		28	5.7	Van Gestel et al (1992, 26)
E. albidus		21	>3.6	Rombke & Moser, (2002, 23)
		21	5.9	Pokarzhevskii et al (2003, 119)
E. coronatus		21	>321.8	Arrate et al (2002, 83)

Summary Of Literature Data On The Chronic Toxicity Of Carbendazim

Organism	Soil type	Test Duration Days	EC_{10} (Repro) mg/kg	EC_{50} (Repro) mg/kg	NOEC (Repro) mg/kg	Reference
E. andrei	OECD or Similar	21	-	2.9	-	Van Gestel et al (1992, 26)
E. fetida					2	Vonk et al (1986, 77)
		28		2.7	0.1	Garcia (2004, 79 see 28)
E. albidus		42			1.8	Pokarzhevskii et al (2003, 119)
		42	0.26		0.68	Rombke & Moser, 1999
		42	1.14	3.67	3.74	Rombke & Moser (2002, 23)
		42	0.82	2.76	2.12	
		42			1.2	Collado et al, (1999, 50)
		42		1.4		Kuperman et al (2006, 16)
E.crypticus		28			18	Pokarzhevskii et al (2003, 119)
		42		44		Kuperman et al (2006, 16)
E. buchholzi		42			2.7	Collado et al, (1999, 50)
E. coronatus		21	4.3	14.1	10.2	Arrate et al (2002, 83)

Summary Of Literature Data On Effects Of Carbendazim On Avoidance Behaviour

Species	Soil type	Test duration (days)	Avoidance (mg/kg)		References
			EC_{50}	NOEC	
E. andrei	OECD	2	<1		Loureiro et al (2005, 71)
E. fetida			127.4	31.6	Garcia et al (2008, 28)
E. albidus			>32		Amorim et al (2005, 4)

Species	Soil type	Test duration (days)	Avoidance (mg/kg)		References
			EC_{50}	NOEC	
E. fetida	LUFA 2.2	2	7.1	< 1.0	Garcia et al (2008, 28)
E. albidus			7.9		Amorim et al (2005, 4)
			8		Amorim et al (2008, 2)
		18 h	7.6		Kobeticova et al (2009, 82)

1.10 Phenmedipham

Summary Of Literature Data On The Acute Toxicity Of Phenmedipham

Species	Soil type	Test duration (days)	Survival LC50 mg /kg	Reference
E. fetida	OECD or Similar	14	244	Pesticide Properties Database http://sitem.herts.ac.uk/aeru/iupac/index.htm
E. andrei		21	129	Van Gestel at al (1992, 26)
E. albidus		21	>100	Amorim, et al (2005, 3)
		21	>100	Kuperman et al (2006, 16)
E. luxuriosus		28	118	Amorim, et al (2005, 3)
		28	118	Kuperman et al (2006, 16)

Species	Soil type	Test duration (days)	Survival LC50 mg /kg	Reference
E. albidus	LUFA 2.2	14	56.6	Amorim, et al (2005, 4)
		21	49.8	Amorim, et al (2005, 3)
		21	50	Kuperman et al (2006, 16)
E. luxuriosus		28	51.3	Amorim, et al (2005, 3)
		28	51	Kuperman et al (2006, 16)
E .crypticus		7	74.8	Wagner-Vaske in Rombke et al, 2000 (Cited by Amorim et al 2005 4)

Summary Of Literature Data On The Chronic Toxicity Of Phenmedipham

Species	Soil type	Test duration (days)	Reproduction		Reference
			EC_{50} mg /kg	NOEC mg /kg	
E. albidus	OECD or Similar	42	52	-	Kuperman et al (2006, 16)
E. luxuriosus		42	45	-	
E. albidus		-	46	-	Amorim, et al (2005, 122)
		42	52.5	32	Amorim, et al (2005, 3)
E. luxuriosus		28	44.5	3.2	
E. andrei		21	52	<1.6	Van Gestel at al (1992, 26)

Species	Soil type	Test duration (days)	Reproduction		Reference
			EC_{50} mg /kg	NOEC mg /kg	
E. albidus	LUFA 2.2	42	24	-	Kuperman et al (2006, 16)
E. luxuriosus		42	22	-	
E. albidus		-	31	-	Amorim, et al (2005, 122)
		42	24.2	10	Amorim, et al (2005, 3)
E. luxuriosus		28	22	10	
E. crypticus		7	36.9	-	Wagner-Vaske in Rombke et al, 2000 (Cited by Amorim et al 2005 4)

Based on the mortality endpoint, *E. albidus* and *E. luxuriosus* seem to be more sensitive than *E. crypticus* while the effects on reproduction are very similar for all three species.

Summary Of Literature Data On Effects Of Phenmedipham On Avoidance Behaviour

Species	Soil type	Test duration (days)	Avoidance (mg ai/kg) EC50	Reference
E. albidus	LUFA 2.2	2	50.7	Amorim, et al (2005, 4)
			7	Amorim et al (2008, 2)
E. crypticus			20	Wagner-Vaske in Rombke et al, 2000 (Cited by Amorim et al 2005 4)

1.11 Pentachlorophenol

Class of pesticide	**Sub class**	**Log K_{ow}**	**Soil DT_{50} Lab @ 20ºC**	**Targeted system/process**	**Mode of action**
Organochlorine		5.1	48	Metabolism	Accelerates aerobic metabolism and increases heat production

Summary Of Literature Data On Acute Toxicity Of Pentachlorophenol

Species	Soil type	Test duration (days)	Mortality	Reference
			LC_{50} mg /kg	
E. abidus	OECD or Similar	28	136	Rombke(1989, 65)
E. fetida			87	Heimbach (1984, 62)
		14	68.9	Edwards & Bater (1992, 134)
E. andrei			75.1	Van Gestel & Ma (1988, 129)
			83	Van Gestel & Ma (1990, 150)
L. rubellus			362	

1.12 Toxaphene

Summary Of Literature Data On Acute Toxicity Of Toxaphene

Species	Soil type	Test duration (days)	Mortality (mg/kg)			Reference
			NOEC	LOEC	LC_{50}	
E. fetida	OECD	28	248	496	ND	Bezchlebova et al (2007, 93)
E. albidus		42	620	ND	ND	
E. crypticus		28	620	ND	ND	

ND: could not be estimated

Summary Of Literature Data On Chronic Toxicity Of Toxaphene

Species	Soil type	Test duration (days)	Reproduction (mg/kg)			Reference
			NOEC	LOEC	EC_{50}	
E. fetida	OECD	28	15.5	31.0	54.5	Bezchlebova et al (2007, 93)
E. albidus		42	620	ND	ND	
E. crypticus		28	620	ND	ND	

ND: could not be estimated

1.13 Abamectin

Summary Of Literature Data On The Acute Toxicity Of Abamectin

Species	Soil type	Test duration (days)	Mortality (mg/kg)	Reference
			LC_{50}	
E. crypticus	LUFA 2.2	28	111	Kolar et al (2008, 15)
E. andrei			18	

Species	Soil type	Test duration (days)	Mortality (mg/kg)				Reference
			NOEC	LOEC	LC_{10}	LC_{50}	
E. crypticus	Sandy	21	50	150	78.3	-	Diao et al (2007, 9)
E. fetida	Loam	24	5	>5	>5	>5	

Summary Of Literature Data On The Chronic Toxicity Of Abamectin

Species	Soil type	Test duration (days)	Reproduction (mg/kg)		Reference
			EC_{50}	NOEC	
E. crypticus	LUFA 2.2	28	38	8	Kolar et al (2008, 15)
E. andrei			-	9.8	

Species	Soil type	Test duration (days)	Reproduction (mg/kg)				Reference
			NOEC	LOEC	EC_{10}	EC_{50}	
E. crypticus	Sandy	21	10	25	12.7	23.7	Diao et al (2007, 9)
E. fetida	Loam	24	<0.25	0.25	0.06	0.39	

The sensitivity of enchytraeids to abamectin is lower than that of earthworms. In all cases reproduction was a more sensitive endpoint than survival (Diao et al, 2007, 9).

1.14 Doramectin

Summary Of Literature Data On The Acute Toxicity Of Doramectin

Species	Soil type	Test duration (days)	Mortality (mg/kg) LC_{50}	Reference
E. crypticus	LUFA 2.2	28	>300	Kolar et al (2008, 15)
E. andrei			228	

Summary Of Literature Data On The Chronic Toxicity Of Doramectin

Species	Soil type	Test duration (days)	Reproduction (mg/kg)		Reference
			EC_{50}	NOEC	
E. crypticus	LUFA 2.2	28	170	100	Kolar et al (2008, 15)
E. andrei			-	8.4	

1.15 Polycyclic Aromatic Compounds

Summary Of Literature Data On The Acute Toxicity Of PACs

Chemical	Species	Soil type	Test duration (days)	Mortality (mg/kg) LC$_{50}$	Reference
Pyrene	*E. veneta*	Sandy Loam	28	155	Sverdrup et al (2002, 102)
	E. crypticus		21	>2300	Sverdrup et al (2002, 137)
Fluoranthene	*E. veneta*		28	416	
	E. crypticus		21	>2500	
Phenanthrene	*E. veneta*		28	134	
	E. crypticus		21	>2500	
Fluorene	*E. veneta*		28	69	
	E. crypticus		21	1600	
Carbazole	*E. veneta*		28	106	
	E. crypticus		21	>2100	
Dibenzofuran	*E. veneta*		28	78	
	E. crypticus		21	400	
Acridine	*E. veneta*		28	863	
	E. crypticus		21	3600	

Summary Of Literature Data On The Chronic Toxicity Of PACs

Chemical	Species	Soil type	Test duration (days)	NOEC (mg/kg)	Reference
Pyrene	*E. veneta*	Sandy Loam	28	29	Sverdrup et al (2002, 102)
	E. crypticus		21	18	Sverdrup et al (2002, 137)
Fluoranthene	*E. veneta*		28	98	
	E. crypticus		21	38	
Phenanthrene	*E. veneta*		28	31	
	E. crypticus		21	34	
Fluorene	*E. veneta*		28	28	
	E. crypticus		21	27	
Carbazole	*E. veneta*		28	31	
	E. crypticus		21	34	
Dibenzofuran	*E. veneta*		28	30	
	E. crypticus		21	62	
Acridine	*E. veneta*		28	26	
	E. crypticus		21	570	

1.16 Short Chain Chlorinated Paraffin

Summary Of Literature Data On The Acute Toxicity Of SCCP

Species	Soil type	Test duration (days)	Mortality (mg/kg)			Reference
			NOEC	LOEC	LC_{50}	
E. fetida	OECD or Similar	28	10000	ND	ND	Bezchlebova et al (2007, 121)
E. albidus		42	10000	ND	ND	
E. crypticus		28	6000	10000	ND	

Summary Of Literature Data On The Chronic Toxicity Of SCCP

Species	Soil type	Test duration (days)	Fecundity (mg/kg)			Reference
			NOEC	LOEC	EC_{50}	
E. fetida	OECD or Similar	28	1000	3200	2849	Bezchlebova et al (2007, 121)
E. albidus		42	3000	6000	6027	
E. crypticus		28	6000	10000	7809	

1.17 4-Nitrophenol

Summary Of Literature Data On The Acute Toxicity Of 4-Nitrophenol

Organism	Soil type	Test duration (days)	LC_{50} mg/ kg	References
E. albidus	OECD or Similar	21	55	Rombke & Moser (2002, 23)
		14	40.5	Pokarzhevskii et al (2003, 119)
E. crypticus			121.6	
A. tuberculate		14	56	Neuhauser, et al (1986, 99)
E. fetida			38	
E. eugeniae			40	
P. excavatus			44	

Summary Of Literature Data On The Chronic Toxicity Of 4-Nitrophenol

Organism	Soil type	Test duration (days)	EC_{10} mg/ kg	EC_{50} mg/ kg	NOEC mg/ kg	References
E. albidus	OECD or Similar	42	5.13	37.1	46.7	Rombke & Moser (2002, 23)
		42			10	Collado et al, (1999, 50)
E. buchholzi					5.6	
E. coronatus		28	0.25	7.6	0.32	Arrate et al (2002, 83)

1.18 Nitrogen-Heterocyclic Polyaromatic Hydrocarbons

Summary Of Literature Data On The Acute Toxicity Of NPAH'S

Chemical	Species	Soil type	Test duration (days)	Mortality (mg/kg)		Reference
				LC_{10}	LC_{50}	
Quinoline	*E. fetida*	OECD or Similar	28	-	1993	Kobeticova et al (2008, 92)
	E. crypticus			1889	2093	
Acridine	*E. fetida*			>2500	>2500	
	E. crypticus			1501	2610	
Phenazine	*E. fetida*			1755	2018	
	E. crypticus			2012	2488	
1,10-Phenanthroline	*E. fetida*			1515	-	
	E. crypticus			939	1692	

Summary Of Literature Data On The Chronic Toxicity Of NPAH'S

Chemical	Species	Soil type	Test duration (days)	Mortality (mg/kg)		Reference
				EC_{10}	EC_{50}	
Quinoline	*E. fetida*	OECD or Similar	28	1641	1948	Kobeticova et al (2008, 92)
	E. crypticus			253	990	
Acridine	*E. fetida*			451	1460	
	E. crypticus			666	1412	
Phenazine	*E. fetida*			372	649	
	E. crypticus			413	1073	
1,10-Phenanthroline	*E. fetida*			787	1033	
	E. crypticus			379	796	

Further detailed test conditions for reported studies

ID	Reference	Test species	Study type	Chemicals	Soil	Temp ^{o}C	Light cycle h (light:dark)
2	Amorim et al (2008)	*E. albidus*:	Avoidance (2 section vessel)	Phenmedipham (Betosip 157 g/l), Atrazine (tech 97.4%), Benomyl (Benlate 50%), Carbendazim (Derosol 360 g/l), Pentachlorophenol (tech 98%), Dimethoate (tech 99.8%), Lindane (tech 97%) and Chlorpyriphos (98%)	LUFA 2.2	20	16:8
3	Amorim et al (2005)	*E. albidus & E. crypticus*:	Reproduction & Survival tests (ISO 16387, OECD 220)	Phenmedipham (Betosip 157 g/l)	LUFA 2.2 & OECD	20	16:8
4	Amorim et al (2005)	*E. albidus:*	Avoidance (2 section vessel)	Phenmedipham (Betosip 157 g/l) , Benomyl (Benlate 50%), Carbendazim (Derosol 360 g/l),	LUFA 2.2,OECD and field soils	20	16:8
5	Amorim et al 1999	E albidus	Reproduction	Lindane	OECD varying pH	20	
9	Diao et al (2007)	*E. crypticus & E. fetida* :	Reproduction & Survival tests (modified international guidelines)	Abamectin (95%)	Sandy loam	20	12:12

ID	Reference	*Test species*	Study type	Chemicals	Soil	Temp o C	Light cycle h (light:dark)
12	Hartnik et al (2008)	*E. crypticus & E. fetida* :	Reproduction & Survival tests (modified international guidelines)	Alpha-cypermethrin (Tech 97.6%)	Natural soils	20	16:8
15	Kolar et al (2008)	*E andrei,*	Reproduction and survival	Abamectin, doramectin	Lufa 2.2	20	16:8
15	Kolar et al (2008)	*E crypticus*	Reproduction and survival	Abamectin, doramectin	Lufa 2.2	18	12:12
16	Kuperman et al (2006)	*E. albidus, E. luxurious*	Reproduction & Survival tests (ISO 16387 & OECD 220)	Phenmedipham (Betosyp 157 g/L a.i.) & Carbendazim	OECD, LUFA 2.2 & Natural soil	20	16:8
17	Kuperman et al (1999)	*E. albidus & E. fetida*	Reproduction & Survival tests	Malathion	Artificial soil (EPA) & Natural soil	20	16:8
18	Ma & Bodt (1993)	6 species of earthworm	OECD 207 acute	Chlorpyrifos (Tech 99%)	OECD & natural soil	15,	16:8
19	Marrtiken (1995)	A. tuberculata & E. crypticus	(OECD 207, ISO 11268-1)	Dimethoate	OECD & Natural soil	20	16:8
23	Rombke and Moser (2002)	E albidus	Reproduction and survival	Carbendazim (derosal), 4-nitrophenol	OECD	15-20	
26	Van Gestel et al (1992)	E andrei	Reproduction and survival	Cadmium chloride, chromium nitrate, paraquat dichloride, parathion-ethyl, fentin, benomyl	OECD	20	24:0

ID	Reference	Test species	Study type	Chemicals	Soil	Temp o C	Light cycle h (light:dark)
28	Garcia et al (2008)	E fetida	avoidance	Benmyl, carbendazim, lambda- cyhalothrin	Tropical artificial soil, tropical natural soil	28	0:24
28	Garcia et al (2008)	E fetida	avoidance	Benmyl, carbendazim, lambda- cyhalothrin	OECD, LUFA 2.2	20	0:24
34	Lock et al (2002)	E fetida, E albidus	Reproduction and survival	lindane	OECD, sandy field soil, loamy field soil	20	16:8
44	Haque and Ebing (1983)	L terrestris	Acute	Formulations of benomyl, bupirimate, captafol, captan, copper oxychloride, fentin acetate+maneb, folpet, triadimefon	10% peat moss:90% sandy loam soil	10-15	0:24
44	Haque and Ebing (1983)	E fetida	Acute	Formulations of benomyl, bupirimate, captafol, captan, copper oxychloride, fentin acetate+maneb, folpet, triadimefon	OECD	22	12:12
50	Collado et al (1999)	E albidus, E buchholzi/minutes	Reproduction	Carbendazim (Derosal), 4-nitrophenol	OECD	20	
60	Kula and Larink (1997)	E fetida, E andrei	Reproduction and survival	Dimethoate, copper, linear alkylbenzene sulfonate	OECD, LUFA2.2		

ID	Reference	Test species	Study type	Chemicals	Soil	Temp o C	Light cycle h (light:dark)
62	Heimbach (1984)	E fetida	Acute	Formulations of benomyl, bupirimate, captafol, captan, carbaryl, chlordane, chloracetamide, copper (II) sulphate, dialifos, DNOC, endosulfan, ethiofencarb, fentin acetate+maneb, potassium bromated, mercaptodimethur, methphenamiphos, methidathion, pentachlorophenol, propoxur	OECD	22	12:12
63	Heimbach (1985)	E fetida	Acute	Formulations of aldicarb, atrazine, benomyl, bupirimate, calcium cyanide, captafol, captan, carbofuran, chlormequat chloride, copper oxychloride, fentin acetate+maneb, folpet, lindane, methamidophos, methidathion, paraquat, propoxur, sodium chlorate, terbufos, triadimefon, triazophos	OECD	22	12:12

ID	Reference	Test species	Study type	Chemicals	Soil	Temp o C	Light cycle h (light:dark)
65	Rombke (1989)	E albidus	Reproduction and survival	Chloroacetamide, potassium dichromate, benomyl, pentachlorophenol, 2,3,5-T, cadmium chloride	Artificial soil	12	0:24
71	Loureiro et al (2005)	E Andrei	Avoidance	Carbendazim, benomyl, dimethoate, copper	LUFA2.2	20	16:8
77	Vonk (1985)	E fetida	Acute	Carbendazim	OECD		
82	Kobeticova et al (2009)	E albidus	Avoidance	Carbendazim	LUFA 2.2	20	16:8
83	Arrate et al (2002)	E coronatus	Reproduction and survival	Carbendazim (Derosal)	OECD	20	0:24
84	Ellis et al (2007)	E fetida	Acute	Carbendazim	OECD + 7 artificial soils		
85	Shi et al (2007)	E fetida	Mortality and growth	Lindane	OECD	20	24:0
86	Hans et al (1990)	Pheretima posthuma	Acute	Aldrin, endosulfan, heptachlor, lindane		25	
92	Kobeticova et al (2008)	E fetida, E crypticus	Reproduction and survival	Quinoline, acridine, phenazine, 1,10-phenanthroline	OECD	20	16:8
93	Bezchlebova et al (2007)	E fetida	Reproduction and survival	Toxaphene	OECD	20	16:8
93	Bezchlebova et al (2007)	E crypticus, E albidus	Reproduction and survival	Toxaphene	OECD	18	16:8

ID	Reference	Test species	Study type	Chemicals	Soil	Temp o C	Light cycle h (light:dark)
99	Neuhauser et al (1986)	A tuberculata, E fetida, E eugeniae, P excavates	Acute	4-nitrophenol, 2,4,6-trinitrophenol, carbaryl, N-nitrosodiphenylamine, fluorine, 1,2,4-trichlorobenzene, nitrobenzene, phenol, dimethylphthalate, 1,2 dichloropropane	OECD	20	
101	Hartnik and Styrishave (2008)	E fetida	Acute , reproduction, uptake and metabolism	Alphacypermethrin, chlorfenvinphos	Field soils		
102	Sverdrup et al (2002)	E veneta	Survival and growth	Pyrene, fluoranthrene, phenanthrene, fluorene, carbazole, dibenzothiophene, dibenzofuran, acridine	Natural soil	20	24:0
119	Pokarzhevskii et al (2003)	E albidus, E crypticus	Reproduction and survival	Carbendazim, 4 nitrophenol	OECD	20	16:8
121	Bezchlebova et al (2007)	E fetida, E albidus, E crypticus	Reproduction and survival	Short chain chlorinated paraffins	OECD	20	16:8
122	Amorim et al (2005)	E albidus	acute	Phenmedipham, benomyl, carbendazim	OECD, LUFA 2.2	20	16:8
129	Van Gestel and Ma (1988)	E fetida	Acute	3-, 3,4-di-, 2,4,5-tri-, 2.3.4.5-tetrachlorophenol	Natural soil	23	
129	Van Gestel and Ma (1988)	L rubellus	Acute	3-, 3,4-di-, 2,4,5-tri-, 2.3.4.5-tetrachlorophenol	Natural soil	15	

ID	Reference	Test species	Study type	Chemicals	Soil	Temp o C	Light cycle h (light:dark)
134	Edwards and Bater (1992)	E fetida	acute	Chloracetamide, pentachlorophenol, chlordane, carbaryl, potassium bromide, copper sulphate, trichloroacetic acid	OECD	20	
137	Sverdrup et al (2002)	E crypticus	Reproduction and survival	Phenanthrene, pyrene, fluoranthrene, fluorene, carbazole, dibenzothiophene, dibenzofuran, acridine	Natural soil	20	12:12
150	Van Gestel and Wei-chun Ma (1990)	L rubellus, E andrei	Acute	Chlorophenols, dichloroaniline and trichlorobenzene	OECD, 2 sandy soils and peaty soil		
151	Rombke et al (1994)	E fetida, E albidus	Acute	Parathion, amitrole and diuron	OECD	20	16:8

Appendix 2. All Extracted Data

PESTICIDES

Insecticides (from BCPC E- Pesticide Manual no supporting information on study conduct)

		LC_{50} (14d)	LC_{50} (14d)	LC_{50} (28d)	LD_{50} (14d)
E. fetida	Lambda-cyhalothrin	>1000 mg/kg			
	Tau-fluvalinate		>1000 ppm.		
	Alpha-cypermethrin				>100 mg/kg
	Deltamethrin	>1290 mg/kg			
	Chlorpyrifos	210 mg/kg			
	Pirimicarb	>60 mg/kg			
	Etofenprox		24.6 ppm		
	Fipronil	None toxic			
	Thiamethoxam	>1000 mg/kg			
	Abamectin			28 mg/kg	
	Pirimiphos-methyl	419 mg/kg			
	Tefluthrin	0.32 mg/kg			
	Fenoxycarb	850 mg/kg			
	Fosthiazate	209 mg/kg			
	Pymetrozine	>250 mg/kg			
	Imidacloprid	10.7 mg/kg			
	Thiacloprid	105 mg/kg			
	Methiocarb	>200 mg/kg			
	Spiromesifen	>1000 mg/kg			
	Methoxyfenozide	>1213 mg/kg			
	Clothianidin	13.2 mg/kg			
	Beta-cyfluthrin	>1000 mg/kg			
	Parathion	267 mg/kg			
	Lindane	68 mg/kg			
	Malathion	613 mg/kg			

Fungicides (E Pesticide Manual; no supporting information on study conduct)

		LC_{50} (14d)	LC_{50} (28d)	NOEC (58d)	
E. fetida	Chlorothalonil	>404 mg/kg			
	Epoxiconazole	>1000 mg/kg			
	Prothioconazole	>1000 mg/kg			
	Tebuconazole	1381 mg/kg			
	Carbendazim	6 mg/kg			
	Imidacloprid	10.7 mg/kg			
	Penconazole	>1000 mg/kg			
	Kresoxim-methyl	>937 mg/kg.			
	Difenoconazole	>610 mg/kg			
	Chlorothalonil	>404 mg/kg			
	Cyproconazole	335 mg/kg			
	Azoxystrobin	283 mg/kg			
	Fenpropimorph	>1000 mg/kg			
	Difenoconazole	>610 mg/kg			
	Fludioxonil	>1000 mg/kg			
	Flutriafol	>1000 mg/kg			
	Propiconazole*	None Toxic			
	Metalaxyl-m	830 mg/kg			
	Mancozeb	>1000 mg/kg		20 mg/kg	
	Cyprodinil	192 mg/kg			
	Mandipropamid	>1000 mg/kg			
	Fluazinam		>1000 mg/kg		
	Cymoxanil	>2208 mg/kg			
	Spiroxamine	≥1000 mg/kg			
	Fenamidone	25 mg/kg			
	Propamocarb hydrochloride.	>660 mg/kg			
	Trifloxystrobin.	>1000 mg/kg			
	Fluoxastrobin	>1000 mg/kg			
	Fluopicolide	>1000 mg/kg			
	Pencycuron	>1000 mg/kg			
	Fluquinconazole	>1000 mg/kg			
	Triadimenol	772 mg/kg			
	Fenhexamid	>1000 mg/kg			
	Thiram	540 mg/kg			
	Imazalil	541 mg/kg			
	Triazoxide	>1000 mg/kg			
	Benomyl	10.5 mg/kg			

* Includes *Lumbricus rubellus*

Herbicides (BCPC E- Pesticide Manual no supporting information on study conduct)

		LC_{50} (14d)	LC_{50} (7d)	NOEL	NOEC
E. fetida	Isoproturon	>1000 mg/kg			
	Fluroxypyr	>1000 mg/kg			
	Glyphosate	>5000 mg/kg			
	Mecoprop-P	494 mg/kg			
	Trifluralin	>1000 mg/kg			
	Imazethapyr	>15.7 mg/kg			
	Nicosulfuron	>1000 mg/kg			
	Clopyralid	>1000 mg/kg			
	Fenoxaprop-p-ethyl	>1000 mg/kg			
	Metsulfuron-methyl	>1000 mg/kg			
	Rimsulfuron	>1000 mg/kg			
	Tribenuron-Methy	>1000 mg/kg			
	Bispyribac-Sodium			>1000 mg/kg	
	Pinoxaden	>1000 mg/kg			
	Fludioxonil	>1000 mg/kg			
	Mesotrione			>1000 mg/kg	
	Terbuthylazine		>200 mg/kg		
	Prosulfocarb	144 mg/kg			
	Fluazifop-p-butyl	>1000 mg/kg			
	Bromoxynil	96.7 mg/kg			
	Prosulfuron	>1000 mg/kg			
	Diquat	243 mg/kg			
	Isoxaben				>500 mg/kg
	Glyphosate	>5000 mg/kg			28.79 mg/kg
	Ethofumesate	134 mg/kg			
	Metamitron	>1000 mg/kg			
	Phenmedipham	>156 mg/kg			

Various Formulated Pesticides

Test Substrates

Soil type	pH	OC %	C/N	Peat	Clay %	Silt %	Sand %	CEC Mval/100g	WHC %	Reference
Sandy loam soil & peat (9:1)	6.1	1.0			3.2	12.1	94.7			Haque et al 1983 44
OECD	6			10	5		83.5			

Data On Acute Toxicity Of Various Formulated Pesticides

Pesticide class	Active ingredient	Log K_{ow}	LC_{50} mg /kg		Reference
			L. terrestris	*E. fetida*	Haque et al (1983, 44) Heimbach (1984, 62) Pesticide Properties Database http://sitem.herts.ac.uk/aeru/iupac/index.htm
Fungicide	Triadimefon	3.11	> 250	>250	
	Folpet	3.11	459.4	338.8	
	Benoyml	1.37	3.5	27.2	
	Cu – oxychloride	-	98.1		
	Captafol	3.8	> 800	496	
	Bupirimat	3.9	103.5	338	
	Captan	2.8	237.4	625	
Herbicides	Calcium Cyanamide	-	118.4	109.8	
	Sodium Chlorate	-	>750	>750	
	Paraquat	-4.5	>200	>200	
	Atrazine	2.5	444.4	130.9	
	Monolinuron	2.2	288.2	1000	

Test duration: 14 days
Test substrate: OECD (*E. fetida*), Sandy loam (*L. terrestris*)

Data On Acute Toxicity Of Various Formulated Pesticides

Active Ingredient	Class of pesticide	Log K_{ow}	LC_{50} mg /kg			Reference
			L. terrestris	*E. fetida*	*A. caliginosa*	
Terbufos	Organophosphate	2.77	4.6	6.6		Haque et al (1983, 44)
Aldicarb	Carbamate	1.15	26.5	3.3	0.68	
Lindane	Organochlorine	3.5	113.3	135.9		
Methamidophos	Organophosphate	-0.5	109.7	17.3		Heimbach (1985, 63)
Carbofuran	Carbamate	1.52	4.7	28.3		
Endosulfan	Organochlorine	4.74	9.0	6.7		Heimbach (1984, 62)
Methidathion	Organophosphate	2.2	7.6	3.6		
Triazophos	Organophosphate	3.34	210.1	116		Ma et al (1993, 18)
Propoxur	Carbamate	1.56	5.2	10.0		
Dialifos	Organophosphate	-	173.8	133		Lanno et al (1997, 130)
Chlorpyrifos	Organophosphate	4.7	458	1077		
Carbaryl	Carbamate	1.85	33	174		Cathey (1982, 104)
Pentachlorophenol	-	5.1	93	87		

Test duration: 14 days

Test substrate: OECD (*E. fetida*), Sandy loam (*L. terrestris*)

2.1 Aldicarb

Class of pesticide	**Sub class**	**Log K_{ow}**	**Soil DT_{50} Lab @ 20º**	**Targeted system/process**	**Mode of action**
Carbamate	Oxime carbamate	1.15	2.4 d	Nervous System	Cholinesterase inhibitor

<u>Substrates</u>

Soil type	pH	OC %	OM %	C/N	Peat %	Clay %	Silt %	Sand %	WHC %	Reference
Sandy loam soil & peat (9:1)	6.1	1.0				3.2	12.1	94.7		Haque & Ebing (1983, 44)
OECD					10	5		83.5		

Summary Of Literature Data On The Acute Toxicity Of Aldicarb

Species	Soil type	Test duration (days)	Mortality	References
			LC_{50} mg /kg	
E. fetida		14	65	Pesticide Properties Database http://sitem.herts.ac.uk/aeru/iupac/index.htm
E. fetida	OECD	14	3.3	Haque et al (1983, 44)
L. terrestris	Sandy Loam	14	26.5	
A. caliginosa	Artificial soil	28	0.68	Mosleh et al (2003, 133)

2.2 Captan

Class of pesticide	**Log K_{ow}**	**Soil DT_{50} Lab @ 20º**	**Targeted system/process**	**Mode of action**
Fungicide	2.8	0.8 d	-	-

Summary Of Literature Data On The Acute Toxicity Of Captan

Species	Soil type	Test duration (days)	Mortality	References
			LC_{50} mg /kg	
E. fetida	OECD	14	839	EFSA Draft assessment report
E. fetida	OECD	14	625	Heimbach (1984, 62)
L. terrestris	Sandy loam	14	237	Haque et al (1983, 44)

Species	Soil type	Test duration (days)	Mortality	References
			NOEC mg /kg	
E. fetida	OECD		9.14	EFSA Draft assessment report

2.3 Malathion

Class of pesticide	Sub class	Log K_{ow}	Soil DT_{50} Lab @ 20ºC	Targeted system/process	Mode of action
Organophosphorus Insecticide	Aliphatic Organothiophosphate	2.75	0.18 d	Nervous System	Cholinesterase inhibitor

Substrates

Soil type	pH	OM %	C/N	Peat %	Clay %	Silt %	Sand %	CEC Mval/100g	WHC %	Reference
Artificial soil	6			10	20		70		75	Kuperman et al (1999, 17)
Sassafras Sandy Loam	4.9	2.3			12	38	50	4		
O'Neill-Hall Sandy Loam	5.1	4.3			10	14	76	7.6		

Summary Of Literature Data On The Acute Toxicity Of Malathion

Species	Soil type	Test duration (days)	Survival		References
			LOEC mg /kg	LC_{50} mg /kg	
E. albidus	OECD	14	23	-	Kuperman et al (1999, 17)
E. fetida			75	70	
E. albidus	O'Neill-Hall	14	6.6	-	
E. fetida			75	95	
E. albidus	Sassafras	14	23.2	-	
E. fetida			60	42	
E. fetida	OECD	14		306* 54**	EFSA Draft assessment report

* Technical, ** Formulation

Summary Of Literature Data On The Chronic Toxicity Of Malathion

Species	Soil type	Test duration (days)	Reproduction		References
			LOEC mg /kg	EC_{50} mg /kg	
E. albidus	OECD	42	7.8	9.8	Kuperman et al (1999, 17)
E. fetida		21	18	16	
E. albidus	O'Neill-Hall	42	-	-	
E. fetida		21	14	37	
E. albidus	Sassafras	42	-	-	
E. fetida		21	21	20	

2.4 Dimethoate

Class of pesticide	**Sub class**	**Log K_{ow}**	**Soil DT_{50} Lab @ 20°C**	**Targeted system/process**	**Mode of action**
Organophosphorus Insecticide	Aliphatic Organothiophosphate	0.7	2.6 d	Nervous System	Cholinesterase inhibitor

The Log K_{ow} of the active substance is 0.7 suggesting that bioaccumulation is unlikely.

Test Substrates

Soil type	pH	OM %	OC %	C/N	Peat %	Clay %	Silt %	Sand %	WHC %	Reference
OECD	6.0		5.8		10	20		70		Kula & Larink (1997, 60)
LUFA 2.2	5.8	4.64*	2.3	14.2*					50.0*	
OECD	5.9	11.8							78	Martikainen (1996, 19)
Clayey soil	6.6	6.5							76	
Humus sandy soil	6.2	12.1							81	
Natural soil	6.2		8.5			7	15	78		Puurtinen & Martikainen, (1997, 58)

* (Garcia, 2008)

Species	Test duration (days)	Immobility EC_{50} mg /l	References
E. fetida	4	780	Ronday & Houx (1996, 80)
E. buchholzi	4	340	
E. albidus	4	1400	

Summary Of Literature Data On Acute Toxicity Of Dimethoate

Species	Soil type	Test duration (days)	Mortality (mg ai/kg)			Reference
			NOEC	LC_{10}	LC_{50}	
E. fetida	OECD	14			31* 84.5**	EFSA Draft assessment report
E. fetida	OECD	14			207	Kula & Larink (1997, 60)
	LUFA 2.2				98	
A. caliginosa	OECD				179	
	LUFA 2.2				47	
A. chlorotica	OECD				191	
	LUFA 2.2				316	
A. rosea	OECD				89	
	LUFA 2.2				13	
A. tuberculata	OECD	14	27	19.9	56	Martikainen (1996, 19)
	Clayey soil		9	8*	40*	
	Humus soil		27	20.6	65	
E. crypticus	OECD	89	8.1**			
	Clayey soil		8.1**			
	Humus soil		8.1**			
Enchytraeus sp	Humus sandy soil	24	1600		>1600	Puurtinen & Martikainen, (1997, 58)

* Technical, ** Formulation

Summary Of Literature Data On Chronic Toxicity Of Dimethoate

Species	Soil type	Test duration (days)	Biomass (mg ai/kg)			Reference
			NOEC	LOEC	EC_{50}	
E. fetida	OECD	56	2.87* < 5.2**			EFSA Draft assessment report
E. fetida	Natural soil/cow dung (75/25%)	28	0.4	1.6		Yasmin & D'souza, (2007, 59)
E. fetida	OECD	28	5.0	7.5		Kula & Larink (1997, 60)
E. andrei	OECD	28	2.5	5.0		
Enchytraeus sp	Humus sandy soil 70% soil moisture	24	200	400		Puurtinen & Martikainen, (1997, 58)
Enchytraeus sp	Humus sandy soil 40% soil moisture	24	200	400		Puurtinen & Martikainen, (1997, 58)
A. *caliginosa*	OECD	14	3		29.7	Martikainen (1996, 19)
	Clayey soil		3		14.4	
	Humus soil		3		42.9	
E. crypticus	OECD	89	8.1**			
	Clayey soil		8.1**			
	Humus soil		8.1**			

* Technical, ** Formulation

Summary Of Literature Data On Chronic Toxicity Of Dimethoate

Species	Soil type	Test duration (days)	Reproduction (mg ai/kg)			Reference
			NOEC	LOEC	EC_{50}	
E. fetida	OECD	28	5.0	7.5		Kula & Larink (1997, 60)
E. andrei	OECD	28	2.5	5.0		
Enchytraeus sp	Humus sandy soil 70% soil moisture	24	200	400		Puurtinen & Martikainen, (1997, 58)
Enchytraeus sp	Humus sandy soil 40% soil moisture	24	800	1600		Puurtinen & Martikainen, (1997, 58)
E. crypticus	OECD	89	8.1**			Martikainen (1996, 19)
	Clayey soil		8.1**			
	Humus soil		8.1**			

Summary Of Literature Data On Effects Of Dimethoate On Avoidance Behaviour

Species	Soil type	Test duration (days)	Avoidance (mg ai/kg)	Reference
			EC_{50}	
E. albidus	OECD	2	58.3	Amorim et al (2008, 2)
E. andrei	OECD	2	50.07	Loureiro et al (2005, 71)

*Confidence interval could not be calculated
**Maximum dose tested

2.5 Toxaphene

Class of pesticide	**Sub class**	**Log K_{ow}**	**Targeted system/process**	**Mode of action**
Organochlorine Insecticide	Cyclodiene	3.3	Nervous System	GABA-gated chloride channel antagonist

Summary Of Literature Data On Acute Toxicity Of Toxaphene

Species	Soil type	Test duration (days)	Mortality (mg/kg)			Reference
			NOEC	LOEC	LC_{50}	
E. fetida	OECD	28	248	496	ND	Bezchlebova et al (2007, 93)
E. albidus	OECD	42	620	ND	ND	
E. crypticus	OECD	28	620	ND	ND	

ND: could not be estimated

Summary Of Literature Data On Chronic Toxicity Of Toxaphene

Species	Soil type	Test duration (days)	Reproduction (mg/kg)			Reference
			NOEC	LOEC	EC_{50}	
E. fetida	OECD	28	15.5	31.0	54.5	Bezchlebova et al (2007, 93)
E. albidus	OECD	42	620	ND	ND	
E. crypticus	OECD	28	620	ND	ND	

ND: could not be estimated

2.6 Atrazine

Class of pesticide	**Sub class**	**Log K_{ow}**	**Soil DT_{50} Lab @ 20°C**	**Targeted system/process**	**Mode of action**
Herbicide	Triazine	2.5	66	Photosynthesis	Inhibits photosystem II.

Summary Of Literature Data On The Acute Toxicity Of Atrazine

Species	Soil type	Test duration (days)	Mortality LC_{50} mg /kg	References
E. fetida	OECD	14	79	Pesticide Properties Database http://sitem.herts.ac.uk/aeru/iupac/index.htm
	OECD	14	130.9	Haque et al (1983, 44)
L. terrestris	Sandy loam	14	444.4	
A. caliginosa	OECD	28	381.2	Mosleh et al (2003, 133)

Summary Of Literature Data On Effects Of Atrazine On Avoidance Behaviour

Species	Soil type	Test duration (days)	Avoidance EC_{50} (mg /kg)	Reference
E. albidus	LUFA 2.2	2	38	Amorim et al (2008, 2)

2.7 Pentachlorophenol

Class of pesticide	Sub class	Log K_{ow}	Soil DT_{50} Lab @ 20ºC	Targeted system/process	Mode of action
Organochlorine		5.1	48	Metabolism	Accelerates aerobic metabolism and increases heat production

Test Substrates

Soil type	pH	OM %	OC %	C/N	Clay %	Silt %	Sand %	WHC %	CEC	Reference
Natural soil	7.8	1.5			4.1	8.2	87.7			Lanno et al (1997, 130)
Kooyenburg soil	5.2	3.7			1.4				6.6	Van Gestel & Ma (1988, 129)
Holton soil	5.6	6.1			2.4				10	

Summary Of Literature Data On Acute Toxicity Of Pentachlorophenol

Species	Soil type	Test duration (days)	Mortality (mg/kg) LC50	Reference
E. albidus	**OECD**	**28**	**136**	**Rombke (1989, 65)**
E. fetida	OECD	14	48	Pesticide Properties Database http://sitem.herts.ac.uk/aeru/iupac/index.htm
		28	87	Heimbach (1984, 62)
E. andrei	Kooyenburg soil	14	94	Van Gestel & Ma (1988, 129)
	Holton soil		143	
	OECD		75.1	
L. terrestris	Natural soil	14	93	Lanno et al (1997, 130)
L. rubellus	Kooyenburg soil	14	1094	Van Gestel & Ma (1988, 129)
	Holton soil		883	

Summary Of Literature Data On Effects Of Pentachlorophenol On Avoidance Behaviour

Species	Soil type	Test duration (days)	Avoidance EC_{50} (mg /kg)	Reference
E. albidus	LUFA 2.2	2	703	Amorim et al (2008, 2)

Summary Of Literature Data On Chronic Toxicity Of Pentachlorophenol

Species	Soil type	Duration	Cocoon production		Reference
			EC50 mg/kg	NOEC mg/kg	
E. andrei	OECD	21		40	Van Gestel et al (1992, 26)

2.8 Benomyl

Class of pesticide	Sub class	Log K_{ow}	Soil DT_{50} Lab @ 20°C	Targeted system/process	Mode of action
Fungicide	Benzimidazole	1.37	0.8	Mitosis	Inhibits mitosis by binding to beta-tubuline.

Substrates

Soil type	pH	OC %	OM %	C/N	Peat %	Clay %	Silt %	Sand %	WHC %	Reference
Sandy loam soil & peat (9:1)	6.1	1.0				3.2	12.1	94.7		Haque & Ebing (1983, 44)
OECD	6.1	3.59	6.17	32.6	10	20		50	56.1	Garcia (2008, 28) Rombke et al (2007, 70)
TAS	6.6	3.48	5.99	23.2	10	20		50	47.7	
LUFA 2.2	6.1	2.7	4.64	14.2					50.0	
TNS	3.9	2.49	4.28	19.2					40.1	
OECD	6.0				10	20		69	35.5	Van Gestel at al (1992, 26)
OECD	7.0				10	5		84	35.0	Heimbach (1984, 62)
Natural soil	6.2	8.5	10.1			7	15	78	40 - 70.0	Puurtinen & Martikainen, (1997 58)

TAS (Tropical artificial soil)

TNS (Tropical natural soil)

Summary Of Literature Data On Acute Toxicity Of Benomyl

Species	Soil type	Duration	LC50 mg/kg	Reference
E. andrei	OECD or similar	21	6	Van Gestel at al (1992, 26)
		42	5.7	
		14	19	Heimbach (1985, 63)
E. fetida	OECD or similar	14	27	Haque & Ebing (1983, 44)
		28	22	Heimbach (1984, 62)
	LUFA 2.2	14	14.6	Rombke et al (2007, 70)
	OECD*	14	458.3	
	TAS*	14	633	
	LUFA 2.2*	14	66.8	
	TNS*	14	61.4	
	TAS*	14	633	Garcia (2004, 79)
	OECD	14	22	
	LUFA 2.2	14	14.6	
L. terrestris	Sandy loam/peat	14	3.5	Haque & Ebing (1983, 44)
	Sandy loam/ rabbit faeces (85:5)	7	1.7	Karnak & Hamelink (1982, 66)
		14	0.4	
E. albidus	LUFA 2.2		1.8	Amorium et al (2005, 122)
	OECD or similar		25.7	
E. albidus		28	22	Rombke (1989, 65)

* Tropical species of *E. fetida*

Summary Of Literature Data On Chronic Toxicity Of Benomyl

Species	Soil type	Duration	Endpoint	EC50 mg/kg	NOEC mg/kg	Reference
E. andrei	OECD	42	Reproduction	1.6	1	Van Gestel at al (1992, 26)
E. fetida	LUFA 2.2	28		1.0	0.32	Rombke et al, (2007 70)
	OECD*	28		12.9	0.32	
	TAS*	28		3.8	3.16	
	LUFA 2.2*	28		0.8	0.32	
	TAS*	28		3.8	3.2	Garcia, 2004 (79 see 28)
	OECD	28		1.6	1.0	
	LUFA 2.2	28		1.0	3.2	
A. caliginosa	Clay & dung 1:1 (10% OM	26	Cocoon Production		0.25	Lof-Holmin (1982,67)
Enchytraeus sp	Natural soil	24	Reproduction		16	Puurtinen & Martikainen, (1997, 58)
E. albidus	LUFA 2.2		Reproduction	1		Amorium et al (2005, 122)
	OECD			5		
E.andrei	OECD	42	Growth		1	Van Gestel, (1992 26)
A. caliginosa	Clay & dung 1:1 (10% OM)	90	Growth		>0.5	Lof-Holmin (1980,69)
A. chlorotica					>0.5	
A. rosea					>0.5	
L. terrestris					0.25	
A. caliginosa	Sand & dung 1:1 (10% OM)	90	Growth		<0.25	Lof-Holmin (1980,69)
A. chlorotica					<0.25	
A. rosea					<0.25	
L. terrestris					<0.25	
Enchytraeus sp	Natural soil	24	Growth		32 - 64	Puurtinen & Martikainen, (1997, 58)

* Tropical species of *E. fetida*

Summary Of Literature Data On Effects Of Benomyl On Avoidance Behaviour

Species	Soil type	Test duration (days)	Avoidance (mg ai/kg) EC50	Reference
E. andrei	OECD	2	<1	Loureiro et al, (2005, 81)
E. fetida	OECD	2	28.2	Garcia, (2008 28)
	TAS		54.9	
	LUFA 2.2		1.6	
E. albidus	LUFA 2.2	2	46.8	Amorim et al (2005, 122)
	OECD	2	>32	

2.9 Parathion

Class of pesticide	**Sub class**	**Log K_{ow}**	**Soil DT_{50} Lab @ 20°C**	**Targeted system/process**	**Mode of action**
Organophosphate		3.83	14	Nervous System	Cholinesterase inhibitor

Summary Of Literature Data On Acute Toxicity Of Parathion

Species	Soil type	Duration	LC50 mg/kg	Reference
E. andrei	OECD	21	>180	Van Gestel at al (1992, 26)
L. terrestris	Buss bedding	42	44	Cathey (1982, 104)
A. chlorotica	Sandy soil	7	80	Fayolle (1979, 141)
E fetida	OECD	28	135	Rombke et al (1994 151)
E albidus	OECD	42	124	Rombke et al (1994 151)

Summary Of Literature Data On Chronic Toxicity Of Parathion

Species	Soil type	Duration	EC50 mg/kg	Reference
E. andrei	OECD	21	68	Van Gestel at al (1992, 26)

Species	Soil type	Test duration (days)	Immobility	References
			EC_{50} mg /l	
E. fetida	Compost/peat	4	>5	Ronday & Houx (1996, 80)
E. buchholzi	Clay/sand/peat	4	>5	
E. albidus	Clay/sand/peat	4	>5	

2.10 Carbendazim

Class of pesticide	Sub class	Log K_{ow}	Soil DT_{50} Lab @ 20ºC	Targeted system/process	Mode of action
Fungicide	Benzimidazole	1.38	260	Mitosis	Inhibition of mitosis and cell division.

Substrates

Soil type	pH	OM %	C/N	Peat %	Clay %	Silt %	Sand %	CEC Mval/100g	WHC %	Reference
OECD	7.3									Van Gestel, (1992, 26)
Silty clay loam	4.4	3			36.5			243		
OECD	6.1	6.17	32.6	10	20	-	50	-	56.1	Garcia (2008, 28)
TAS	6.6	5.99	23.2	10	20	-	50	-	47.7	
LUFA 2.2	6.1	4.64	14.2		-	-	-	-	50.0	
Kettering Loam	6.6	7			12				25.0	Ellis et al, (2007, 84)
Artificial 1	6.6	7			12*				55.3	
Artificial 2	4.5	7			12**				55.3	
Artificial 3	9	7			12**				55.3	
Artificial 4	6.6	20			12**				78.1	
Artificial 5	6.6	3			12**				48.2	
Artificial 6	6.6	7			30**				59.2	
Artificial 7	6.6	7			6**				50.3	

*Bentonite clay

** Kalonite clay

TAS (Tropical artificial soil)

Summary Of Literature Data On The Acute Toxicity Of Carbendazim

Organism	Soil type	Test Duration Days	LC_{50} mg/kg	Reference
E. albidus			7	Rombke, (1989, 65)
			5.5	Federschmidt (1994)
	OECD	21	>3.6	Rombke & Moser, (2002, 23)
		21	5.9	Pokarzhevskii et al (2003, 119)
E.crypticus		14	129.4	
E. coronatus		14	>321.8	Arrate et al (2002, 83)
F. ratzeli			15.2	Federschmidt (1994)
L. terrestris	Silty clay loam	28	6.4	Burrows & Edwards (2004, 109)
E. fetida	OECD	14	3.9	Pesticide Properties Database http://sitem.herts.ac.uk/aeru/iupac/index.htm
E. fetida	OECD	14	9.3	Vonk et al, (1986 77)
E. fetida	TAS		>1000	Garcia, (2004 79 see 28)
	OECD		5.8	
	LUFA 2.2		4.1	
E. fetida	Kettering Loam	14	2.5	Ellis et al, (2007, 84)
	OECD		8	
	Artificial 2		16	
	Artificial 3		6	
	Artificial 4		ND	
	Artificial 5		7.4	
	Artificial 6		14.3	
	Artificial 7		ND	
E. andrei	OECD	28	5.7	Van Gestel et al, (1992 26)
E. andrei			6	Rombke, (2004, 136)

Summary Of Literature Data On The Chronic Toxicity Of Carbendazim

Organism	Soil type	Test Duration Days	EC_{10} (Repro) mg/kg	EC_{50} (Repro) mg/kg	NOEC (Repro) mg/kg	Reference
E. albidus	OECD	42			1.8	Pokarzhevskii et al (2003, 119)
E. crypticus	OECD	28			18	
E. albidus	OECD	42	0.26		0.68	Rombke & Moser, (1999 cited in 136)
E. albidus	OECD	42	1.14	3.67	3.74	Rombke & Moser (2002, 23)
E. albidus	OECD	42			1.2	Collado et al, (1999, 50)
E. buchholzi					2.7	
E. coronatus	OECD	21	4.28	14.1	10.7	Arrate et al (2002, 83)
L. terrestris	Silty clay loam	28				Burrows & Edwards (2004, 109)
E. andrei	OECD	21	-	2.9	1.9	Van Gestel et al, (1992 26)
E. andrei			0.6		0.6	Rombke, (2004 136)
E. fetida	OECD	28			2	Vonk et al, (1986 77)
E. fetida	TAS			4.6	3.2	Garcia, (2004 79 see 28)
	OECD			2.7	0.1	
	LUFA 2.2			0.6	0.5	
E. fetida		14			1	Pesticide Properties Database http://sitem.herts.ac.uk/aeru/iupac/index.htm

Summary Of Literature Data On Effects Of Carbendazim On Avoidance Behaviour

Species	Soil type	Test duration (days)	Avoidance EC_{50} (mg/kg)	References
E. andrei	OECD	2	<1	Loureiro et al (2005, 71)
E. fetida	TAS	2	33.3	Garcia et al (2008, 28)
	OECD		127.4	
	LUFA 2.2		7.1	
E. albidus	OECD	2	>32	Amorim et al (2005, 122)
	LUFA 2.2		7.9	
E. albidus	LUFA 2.2	2	8	Amorim et al, (2008 1)
E. albidus	LUFA 2.2	18 h	7.6	Kobeticova et al, (2009 82)

2.11 Chlorpyrifos

Class of pesticide	Sub class	Log K_{ow}	Soil DT_{50} Lab @ 20ºC	Targeted system/process	Mode of action
Organophosphorus Insecticide	Pyridine Organothiophosphate	4.7	2.5	Nervous System	Cholinesterase inhibitor

Summary Of Literature Data On The Acute Toxicity Of Chlorpyrifos

Organism	Soil type	Test duration (days)	Mortality		Reference
			LC_{50} mg/kg	NOEC mg/kg	
A.caliginosa	OECD	14	755	486	Ma et al (1993, 18)
A. longa			778	486	
E. fetida			1077	486	
E.veneta			1174	875	
L. rubellus			129	83	
L. terrestris			458	270	
E. fetida		14	182		Pesticide Properties Database http://sitem.herts.ac.uk/aeru/iupac/index.htm

Summary Of Literature Data On The Chronic Toxicity Of Chlorpyrifos

Organism	Soil type	Test duration (days)	Reproduction		Reference
			EC_{50} mg/kg	NOEC mg/kg	
E. veneta	Kooyenburg soil	14	121	49	Ma et al (1993, 18)
L. rubellus			9.5	4.6	

Summary Of Literature Data On Effects Of Chlorpyrifos On Avoidance Behaviour

Species	Soil type	Test duration (days)	Avoidance EC_{50} (mg/kg)	Reference
E. albidus	LUFA 2.2	2	933	Amorim et al (2008 1)

2.12 Lindane

Class of pesticide	Sub class	Log K_{ow}	Targeted system/process	Mode of action
Organochlorine Insecticide	Cyclodiene	3.5	Nervous System	GABA-gated chloride channel antagonist

Soil type	pH	OM %	OC %	C/N	Peat %	Clay %	Silt %	Sand %	CEC Mval/100g	WHC %	Reference
Sandy loam soil & peat (9:1)	6.1	10.9	1.0			3.2	12.1	94.7			Haque & Ebing (1983 44)
OECD	6.0	10			10	20		70			Lock et al, (2002 34)
Sandy soil	4.4	4.8				1	22	77			
Loamy soil	6.3	1.5				17	72	11			

Summary Of Literature Data On The Acute Toxicity Of Lindane

Organism	Test soil	Test duration (Days)	Mortality LC50 mg/kg	References
E.fetida	OECD	14	165	Lock et al, (2002 34)
	OECD	14	136	Haque & Ebing (1983 44)
	OECD	14	162.1	Shi et al, (2007 85)
	OECD	14	59	Heimbach, (1985 63)
	Sandy Soil	14	399	Lock et al, (2002 34)
	Loamy soil	14	78.5	Lock et al, (2002 34)
		14	68	Pesticide Properties Database http://sitem.herts.ac.uk/aeru/iupac/index.htm
E. albidus	OECD	14	107	Lock et al, (2002 34)
	OECD	14	200	Amorim et al, (1999 5)
	Sandy Soil	14	384	Lock et al, (2002 34)
	Loam soil	14	76.7	
L. terrestris	Sandy Loam + Peat	14	113	Haque & Ebing (1983 44)
L. rubellus		14	117	
P. posthuma	OECD	14	40.4	Hans et al, (1990 86)

Chronic toxicity data of Lindane

Organism	Test soil	Test Duration (days)	Endpoint	NOEC mg/kg	LOEC mg/kg	EC10 mg/kg	EC_{50} mg/kg	References
E. albidus	OECD	42	Juveniles	10	18	3.29	9.68	Lock et al (2002, 34)
	Loamy soil			32	56	19.2	41.9	
E. fetida	10	21	Cocoons	10	18	11.5	25.9	
	4.8			18	32	15.7	30.2	
	1.5			3.2	5.6	2.38	6.51	
E. fetida	10	21	Juveniles	10	18	7.74	15.2	
	4.8			18	32	11.7	23.3	
	1.5			5.6	10	2.83	6.32	

Summary Of Literature Data On Effects Of Lindane On Avoidance Behaviour

Species	Soil type	Test duration (days)	Avoidance EC_{50} (mg/kg)	Reference
E. andrei	OECD	2	48.6	Loureiro et al, (2005 71)
E. albidus	LUFA 2.2	2	172.5	Amorim et al (2008 1)

2.13 Phenmedipham

Herbicide

Log K_{ow} 3.59

Biochemistry: Photosynthetic electron transport inhibitor at the photosystem II receptor site.

Mode of action: Selective systemic herbicide, absorbed through the leaves, with translocation primarily in the apoplast.

Test Substrates

Soil type	pH	OM %	C/N	Clay %	Silt %	Sand %	CEC Mval/100g	WHC %	Reference
OECD	6	8.0	107.5	15	9	76	45.8	58	Amorim, et al (2005, 3)
LUFA 2.2	5.5	3.9	13.5	6	17	77	11.2	55	
ES1*	5.1	2.7	7.7	75	22	3	29.9	62.6	
Nat1*	6.2	1.7	8.7	33	66	5	40.7	58.4	
ES2*	7.4	6.4	18.5	23	64	13	28.3	68.5	
Hoh2*	6.2	12.9	25	6	61	33	78.3	73.9	
ES3*	5.2	6.5	13.3	17	37	46	18.3	42.6	
Coi3*	6.7	6.5	17	26	60	14	75.8	68.1	
Sch3*	5.4	4.1	10.4	23	45	32	68.5	67.4	
ES4*	6.5	2.9	9.7	20	76	4	17.5	42.9	
Tau4*	6.9	2.9	9.7	17	79	4	61.3	63.1	
ES7*	4.4	11.5	14.2	19	35	46	5	80.6	

OM (Organic Matter)
C/N (Carbon/Nitrogen)
CEC (Cation exchange capacity)
WHC (Water holding capacity)

*Natural soils based on Euro-Soils concept

Summary Of Literature Data On The Acute & Chronic Toxicity Of Phenmedipham

Species	Test duration (days)	Soil type	Adult survival		Juvenile production		Reference
			NOEC mg/kg	EC_{50} mg/kg	NOEC mg/kg	EC_{50} mg/kg	
E.albidus	42	OECD	>100	>100	32	52.5	Amorim, et al (2005, 3)
E.luxuriosus	28		32	118	3.2	44.5	
E.albidus	42	LUFA 2.2	32	49.8	10	24.2	
E.luxuriosus	28		3.2	51.3	10	22	
E.albidus	42	ES1	>100	>100	10	21.6	
E.albidus	42	ES2	32	103.4	3.2	17	
E.luxuriosus	28		3.2	86.5	1	28.3	
E.albidus	42	ES3	32	105.2	32	44.4	
E.luxuriosus	28		3.2	98.1	32	61.5	
E.luxuriosus	28	ES4	3.2	50.4	32	49.1	
E.albidus	42	Coi3	32	59	10	27.5	
E.luxuriosus	28		32	41.4	1	1.05	
E.luxuriosus	28	Sch3	1	6.6	1	4.5	
E.luxuriosus	28	Tau4	10	48.1	<1	6.1	

Summary Of Literature Data On The Acute Toxicity Of Phenmedipham

Species	Soil type	Test duration (days)	Survival LC_{50} mg /kg	Reference
E. albidus	LUFA 2.2	21	49.8	Amorim, et al (2005, 3)
	OECD		>100	
E. luxuriosus	LUFA 2.2	28	51.3	
	OECD		118	
E .crypticus	LUFA 2.2	7	74.8	Wagner-Vaske in Rombke et al, 2000 (Cited by Amorim et al 2005 4)
E. andrei	OECD	21	129	Van Gestel at al (1992, 26)

Summary Of Literature Data On The Chronic Toxicity Of Phenmedipham

Species	Soil type	Test duration (days)	Reproduction EC_{50} mg /kg	Reference
E. albidus	LUFA 2.2	42	24.2	Amorim, et al (2005, 3)
E.crypticus		28	22	
E.crypticus		7	36.9	Wagner-Vaske in Rombke et al, 2000 (Cited by Amorim et al 2005 4)
E. andrei	OECD	21	52	Van Gestel at al (1992, 26)

Summary Of Literature Data On Effects Of Phenmedipham On Avoidance Behaviour

Species	Soil type	Test duration (days)	Avoidance (mg ai/kg) EC_{50}	Reference
E. albidus	LUFA 2.2	2	50.7	Amorim, et al (2005, 4)
	OECD		252.2	
	Nat 1		45.9	
	Hoh2		<1	
	ES7		34.2	
E. albidus	LUFA 2.2	2	7	Amorim et al (2008 1)
E.crypticus	LUFA 2.2	2	20	Wagner-Vaske in Rombke et al, 2000 (cited by Amorim et al 2005 4)

2.14 Alpha-cypermethrin

Class of pesticide	**Log K_{ow}**	**Targeted system/process**	**Mode of action**
Pyrethroid Insecticide	6.94	Nervous System	Sodium channel modulator

Soil type	pH	OC %	C/N	Clay %	Silt %	Sand %	CEC Mval/100g	WHC %	Reference
Sandy Loam	6.5	2.2		10.1	17.5	72.4	132	34	Hartnik et al (2008, 12)
Sandy Loam 1	6.2	1.39		10.4	18.8	68.4	106	33.8	Hartnik & Styrishave (2008, 101)
Sandy Loam 2	5.5	5.5		9.6	36.2	54.2		44	

Summary Of Literature Data On The Acute Toxicity Of Alpha-cypermethrin

Species	Soil type	Test duration (days)	Survival LC_{50} mg /kg	Reference
E. fetida	Sandy Loam	28	762	Hartnik et al (2008, 12)
	Sandy Loam 1	28	>1000	Hartnik & Styrishave (2008, 101)
	Sandy Loam 2	28	>1000	
	OECD	14	>100	Inglesfield (1984, 61)
E. crypticus	Sandy Loam	28	31.4	Hartnik et al (2008, 12)

Summary Of Literature Data On The Chronic Toxicity Of Alpha-cypermethrin

Species	Soil type	Test duration (days)	Reproduction		Reference
			NOEC mg /kg	EC_{50} mg /kg	
E. crypticus	Sandy Loam	28	2.51	4.9	Hartnik et al (2008, 12)
E. fetida	Sandy Loam		<4.65	31	
	Sandy Loam 1		5	43	Hartnik & Styrishave (2008, 101)
	Sandy Loam 2		50	80	

2.15 Chloroacetamide

Organism	LC_{50} (14d)	LC_{50} (28 d)	NOEC	Reference
E. albidus		4 mg/kg		
E. fetida	38.5 mg/kg			
E. fetida	40 – 80 mg/kg			OECD
E. fetida	41 mg/kg		20 mg/kg	Ma, 1993
E. veneta	58 mg/kg		36 mg/kg	Ma, 1993
L. rubellus	48 mg/kg		36 mg/kg	Ma, 1993

2.16 Carbofuran

Test Substrate

Soil type	pH	OC %	C/N	Clay %	Silt %	Sand %	CEC Mval/100g	WHC %	Reference
Sandy loam soil & peat (9:1)	6.1	1.0		3.2	12.1	94.7			Haque & Ebing (1983 44)

Organism	Soil type	Test Duration days	Mortality LC_{50} mg/kg	Reference
E. fetida	OECD	14	3.1	Anton et al (1993 6)
L. terrestris	Sandy loam	14	4.7	Haque & Ebing (1983 44)
E. fetida	OECD	14	28.3	

2.17 Lambda – cyhalothrin

Summary Of Literature Data On Acute Toxicity Of Lambda – cyhalothrin

Species	Soil type	Duration	LC50 mg/kg	Reference
E. fetida	TAS		23.9	Garcia, (2004 79 see 28)
	OECD		99.8	
	LUFA 2.2		13.9	

Summary Of Literature Data On Acute Toxicity Of Lambda – cyhalothrin

Species	Soil type	Duration	LC50 mg/kg	NOEC mg/kg	Reference
E. fetida	TAS		7.7	6.2	Garcia, (2004 79 see 28)
	OECD		37.4	10	
	LUFA 2.2		44.5	3.2	

Summary Of Literature Data On Effects Of Lambda – Cyhalothrin On Avoidance Behaviour

Species	Soil type	Test duration (days)	Avoidance EC_{50} (mg /kg)	Reference
E. fetida	TAS	2	0.2	Garcia, (2008 28)
	OECD		3.3	
	LUFA 2.2		0.5	

Industrial Chemicals

2.18 Short Chain Chlorinated Paraffin

Summary Of Literature Data On The Acute Toxicity Of SCCP

Species	Soil type	Test duration (days)	Mortality (mg/kg)			Reference
			NOEC	LOEC	LC_{50}	
E. fetida	OECD	28	10000	ND	ND	Bezchlebova et al (2007, 121)
E. albidus	OECD	42	10000	ND	ND	
E. crypticus	OECD	28	6000	10000	ND	

Summary Of Literature Data On The Chronic Toxicity Of SCCP

Species	Soil type	Test duration (days)	Fecundity (mg/kg)			Reference
			NOEC	LOEC	EC_{50}	
E. fetida	OECD	28	1000	3200	2849	Bezchlebova et al (2007, 121)
E. albidus	OECD	42	3000	6000	6027	
E. crypticus	OECD	28	6000	10000	7809	

Enchytraeid species *E. crypticus* and *E. albidus* showed lower sensitivity to SCCP than the earthworm *E. fetida*.

The following order of species sensitivity to SCCP ranked from the most to least sensitive *E. fetida* > *E. albidus* ~ *E. crypticus*.

2.19 4-Nitrophenol

Summary Of Literature Data On The Acute Toxicity Of 4-Nitrophenol

Organism	Soil type	Test duration (days)	LC_{50} mg/ kg	References
E. albidus	OECD	21	55	Rombke & Moser (2002, 23)
E. albidus	OECD	14	40.5	Pokarzhevskii et al (2003, 119)
E. crypticus			121.6	
A. tuberculate	OECD	14	56	Neuhauser, et al (1986, 99)
E. fetida			38	
E. eugeniae			40	
P. excavatus			44	

Enchytraeid species are similarly sensitive to 4-Nitrophenol as the earthworm species when using survival as an endpoint.

Summary Of Literature Data On The Chronic Toxicity Of 4-Nitrophenol

Organism	Soil type	Test duration (days)	EC_{10} mg/ kg	EC_{50} mg/ kg	NOEC mg/ kg	References
E. albidus	OECD	42	5.13	37.1	46.7	Rombke & Moser (2002, 23)
E. albidus	OECD	42			10	Collado et al, (1999, 50)
E. buchholzi					5.6	

2.20 Nitrogen-Heterocyclic Polyaromatic Hydrocarbons

Summary Of Literature Data On The Acute Toxicity Of NPAH'S

Chemical	Species	Soil type	Test duration (days)	Mortality (mg/kg)		Reference
				LC_{10}	LC_{50}	
Quinoline	*E. fetida*	OECD	28		1993	Kobeticova et al (2008, 92)
	E. crypticus			1889	2093	
Acridine	*E. fetida*			>2500	>2500	
	E. crypticus			1501	2610	
Phenazine	*E. fetida*			1755	2018	
	E. crypticus			2012	2488	
1,10-Phenanthroline	*E. fetida*			1515		
	E. crypticus			939	1692	

Summary Of Literature Data On The Chronic Toxicity Of NPAH'S

Chemical	Species	Soil type	Test duration (days)	Mortality (mg/kg)		Reference
				EC_{10}	EC_{50}	
Quinoline	*E. fetida*	OECD	28	1641	1948	Kobeticova et al (2008, 92)
	E. crypticus			253	990	
Acridine	*E. fetida*			451	1460	
	E. crypticus			666	1412	
Phenazine	*E. fetida*			372	649	
	E. crypticus			413	1073	
1,10-Phenanthroline	*E. fetida*			787	1033	
	E. crypticus			379	796	

The ranking of chemicals according to their toxicity were different for survival and reproduction endpoints and differed among species.

Enchytraeid *E. crypticus* was similarly sensitive as the earthworm *E. fetida.*

2.21 Polycyclic Aromatic Compounds (PACs)

Summary Of Literature Data On The Acute Toxicity Of PACs

Chemical	Species	Soil type	Test duration (days)	Mortality (mg/kg) LC50	Reference
Pyrene	*E. veneta*	Sandy Loam	28	155	Sverdrup et al (2002, 102)
	E. crypticus		21	>2300	Sverdrup et al (2002, 137)
Fluoranthene	*E. veneta*		28	416	
	E. crypticus		21	>2500	
Phenanthrene	*E. veneta*		28	134	
	E. crypticus		21	>2500	
Fluorene	*E. veneta*		28	69	
	E. crypticus		21	1600	
Carbazole	*E. veneta*		28	106	
	E. crypticus		21	>2100	
Dibenzofuran	*E. veneta*		28	78	
	E. crypticus		21	400	
Acridine	*E. veneta*		28	863	
	E. crypticus		21	3600	

Summary Of Literature Data On The Chronic Toxicity Of PACs

Chemical	Species	Soil type	Test duration (days)	Growth / Reproduction (mg/kg)			Reference
				EC10	EC50	NOEC	
Pyrene	*E. veneta*	Sandy Loam	28	38	71	29	Sverdrup et al (2002, 102)
	E. crypticus		21	11	42	18	Sverdrup et al (2002, 137)
Fluoranthene	*E. veneta*		28	113	166	98	
	E. crypticus		21	15	61	38	
Phenanthrene	*E. veneta*		28	25	94	31	
	E. crypticus		21	40	87	34	
Fluorene	*E. veneta*		28	31	50	28	
	E. crypticus		21	25	55	27	
Carbazole	*E. veneta*		28	35	54	31	
	E. crypticus		21	19	52	34	
Dibenzofuran	*E. veneta*		28	36	61	30	
	E. crypticus		21	36	130	62	
Acridine	*E. veneta*		28	25	125	26	
	E. crypticus		21	310	1500	570	

2.22 Trinitrotoluene (TNT)

Summary Of Literature Data On The Acute Toxicity Of TNT

Species	Soil type	Test duration (days)	Survival		Reference
			LOEC mg /kg	LC_{50} mg /kg	
E. albidus	OECD	21		422	Dodard et al (2003, 117)
E. crypticus	LUFA 2.2	7		570	Schafer & Achazi (1999, 126)
E. andrei	Forest soil	14	260	222.4	Robidoux et al (1999, 125)
	OECD	14	420	364.9	
E. andrei	Sandy loam	14		132	Lachance et al (2004, 127)

Summary Of Literature Data On The Acute Toxicity Of TNT

Species	Soil type	Test duration (days)	Fecundity	Reference
			EC_{50} mg /kg	
E. albidus	OECD	42	111	Dodard et al (2003, 117)
E. crypticus	LUFA 2.2	28	369	Schafer & Achazi (1999, 126)

PHARMACEUTICALS

2.23 Oxytetracycline (Antibiotic)

Soil type	pH	OC %	Humus	Clay %	Silt %	Sand %	CEC Mval/100g	WHC %	Reference
Sandy soil	5.5	1.5	2.7	6.2	8.6	82.7			Baguer et al (2000, 103)
Sandy loam soil	6.2	1.6	2.8	13	22.3	62			

Summary Of Literature Data On Acute Toxicity Of Oxytetracycline

Species	Soil type	Duration	Mortality			Reference
			LC50 mg/kg	NOEC mg/kg	LOEC mg/kg	
E. crypticus	Sandy soil	21	>5000	3000	5000	Baguer et al (2000, 103)
A. caliginosa	Sandy loam soil	21	>5000	≥5000	>5000	

Summary Of Literature Data On chronic Toxicity Of Oxytetracycline

Species	Soil type	Duration	Reproduction			Reference
			EC50 mg/kg	NOEC mg/kg	LOEC mg/kg	
E. crypticus	Sandy soil	42	2701	2000	3000	Baguer et al (2000, 103)
A. caliginosa	Sandy loam soil	84	4420	3000	5000	

2.24 Tylosin (Antibiotic)

Soil type	pH	OC %	Humus	Clay %	Silt %	Sand %	CEC Mval/100g	WHC %	Reference
Sandy soil	5.5	1.5	2.7	6.2	8.6	82.7			Baguer et al (2000, 103)
Sandy loam soil	6.2	1.6	2.8	13	22.3	62			

Summary Of Literature Data On Acute Toxicity Of Tylosin

Species	Soil type	Duration	Mortality			Reference
			LC50 mg/kg	NOEC mg/kg	LOEC mg/kg	
E. crypticus	Sandy soil	21	3381	2000	3000	Baguer et al (2000, 103)
A. caliginosa	Sandy loam soil	21	>5000	≥5000	>5000	

Summary Of Literature Data On chronic Toxicity Of Tylosin

Species	Soil type	Duration	Rproductio			Reference
			EC50 mg/kg	NOEC mg/kg	LOEC mg/kg	
E. crypticus	Sandy soil	42	3109	3000	4000	Baguer et al (2000, 103)
A. caliginosa	Sandy loam soil	84	4530	3000	5000	

2.25 Abamectin (Veterinary medicine)

Soil type	pH	OM %	C/N	Clay %	Silt %	Sand %	CEC Mval/100g	WHC %	Reference
Sandy Loam	7			21	12	67			Diao et al, (2006, **9**)
LUFA 2.2	6	3.7		6.8				40 - 50	Kolar et al (2008, **15**)
Sheep faeces	6.7 – 7.2							40 - 50	

Summary Of Literature Data On Acute Toxicity Of Abamectin

Species	Soil type	Duration	Mortality			Reference
			LC50 mg/kg	NOEC mg/kg	LOEC mg/kg	
E. crypticus	Sandy Loam	21	>500	50	150	Diao et al, (2006, **9**)
E. crypticus	LUFA 2.2	28	111			Kolar et al (2008, **15**)
	Faeces	28	1.1			
E. fetida	Sandy Loam	24	>5	5	>5	Diao et al, (2006, **9**)
		28	38			Wislocki et al, (1989, **89**)
	OECD	14	17			Sun et al, (2005, **53**).
E. andrei	LUFA 2.2	28	18			Kolar et al (2008, **15**)
	Faeces	28	>1.4			

Summary Of Literature Data On Chronic Toxicity Of Abamectin

Species	Soil type	Duration	Reproduction			Reference
			EC50 mg/kg	NOEC mg/kg	LOEC mg/kg	
E. crypticus	Sandy Loam	21	23.7	10	25	Diao et al, (2006, **9**)
E. crypticus	LUFA 2.2	28	38	8		Kolar et al (2008, **15**)
	Faeces	28	0.9	0.8		
E. fetida	Sandy Loam	70	0.39	<0.25	0.25	Diao et al, (2006, **9**)
E. andrei	Faeces	56	>1.4	>1.4		Kolar et al (2008, **15**)

Abamectin

Organism	Test Substrate	Mortality	Reproduction		
		LC_{50} mg a.i./kg	EC_{10} mg a.i./kg	EC_{50} mg a.i./kg	NOEC mg a.i./kg
E. crypticus	LUFA 2.2 *[1]	111	4.6	38	8
	Faeces *[1]	1.1	-	0.94	0.81
	Sandy-loamy soil *[2]	>500	12.7	23.7	10
E. andrei	LUFA 2.2 *[1]	18	-	-	9.8*
	Faeces *[1]	>1.4	-	> 1.4	>1.4
E. fetida	Sandy-loamy soil *[2]	> 5	0.06	0.39	<0.25
E. fetida	*[3]	28			

* *E. andrei* did not reproduce in soil. NOEC values are for the effect of abamectin on weight loss.

*[1] Kolar, 2008.
*[2] Diao et al, 2006.
*[3] Halley et al, 1993.

Doramectin

Organism	Test Substrate	Mortality	Reproduction		
		LC_{50} mg a.i./kg	EC_{10} mg a.i./kg	EC_{50} mg a.i./kg	NOEC mg a.i./kg
E. crypticus	LUFA 2.2	>300	79	170	100
	Faeces	>2.5	-	2.2	<1.4
E. andrei	LUFA 2.2	288	-	-	8.4*
	Faeces	>2.5	-	>2.5	2.5

* *E. andrei* did not reproduce in soil. NOEC values are for the effect of doramectin on weight loss.

Avermectin (Technical 98%)– *Eisenia fetida* (Sun et al, 2005).

Test Duration

Artificial Soil: mortality 14d
Filter paper: 2d

Test Substrate

OECD test soil: pH 6.5
Filter paper (OECD 207)

Organism	Test Substrate	Mortality	
		LC_{50} mg a.i./kg	LC_{50} $\mu g/cm^2$
E. fetida	OECD	17.1	-
	Filter paper	-	4.63

2.26 Ivermectin

Soil type	pH	OC %	Humus	Clay %	Silt %	Sand %	CEC Mval/100g	WHC %	Reference
Sandy loam	6.2	1.6	2.8	13	22.3	62			Jensen et al, (2003, 14)

Summary Of Literature Data On The Acute Toxicity Of Ivermectin

Species	Soil type	Test duration (days)	Mortality (mg/kg)	Reference
			LC_{50}	
E. crypticus	Sandy loam	21	>300	Jensen et al, (2003, 14)
E. fetida	OECD or similar	28	315	Halley et al, (1989, 52)

Summary Of Literature Data On The Chronic Toxicity Of Ivermectin

Species	Soil type	Test duration (days)	Reproduction (mg/kg)				Reference
			NOEC	LOEC	EC_{10}	EC_{50}	
E. crypticus	Sandy loam	21	3	-	14	36	Jensen et al, (2003, 14)
E. fetida	OECD or similar	28	12				Halley et al, (1989, 52)

<u>Ivermectin (Oramec R, 0.08% w/v) – *Eisenia fetida* (Gunn & Sadd, 1994).</u>

<u>Test Substrate</u>

OECD test soil: pH 6

Organism	Test Substrate	Mortality (14d)		Growth	
		LC_{50} mg a.i./kg	LOEC mg a.i./kg	EC_{50} mg a.i./kg	LOEC mg a.i./kg
E. fetida	OECD	15.8	4.0	4.7	-
		314			

Ivermectin (Technical 98%) – *Eisenia fetida* (Halley et al, 1989).

Test Substrate

Artificial test soil: Peat 10%, Bentonite clay 5%, Cow manure 0.5%, $CaCO_3$ 1% and 83.5%, pH 7.

Organism	Test Substrate	Mortality (28d)	
		LC_{50} mg a.i./kg	NOEC mg a.i./kg
E. fetida	Artificial soil	>200*	12
	*[1]	315	

*Corrected mortality at top dose (200 mg/kg) was 34%. Range finder test indicated LC_{50} to be between 18 – 100 mg/kg.

*[1] Halley et al, 1993.

Choice test indicated high concentrations (20 mg/kg) of ivermectin had a repellent effect.

Differences in LC_{50} could be the result of differences in the proportions and qualities of the peat and clay used for the artificial soil. This could affect binding of the drug to the substrate.

It is known that pH affects the toxicity (Lock & Janssen 2001).

Formulated products contain stabilisers, emulsifiers and additives, which might increase its availability in the soil or might be toxic in their own right.

Appendix 3 Database search terms

All searches included the terms in the title, abstract and/or keywords

Set	Items	Description
S1	4252	ENCHYTRAEID? OR ENCHYTRAEUS OR POTWORM?
S2	36178	LUMBRICID? OR EISENIA OR EARTHWORM?
S3	1036810	PESTICIDE? OR INSECTICIDE? OR NEMATICIDE?
S4	478889	HERBICIDE? OR MOLLUSCICIDE? OR FUNGICIDE?
S5	299987	ANTIBACTERIAL? OR PLANT()PROTECTION()(PRODUCT? OR COMPOUND?)
S6	312997	VETERINARY()MEDICINE?
S7	415354	PHARMACEUTICAL?
S8	2269615	S3 OR S4 OR S5 OR S6 OR S7
S9	351	S1 AND S8
S10	3870	S2 AND S8
S11	3572288	TOXIC?
S12	69073	LD50 OR LC50 OR NOEC OR LOEC OR NOEL OR LOEL
S13	80049	ECOTOX? OR NON()TARGET?
S14	3629295	S11 OR S12 OR S13
S15	11957002	COMPAR? OR RELATIV?
S16	130	S1 AND S2 AND S8 AND S14
S17	56	RD S16 (unique items)
S18	169	RD S9 (unique items)
S19	**120**	**S18 NOT S17**
S20	**16**	**S17 AND S15**
S21	**40**	**S17 NOT S20**

Note RD- read unique items

Databases searched

File 154:MEDLINE(R) 1990-2009/Feb 12
File 50:CAB Abstracts 1972-2009/Feb W2 (week 2)
File 10:AGRICOLA 70-2009/Feb
File 203:AGRIS 1974-2009/Dec
File 5:Biosis Previews(R) 1926-2009/Feb W2 (week 2)
File 156:ToxFile 1965-2009/Feb W2 (week 2)
File 40:Enviroline(R) 1975-2008/May
File 41:Pollution Abstracts 1966-2009/May
File 44:Aquatic Science & Fisheries Abstracts 1966-2009/May
File 117:Water Resources Abstracts 1966-2008/May
File 34:SciSearch(R) Cited Ref Sci 1990-2009/Feb W1 (week 1)
File 434:SciSearch(R) Cited Ref Sci 1974-1989/Dec

Additional searches
EPA ECOTOX Database [March 2009]

Web of Knowledge/Web of Science [March 2009]
Science Citation Index Expanded (SCI-EXPANDED)--1981-present
Conference Proceedings Citation Index- Science (CPCI-S)--1990-present

OVID [March 2009]
Biosis Previews 1985- present
CAB Abstracts 1983-
Zoological Record 1993-

All results were combined, duplicates removed and clearly irrelevant references also deleted to produce the EndNote database. The DIALOGUE output is shown in Appendix 5. The EndNote database was updated with further references as these were identified during the project, e.g. cited in papers/reports or as a result of further searches on Web of Science/OVID.

Appendix 4 Identified data sources

Ref ID	Authors	Title	Journal	year	vol	pages		comments
1	Amorim MJB;Novais S;Rombke J;Soares A;	Avoidance test with Enchytraeus albidus (Enchytraeidae): Effects of different exposure time and soil properties	Environmental Pollution	2008	155	112	116	
2	Amorim MJB;Novais S;Rombke J;Soares A;	Enchytraeus albidus (Enchytraeidae): A test organism in a standardised avoidance test? Effects of different chemical substances	Environment International	2008	34	363	371	
3	Amorim MJB;Rombke J;Scheffczyk A;Soares A;	Effect of different soil types on the enchytraeids Enchytraeus albidus and Enchytraeus luxuriosus using the herbicide Phenmedipham	Chemosphere	2005	61	1102	1114	
4	Amorim MJB;Rombke J;Soares A;	Avoidance behaviour of Enchytraeus albidus: Effects of Benomyl, Carbendazim, phenmedipham and different soil types	Chemosphere	2005	59	501	510	
5	Amorim MJ;Sousa JP;Nogueira AJA;Soares A;	Comparison of chronic toxicity of Lindane (gamma-HCH) to Enchytraeus albidus in two soil types: the influence of soil pH	Pedobiologia	1999	43	635	640	
6	Anton FA;Laborda E;Laborda P;Ramos E;	Carbofuran acute toxicity to Eisenia-foetida-savigny - earthworms	Bulletin of Environmental Contamination and Toxicology	1993	50	407	412	no data on carbofuran for enchytraeids
7	Casabe N;Piola L;Fuchs J;Oneto ML;Pamparato L;Basack S;Gimenez R;Massaro R;Papa JC;Kesten E;	Ecotoxicological assessment of the effects of glyphosate and chlorpyrifos in an Argentine soya field	Journal of Soils and Sediments	2007	7	232	239	single dose rate in field no comparable data for enchytraeids
8	Cortet J;Gomot-De Vauflery A;Poinsot-	The use of invertebrate soil fauna in monitoring pollutant effects	European Journal of Soil Biology	1999	35	115	134	review paper of methodology no

	Balaguer N;Gomot L;Texier C;Cluzeau D;							toxicity data
9	Diao XP;Jensen J;Hansen AD;	Toxicity of the anthelmintic abamectin to four species of soil invertebrates	Environmental Pollution	2007	148	514	519	
10	Didden WAM;	Ecology of terrestrial Enchytraeidae	Pedobiologia	1993	37	2	29	ecology paper no toxicity data
11	Gunn A;Sadd JW;	The effect of ivermectin on the survival, behavior and cocoon production of the earthworm Eisenia-foetida	Pedobiologia	1994	38	327	333	
12	Hartnik T;Sverdrup LE;Jensen J;	Toxicity of the pesticide alpha-cypermethrin to four soil nontarget invertebrates and implications for risk assessment	Environmental Toxicology and Chemistry	2008	27	1408	1415	
13	Jansch S;Frampton GK;Rombke J;Van den Brink PJ;Scott-Fordsmand JJ;	Effects of pesticides on soil invertebrates in model ecosystem and field studies: A review and comparison with laboratory toxicity data	Environmental Toxicology and Chemistry	2006	25	2490	2501	no extractable toxicity data
14	Jensen J;Krogh PH;Sverdrup LE;	Effects of the antibacterial agents tiamulin, olanquindox and metronidazole and the anthelmintic ivermectin on the soil invertebrate species Folsomia fimetaria (Collembola) and Enchytraeus crypticus (Enchytraeidae)	Chemosphere	2003	50	437	443	
15	Kolar L;Erzen NK;Hogerwerf L;van Gestel CAM;	Toxicity of abamectin and doramectin to soil invertebrates	Environmental Pollution	2008	151	182	189	
16	Kuperman RG;Amorim MJB;Rombke J;Lanno R;Checkai RT;Dodard SG;Sunahara	Adaptation of the enchytraeid toxicity test for use with natural soil types	European Journal of Soil Biology	2006	42	S234	S243	

	GI;Scheffczyk A;							
17	Kuperman RG;Simini M;Phillips CT;Checkai RT;	Comparison of Malathion toxicity using enchytraeid reproduction test and earthworm toxicity test in different soil types	Pedobiologia	1999	43	630	634	
18	Ma WC;Bodt J;	Differences in toxicity of the insecticide chlorpyrifos to 6 species of earthworms (Oligochaeta, Lumbricidae) in standardized soil tests	Bulletin of Environmental Contamination and Toxicology	1993	50	864	870	
19	Martikainen E;	Toxicity of dimethoate to some soil animal species in different soil types	Ecotoxicology and Environmental Safety	1996	33	128	136	
20	Martin NA;	toxicity of pesticides to Allolobophora-caliginosa (Oligochaeta, Lumbricidae)	New Zealand Journal of Agricultural Research	1986	29	699	706	
21	Natal-da-Luz T;Amorim MJB;Rombke J;Sousa JP;	Avoidance tests with earthworms and springtails: Defining the minimum exposure time to observe a significant response	Ecotoxicology and Environmental Safety	2008	71	545	551	
22	Rombke J;	Ecotoxicological laboratory tests with enchytraeids: A review	Pedobiologia	2003	47	607	616	review paper data collected from original papers
23	Rombke J;Moser T;	Validating the enchytraeid reproduction test: organisation and results of an international ringtest	Chemosphere	2002	46	1117	1140	
24	Slimak KM;	Avoidance response as a sublethal effect of pesticides on Lumbricus terrestris (Oligochaeta)	Soil Bioogy and Biochemistry	1997	29	713	715	avoidance - no comparable data for enchytraeids
25	Somogyi Z;Kiss I;Kadar I;Bakonyi G;	Toxicity of selenate and selenite to the potworm Enchytraeus albidus (Annelida : Enchytraeidae): a laboratory test	Ecotoxicology	2007	16	379	384	metals -review limited to organics
26	Vangestel CAM;Dirvenvanbreeme	Comparison of sublethal and lethal criteria for 9 different chemicals in standardized toxicity	Ecotoxicology and Environmental Safety	1992	23	206	220	

	n EM;Baerselman R;Emans HJB;Janssen JAM;Postuma R;Vanvliet PJM;	tests using the earthworm Eisenia-andrei						
27	Zhou SP;Duan CQ;Wang XH;Michelle WHG;Yu ZF;Fu H;	Assessing cypermethrin-contaminated soil with three different earthworm test methods	Journal of Environmental Sciences-China	2008	20	1381	1385	methodology paper on avoidance of earthworms
28	Garcia M;Rombke J;de Brito MT;Scheffczyk A;	Effects of three pesticides on the avoidance behavior of earthworms in laboratory tests performed under temperate and tropical conditions	Environmental Pollution	2008	153	450	456	
29	Lock K;Janssen CR;	Comparative toxicity of a zinc salt, zinc powder and zinc oxide to Eisenia fetida, Enchytraeus albidus and Folsomia candida	Chemosphere	2003	53	851	856	metals -review limited to organics
30	Criel P;Lock K;Van Eeckhout H;Oorts K;Smolders E;Janssen CR;	Influence of soil properties on copper toxicity for two soil invertebrates	Environmental Toxicology and Chemistry	2008	27	1748	1755	metals -review limited to organics
31	Lock K;Janssen CR;	Multi-generation toxicity of zinc, cadmium, copper and lead to the potworm Enchytraeus albidus	Environmental Pollution	2002	117	89	92	metals -review limited to organics
32	Lock K;Janssen CR;	Toxicity of arsenate to the compostworm Eisenia fetida, the potworm Enchytraeus albidus and the springtail Folsomia candida	Bulletin of Environmental Contamination and Toxicology	2002	68	760	765	metals -review limited to organics
33	Lock K;Janssen CR;	Ecotoxicity of chromium (III) to Eisenia fetida, Enchytraeus albidus, and Folsomia candida	Ecotoxicology and Environmental Safety	2002	51	203	205	metals -review limited to organics
34	Lock K;De Schamphelaere	The effect of lindane on terrestrial invertebrates	Archives of Environmental	2002	42	217	221	

	KAC;Janssen CR;		Contamination and Toxicology					
35	Lock K;Janssen CR;	Ecotoxicity of nickel to Eisenia fetida, Enchytraeus albidus and Folsomia candida	Chemosphere	2002	46	197	200	metals -review limited to organics
36	Lock K;Janssen CR;	Ecotoxicity of mercury to Eisenia fetida, Enchytraeus albidus and Folsomia candida	Biology and Fertility of Soils	2001	34	219	221	metals -review limited to organics
37	Lock K;Janssen CR;	Cadmium toxicity for terrestrial invertebrates: Taking soil parameters affecting bioavailability into account	Ecotoxicology	2001	10	315	322	metals -review limited to organics
38	Lock K;Janssen CR;	Effect of clay and organic matter type on the ecotoxicity of zinc and cadmium to the potworm Enchytraeus albidus	Chemosphere	2001	44	1669	1672	metals -review limited to organics
39	Lock K;Janssen CR;	Zinc and cadmium body burdens in terrestrial oligochaetes: Use and significance in environmental risk assessment	Environmental Toxicology and Chemistry	2001	20	2067	2072	metals -review limited to organics
40	Callahan CA;Shirazi MA;Neuhauser EF;	Comparative toxicity of chemicals to earthworms	Environmental Toxicology and Chemistry	1994	13	291	298	insufficient info on methods- more robust data available in other sources
41	Neuhauser EF;Loehr RC;Milligan DL;Malecki MR;	Toxicity of metals to the earthworm eisenia-foetida	Biology and Fertility of Soils	1985	1	149	152	metals -review limited to organics
42	Frampton GK;Jansch S;Scott-Fordsmand JJ;Rombke J;Van den Brink PJ;	Effects of pesticides on soil invertebrates in laboratory studies: A review and analysis using species sensitivity distributions	Environmental Toxicology and Chemistry	2006	25	2480	2489	review data - data extracted from original sources
43	Scott-Fordsmand JJ;Weeks JM;Hopkin SP;	Toxicity of nickel to the earthworm and the applicability of the neutral red retention assay	Ecotoxicology	1998	7	291	295	metals -review limited to organics
44	Haque A;Ebing W;	Toxicity determination of pesticides to	Zeitschrift fur	1983	90	395	408	

		earthworms in the soil substrate	Pflanzenkrankheiten und Pflanzenschutz-Journal of Plant Diseases and Protection					
46	Ebere AG;Akintonwa A;	Acute toxicity studies with earthworms, Lumbricus-terrestris	Bulletin of Environmental Contamination and Toxicology	1995	55	766	770	no info on soil type
47	Vangestel CAM;	Validation of earthworm toxicity tests by comparison with field studies - a review of benomyl, carbendazim, carbofuran, and carbaryl	Ecotoxicology and Environmental Safety	1992	23	221	236	review data - data extracted from original sources
48	Moser T;van Gestel CAM;Jones SE;Koolhaas JE;Rodrigues JML;Rombke J;	Ring-testing and field-validation of a Terrestrial Model Ecosystem (TME) - An instrument for testing potentially harmful substances: Effects of carbendazim on enchytraeids	Ecotoxicology	2004	13	89	103	see 136
49	Weyers A;Rombke J;Moser T;Ratte HT;	Statistical results and implications of the enchytraeid reproduction ringtest	Environmental Science & Technology	2002	36	2116	2121	
50	Collado R;Schmelz RM;Moser T;Rombke J;	Enchytraeid Reproduction Test (ERT): Sublethal responses of two Enchytraeus species (Oligochaeta) to toxic chemicals	Pedobiologia	1999	43	625	629	
51	Spurgeon DJ;Hopkin SP;	Effects of variations of the organic matter content and pH of soils on the availability and toxicity of zinc to the earthworm Eisenia fetida	Pedobiologia	1996	40	80	96	metals -review limited to organics
52	Halley BA;Jacob TA;Lu AYH;	The environmental-impact of the use of ivermectin - environmental-effects and fate	Chemosphere	1989	18	1543	1563	
53	Sun YJ;Diao XP;Zhang QD;Shen JZ;	Bioaccumulation and elimination of avermectin B-1a in the earthworms (Eisenia fetida)	Chemosphere	2005	60	699	704	
54	Halley	Environmental-effects of the usage of	Veterinary Parasitology	1993	48	109	125	

	BA;Vandenheuvel WJA;Wislocki PG;	avermectins in livestock						
55	Zhou SP;Duan CQ;Fu H;Chen YH;Wang XH;Yu ZF;	Toxicity assessment for chlorpyrifos-contaminated soil with three different earthworm test methods	Journal of Environmental Sciences-China	2007	19	854	858	data not comparable
56	Moser T;Rombke J;Schallnass HJ;van Gestel CAM;	The use of the multivariate Principal Response Curve (PRC) for community level analysis: a case study on the effects of carbendazim on enchytraeids in Terrestrial Model Ecosystems (TME)	Ecotoxicology	2007	16	573	583	
57	Kula H;	Species-specific sensitivity differences of earthworms to pesticides in laboratory tests	Ecotoxicology of Soil Organisms; ed Donker MH;Eijsackers H;Heimbach F;	1994		241	250	review data - data extracted from original sources
58	Puurtinen HM;Martikainen EAT;	Effect of soil moisture on pesticide toxicity to an enchytraeid worm, Enchytraeus sp	Archives of Environmental Contamination and Toxicology	1997	33	34	41	
59	Yasmin S;D'Souza D;	Effect of pesticides on the reproductive output of Eisenia fetida	Bulletin of Environmental Contamination and Toxicology	2007	79	529	532	
60	Kula H;Larink O;	Development and standardization of test methods for the prediction of sublethal effects of chemicals on earthworms	Soil Biology & Biochemistry	1997	29	635	639	
61	Inglesfield C;	Toxicity of the Pyrethroid Insecticides Cypermethrin and Wl85871 to the Earthworm, Eisenia-Foetida Savigny	Bulletin of Environmental Contamination and Toxicology	1984	33	568	570	

62	Heimbach F;	Correlations Between 3 Methods for Determining the Toxicity of Chemicals to Earthworms	Pesticide Science	1984	15	605	611	
63	Heimbach F;	Comparison of Laboratory Methods, Using Eisenia-Foetida and Lumbricus-Terrestris, for the Assessment of the Hazard of Chemicals to Earthworms	Zeitschrift fur Pflanzenkrankheiten und Pflanzenschutz-Journal of Plant Diseases and Protection	1985	92	186	193	
65	Rombke J;	Enchytraeus albidus (Enchytraeidae, Oligochaeta) as a Test Organism in Terrestrial Laboratory Systems	Archives of Toxicology Supplement	1989	13	402	405	
66	Karnak RE;Hamelink JL;	A Standardized Method for Determining the Acute Toxicity of Chemicals to Earthworms	Ecotoxicology and Environmental Safety	1982	6	216	222	
67	Lofsholmin A;	Measuring Cocoon Production of the Earthworm Allolobophora-Caliginosa (Sav) As A Method of Testing Sublethal Toxicity of Pesticides - An Experiment with Benomyl	Swedish Journal of Agricultural Research	1982	12	117	119	
68	Lofsholmin A;	Influence of Routine Pesticide Spraying on Earthworms (Lumbricidae) in Field Experiments with Winter-Wheat	Swedish Journal of Agricultural Research	1982	12	121	123	single dose rate in field no comparable data for enchytraeids
69	Lofs-Holmin A;	Measuring growth of earthworms as a method of testing sublethal toxicity of pesticides.	Swedish Journal of Agricultural Research	1980	10	25	33	
70	Rombke J;Garcia MV;Scheffczyk A;	Effects of the fungicide benomyl on earthworms in laboratory tests under tropical and temperate conditions	Archives of Environmental Contamination and Toxicology	2007	53	590	598	
71	Loureiro S;Soares AMVM;Nogueira AJA;	Terrestrial avoidance behaviour tests as screening tool to assess soil contamination	Environmental Pollution	2005	138	121	131	
72	Heimbach F;Edwards PJ;	The Toxicity of 2-Chloroacetamide and	Pesticide Science	1983	14	635	636	data included

		Benomyl to Earthworms Under Various Test Conditions in An Artificial Soil Test						elsewhere
73	Hund-Rinke K;Simon M;	Terrestrial ecotoxicity of eight chemicals in a systematic approach	Journal of Soils and Sediments	2005	5	59	65	industrial chemicals for which no enchytraeid data available
74	Hund-Rinke K;Lindemann M;Simon M;	Experiences with novel approaches in earthworm testing alternatives	Journal of Soils and Sediments	2005	5	233	239	methodology paper on earthworms
75	Belfroid AC;Sijm DTHM;	Influence of soil organic matter content on elimination rates of hydrophobic compounds in the earthworm: Possible causes and consequences	Chemosphere	1998	37	1221	1234	effect of organic matter content
76	Achazi RK;Chroszcz G;Pilz C;Rothe B;Steudel I;Throl C;	The effect of pH and PCB 52 upon reproduction and colonization activity of terrestrial enchytraeids in soils of sewage farms contaminated with PAH, PCB and heavy metals	Verhandlungen der Gesellschaft fur Okologie,	1996	26	37	42	
77	Vonk JW;	Comparison of the effects of several chemicals on microoroganisms, higher plants and earthworms.	Contaminated soil Ed Assinsk JW & Van den Brink WJ	1985		191	202	
78	Natal-da-Luz T;Rombke J;Sousa JP;	Avoidance tests in site-specific risk assessment- influence of soil properties on the avoidance response of collembola and earthworms	Environmental Toxicology and Chemistry	2008	27	1112	1117	effects of soil type on avoidance
79	Garcia M;	Effects of pesticides on soil fauna: development of ecotoxicological test methods for tropical regions.	Ph D Dissertation	2004				
80	Ronday R;Houx NWH;	Suitability of seven species of soil-inhabiting invertebrates for testing toxicity of pesticides in soil pore water	Pedobiologia	1996	40	106	112	

81	Loureiro S;Amorim MJB;Campos B;Rodrigues SMG;Soares AMVM;	Assessing joint toxicity of chemicals in Enchytraeus albidus (Enchytraeidae) and Porcellionides pruinosus (Isopoda) using avoidance behaviour as an endpoint	Environmental Pollution	2009	157	625	636	
82	Kobeticova K;Hofman J;Holoubek I;	Avoidance response of Enchytraeus albidus in relation to carbendazim ageing	Environmental Pollution	2009	157	704	706	
83	Arrate JA;Rodriguez P;Martinez-Madrid M;	Effects of three chemicals on the survival and reproduction of the oligochaete worm Enchytraeus coronatus in chronic toxicity tests	Pedobiologia	2002	46	136	149	
84	Ellis SR;Hodson ME;Wege P;	The influence of different artificial soil types on the acute toxicity of carbendazim to the earthworm Eisenia fetida in laboratory toxicity tests	European Journal of Soil Biology	2007	43	S239	S245	
85	Shi YJ;Shi YJ;Wang X;Lu YL;Yan S;	Comparative effects of lindane and deltamethrin on mortality, growth, and cellulase activity in earthworms (Eisenia fetida)	Pesticide Biochemistry and Physiology	2007	89	31	38	
86	Hans RK;Gupta RC;Beg MU;	Toxicity Assessment of 4 Insecticides to Earthworm, Pheretima-Posthuma	Bulletin of Environmental Contamination and Toxicology	1990	45	358	364	
87	Lock K;Janssen CR;	Mixture toxicity of zinc, cadmium, copper, and lead to the potworm Enchytraeus albidus	Ecotoxicology and Environmental Safety	2002	52	1	7	metals -review limited to organics
88	Huhta V;	Response of Cognettia-Sphagnetorum (Enchytraeidae) to Manipulation of Ph and Nutrient Status in Coniferous Forest Soil	Pedobiologia	1984	27	245	260	ph/nutrient effects
89	Wislocki PG;Crosso LS;Dybas RA;	Environmental Aspects of Abamectin Use	Crop Protection in Ivermectin and abamectin. In Campbell, W.C (Ed.), Ivermectin	1989		139	157	

			and Abamectin					
90	Fraser DS;O'Halloran K;van den Heuvel MR;	Toxicity of pulp and paper solid organic waste constituents to soil organisms	Chemosphere	2009	74	660	668	combinations on industrial chemicals
91	Jensen J;Diao XP;Hansen AD;	Single- and Two-Species Tests to Study Effects of the Anthelmintics Ivermectin and Morantel and the Coccidiostatic Monensin on Soil Invertebrates	Environmental Toxicology and Chemistry	2009	28	316	323	data included in 14
92	Kobeticova K;Buchlebova J;Lana J;Sochova I;Hofman J;	Toxicity of four nitrogen-heterocyclic polyaromatic hydrocarbons (NPAHs) to soil organisms	Ecotoxicology and Environmental Safety	2008	71	650	660	
93	Bezchlebova J;Cernohlavkova J;Lana J;Sochova I;Kobeticova K;Hofman J;	Effects of toxaphene on soil organisms	Ecotoxicology and Environmental Safety	2007	68	326	334	
94	Krogh PH;Lopez CV;Cassani G;Jensen J;Holmstrup M;Schraepen N;Jorgensen E;Gavor Z;Ternara A;	Risk assessment of linear alkylbenzene sulphonates, LAS, in agricultural soil revisited: Robust chronic toxicity tests for Folsomia candida (Collembola), Aporrectodea caliginosa (Oligochaeta) and Enchytraeus crypticus (Enchytraeidae)	Chemosphere	2007	69	872	879	no lumbricid data for LAS
95	Droge STJ;Paumen ML;Bleeker EAJ;Kraak MHS;van Gestelt CAM;	Chronic toxicity of polycyclic aromatic compounds to the springtail Folsomia candida and the enchytraeid Enchytraeus crypticus	Environmental Toxicology and Chemistry	2006	25	2423	2431	
96	Kuperman RG;Checkai RT;Simini M;Phillips CT;Kolakowski JE;Kurnas CW;	Toxicities of dinitrotoluenes and trinitrobenzene freshly amended or weathered and aged in a sandy loam soil to Enchytraeus crypticus	Environmental Toxicology and Chemistry	2006	25	1368	1375	Effect of soil type
97	Dodard SG;Sunahara GI;Kuperman	Survival and reproduction of enchytraeid worms, oligochaeta, in different soil types	Environmental Toxicology and	2005	24	2579	2587	no comparable data for lumbricidae

	RG;Sarrazin M;Gong P;Ampleman G;Thiboutot S;Hawari J;	amended with energetic cyclic nitramines	Chemistry					
98	Cairns J;	The Myth of the Most Sensitive Species	Bioscience	1986	36	670	672	not relevant, no data
99	Neuhauser EF;Durkin PR;Malecki MR;Anatra M;	Comparative Toxicity of 10 Organic-Chemicals to 4 Earthworm Species	Comparative Biochemistry and Physiology C-Pharmacology Toxicology & Endocrinology	1986	83	197	200	
100	Lydy MJ;Linck SL;	Assessing the impact of triazine herbicides on organophosphate insecticide toxicity to the earthworm Eisenia fetida	Archives of Environmental Contamination and Toxicology	2003	45	343	349	Filter paper exposure
101	Hartnik T;Styrishave B;	Impact of Biotransformation and Bioavailability on the Toxicity of the Insecticides alpha-Cypermethrin and Chlorfenvinphos in Earthworm	Journal of Agricultural and Food Chemistry	2008	56	11057	11064	
102	Sverdrup LE;Krogh PH;Nielsen T;Stenersen J;	Relative sensitivity of three terrestrial invertebrate tests to polycyclic aromatic compounds	Environmental Toxicology and Chemistry	2002	21	1927	1933	
103	Baguer AJ;Jensen J;Krogh PH;	Effects of the antibiotics oxytetracycline and tylosin on soil fauna	Chemosphere	2000	40	751	757	
104	Cathey B;	Comparative Toxicities of 5 Insecticides to the Earthworm, Lumbricus-Terrestris	Agriculture and Environment	1982	7	73	81	
105	Bauer C;Rombke J;	Factors influencing the toxicity of two pesticides on three lumbricid species in laboratory tests	Soil Biology & Biochemistry	1997	29	705	708	effects of soil properties
106	Edwards CA;Bohlen PJ;	The Effects of Toxic-Chemicals on Earthworms	Reviews of	1992	125	23	99	review paper- data

			Environmental Contamination and Toxicology					from original sources
107	Henson-Ramsey H;Kennedy-Stoskopf S;Levine J;Shea D;Taylor SK;Stoskopf MK;	A comparison of two exposure systems to apply malathion to Lumbricus terrestris L	Bulletin of Environmental Contamination and Toxicology	2007	78	427	431	methodology paper
108	Roberts BL;Dorough HW;	Relative Toxicities of Chemicals to the Earthworm Eisenia-Foetida	Environmental Toxicology and Chemistry	1984	3	67	78	non-standard contact toxicity test
109	Burrows LA;Edwards CA;	The use of integrated soil microcosms to assess the impact of carbendazim on soil ecosystems	Ecotoxicology	2004	13	143	161	
110	Forster B;van Gestel CAM;Koolhaas JE;Nentwig G;Rodrigues JML;Sousa JP;Jones SE;Knacker T;	Ring-testing and field-validation of a Terrestrial Model Ecosystem (TME) - An instrument for testing potentially harmful substances: Effects of carbendazim on organic matter breakdown and soil fauna feeding activity	Ecotoxicology	2004	13	129	141	data included elsewhere
111	Bruns E;Egeler P;Roembke J;Scheffczyk A;Spoerlein P;	Bioaccumulation of lindane and hexachlorobenzene by the oligochaetes Enchytraeus luxuriosus and Enchytraeus albidus (Enchytraeidae, Oligochaeta, Annelida)	Hydrobiologia	2001	463	185	196	bioaccumulation
112	Amorim MJD;Sousa JP;Nogueira AJA;Soares AMVM;	Bioaccumulation and elimination of C-14-lindane by Enchytraeus albidus in artificial (OECD) and a natural soil	Chemosphere	2002	49	323	329	bioaccumulation
113	Amorim MJ;Sousa JP;Nogueira AJA;Soares AMVM;	Bioavailability and toxicokinetics of C-14-lindane (gamma-HCH) in the enchytraeid Enchytraeus albidus in two soil types: The aging effect	Archives of Environmental Contamination and Toxicology	2002	43	221	228	bioaccumulation
114	Rombke J;Jansch	State-of-the-art: the use of Enchytraeidae	Proceedings of the	2005	54	342	346	methodology review

	S;Moser T;	(Oligochaeta) as test and indicator organisms in standardized ecotoxicological tests.	Estonian Academy of Sciences, Biology, Ecology					paper
115	Burrows LA;Edwards CA;	The effects of the fungicide carbendazim in an innovative integrated terrestrial microcosm system	Bcpc Conference: Pests & Diseases 2000, Vols 1-3, Proceedings	2000	01-Mar	365	370	microcosm data not mesocosm
116	Didden W;Rombke J;	Enchytraeids as indicator organisms for chemical stress in terrestrial ecosystems	Ecotoxicology and Environmental Safety	2001	50	25	43	review paper- data for soil based assays taken from original papers
117	Dodard SG;Renoux AY;Powlowski J;Sunahara GI;	Lethal and subchronic effects of 2,4,6-trinitrotoluene (TNT) on Enchytraeus albidus in spiked artificial soil	Ecotoxicology and Environmental Safety	2003	54	131	138	
118	Choo LPD;Baker GH;	Influence of four commonly used pesticides on the survival, growth, and reproduction of the earthworm Aporrectodea trapezoides (Lumbricidae)	Australian Journal of Agricultural Research	1998	49	1297	1303	non-standard test
119	Pokarzhevskii A.D.;Filimonova Z.V;Goryachev O.A;	Life-cycle length determines the differences in sensitivity to toxicants between enchytraeid species.	Doklady Biological Sciences	2003	390	256	258	
120	Sverdrup LE;Hagen SB;Krogh PH;van Gestel CAM;	Benzo(a)pyrene shows low toxicity to three species of terrestrial plants, two soil invertebrates, and soil-nitrifying bacteria	Ecotoxicology and Environmental Safety	2007	66	362	368	no relevant data
121	Bezchlebova J;Cernohlavkova J;Kobeticova K;Lana J;Sochova I;Hofman J;	Effects of short-chain chlorinated paraffins on soil organisms	Ecotoxicology and Environmental Safety	2007	67	206	211	
122	Amorim MJB;Rombke J;Soares AMVM;	Comparison of the influence of an artificial and a natural soil on the behaviour of Enchytraeus	Proceedings of the Estonian Academy of	2005	54	335	341	

		albidus - laboratory tests.	Sciences, Biology, Ecology					
123	Kuperman RG;Checkai RT;Simini M;Phillips CT;Kolakowski JE;Kurnas CW;	Weathering and aging of 2,4,6-trinitrotoluene in soil increases toxicity to potworm Enchytraeus crypticus	Environmental Toxicology and Chemistry	2005	24	2509	2518	soil effects
124	Best EPH;Tatem HE;Geter KN;Wells ML;Lane BK;	Effects, Uptake, and Fate of 2,4,6-Trinitrotoluene Aged in Soil in Plants and Worms	Environmental Toxicology and Chemistry	2008	27	2539	2547	soil effects
125	Robidoux PY;Hawari J;Thiboutot S;Ampleman G;Sunahara GI;	Acute toxicity of 2,4,6-trinitrotoluene in earthworm (Eisenia andrei)	Ecotoxicology and Environmental Safety	1999	44	311	321	
126	Schafer R;Achazi RK;	The toxicity of soil samples containing TNT and other ammunition derived compounds in the enchytraeid and collembola-biotest	Environmental Science and Pollution Research	1999	6	213	219	
127	Lachance B;Renoux AY;Sarrazin M;Hawari J;Sunahara GI;	Toxicity and bioaccumulation of reduced TNT metabolites in the earthworm Eisenia andrei exposed to amended forest soil	Chemosphere	2004	55	1339	1348	
128	Vaal M;vanderWal JT;Hoekstra J;Hermens J;	Variation in the sensitivity of aquatic species in relation to the classification of environmental pollutants	Chemosphere	1997	35	1311	1327	aquatic data
129	Vangestel CAM;Ma WC;	Toxicity and Bioaccumulation of Chlorophenols in Earthworms, in Relation to Bioavailability in Soil	Ecotoxicology and Environmental Safety	1988	15	289	297	
130	Lanno RP;Stephenson GL;Wren CD;	Applications of toxicity curves in assessing the toxicity of diazinon and pentachlorophenol to Lumbricus terrestris in natural soils	Soil Biology & Biochemistry	1997	29	689	692	
131	Ma WC;van Kleunen	Bioaccumulation of polycyclic aromatic	Environmental	1998	17	1730	1737	bioaccumulation data

	A;Immerzeel J;de Maagd PGJ;	hydrocarbons by earthworms: Assessment of equilibrium partitioning theory in in situ studies and water experiments	Toxicology and Chemistry					
132	Henson-Ramsey H;Kennedy-Stoskopf S;Levine J;Shea D;Taylor SK;Stoskopf MK;	A comparison of two exposure systems to apply malathion to Lumbricus terrestris L	Bulletin of Environmental Contamination and Toxicology	2007	78	427	431	methodology paper
133	Mosleh YY;Ismail SMM;Ahmed MT;Ahmed YM;	Comparative toxicity and biochemical responses of certain pesticides to the mature earthworm Aporrectodea caliginosa under laboratory conditions	Environmental Toxicology	2003	18	338	346	
134	Edwards CA;Bater JE;	The Use of Earthworms in Environmental-Management	Soil Biology & Biochemistry	1992	24	1683	1689	
135	Sverdrup LE;Hartnik T;Mariussen E;Jensen J;	Toxicity of three halogenated flame retardants to nitrifying bacteria, red clover (Trifolium pratense), and a soil invertebrate (Enchytraeus crypticus)	Chemosphere	2006	64	96	103	no comparabrable lumbricid data
136	Rombke J;van Gestel CAM;Jones SE;Koolhaas JE;Rodrigues JML;Moser T;	Ring-testing and field-validation of a Terrestrial Model Ecosystem (TME) - An instrument for testing potentially harmful substances: Effects of carbendazim on earthworms	Ecotoxicology	2004	13	105	118	
137	Sverdrup LE;Jensen J;Kelley AE;Krogh PH;Stenersen J;	Effects of eight polycyclic aromatic compounds on the survival and reproduction of Enchytraeus crypticus (Oligochaeta, Clitellata)	Environmental Toxicology and Chemistry	2002	21	109	114	
138	Amorim MJD;Rombke J;Schallnass HJ;Mortagua A;Soares VM;	Effect of soil properties and aging on the toxicity of copper for Enchytraeus albidus, Enchytraeus luxuriosus, and Folsomia candida	Environmental Toxicology and Chemistry	2005	24	1875	1885	metals -review limited to organics
139	Rida AMMA;Bouche	Earthworm toxicology: From acute to chronic	Soil Biology &	1997	29	699	703	review- original data

	MB;	tests	Biochemistry					included
140	Vangestel CAM;van Dis WA;	The influence of soil characteristics on the toxicity of four chemicals to the earthworm Eisenia fetida andrei (Oligochaeta)	Biology and Fertility of Soils	1988	6	262	265	soil properties
141	Fayolle L;	Consequences of the impact of pollutants on earthworms. III. Laboratory tests	Documents Pedozoologiques	1979	1	34	65	
142	Howcroft CF;Amorim MJB;Gravato C;Guilhermino L;Soares AMVM;	Effects of natural and chemical stressors on Enchytraeus albidus: Can oxidative stress parameters be used as fast screening tools for the assessment of different stress impacts in soils?	Environment International	2009	35	318	324	effects on biomarkers
143	Hofman J;Rhodes A;Semple KT;	Fate and behaviour of phenanthrene in the natural and artificial soils	Environmental Pollution	2008	152	468	475	fate paper
144	Edwards CA;Bohlen PJ;	Biology of earthworms		1996	3		276	
145	Yeardley RB;Lazorchak JM;Pence MA;	Evaluation of Alternative Reference Toxicants for Use in the Earthworm Toxicity Test	Environmental Toxicology and Chemistry	1995	14	1189	1194	non-standard merthod
146	Yeardley RB;Lazorchak JM;Gast LC;	The potential of an earthworm avoidance test for evaluation of hazardous waste sites	Environmental Toxicology and Chemistry	1996	15	1532	1537	non-standard merthod
147	Slimak KM;	Avoidance response as a sublethal effect of pesticides on Lumbricus terrestris (Oligochaeta)	Soil Biology & Biochemistry	1997	29	713	715	non-standard merthod
148	Roex EWM;Van Gestel CA;Van Wezel AP;Van Straalen NM;	Ratios between acute aquatic toxicity and effects on population growth rates in relation to toxicant mode of action	Environmental Toxicology and Chemistry	2000	19	685	693	aquatic data
150	Vangestel CAM;Ma WC;	An Approach to Quantitative Structure-Activity-Relationships (Qsars) in Earthworm Toxicity Studies	Chemosphere	1990	21	1023	1033	
151	Rombke J;Knacker	Comparison of the effects of two pesticides on	Ecotoxicology of soil	1994		229	240	

	T;Forster B;Mariussen E;	soil organisms in laboratory tests, microcosms and in the field	organisms ed Donker MH;Eijsackers H;Heimbach F;					
152	Lock K;Janssen CR;de Coen WM;	Multivariate test designs to asses the influence of zinc and cadmium bioavailability in soils on the toxicity to Enchytraeus albidus	Environmental Toxicology and Chemistry	2000	19	2666	2671	metals -review limited to organics
153	Lock K;Janssen CR;	Test designs to assess the influence of soil characteristics on the toxicity of copper and lead to the oligochaete Enchytraeus albidus	Ecotoxicology	2001	10	137	144	soil effects

Please note references 45, 64 and 149 deleted as duplicate references

Appendix 5. Output from DIALOG Database searches

20/4/1 (Item 1 from file: 154)

DIALOG(R)File 154: MEDLINE(R)

FN- DIALOG(R) File 154:MEDLINE(R)|

AN- 18139537|

AA- 17597206|

TI- Effects of toxaphene on soil organisms.|

AU- Bezchlebova Jitka; Cernohlavkova Jitka; Lana Jan; Sochova Ivana; Kobeticova Klara; Hofman Jakub|

CS- RECETOX-Research Centre for Environmental Chemistry and Ecotoxicology, Faculty of Science, Masaryk University, Kamenice 126/3, CZ-625 00 Brno, Czech Republic.|

JN- Ecotoxicology and environmental safety; 68 (3) p326-34|

CP- United States|

PY- Nov 2007|

SN- 0147-6513--Print|

JC- 7805381|

NT- Publishing Model Print-Electronic|

DT- Comparative Study; Journal Article; Research Support, Non-U.S. Gov't|

LA- ENGLISH|

OA- NLM|

RT- MEDLINE; Completed|

SF- INDEX MEDICUS; Toxbib|

AB- The polychlorinated insecticide toxaphene belonged to the most used pesticides in the 20th century. Even recently, significant residues have been found in soils at various sites in the world. However, knowledge on toxicity to soil organisms is limited. In this study, the effects of toxaphene on soil invertebrates Folsomia candida, Eisenia fetida, Enchytraeus albidus, Enchytraeus crypticus, Caenorhabditis elegans, and microorganisms were investigated. Among the organisms tested, F. candida was the most sensitive. The 50% effect on survival and reproduction output (LC50 and EC50) was found at concentrations of 10.4 and 3.6 mg/kg, respectively. Sensitivity of other organisms was significantly lower with effective concentrations at tens or hundreds of mg/kg. Our data on soil toxicity were recalculated to soil pore-water concentrations and good accordance with available data reported for aquatic toxicity was found. Since soil concentrations at some sites are comparable to concentrations effective in our tests, toxaphene may negatively affect soil communities at these sites.|

DE- *Arthropods --drug effects --DE; * Insecticides --toxicity --TO; *Oligochaeta --drug effects --DE; * Pesticide Residues --toxicity --TO; *Soil Microbiology; *Soil Pollutants --toxicity --TO; *Toxaphene --toxicity --TO|

DE- Ammonia --metabolism --ME; Animals; Arginine --metabolism --ME; Bacteria --drug effects --DE; Bacteria --metabolism --ME; Caenorhabditis elegans --drug effects --DE; Dose-Response Relationship, Drug; Energy Metabolism --drug effects --DE; Insecticides --analysis --AN; Lethal Dose 50; Nitrogen --metabolism --ME; Pesticide Residues --analysis --AN; Reproduction --drug effects --DE; Soil Pollutants --analysis --AN; Species Specificity; Toxaphene --analysis --AN|

RN- 0 (Insecticides); 0 (Pesticide Residues); 0 (Soil Pollutants); 74-79-3 (Arginine); 7664-41-7 (Ammonia); 7727-37-9 (Nitrogen); 8001-35-2 (Toxaphene)|

UP- 20071010|

RC- 20071206|

EP- 20070626||

20/4/2 (Item 2 from file: 154)

DIALOG(R)File 154: MEDLINE(R)

FN- DIALOG(R) File 154:MEDLINE(R)|

AN- 17434116|

AA- 16986805|

TI- Effects of pesticides on soil invertebrates in model ecosystem and field studies: a review and comparison with laboratory toxicity data.|

AU- Jansch Stephan; Frampton Geoff K; Rombke Jorg; Van den Brink Paul J; Scott-Fordsmand Janeck J|

CS- ECT Oekotoxikologie, Bottgerstrasse 2-14, D-65439 Florsheim, Germany. s-jaensch@ect.de|

JN- Environmental toxicology and chemistry / SETAC; 25 (9) p2490-501|

CP- United States|

PY- Sep 2006|

SN- 0730-7268--Print|

JC- 8308958|

NT- Publishing Model Print|

DT- Journal Article; Research Support, Non-U.S. Gov't; Review|

LA- ENGLISH|

OA- NLM|

RT- MEDLINE; Completed|

SF- INDEX MEDICUS; Toxbib|

AB- A systematic review was carried out to investigate the extent to which higher-tier (terrestrial model ecosystem [TME] and field) data regarding pesticide effects can be compared with laboratory toxicity data for soil invertebrates. Data in the public domain yielded 970 toxicity endpoint data sets, representing 71 pesticides and 42 soil invertebrate species or groups. For most pesticides, the most frequent effect class was for no observed effects, although relatively high numbers of pronounced and persistent effects occurred when Lumbricidae and Enchytraeidae were exposed to

fungicides and when Lumbricidae,
Collembola, and Arachnida were exposed to
insecticides. No effects of
fungicides on Arachnida, Formicidae, or Nematoda or
of herbicides on Lumbricidae,
Formicidae, or Nematoda were observed in any studies. For most
pesticides, higher-tier no-observed-effect
concentration or lowest-observed-effect concentration values cannot be
determined because of a lack of information at low
pesticide concentrations. Ten
pesticides had sufficient laboratory data to enable
the observed higher-tier effects to be compared with
5% hazardous concentrations (HC5) estimated from acute
toxicity laboratory data (atrazine, carbendazim,
chlorpyrifos, diazinon, dimethoate, gamma-hexachlorocy-clohexane,
lambda-cyhalothrin, parathion, pentachlorophenol, and propoxur). In
eight cases, higher-tier effects concentrations were within or below
the 90% confidence interval of the HC5. Good agreement exists between
the results of TME and field tests for carbendazim, but insufficient
information is available for a comparison between
TME and field studies for other pesticides.
Availability and characteristics (e.g., taxonomic composition and
heterogeneity) of the higher-tier effects data are discussed in terms
of possible developments in risk assessment procedures.|

RF- 46|

DE- *Ecosystem; *Invertebrates --drug effects --DE; *
Pesticides --toxicity --TO;
*Soil --analysis --AN|

DE- Animals|

RN- 0 (Pesticides); 0 (Soil)|

UP- 20060921|

RC- 20061026||

20/4/3 (Item 3 from file: 154)

DIALOG(R)File 154: MEDLINE(R)

FN- DIALOG(R) File 154:MEDLINE(R)|

AN- 16472146|

AA- 15788173|

TI- Avoidance behaviour of Enchytraeus albidus: effects of benomyl, carbendazim, phenmedipham and different soil types.|

AU- Amorim Monica J B; Rombke Jorg; Soares Amadeu M V M|

CS- Departamento de Biologia, Universidade de Aveiro, 3810-193 Aveiro, Portugal. mjamorim@bio.ua.pt|

JN- Chemosphere; 59 (4) p501-10|

CP- England|

PY- Apr 2005|

SN- 0045-6535--Print|

JC- 0320657|

NT- Publishing Model Print|

DT- Journal Article; Research Support, Non-U.S. Gov't|

LA- ENGLISH|

OA- NLM|

RT- MEDLINE; Completed|

SF- INDEX MEDICUS; Toxbib|

AB- Enchytraeids are typical inhabitants of many soils, contributing to vital processes of this environmental compartment. Indirectly they are involved in regulating the degradation of organic matter, as well as improving the pore structure of the soil. Due to their behaviour, they are able to avoid unfavourable environmental conditions. Avoidance tests with enchytraeids, initially developed with earthworms by several authors, are quick and easy to perform. With these tests a first assessment of the toxicity of a (contaminated or spiked) soil is possible in just 48 h by using the reaction of the enchytraeids as measurement endpoint. In this period of time the organisms can choose between the control soil and the other soil (a contaminated or spiked or another soil with different physico-chemical properties). In the tests reported here, the

enchytraeids were exposed to control soils spiked
with the fungicides Benomyl and Carbendazim and the
herbicide Phenmedipham. Several chemical
concentrations were tested in order to evaluate the avoidance behaviour
to toxic substances. In fact, often these short-term
screening tests gave results showing avoidance at concentrations in a
range similar to the acute test results but, higher than in chronic
tests. Further tests are needed to decide whether the results gained in
this study can be extrapolated to other chemicals. It is proposed to
standardize the Enchytraeid Avoidance Test as it is
currently done for the Earthworm Avoidance Test by
the International Standard Organization (ISO).|

DE- *Benomyl --toxicity --TO; *Benzimidazoles --
toxicity --TO; *Carbamates --
toxicity --TO; *Escape Reaction --drug effects --DE
; *Oligochaeta --drug effects --DE; *Soil Pollutants --
toxicity --TO|

DE- Animals; Behavior, Animal --drug effects --DE; Lethal Dose 50;
Oligochaeta --physiology --PH; Reproduction --drug effects --DE;
Time Factors|

RN- 0 (Benzimidazoles); 0 (Carbamates); 0 (Soil Pollutants);
10605-21-7 (mecarzole); 13684-63-4 (phenmedipham); 17804-35-2
(Benomyl)|

UP- 20050324|

RC- 20050614||

20/4/4 (Item 4 from file: 154)

DIALOG(R)File 154: MEDLINE(R)

FN- DIALOG(R) File 154:MEDLINE(R)|

AN- 15818643|

AA- 14992477|

TI- The use of integrated soil microcosms to assess the impact of carbendazim on soil ecosystems.|

AU- Burrows Lisa A; Edwards Clive A|

CS- Soil Ecology Program, Department of Entomology, The Ohio State University, 1735 Neil Avenue, Columbus, Ohio 43210, USA.|

JN- Ecotoxicology (London, England); 13 (1-2) p143-61|

CP- United States|

PY- Feb-Mar 2004|

SN- 0963-9292--Print|

JC- 9885956|

NT- Publishing Model Print|

DT- Journal Article; Validation Studies|

LA- ENGLISH|

OA- NLM|

RT- MEDLINE; Completed|

SF- INDEX MEDICUS; Toxbib|

AB- Our investigation used carbendazim as a representative pesticide for testing an integrated soil microcosm (ISM) test protocol. Microcosms, set up in a greenhouse, consisted of cylinders made from high-density polyethylene (HDPE) pipe, 7.5 cm (i.d.) x 15 cm high. A fine nylon mesh was placed across the bottom of each microcosm for leachate collection. Field soil, (silty clay loam), collected from Florsheim, Germany, was sieved through a 5 mm screen and mixed thoroughly. Earthworms, enchytraeids, and microarthropods were added to each microcosm. Each microcosm contained five wheat seedlings, and was maintained at a 12 h-12 h light-dark cycle. Artificial rainwater was used to water microcosms as required. Soil microcosms were treated with carbendazim at concentrations 1, 3, 9, 27, and 81 times higher than the predicted environmental concentration (PEC) of 0.76 mg a.i./kg soil dry weight. A water-only control treatment was also used. The key soil processes used as endpoints were microbial activity, nitrogen mineralization. soil enzymatic activity, ammonium and nitrate leaching, organic matter decomposition and biological feeding activity. Key structural parameters measured were microbial biomass, nematode communities, microarthropod populations and diversity,

enchytraeid and earthworm
populations and plant growth. Pesticide degradation,
leaching and uptake into plants and earthworms were
also assessed. Carbendazim had significant effects on several key soil
processes including soil ammonium-N and nitrate-N concentrations and
soil dehydrogenase activity. Wheat growth, nematode and
earthworm populations, and invertebrate feeding
activity were soil structural parameters affected significantly by
carbendazim. Earthworm biomass was the most
sensitive parameter measured with an EC50 of 1.9 mg a.i./kg soil dry
weight 28 days after treatment. A comparison of
these results with results from single-species tests, small microcosms,
large terrestrial model ecosystems, and field tests indicated that the
ISM protocol may adequately predict environmental effects.|

DE- *Arthropods; *Benzimidazoles --toxicity --TO;
*Carbamates; *Fungicides, Industrial --
toxicity --TO; *Models, Theoretical; *Nematoda;
*Oligochaeta; *Soil Pollutants --toxicity --TO|

DE- Animals; Biomass; Ecosystem; Lethal Dose 50; Population Dynamics;
Soil Microbiology|

RN- 0 (Benzimidazoles); 0 (Carbamates); 0 (Fungicides, Industrial); 0
(Soil Pollutants); 10605-21-7 (mecarzole)|

UP- 20040302|

RC- 20040519||

20/4/5 (Item 5 from file: 154)

DIALOG(R)File 154: MEDLINE(R)

FN- DIALOG(R) File 154:MEDLINE(R)|

AN- 15818642|

AA- 14992476|

TI- Ring-testing and field-validation of a terrestrial model ecosystem

(TME)--an instrument for testing potentially harmful substances: effects of carbendazim on organic matter breakdown and soil fauna feeding activity.|

AU- Forster Bernhard; Van Gestel Cornelis A M; Koolhaas Josee E; Nentwig Gerrit; Rodrigues Jose M L; Sousa J Paulo; Jones Susan E; Knacker Thomas|

CS- ECT Oekotoxikologie GmbH, Bottgerstr. 2-14, D-65439 Florsheim, Germany. b-foerster@ect.de|

JN- Ecotoxicology (London, England); 13 (1-2) p129-41|

CP- United States|

PY- Feb-Mar 2004|

SN- 0963-9292--Print|

JC- 9885956|

NT- Publishing Model Print|

DT- Journal Article; Research Support, Non-U.S. Gov't; Validation Studies|

LA- ENGLISH|

OA- NLM|

RT- MEDLINE; Completed|

SF- INDEX MEDICUS; Toxbib|

AB- Organic matter (OM) decomposition and soil fauna feeding activity were integrated as functional endpoints into ecotoxicological tests with intact-soil-core Terrestrial Model Ecosystems (TMEs). Cellulose filter paper served as standardized OM and was either inserted into the top soil or placed on the soil surface for a period of up to 16 weeks. Faunal feeding activity was assessed by the bait-lamina method. The fungicide carbendazim, applied at six dosages ranging from 0.36 kg/ha to 87.5 kg a.i./ha, served as a model chemical. To validate the results from the TME test, a field study was run in parallel. In TMEs the cellulose paper inserted into the soil was decomposed faster than under field conditions. The carbendazim-induced effects on OM decomposition in TMEs and in the field were comparable and followed a clear dose-response relationship. The calculated EC50 values after 8 weeks of incubation were 9.5, 7.1 and 2.1 kg carbendazim/ha for grassland TMEs, grassland field and arable TMEs, respectively. The feeding activity of the soil

fauna showed a large variability. The EC50 values for the effect of carbendazim on bait-lamina consumption ranged between 2.0 and 56 kg a.i./ha. Effects on decomposition were correlated with effects on enchytraeids and earthworms but
not with effects on bait-lamina consumption.|

DE- *Benzimidazoles --toxicity --TO; *Carbamates; * Fungicides, Industrial --toxicity --TO; *Soil Microbiology; *Soil Pollutants --toxicity --TO|

DE- Animals; Feeding Behavior; Invertebrates; Lethal Dose 50; Organic Chemicals --metabolism --ME|

RN- 0 (Benzimidazoles); 0 (Carbamates); 0 (Fungicides, Industrial); 0 (Organic Chemicals); 0 (Soil Pollutants); 10605-21-7 (mecarzole)|

UP- 20040302|

RC- 20040519||

20/4/6 (Item 6 from file: 154)

DIALOG(R)File 154: MEDLINE(R)

FN- DIALOG(R) File 154:MEDLINE(R)|

AN- 14653702|

AA- 11815813|

TI- The effect of lindane on terrestrial invertebrates.|

AU- Lock K; De Schamphelaere K A C; Janssen C R|

CS- Ghent University, Laboratory of Environmental Toxicology and Aquatic Ecology, J. Plateaustraat 22, 9000 Gent, Belgium. koen.lock@rug.ac.be|

JN- Archives of environmental contamination and toxicology; 42 (2) p217-21|

CP- United States|

PY- Feb 2002|

SN- 0090-4341--Print|

JC- 0357245|

NT- Publishing Model Print|

DT- Journal Article; Research Support, Non-U.S. Gov't|

LA- ENGLISH|

OA- NLM|

RT- MEDLINE; Completed|

SF- INDEX MEDICUS; Toxbib|

AB- Acute and chronic ecotoxicity tests with lindane were carried out using the soil invertebrates Eisenia fetida, Enchytraeus albidus, and Folsomia candida. To assess the influence of soil type on the bioavailability, these tests were carried out in a standard artificial OECD soil and in sandy and loamy field soil. For each species, differences in lindane toxicity were observed for the three soil types. These differences were, however, not related to the organic matter content. The relative differences in lindane toxicity between the soils was species-specific. These results therefore indicate that the pore-water hypothesis, i.e., the pore-water contaminant fraction being the toxicological bioavailable fraction, is not always applicable for organic substances. NOEC, NEC, as well as EC10 data were subsequently used to calculate hazardous concentrations for 5% of the species; this methodology, aimed at setting environmental quality criteria, is discussed.|

DE- *Insecticides --adverse effects --AE; *Insects; *Lindane --adverse effects --AE; *Oligochaeta; *Soil Pollutants --adverse effects --AE|

DE- Animals; Biological Availability; No-Observed-Adverse-Effect Level; Population Dynamics; Risk Assessment; Solubility|

RN- 0 (Insecticides); 0 (Soil Pollutants); 58-89-9 (Lindane)|

UP- 20020129|

RC- 20020319||

20/4/7 (Item 1 from file: 50)

DIALOG(R)File 50: CAB Abstracts

FN- DIALOG(R) File 50:CAB Abstracts|

AN- 0009194153|

AA- 20073037601|

TI- Impact on soil fauna of sheep faeces containing a range of parasite control agents.|

AU- Yeates, G. W.; Skipp, R. A.; Gray, R. A. J.; Chen, L. Y.; Waghorn, T. S.|

CS- Landcare Research, Private Bag 11-052, Palmerston North 4442, New Zealand.|

EL- YeatesG@landcareresearch.co.nz|

PU- Elsevier|

PU- Amsterdam|

CP- Netherlands|

JN- Applied Soil Ecology|

SN- 0929-1393|

II- 10.1016/j.apsoil.2006.07.003|

PY- 2007|

VO- 35|

IS- 2|

PG- p.380-389|

LA- English|

RT- Abstract|

DT- Journal article|

AB- To compare the impact of parasite control agents in sheep faeces, 1 kg quantities of fresh faeces were spread uniformly over 1 m SUP 2 pasture plots in June 2001 (winter; a time of high earthworm activity). Faecal treatments applied to five replicate plots were C- (none), C+ (from untreated sheep), B (from sheep with an intra-ruminal bolus releasing a benzimidazole anthelmintic - 'albendazole'), ML (from sheep with a bolus releasing a macrocyclic lactone anthelmintic - 'ivermectin'), F (from sheep receiving a daily feed supplement containing chlamydospores of the nematophagous fungus, Duddingtonia flagrans). The disappearance of faeces was assessed visually over the 50 days following faecal application, then soil samples were taken to assess: (a) populations of earthworms and other soil macrofauna, (b) nematodes and other soil microfauna, and (c) the presence of D. flagrans in soil. Faecal disappearance was greatest in F and C+ plots and least in ML and B plots at 12 and 23 days (P <0.05). Earthworm casting after 23 and 50 days was greater (P <0.05) in plots with faeces (C+, ML, F, but not B) than in plots without faeces (C-). Greater earthworm activity in plots with faeces was reflected in greater numbers of earthworms, cocoons and greater biomass m SUP -2 than in C- plots. On the basis of faecal dry weight applied, F plots had most earthworms and ML plots the least. After 50 days total nematodes in 0-5 cm soil showed a treatment effect (P <0.001), being more abundant in F, C+ and B than in C- and ML plots; enchytraeids, rotifers, tardigrades and copepods showed no treatment effects. A few nematode taxa (Acrobeles , Alaimus , Pungentus , Tylencholaimus) showed significant treatment effects. The greatest effect among nematodes was in nematode channel ratio (NCR) (P <0.008), with a decrease in F plots; changes in NCR may reflect the impact of earthworm activity on soil processes rather than a direct effect of the fungal treatment on nematodes. D. flagrans did not become established in the soil. During the trial conditions were favourable for earthworms and their activity was high in all treatments receiving faeces, with F and ML plots being the extremes. There was an apparent shift towards fungal-mediated decomposition in F plots. At the end of the 50-day trial, in a period when earthworms were active, there was no evidence of differential effects of any of the anthelmintic treatments on environmental indicators.|

RF- 40 ref.|

DE- anthelmintics; biological control; biological control agents; chlamydospores; decomposition; environmental impact; feed supplements; feeding habits; grassland soils; natural enemies; nematophagous fungi; parasites; pastures; sheep manure; soil fauna; soil types; species diversity; worm casts|

ID- Adenophorea; Alaimus; biocontrol agents; biological control organisms; Dorylaimida; Duddingtonia; Duddingtonia flagrans; earthworm casts; eating habits; environmental effects; grazing lands; Leotiales; Nordiidae; Orbiliaceae; pasture soils; Pungentus; Rhabditida; Secernentea; Tylencholaimidae; Tylencholaimus|

OD- Acrobeles; Copepoda; earthworms; Nematoda; Tardigrada|

GN- New Zealand|

BT- Cephalobidae; Nematoda; invertebrates; animals; eukaryotes; Crustacea; arthropods; Ascomycotina; Eumycota; fungi; Oligochaeta; Annelida; Australasia; Oceania; Developed Countries; Commonwealth of Nations; OECD Countries|

CN- Biological Control (HH100); Pesticide and Drug Residues and Ecotoxicology, (New March 2000) (HH430) ; Soil Biology (JJ100); Fertilizers and other Amendments (JJ700); Animal Wastes (XX100); Behaviour (Wild Animals), (New March 2000) (YY500); Animal Ecology (ZZ332)||

20/4/8 (Item 2 from file: 50)

DIALOG(R)File 50: CAB Abstracts

FN- DIALOG(R) File 50:CAB Abstracts|

AN- 0009071947|

AA- 20063111883|

TI- Using nematodes in soil ecotoxicology. |

AU- Sochova, I.; Hofman, J.; Holoubek, I.|

CS- RECETOX-Research Centre for Environmental Chemistry and Ecotoxicology, Masaryk University of Brno, Kamenice 126/3, 625 00 Brno, Czech Republic.|

EL- hofman@recetox.muni.cz|

PU- Pergamon Press|

PU- Oxford|

CP- UK|

JN- Environment International|

SN- 0160-4120|

II- 10.1016/j.envint.2005.08.031|

PY- 2006|

VO- 32|

IS- 3|

PG- p.374-383|

LA- English|

RT- Abstract|

DT- Journal article|

AB- Nematodes represent a very abundant group of soil organisms and non-parasitic species are important for soil quality and in the soil food web. In recent years, it has been shown that nematodes are appropriate bioindicators of soil condition and they are also suitable organisms for laboratory toxicity testing. The aims of this paper are to overview and critically assess methods and approaches for researching soil nematode ecotoxicology. In natural ecosystems, nematode abundance and community structure analyses were proved to be sensitive indicators of stress caused by soil pollutants and ecological disturbance. Community structure analyses may be approached from a functional or ecological point of view; species are divided into groups according to their feeding habits or alternatively the maturity index is calculated according to their ecological strategy. Many environmental factors have the potential to affect nematode community, which consequently results in high space and time variability. This variance is major handicap in field ecotoxicological studies because pollutant-nematode relationships are obscured. For prospective risk assessment of chemicals, several toxicity tests with nematodes were developed and are increasingly used. Sensitivity of these tests is comparable to tests with other soil species (e.g. enchytraeids, earthworms and springtails) while tests are less demanding to space and time. Most

studies have focused on metal toxicity but organic
compounds are almost overlooked. Endpoints used in tests were often
mortality, reproduction or movement, but more sublethal endpoints such
as feeding or biomarkers have been used recently too. Although there is
an increasing amount of knowledge in soil nematode
ecotoxicology, there is still a lot of various
issues in this topic to research.|

RF- many ref.|

DE- behaviour; biological indicators; ecological disturbance; feeding
behaviour; food webs; free living nematodes; indicator species;
maturity; mortality; pollutants; polluted soils; population density;
population structure; reproduction; risk assessment; soil fertility;
soil invertebrates; soil pollution; soil toxicity;
soil types; spatial variation; stress; temporal variation|

ID- animal communities; behavior; biomarkers; death rate;
ecotoxicology; feeding behavior; soil quality;
toxic soils|

OD- Collembola; earthworms;
Enchytraeidae|

BT- Hexapoda; arthropods; invertebrates; animals; eukaryotes; Oligochaeta;
Annelida|

CN- Pesticide and Drug Residues and
Ecotoxicology, (New March 2000) (HH430); Soil
Biology (JJ100); Soil Chemistry and Mineralogy (JJ200); Soil Fertility
(JJ600); Pollution and Degradation (PP600); Behaviour (Wild Animals),
(New March 2000) (YY500); Animal Ecology (ZZ332)||

20/4/9 (Item 3 from file: 50)

DIALOG(R)File 50: CAB Abstracts

FN- DIALOG(R) File 50:CAB Abstracts|

AN- 0008383650|

AA- 20033024556|

TI- Soil ciliate bioassay for the pore water habitat: a missing link between microflora and earthworm testing in soil toxicity assessment.|

AU- Berthold, A.; Jakl, T.|

CS- Laboratory for Ecotoxicology, University of Veterinary Medicine, Veterinaerplatz 1, A-1210 Vienna, Austria.|

EL- Aline.Berthold@univie.ac.at|

PU- Ecomed Publishers|

PU- Landsberg|

CP- Germany|

JN- Journal of Soils and Sediments|

SN- 1439-0108|

PY- 2002|

VO- 2|

IS- 4|

PG- p.179-193|

LA- English|

RT- Abstract|

DT- Journal article|

AB- In this study, a test with the soil ciliate Colpoda inflata , introduced by Pratt et al. [See Rapid toxicity estimation using soil ciliates: sensitivity and bioavailability. Bull Environ Contam Toxicol (1997) 58, 387-393], was improved to widen the spectrum of available toxicity tests for a meaningful effect assessment for the soil compartment. Five test substances: cadmium chloride, potassium dichromate, acetone, atrazine and metolachlor, were used in single-compound, static, short-term exposure (24 and 48 h) tests to examine its effect on the population growth of C. inflata . The median effective concentrations were 0.17-0.26 mg/l for Cd, 34-63 mg/l for Cr, >3000 mg/l for acetone, 91-112 mg/l for atrazine and 83-119 mg/l for metolachlor. The equilibrium partitioning approach was used to extrapolate the results to total soil exposure and thus enable a sensitivity comparison to literature data on other below ground animals, such as earthworms,

enchytraeids or nematodes. The
comparison revealed that the soil ciliate bioassay
will be able to enhance the sensitivity of soil
toxicity assessments, in most cases. Amending risk
assessments for the soil compartment by a test with
a soil pore water indicator will enable an essentially improved model
for the soil ecosystem.|

RF- many ref.|

DE- acetone; atrazine; bioassays; cadmium; chlorine; chromium; growth; habitats; metolachlor; microbial flora; pesticides; polluted soils; pores; potassium; soil pollution; soil toxicity; soil types; soil water|

ID- 2-propanone; Colpoda inflata; dimethyl ketone; microflora; soil moisture; toxic soils|

RN- 67-64-1; 1912-24-9; 7440-43-9; 7782-50-5; 7440-47-3; 51218-45-2; 7440-09-7|

OD- Colpoda; earthworms|

BT- Colpodidae; Colpodida; Ciliophora; Protozoa; invertebrates; animals; eukaryotes; Oligochaeta; Annelida; Colpoda|

CN- Pesticide and Drug Residues and Ecotoxicology, (New March 2000) (HH430); Soil Biology (JJ100); Soil Chemistry and Mineralogy (JJ200); Soil Physics (JJ300); Pollution and Degradation (PP600); Industrial Wastes and Effluents (XX400); Microbial Life Cycles, (New March 2000) (ZZ396)||

20/4/10 (Item 4 from file: 50)

DIALOG(R)File 50: CAB Abstracts

FN- DIALOG(R) File 50:CAB Abstracts|

AN- 0008201106|

AA- 20023017251|

TI- Bioaccumulation of lindane and hexachlorobenzene by the oligochaetes

Enchytraeus luxuriosus and Enchytraeus albidus (Enchytraeidae, Oligochaeta, Annelida).|

AU- Bruns, E.; Egeler, P.; Roembke, J.; Scheffczyk, A.; Spoerlein, P.|

AU- Rodriguez, P.; Verdonschot, P. F. M.|

CS- ECT Oekotoxikologie GmbH, Bottgerstr. 2-14, D-65439 Florsheim, Germany.
|

EL- ph-egeler@ect.de|

PU- Kluwer Academic Publishers|

PU- Dordrecht|

CP- Netherlands|

JN- Hydrobiologia|

SN- 0018-8158|

II- 10.1023/A:1013159810067|

PY- 2001|

VO- 463|

PG- p.185-196|

CT- Aquatic Oligochaete Biology VIII. Proceedings of the 8th International Symposium on Aquatic Oligochaeta, Bilbao, Spain, 18-22 July 2000.|

LA- English|

RT- Abstract|

DT- Journal article; Conference paper|

AB- The uptake of chemicals in soil organisms, especially earthworms, has been studied many times. However, in Europe no internationally accepted standardized test guideline for the assessment of bioaccumulation in the soil ecosystem exists. Therefore, the German Federal Environmental Agency recently funded a project in which a standardized test method for measuring bioaccumulation of chemicals using earthworms and enchytraeids is being developed. In this contribution, initial results with the new method are presented, using two model chemicals (the insecticide lindane and the fungicide hexachlorobenzene). Two enchytraeid species (Enchytraeus luxuriosus and Enchytraeus albidus) were selected as test organisms due to their easy handling and their important ecological role in the soil compartment. Artificial soil and a natural standard soil were used as test substrates. Test

concentrations were based on previous results of acute and reproduction toxicity tests performed with the same species.
Uptake as well as the elimination of the test substances were examined under standardized conditions in a closed test system. The first results show that both chemicals were accumulated considerably by both enchytraeid species. The bioaccumulation factors (BAFs) of lindane and hexachlorobenzene found for enchytraeids are significantly higher compared to those for lumbricid earthworms. Evaluation of the preliminary data suggests that the smaller species E. luxuriosus accumulated the two chemicals to a greater extent than E. albidus . In most cases, both chemicals were eliminated completely. The use of this new test method appears suitable for the ecotoxicological risk assessment of bioaccumulative chemicals.|

RF- 43 ref.|

DE- fungicide residues; HCH; hexachlorobenzene; insecticide residues; lindane; poisoning; toxicology|

ID- benzene hexachloride; BHC; bioaccumulation factors; Enchytraeus luxuriosus; HCB; toxicosis|

RN- 118-74-1; 58-89-9|

OD- Enchytraeus; Enchytraeus albidus|

BT- Enchytraeidae; Oligochaeta; Annelida; invertebrates; animals; eukaryotes; Enchytraeus|

CN- Pesticide and Drug Residues and Ecotoxicology, (New March 2000) (HH430); Toxicology and Poisoning (Wild Animals), (New March 2000) (YY900)||

20/4/11 (Item 5 from file: 50)

DIALOG(R)File 50: CAB Abstracts

FN- DIALOG(R) File 50:CAB Abstracts|

AN- 0007858973|

AA- 20001907622|

TI- Comparison of malathion toxicity using enchytraeid reproduction test and earthworm toxicity test in different soil types.|

AU- Kuperman, R. G.; Simini, M.; Phillips, C. T.; Checkai, R. T.|

AU- Diaz Cosin, D. J.; Jesus, J. B.; Trigo, D.; Garvin, M. H.|

CS- U.S. Army Edgewood Chemical Biological Center, U.S.A. ECBC, AMSSB-RRT-BE E5641, 5185 Blackhawk Road, APG, MD 21010-5423, USA.|

JN- Pedobiologia|

SN- 0031-4056|

PY- 1999|

VO- 43|

IS- 6|

PG- p.630-634|

CT- 6th International Symposium on Earthworm Ecology, Vigo, Spain, 1998.|

LA- English|

RT- Abstract|

DT- Conference paper; Journal article|

AB- The toxicity was compared of the organophosphate pesticide malathion between the Enchytraeid Reproduction Test using Enchytraeus albidus and the Earthworm Toxicity Test using Eisenia fetida . The Enchytraeid Reproduction Test has several advantages over the Earthworm Toxicity Test, including greater ecological relevance, world-wide distribution, a short generation time of test species, and greater cost-effectiveness. Toxicity of malathion was studied in three soils with contrasting organic matter (OM) content, including standard artificial soil (10% OM), O'Neill-Hall sandy loam soil (4.3% OM) and Sassafras sandy loam soil (2.3% OM). In the Enchytraeid Reproduction Test, reproducing adults were incubated for three weeks. Adult worms were then removed and counted, and soil with cocoons was incubated for an additional three weeks. Earthworm toxicity was determined using the standard 14-day acute survival test, and a chronic 21-day cocoon production assay. Results showed that malathion had similar toxic effect on E. albidus adults in artificial and Sassafras soils (LOEC of 23.15 mg kg SUP -1), and greater toxicity in the O'Neill-Hall soil (LOEC [lowest observed effect concentration] of 6.64 mg kg SUP -1). The Earthworm Toxicity Test LOEC values for adult E. fetida were 75 mg kg SUP -1 in artificial and O'Neill-Hall soils, and 60 mg kg SUP -1 in Sassafras soil. Malathion was more toxic to E. albidus juveniles compared with adults in artificial soil (LOEC of 7.75 mg kg SUP -1 and EC SUB 50 [median effective concentration] of 9.8 mg kg SUP -1). The earthworm chronic assay LOEC values were 18, 14 and 21 mg kg SUP -1 and EC SUB 50 values were 16, 37 and 20 mg kg SUP -1 in artificial, O'Neill-Hall and Sassafras soils, respectively. Results of this study show that the Enchytraeid Reproduction Test is a more sensitive toxicity test in artificial soil, and has the potential for replacing the Earthworm Toxicity Test in future soil toxicity testing.|

RF- 9 ref.|

DE- assays; cocoons; comparisons; malathion; organic matter; organophosphorus compounds; pesticides; reproduction; sandy loam soils; soil; soil toxicity; soil types; survival; testing; tests; toxicity; toxicology|

ID- organic phosphorus compounds; organophosphates; toxic soils|

RN- 121-75-5|

OD- earthworms; Eisenia;

Eisenia fetida; Oligochaeta|

BT- Oligochaeta; Annelida; invertebrates; animals; eukaryotes;

Eisenia; Lumbricidae|

CN- Soil Biology (JJ100); Soil Morphology, Formation and Classification

(JJ400); Pesticides and Drugs (General) (HH400);

Toxicology and Poisoning (Wild Animals), (New March

2000) (YY900); Techniques and Methodology (ZZ900)||

20/4/12 (Item 6 from file: 50)

DIALOG(R)File 50: CAB Abstracts

FN- DIALOG(R) File 50:CAB Abstracts|

AN- 0006330341|

AA- 19901949782|

TI- Earthworms and enchytraeids in conventional and no-tillage agroecosystems: a biocide approach to assess their role in organic matter breakdown.|

AU- Parmelee, R. W.; Beare, M. H.; Cheng, W.; Hendrix, P. F.; Rider, S. J.;

Crossley, D. A., Jr.; Coleman, D. C.|

CS- Inst. Ecol., Univ. Georgia, Athens, GA 30602, USA.|

JN- Biology and Fertility of Soils|

SN- 0178-2762|

PY- 1990|

VO- 10|

IS- 1|

PG- p.1-10|

LA- English|

RT- Abstract|

DT- Journal article|

AB- To assess the role of annelids in the breakdown of soil organic matter

in conventional and no-till agroecosystems, carbofuran was applied to

field enclosures and target (earthworm and

enchytraeid biomass, standing stocks of organic

matter) and non-target effects

were determined in two 10-month studies. In the winter-fall study, carbofuran reduced the annelid biomass; total soil organic matter standing stocks were 47% greater under no-till with carbofuran compared to control enclosures. In the summer-spring study, carbofuran again significantly reduced the annelid biomass, and treated pens in the no-till area had significantly greater standing stocks of fine organic matter (43%-45%). A 76% difference in the standing stock of coarse organic matter between control and carbofuran-treated pens in the conventional-till system indicated non-target effects. It was concluded that estimates of the amount of organic matter processed by annelids in no-till and conventionally tilled agroecosystems represented a maximum potential because of the confounding non-target effects of carbofuran.

|

RF- 54 ref.|

DE- biocides; decomposition; soil organic matter; tillage|

ID- organic matter in soil; soil cultivation; United States of America|

OD- Oligochaeta|

GN- Georgia; USA|

BT- Annelida; invertebrates; animals; eukaryotes; North America; America; Developed Countries; OECD Countries; South Atlantic States of USA; Southern States of USA; USA; Southeastern States of USA|

CN- Soil Management (JJ900); Soil Chemistry and Mineralogy (JJ200); Soil Morphology, Formation and Classification (JJ400); Pesticides and Drugs (General) (HH400); Soil Biology (JJ100)||

20/4/13 (Item 1 from file: 5)

DIALOG(R)File 5: Biosis Previews(R)

FN- DIALOG(R) File 5:Biosis Previews(R)|

AZ- 09074201|

AA- 198885043092|

TI- THE INVERTEBRATE POPULATION AND RESPONSE TO PESTICIDE TREATMENT OF TWO PERMANENT AND TWO TEMPORARY PASTURES|

AU- CLEMENTS R O(Reprint); BENTLEY B R; NUTTALL R M|

CS- GRASSLAND RES INST, HURLEY, MAIDENHEAD, BERKS SL6 5LR, UK UK|

JN- Annals of Applied Biology|

VO- 111|

IS- 2|

PG- 399-408|

PY- 1987|

SN- 0003-4746|

DT- Article|

RT- Abstract|

LA- ENGLISH|

AB- During 1979 and 1980 the herbage yields of two permanent pastures and two temporary swards were compared. All four swards received 250 kg N/ha per yr. The invertebrate population of all four swards was studied. Pot-worms (Enchytraeidae) and some species with long life cycles, e.g. wireworms (Agriotes spp.) were more numerous in the permanent swards, but aerial species were more numerous in the temporary swards. A range of pesticide treatments was applied. At one temporary sward site, application of the broad-spectrum pesticide aldicarb increased total annual yield of herbage by 16% in 1979 and 33% in 1980. Insecticide application at the same site resulted in no increase in herbage yield in 1979 and 12% yield increase in 1980. At the other three sites no significant increases in total annual yield were recorded in either year, but there were significant responses at one harvest or more at every site.|

RN- 116-06-3: ALDICARB|

DE- Agronomy--Agriculture; Ecology--Environmental Sciences; Economic Entomology; Pest Assessment Control and Management; Physiology ; Toxicology|

DE- Oligochaeta--Annelida, Invertebrata, Animalia;
Coleoptera--Insecta, Arthropoda, Invertebrata, Animalia|
DE- Annelids; Animals; Arthropods; Insects;
Invertebrates|
DE- ALDICARB|
CC- 07506 Ecology: environmental biology - Plant
07508 Ecology: environmental biology - Animal
10060 Biochemistry studies - General
22506 Toxicology - Environment and industry
26504 Animal production - Feeds and feeding
52506 Agronomy - Forage crops and fodder
54600 Pest control: general, pesticides and herbicides
60016 Economic entomology - Chemical
64030 Invertebrata: comparative, experimental morphology, physiology
and pathology - Annelida
64076 Invertebrata: comparative, experimental morphology, physiology
and pathology - Insecta: physiology|
BC- 65400 Oligochaeta
75304 Coleoptera||

20/4/14 (Item 1 from file: 40)
DIALOG(R)File 40: Enviroline(R)
(c) 2008 Congressional Information Service. All rights reserved.
FN- DIALOG(R) File 40:Enviroline(R)|
CZ- (c) 2008 Congressional Information Service. All rights reserved.|
AN- 00457055
AA-(ENVIROLINE) 97-13656|
TI- Effect of Soil Moisture on Pesticide Toxicity to an Enchytraeid Worm, Enchytraeus sp.|
AU- Puurtinen, H. M.; Martikainen, E. A. T. University of Jyvaskyla,
Finland|
CS- Puurtinen, H. M.; Martikainen, E. A. T. University of Jyvaskyla,
Finland|

JN- Arch Environ Contam Toxicol|

PD- Jul 97|

JA- 19971000|

SO- v33, n1, p34(8)|

LA- English|

AV- Full text available from Congressional Information Service at
1-800-227-2477. Article order code: S.|

DT- research article|

SF- 12 graph(s); 25 reference(s); 2 table(s)|

AB- Using dimethoate and benomyl as test chemicals, the effects of soil
moisture on pesticide toxicity to
enchytraeid worms were examined. Five concentrations
were selected for each chemical, along with three soil moistures of 40,
55, and 70% of water-holding capacity. Results indicated that, while
dimethoate was relatively harmless to the species
tested, the size of the adults was significantly affected by the
chemical concentration and the soil moisture: increasing the dimethoate
concentration limited the growth at all soil moistures. Benomyl clearly
showed a greater toxicity to the worms, causing
toxic effects at much lower concentrations than
dimethoate, with very abrupt responses. Adult survival increased with
increasing soil moisture at high benomyl concentration, but soil
moisture alone did not affect survival.

DE-(MAJOR) EARTHWORMS; DIMETHOATE; BENOMYL; SOIL
MOISTURE; PESTICIDE EXPOSURE; DOSE RESPONSE PROFILES|

SH- 02||

20/4/15 (Item 2 from file: 40)

DIALOG(R)File 40: Enviroline(R)

FN- DIALOG(R) File 40:Enviroline(R)|

AN- 00378126

AA-(ENVIROLINE) 90-04009|

TI- Aquatic Toxicity Test for Enchytraeids|

AU- Roembke, J.; Knacker, T. Battelle Inst, Frankfurt, FRG|

CS- Roembke, J.; Knacker, T. Battelle Inst, Frankfurt, FRG|

JN- Hydrobiologia|

PD- 1989|

JA- 19900800|

SO- v180, p235(8)|

LA- English|

AV- Full text available from Congressional Information Service at 1-800-227-2477.|

DT- research article|

SF- 2 graph(s); 21 reference(s); 6 table(s)|

AB- A simple method devised for testing the toxicity of chemicals using enchytraeids in an aquatic environment is described. In demonstrating the protocol, up to eight different chemicals were applied to various species, mainly of the genus Enchytraeus, and results were compared with those achieved for Daphnia magna. No significant differences were observed between the LC50 values of the various enchytraeid species and the LC50 values for enchytraeids and daphnids. Discrepancies between the terrestrial and aquatic toxicities when the LC50 values for earthworms and daphnids were compared are discussed.

DE-(MAJOR) EARTHWORMS; AQUATIC ORGANISMS; PATHOLOGY, ANIMAL-LABORATORY

DE-(MAJOR) BIOLOGICAL INDICATORS, WATER; BIOASSAY; SPECIES COMPARISONS

DE-(MINOR) THRESHOLD LIMIT VALUES; PESTICIDE EXPOSURE|

SH- 02||

20/4/16 (Item 1 from file: 34)

DIALOG(R)File 34: SciSearch(R) Cited Ref Sci

FN- DIALOG(R) File 34:SciSearch(R) Cited Ref Sci|

AN- 01615722|

GA- HL925|

TI- VALIDATION OF EARTHWORM TOXICITY TESTS BY COMPARISON WITH FIELD STUDIES - A REVIEW OF BENOMYL, CARBENDAZIM, CARBOFURAN, AND CARBARYL|

LA- ENGLISH|

AU- VANGESTEL CAM|

CS- FREE UNIV AMSTERDAM,DEPT ECOL & ECOTOXICOL,DE BOELELAAN 1087/1081
HV AMSTERDAM//NETHERLANDS/; NATL INST PUBL HLTH & ENVIRONM
PROTECT/3720 BA BILTHOVEN//NETHERLANDS/|

GL- NETHERLANDS|

JN- ECOTOXICOLOGY AND ENVIRONMENTAL SAFETY
1992, V23, N2, P221-236|

PY- 1992|

DT- REVIEW|

NR- 67|

SF- SciSearch; CC LIFE--Current Contents, Life Sciences; CC AGRI--Current
Contents, Agriculture, Biology & Environmental Sciences|

SC- TOXICOLOGY; ENVIRONMENTAL SCIENCES|

ID- KeyWords Plus: EISENIA-FETIDA; ORGANIC-CHEMICALS;
SOIL; PESTICIDES; INSECTICIDES;
OLIGOCHAETA; ADSORPTION; FUNGICIDE|

RF- 90-1601 001 (ADSORPTION COEFFICIENT (KOC) FOR SOIL; SORPTION OF
HYDROPHOBIC ORGANIC-COMPOUNDS; CLAY SURFACES; ENVIRONMENTAL
FATE)
90-5164 001 (SOIL FAUNA; NO-TILLAGE AGROECOSYSTEMS; LOW-INPUT
SUSTAINABLE AGRICULTURE; ENCHYTRAEIDAE
(OLIGOCHAETA))|

CR- GUIDELINE TESTING CH, 1984, V207
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CARO JH, 1974, V22, P860, J AGR FOOD CHEM

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HOOGERKAMP M, 1983, P85, EARTHWORM ECOLOGY DA

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LOFSHOLMIN A, 1982, V12, P117, SWED J AGR RES

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MARTIN NA, 1976, V19, P111, N Z J AGR RES

MARTIN NA, 1980, V23, P417, N Z J AGR RES

MARTIN NA, 1986, V29, P699, NEW ZEAL J AGR RES

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STRINGER A, 1973, V4, P165, PESTIC SCI
STRINGER A, 1974, V5, P189, PESTIC SCI
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TOMLIN AD, 1980, V2, P319, PROPT ECOL
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VANGESTEL CAM, 1988, V6, P262, BIOL FERT SOILS
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? **t21/6/1-40**

21/6/1 (Item 1 from file: 154)
DIALOG(R)File 154: MEDLINE(R)

18536994 **PMID:** 18211124
Toxicity of the pesticide alpha-cypermethrin to four soil nontarget invertebrates and implications for risk assessment.

Jun 2008

21/6/2 (Item 2 from file: 154)
DIALOG(R)File 154: MEDLINE(R)

14871880 **PMID:** 12115048
Bioavailability and toxicokinetics of (14)C-lindane (gamma-HCH) in the enchytraeid Enchytraeus albidus in two soil types: the aging effect.

Aug 2002

21/6/3 (Item 3 from file: 154)
DIALOG(R)File 154: MEDLINE(R)

14834241 **PMID:** 12068945
Toxicity of arsenate to the compostworm Eisenia fetida, the potworm Enchytraeus albidus and the springtail Folsomia candida.

May 2002

21/6/4 (Item 4 from file: 154)
DIALOG(R)File 154: MEDLINE(R)

13666797 **PMID:** 10705553
Effects of the antibiotics oxytetracycline and tylosin on soil fauna.

Apr 2000

21/6/5 (Item 5 from file: 154)
DIALOG(R)File 154: MEDLINE(R)

11992320 **PMID:** 8723749
Toxicity of dimethoate to some soil animal species in different soil types.

Mar 1996

21/6/6 (Item 1 from file: 50)
DIALOG(R)File 50: CAB Abstracts

0009557229 **CAB Accession Number:** 20083145650
Enchytraeus albidus (Enchytraeidae): a test organism in a standardised avoidance test? Effects of different chemical substances.

Publication Year: 2008

21/6/7 (Item 2 from file: 50)
DIALOG(R)File 50: CAB Abstracts

0009323421 **CAB Accession Number:** 20073173313
Toxicity of the anthelmintic abamectin to four species of soil invertebrates.

Publication Year: 2007

21/6/8 (Item 3 from file: 50)
DIALOG(R)File 50: CAB Abstracts

0009041668 **CAB Accession Number:** 20063021658
State-of-the-art: the use of Enchytraeidae (Oligochaeta) as test and indicator organisms in standardized ecotoxicological tests.

Publication Year: 2005

21/6/9 (Item 4 from file: 50)
DIALOG(R)File 50: CAB Abstracts

0008731193 **CAB Accession Number:** 20043160571
Toxicity and residues of aged TNT in plants and worms.

Proceedings of the First Sustainable Range Management Conference, New Orleans, USA, 5-8 January 2004
Publication Year: 2004

21/6/10 (Item 5 from file: 50)
DIALOG(R)File 50: CAB Abstracts

0008626797 **CAB Accession Number:** 20043066759

Effects of diflubenzuron and Bacillus thuringiensis var. kurstaki toxin on soil invertebrates of a mixed deciduous forest in the Upper Rhine Valley, Germany.

Publication Year: 2004

21/6/11 (Item 6 from file: 50)
DIALOG(R)File 50: CAB Abstracts

0008306487 **CAB Accession Number:** 20023145496
Bioaccumulation and elimination of SUP 14 C-lindane by Enchytraeus albidus in artificial (OECD) and a natural soil.

Publication Year: 2002

21/6/12 (Item 7 from file: 50)
DIALOG(R)File 50: CAB Abstracts

0008122166 **CAB Accession Number:** 20013122391
Modeling zinc toxicity for terrestrial invertebrates.

Publication Year: 2001

21/6/13 (Item 8 from file: 50)
DIALOG(R)File 50: CAB Abstracts

0008115924 **CAB Accession Number:** 20013142917
Ecotoxicity of mercury to Eisenia fetida , Enchytraeus albidus and Folsomia candida .

Publication Year: 2001

21/6/14 (Item 9 from file: 50)
DIALOG(R)File 50: CAB Abstracts

0008106103 **CAB Accession Number:** 20003031410
The effects of the fungicide carbendazim in an innovative integrated terrestrial microcosm system.

Book Title: The BCPC Conference: Pests and diseases, Volume 1. Proceedings of an international conference held at the Brighton Hilton Metropole Hotel, Brighton, UK, 13-16 November 2000
Publication Year: 2000

21/6/15 (Item 10 from file: 50)
DIALOG(R)File 50: CAB Abstracts

0007232059 **CAB Accession Number:** 19961905027
Suitability of seven species of soil-inhabiting invertebrates for testing toxicity of pesticides in soil pore water.

Publication Year: 1996

21/6/16 (Item 11 from file: 50)
DIALOG(R)File 50: CAB Abstracts

0007034664 **CAB Accession Number:** 19952306812
Review of results from the Danish EPA's Pesticide Research Programme concerning effects on flora and fauna.
Original Title: Opsummering af resultater fra Milj<o>styrelsens Pesticidforskningspro gram vedr<o>rende effekter pa flora og fauna.
Publication Year: 1995

21/6/17 (Item 12 from file: 50)
DIALOG(R)File 50: CAB Abstracts

0006596337 **CAB Accession Number:** 19921970348
Animal-coenoses in the "spruce forest" ecosystem (Protozoa, Metazoa-invertebrates): indicators of alterations in forest-ecosystems.

Modern ecology: basic and applied aspects.
Publication Year: 1991

21/6/18 (Item 13 from file: 50)
DIALOG(R)File 50: CAB Abstracts

0005684497 **CAB Accession Number:** 19861902392
Nematicides and field population of enchytraeids and earthworms.

Publication Year: 1984

21/6/19 (Item 1 from file: 10)
DIALOG(R)File 10: AGRICOLA

4007283 23285665 **Holding Library:** AGL
Validating the enchytraeid reproduction test: organisation and results of an international ringtest

2002

21/6/20 (Item 1 from file: 5)
DIALOG(R)File 5: Biosis Previews(R)

0020313110 **Biosis No.:** 200800360049
Ecotoxicology

2008

21/6/21 (Item 2 from file: 5)
DIALOG(R)File 5: Biosis Previews(R)

0019808760 **Biosis No.:** 200700468501
Toxicity of the anthelmintic abarnectin to four species of soil invertebrates

2007

21/6/22 (Item 3 from file: 5)
DIALOG(R)File 5: Biosis Previews(R)

16955959 **Biosis No.:** 200200549470
Bioaccumulation and elimination of 14C-lindane by Enchytraeus albidus in artificial (OECD) and a natural soil

2002

21/6/23 (Item 4 from file: 5)
DIALOG(R)File 5: Biosis Previews(R)

16858402 **Biosis No.:** 200200451913
Bioavailability and toxicokinetics of 14C-lindane (gamma-HCH) in the enchytraeid Enchytraeus albidus in two soil types: The aging effect

2002

21/6/24 (Item 5 from file: 5)
DIALOG(R)File 5: Biosis Previews(R)

15999071 **Biosis No.:** 200100170910
Ecotoxicological test methods in soil: Current status and new examples

2000

21/6/25 (Item 6 from file: 5)
DIALOG(R)File 5: Biosis Previews(R)

05630003 **Biosis No.:** 197967018998
EFFECT OF 4 INSECTICIDES ON THE PASTURE ECOSYSTEM PART 6 ARTHROPODA DRY HEAT EXTRACTED FROM SMALL SOIL CORES AND CONCLUSIONS

1978

21/6/26 (Item 7 from file: 5)
DIALOG(R)File 5: Biosis Previews(R)

03889197 **Biosis No.:** 197253015717
THE INFLUENCE OF SOME PESTICIDES ON THE SOIL FAUNA IN AZALEA-D CULTURE

1970

21/6/27 (Item 8 from file: 5)
DIALOG(R)File 5: Biosis Previews(R)

03276824 **Biosis No.:** 196950094976
INFLUENCE OF REPEATED APPLICATIONS OF NEMATICIDES ON THE SOIL FAUNA IN BEGONIA-D CULTURE DI CHLORO PROPANE DI CHLORO PROPENE NEMATIC NEMATODE FUNGI EARTHWORM ENCHYTRAEIDS MITES COLLEMBOLA

1969

21/6/28 (Item 1 from file: 156)
DIALOG(R)File 156: ToxFile

526534 **NLM Doc No:** HEEP/72/04701 **Sec. Source ID:** HEEP/72/04701
(The influence of some pesticides in the soil fauna in azalea culture.)

1970

21/6/29 (Item 2 from file: 156)
DIALOG(R)File 156: ToxFile

519083 **NLM Doc No:** HAPAB/71/02723 **Sec. Source ID:** HAPAB/71/02723
Pesticides and soil fauna.

1970

21/6/30 (Item 1 from file: 40)
DIALOG(R)File 40: Enviroline(R)

00618082 **Enviroline Number:** 02-05789
Bioaccumulation of Lindane and Hexachlorobenzene by the Oligochaetes Entraeus luxuriosus and Enchytraeus albidus (Enchytraeidae, Oligochaeta, Annelida)

Nov 1, 01

21/6/31 (Item 1 from file: 34)
DIALOG(R)File 34: SciSearch(R) Cited Ref Sci

18475295 **Genuine Article#:** 368YS **Number of References:** 63
Role of clay content in partitioning, uptake and toxicity of zinc in the earthworm Eisenia fetida
(ABSTRACT AVAILABLE)
Publication date: 20090100

21/6/32 (Item 2 from file: 34)
DIALOG(R)File 34: SciSearch(R) Cited Ref Sci

15292404 **Genuine Article#:** 056GL **Number of References:** 83
Identification of potential organisms of relevance to Canadian boreal forest and northern lands for testing of contaminated soils

(ABSTRACT AVAILABLE)
Publication date: 20060600

21/6/33 (Item 3 from file: 34)
DIALOG(R)File 34: SciSearch(R) Cited Ref Sci

15096391 **Genuine Article#:** 036DW **Number of References:** 63
Population growth rate and carrying capacity for springtails Folsomia candida exposed to ivermectin
(ABSTRACT AVAILABLE)
Publication date: 20060400

21/6/34 (Item 4 from file: 34)
DIALOG(R)File 34: SciSearch(R) Cited Ref Sci

14554266 **Genuine Article#:** 985MF **Number of References:** 33
Effect of different soil types on the enchytraeids Enchytraeus albidus and Enchytraeus luxuriosus using the herbicide Phenmedipham
(ABSTRACT AVAILABLE)
Publication date: 20051200

21/6/35 (Item 5 from file: 34)
DIALOG(R)File 34: SciSearch(R) Cited Ref Sci

13544117 **Genuine Article#:** 893GT **Number of References:** 139
Folsomia candida (Collembola): A "standard" soil arthropod
(ABSTRACT AVAILABLE)
Publication date: 20050000

21/6/36 (Item 6 from file: 34)
DIALOG(R)File 34: SciSearch(R) Cited Ref Sci

12445579 **Genuine Article#:** 767CB **Number of References:** 177
A summary of eleven years progress in earthworm ecotoxicology
(ABSTRACT AVAILABLE)
Publication date: 20030000

21/6/37 (Item 7 from file: 34)
DIALOG(R)File 34: SciSearch(R) Cited Ref Sci

10826687 **Genuine Article#:** 575AR **Number of References:** 13
Bioavailability and toxicokinetics of C-14-lindane (gamma-HCH) in the enchytraeid Enchytraeus albidus in two soil types: The aging effect
(ABSTRACT AVAILABLE)
Publication date: 20020800

21/6/38 (Item 8 from file: 34)
DIALOG(R)File 34: SciSearch(R) Cited Ref Sci

09981482 **Genuine Article#:** 472TQ **Number of References:** 172
Enchytraeids as indicator organisms for chemical stress in terrestrial ecosystems
(ABSTRACT AVAILABLE)
Publication date: 20010900

21/6/39 (Item 9 from file: 34)
DIALOG(R)File 34: SciSearch(R) Cited Ref Sci

05059504 **Genuine Article#:** TM898 **Number of References:** 321
SOIL INVERTEBRATES AS BIOINDICATORS OF HUMAN DISTURBANCE
(Abstract Available)

21/6/40 (Item 10 from file: 34)
DIALOG(R)File 34: SciSearch(R) Cited Ref Sci

02443703 **Genuine Article#:** LA740 **Number of References:** 0
EFFECTS OF SOIL CONTAMINATION ON THE ANIMAL COMMUNITY OF FOREST ECOSYSTEMS
(Abstract Available)

? **t19/6/1-120**

19/6/1 (Item 1 from file: 154)
DIALOG(R)File 154: MEDLINE(R)

29007401 **PMID:** 18992976
Avoidance response of Enchytraeus albidus in relation to carbendazim ageing.

Feb 2009

19/6/2 (Item 2 from file: 154)
DIALOG(R)File 154: MEDLINE(R)

28490728 **PMID:** 19005666
Organic residue decomposition: The minicontainer-system a multifunctional tool in decomposition studies.

1999

19/6/3 (Item 3 from file: 154)
DIALOG(R)File 154: MEDLINE(R)

18639830 **PMID:** 18069103
Avoidance test with Enchytraeus albidus (Enchytraeidae): effects of different exposure time and soil properties.

Sep 2008

19/6/4 (Item 4 from file: 154)
DIALOG(R)File 154: MEDLINE(R)

18146516 **PMID:** 17805963
The use of the multivariate Principal Response Curve (PRC) for community level analysis: a case study on the effects of carbendazim on enchytraeids in Terrestrial Model Ecosystems (TME).

Nov 2007

19/6/5 (Item 5 from file: 154)
DIALOG(R)File 154: MEDLINE(R)

17412130 **PMID:** 16927410
Use of crop residues for the control of Meloidogyne incognita under laboratory conditions.

Oct 2006

19/6/6 (Item 6 from file: 154)
DIALOG(R)File 154: MEDLINE(R)

16844612 **PMID:** 16263380
Effect of different soil types on the enchytraeids Enchytraeus albidus and Enchytraeus luxuriosus using the herbicide Phenmedipham.

Dec 2005

19/6/7 (Item 7 from file: 154)
DIALOG(R)File 154: MEDLINE(R)

15818639 **PMID:** 14992473
Ring-testing and field-validation of a terrestrial model ecosystem (TME)--an instrument for testing potentially harmful substances: effects of carbendazim on enchytraeids.

Feb-Mar 2004

19/6/8 (Item 8 from file: 154)
DIALOG(R)File 154: MEDLINE(R)

15508138 **PMID:** 12940157
Life-cycle length determines the differences in sensitivity to toxicants between enchytraeid species.

May-Jun 2003

19/6/9 (Item 9 from file: 154)
DIALOG(R)File 154: MEDLINE(R)

15276033 **PMID:** 12656265
Effects of the antibacterial agents tiamulin, olanquindox and metronidazole and the anthelmintic ivermectin on the soil invertebrate species Folsomia fimetaria (Collembola) and Enchytraeus crypticus (Enchytraeidae).

Jan 2003

19/6/10 (Item 10 from file: 154)
DIALOG(R)File 154: MEDLINE(R)

14776745 **PMID:** 11999775
Validating the enchytraeid reproduction test: organisation and results of an international ringtest.

Feb 2002

19/6/11 (Item 11 from file: 154)
DIALOG(R)File 154: MEDLINE(R)

14407887 **PMID:** 11534950
Enchytraeids as indicator organisms for chemical stress in terrestrial ecosystems.

Sep 2001

19/6/12 (Item 12 from file: 154)
DIALOG(R)File 154: MEDLINE(R)

12454336 **PMID:** 9216868
Effect of soil moisture on pesticide toxicity to an enchytraeid worm, Enchytraeus sp.

Jul 1997

19/6/13 (Item 13 from file: 154)
DIALOG(R)File 154: MEDLINE(R)

12257750 **PMID:** 15093377
Decomposer communities in contaminated soil: Is altered community regulation a proper tool in ecological risk assessment of toxicants?

1997

19/6/14 (Item 14 from file: 154)
DIALOG(R)File 154: MEDLINE(R)

12055328 **PMID:** 8812186
Effects of terbuthylazine on soil fauna and decomposition processes.

Jul 1996

19/6/15 (Item 1 from file: 50)
DIALOG(R)File 50: CAB Abstracts

0009717580 **CAB Accession Number:** 20093004988
Freeze tolerance and accumulation of cryoprotectants in the enchytraeid Enchytraeus albidus (Oligochaeta) from Greenland and Europe.

Publication Year: 2008

19/6/16 (Item 2 from file: 50)
DIALOG(R)File 50: CAB Abstracts

0009645894 **CAB Accession Number:** 20083248367
Long-term organic farming fosters below and aboveground biota: implications for soil quality, biological control and productivity.

Publication Year: 2008

19/6/17 (Item 3 from file: 50)
DIALOG(R)File 50: CAB Abstracts

0009578265 **CAB Accession Number:** 20083156840
Impact of commonly used pesticides on the population of beneficial soil inhabitants (enchytraeids) and yield in rice crop ecosystem.

Publication Year: 2007

19/6/18 (Item 4 from file: 50)
DIALOG(R)File 50: CAB Abstracts

0009363260 **CAB Accession Number:** 20073233145
Microbial and microfaunal community structure in cropping systems with genetically modified plants.

Publication Year: 2007

19/6/19 (Item 5 from file: 50)
DIALOG(R)File 50: CAB Abstracts

0009247568 **CAB Accession Number:** 20073053216

Toxicity of emerging energetic soil contaminant CL-20 to potworm Enchytraeus crypticus in freshly amended or weathered and aged treatments.

Publication Year: 2006

19/6/20 (Item 6 from file: 50)
DIALOG(R)File 50: CAB Abstracts

0009151487 **CAB Accession Number:** 20063231386
Influence of different cultivation practices on the properties of volcanic soils on Santorini Island, Greece.

Publication Year: 2006

19/6/21 (Item 7 from file: 50)
DIALOG(R)File 50: CAB Abstracts

0009040451 **CAB Accession Number:** 20063021657
Comparison of the influence of an artificial and a natural soil on the behaviour of Enchytraeus albidus - laboratory tests.

Publication Year: 2005

19/6/22 (Item 8 from file: 50)
DIALOG(R)File 50: CAB Abstracts

0008983852 **CAB Accession Number:** 20063042074
The effects of B.H.C., D.D.T. and parathion on soil fauna.

Publication Year: 1955

19/6/23 (Item 9 from file: 50)
DIALOG(R)File 50: CAB Abstracts

0008955810 **CAB Accession Number:** 20053216605
Soil animal communities in farmland polluted by organochlorine.

Publication Year: 2005

19/6/24 (Item 10 from file: 50)
DIALOG(R)File 50: CAB Abstracts

0008944019 **CAB Accession Number:** 20053203210
Weathering and aging of 2,4,6-trinitrotoluene in soil increases toxicity to potworm Enchytraeus crypticus .

Publication Year: 2005

19/6/25 (Item 11 from file: 50)
DIALOG(R)File 50: CAB Abstracts

0008944017 **CAB Accession Number:** 20053203212
Survival and reproduction of enchytraeid worms, oligochaeta, in different soil types amended with energetic cyclic nitramines.

Publication Year: 2005

19/6/26 (Item 12 from file: 50)
DIALOG(R)File 50: CAB Abstracts

0008939066 **CAB Accession Number:** 20053200370
Accumulation of polycyclic aromatic hydrocarbons from creosote-contaminated soil in selected plants and the oligochaete worm Enchytraeus crypticus .

Publication Year: 2005

19/6/27 (Item 13 from file: 50)
DIALOG(R)File 50: CAB Abstracts

0008926849 **CAB Accession Number:** 20053189843
Effects of chitanase and glucanase transgenic rice on three species of soil collembola and one species of annelida.

Publication Year: 2004

19/6/28 (Item 14 from file: 50)
DIALOG(R)File 50: CAB Abstracts

0008534275 **CAB Accession Number:** 20033187553

New soil invertebrate testing scheme proposed by EPPO with special reference to formulations of plant protection products like granular formulations and seed dressings.

Publication Year: 2003

19/6/29 (Item 15 from file: 50)
DIALOG(R)File 50: CAB Abstracts

0008407675 **CAB Accession Number:** 20033007944
Comparison of data on heavy metal toxicity: field and laboratory studies of Enchytraeidae.
Original Title: Vergleichbarkeit von Daten zur Schwermetalltoxizitat: Freiland- und Laboruntersuchungen an **Enchytraeiden**.
Publication Year: 2002

19/6/30 (Item 16 from file: 50)
DIALOG(R)File 50: CAB Abstracts

0008316673 **CAB Accession Number:** 20023148526
Influence of coated seeds on soil organisms tested with bait lamina.

Publication Year: 2002

19/6/31 (Item 17 from file: 50)
DIALOG(R)File 50: CAB Abstracts

0008235405 **CAB Accession Number:** 20023060397
Effects of three chemicals on the survival and reproduction of the oligochaete worm Enchytraeus coronatus in chronic toxicity tests.

Publication Year: 2002

19/6/32 (Item 18 from file: 50)
DIALOG(R)File 50: CAB Abstracts

0008186204 **CAB Accession Number:** 20023015201
Indirect effects of zinc on soil microbes via a keystone enchytraeid species.

Publication Year: 2001

19/6/33 (Item 19 from file: 50)
DIALOG(R)File 50: CAB Abstracts

0007858974 **CAB Accession Number:** 20001907621
Enchytraeid reproduction test (ERT): sublethal responses of two Enchytraeus species (Oligochaeta) to toxic chemicals.

Publication Year: 1999

19/6/34 (Item 20 from file: 50)
DIALOG(R)File 50: CAB Abstracts

0007858972 **CAB Accession Number:** 20001907623
Comparison of chronic toxicity of lindane (gamma-HCH) to Enchytraeus albidus in two soil types: the influence of soil pH.

Publication Year: 1999

19/6/35 (Item 21 from file: 50)
DIALOG(R)File 50: CAB Abstracts

0007822376 **CAB Accession Number:** 19991913717
Response of enchytraeidae (Oligochaeta) to soil management in agricultural systems.

Book Title: Management of tropical agroecosystems and the beneficial soil biota.
Publication Year: 1999

19/6/36 (Item 22 from file: 50)
DIALOG(R)File 50: CAB Abstracts

0007704732 **CAB Accession Number:** 19991903576
Responses of the soil decomposer community and decomposition processes to the combined stress of pentachlorophenol and acid precipitation.

Publication Year: 1998

19/6/37 (Item 23 from file: 50)
DIALOG(R)File 50: CAB Abstracts

0007699023 **CAB Accession Number:** 19991903341
Effects of dimethoate and benomyl on soil organisms and soil processes - a microcosm study.

Publication Year: 1998

19/6/38 (Item 24 from file: 50)
DIALOG(R)File 50: CAB Abstracts

0007401320 **CAB Accession Number:** 19971908296
Effects of pentachlorophenol on soil organisms and decomposition in forest soil.

Publication Year: 1997

19/6/39 (Item 25 from file: 50)
DIALOG(R)File 50: CAB Abstracts

0007386871 **CAB Accession Number:** 19971906802
Distribution of soil animals in patchily contaminated soil.

Publication Year: 1996

19/6/40 (Item 26 from file: 50)
DIALOG(R)File 50: CAB Abstracts

0007331388 **CAB Accession Number:** 19971902500
Effects of pentachlorophenol in forest soil: a microcosm experiment for testing ecosystem responses to anthropogenic stress.

Publication Year: 1997

19/6/41 (Item 27 from file: 50)
DIALOG(R)File 50: CAB Abstracts

0007265758 **CAB Accession Number:** 19962302263
The effects of environmental chemicals on the Enchytraeidae (Oligochaeta) of an acid beech forest.
Original Title: Die Auswirkungen von Umweltchemikalien auf die **Enchytraeidae** (Oligochaeta) eines Moder-Buchenwalds.

Publication Year: 1994

19/6/42 (Item 28 from file: 50)
DIALOG(R)File 50: CAB Abstracts

0007174410 **CAB Accession Number:** 19961901386
Effects of pentachlorophenol and biotic interactions on soil fauna and decomposition in humus soil.

Publication Year: 1995

19/6/43 (Item 29 from file: 50)
DIALOG(R)File 50: CAB Abstracts

0007045586 **CAB Accession Number:** 19951907608
The impact of soil and crop management practices on the dynamics of soil microfauna and mesofauna.

Book Title: Soil biota: management in sustainable farming systems.
Publication Year: 1994

19/6/44 (Item 30 from file: 50)
DIALOG(R)File 50: CAB Abstracts

0006729738 **CAB Accession Number:** 19931979519
Environmental behaviour of chemicals in a terrestrial ecosystem section: effect on Enchytraeidae (Oligochaeta).
Original Title: Umweltverhalten von Chemikalien in einem terrestrischen Okosystemausschnitt: Effekte auf **Enchytraeidae** (Oligochaeta).
Publication Year: 1991

19/6/45 (Item 31 from file: 50)
DIALOG(R)File 50: CAB Abstracts

0006729735 **CAB Accession Number:** 19931979516
Environmental behaviour of chemicals in a terrestrial ecosystem section: experimental outline.
Original Title: Umweltverhalten von Chemikalien in einem terrestrischen Okosystemausschnitt: experimentatelle Konzeption.
Publication Year: 1991

19/6/46 (Item 32 from file: 50)
DIALOG(R)File 50: CAB Abstracts

0006638895 **CAB Accession Number:** 19932326086
Comparison of the effects of pesticides on soil microflora and mesofauna in two different ecosystems.

Proceedings of the international symposium on environmental aspects of **pesticide** microbiology, 17-21 August 1992, Sigtuna, Sweden.
Publication Year: 1992

19/6/47 (Item 33 from file: 50)
DIALOG(R)File 50: CAB Abstracts

0006450040 **CAB Accession Number:** 19911155746
Effects of isofenphos on nontarget invertebrates in turfgrass.

Publication Year: 1990

19/6/48 (Item 34 from file: 50)
DIALOG(R)File 50: CAB Abstracts

0006399641 **CAB Accession Number:** 19911179121
The effect of aldicarb and aldicarb sulfone on the soil mesofauna (Enchytraeidae, Acari, Collembola) in microcosms.
Original Title: Einfluss von Aldicarb und Aldicarb-Sulfon auf die Bodenmesofauna (**Enchytraeidae**, Acari, Collembola) in Mikrokosmen.
Publication Year: 1989

19/6/49 (Item 35 from file: 50)
DIALOG(R)File 50: CAB Abstracts

0006363090 **CAB Accession Number:** 19911952575
Enchytraeids (Oligochaeta) of broadleaved and coniferous forests of southern Germany and their reaction to environmental changes.
Original Title: Die Enchytraen (Oligochaeta) von Laub- und Nadelwaldern Suddeutschlands und ihre Reaktion auf substantielle Einflusse.
Publication Year: 1989

19/6/50 (Item 36 from file: 50)
DIALOG(R)File 50: CAB Abstracts

0006320435 **CAB Accession Number:** 19901948106
Enchytraeids as test organisms - prerequisites for a terrestrial test method and test results.

Publication Year: 1989

19/6/51 (Item 37 from file: 50)
DIALOG(R)File 50: CAB Abstracts

0006230461 **CAB Accession Number:** 19901143012
Pests and diseases of vegetable crops.
Original Title: Vrediteli i bolezni ovoshchykh kul'tur.
Publication Year: 1989

19/6/52 (Item 38 from file: 50)
DIALOG(R)File 50: CAB Abstracts

0006184103 **CAB Accession Number:** 19901138268
The influence of Zeazin 50 on Enchytraeidae (Oligochaeta) in an apple orchard soil.

Publication Year: 1989

19/6/53 (Item 39 from file: 50)
DIALOG(R)File 50: CAB Abstracts

0006111782 **CAB Accession Number:** 19891121596
Institute for Plant Protection in Agriculture and Grasslands in Braunschweig.
Original Title: Institut fur Pflanzenschutz in Ackerbau und Grunland in Braunschweig. Jahresbericht 1987, Biologische Bundesanstalt fur Land- und Forstwirtschaft in Berlin und Braunschweig.

19/6/54 (Item 40 from file: 50)
DIALOG(R)File 50: CAB Abstracts

0006040855 **CAB Accession Number:** 19881929506
Abundance of lumbricids and enchytraeids in an organically farmed field in northern Hokkaido, Japan.

Publication Year: 1988

19/6/55 (Item 41 from file: 50)
DIALOG(R)File 50: CAB Abstracts

0005905255 **CAB Accession Number:** 19870707780
The invertebrate population and response to pesticide treatment of two permanent and two temporary pastures.

Publication Year: 1987

19/6/56 (Item 42 from file: 50)
DIALOG(R)File 50: CAB Abstracts

0005814260 **CAB Accession Number:** 19870839743
Numbers of virus-transmitting nematodes in treated and untreated strawberry fields.
Original Title: Het aandeel van virusoverdragende nematoden in ontsmette en niet-ontsmette aardbeivelden.
Publication Year: 1986

19/6/57 (Item 43 from file: 50)
DIALOG(R)File 50: CAB Abstracts

0005434274 **CAB Accession Number:** 19841984423
Soil fauna (Microarthropods, Enchytraeids , Nematodes) in Swedish agricultural cropping systems.

Publication Year: 1983

19/6/58 (Item 44 from file: 50)
DIALOG(R)File 50: CAB Abstracts

0005077723 **CAB Accession Number:** 19801956837
The influence of salt concentration on an enchytraeid population in pine litter.

Publication Year: 1980

19/6/59 (Item 45 from file: 50)
DIALOG(R)File 50: CAB Abstracts

0005035178 **CAB Accession Number:** 19800874499
Testing of compounds with potential antiparasitic action. V. Antihistamines.
Original Title: Badania zwiazkow o potencjalnym dzialaniu przeciwpasozytniczym. V. Leki przeciwhistaminowe.
Publication Year: 1980

19/6/60 (Item 46 from file: 50)
DIALOG(R)File 50: CAB Abstracts

0004891199 **CAB Accession Number:** 19790861173
Tests on compounds with potential antiparasitic action. III. New derivatives of cyclohexanedione and ketobutylocyclohexanedione.
Original Title: Badania zwiazkow o potencjalnym dzialaniu przeciwpasozytniczym. III. Nowe pochodne cykloheksandionu i ketobutylocykloheksandionu.
Publication Year: 1978

19/6/61 (Item 47 from file: 50)
DIALOG(R)File 50: CAB Abstracts

0004891198 **CAB Accession Number:** 19790861172
Tests on compounds with potential antiparasitic action. II. New derivatives of homomorpholine containing ether bonds.
Original Title: Badania zwiazkow o potencjalnym dzialaniu przeciwpasozytniczym. II. Nowe pochodne homomorfoliny zawierajace wiazania eterowe.
Publication Year: 1978

19/6/62 (Item 48 from file: 50)
DIALOG(R)File 50: CAB Abstracts

0004765529 **CAB Accession Number:** 19790861177
Tests on compounds with potential antiparasitic action. I. New aliphatic esters of N-ethanolmorpholine.
Original Title: Badania zwiazkow o potencjalnym dzialaniu przeciwpasozytniczym. I. Nowe estry alifatyczne N-etanolomorfoliny.
Publication Year: 1978

19/6/63 (Item 49 from file: 50)
DIALOG(R)File 50: CAB Abstracts

0004747264 **CAB Accession Number:** 19790652792
The influence of paraquat and simazine herbicides on the forest soil fauna.
Original Title: Uber den Einfluss der Herbizide Paraquat und Simazin auf die Fauna forstlich genutzer Boden.
Publication Year: 1978

19/6/64 (Item 50 from file: 50)
DIALOG(R)File 50: CAB Abstracts

0004680893 **CAB Accession Number:** 19771937213
The results of long-term repeated applications of herbicides to a crop rotation.
Original Title: Gevolgen van langdurig Lerhaalde **Herbicidentoedieningen** in een vruchtwisselingssysteem.
Publication Year: 1976

19/6/65 (Item 51 from file: 50)
DIALOG(R)File 50: CAB Abstracts

0004612475 **CAB Accession Number:** 19780558430
Effect of four insecticides on the pasture ecosystem. VI. Arthropoda dry heat-extracted from small soil cores, and conclusions.

Publication Year: 1978

19/6/66 (Item 52 from file: 50)
DIALOG(R)File 50: CAB Abstracts

0004571707 **CAB Accession Number:** 19772315906
Effect of long-term repeated herbicide applications in a crop rotation system.
Original Title: [Paper at] 28th International Symposium on Crop Protection, Part II.
Publication Year: 1976

19/6/67 (Item 53 from file: 50)
DIALOG(R)File 50: CAB Abstracts

0004473482 **CAB Accession Number:** 19772318489
The influence of atrazine on soil fauna.

Publication Year: 1977

19/6/68 (Item 54 from file: 50)
DIALOG(R)File 50: CAB Abstracts

0004397991 **CAB Accession Number:** 19760828362
Control of nematode pests, background and outlook for biological control.

The 13th Symposium of the British Ecological Society, Oxford, 4-7 January 1972.
Publication Year: 1974

19/6/69 (Item 55 from file: 50)
DIALOG(R)File 50: CAB Abstracts

0004370000 **CAB Accession Number:** 19750530506
Effect of four insecticides on the pasture ecosystem. IV. Enchytraeidae and Diptera larvae heat-extracted in water-filled funnels.

Publication Year: 1975

19/6/70 (Item 56 from file: 50)
DIALOG(R)File 50: CAB Abstracts

0004157112 **CAB Accession Number:** 19740513382
Dursban and diazinon residues in biota following treatment of intertidal plots on Cape Cod - 1967-69.

Publication Year: 1972

19/6/71 (Item 57 from file: 50)
DIALOG(R)File 50: CAB Abstracts

0004100362 **CAB Accession Number:** 19731905874
Effect of insecticides on the soil-forming fauna (Arthropoda, Oligochaeta).

Publication Year: 1973

19/6/72 (Item 1 from file: 10)
DIALOG(R)File 10: AGRICOLA

4494151 43813797 **Holding Library:** AGL
Toxicity of three halogenated flame retardants to nitrifying bacteria, red clover (Trifolium pratense), and a soil invertebrate (Enchytraeus crypticus)

2006
URL: http://dx.doi.org/10.1016/j.chemosphere.2005.11.056

19/6/73 (Item 2 from file: 10)
DIALOG(R)File 10: AGRICOLA

4208035 22030669 **Holding Library:** AGL
Effects of dimethoate and benomy on soil organisms and soil processes--a microcosm study

1998
URL: http://www.sciencedirect.com/science/journal/09291393

19/6/74 (Item 3 from file: 10)
DIALOG(R)File 10: AGRICOLA

4076648 23339864 **Holding Library:** AGL
Bioavailability and toxicokinetics of 14C-lindane (gamma-HCH) in the Enchytraeid Enchytraeus albidus in two soil types: the aging effect

2002

19/6/75 (Item 4 from file: 10)
DIALOG(R)File 10: AGRICOLA

4022082 23293081 **Holding Library:** AGL
Bioaccumulation and elimination of 14C-lindane by Enchytraeus albidus in artificial (OECD) and a natural soil

2002

19/6/76 (Item 5 from file: 10)
DIALOG(R)File 10: AGRICOLA

3286081 93031102 **Holding Library:** AGL

The use of soil mesofauna for the judgement of chemical impact on ecosystems

1992 May

19/6/77 (Item 6 from file: 10)
DIALOG(R)File 10: AGRICOLA

3127317 91052596 **Holding Library:** AGL
Effects of benomyl on reproduction and population structure of Enchytraeid oligochaetes (Annelida)--sublethal tests on agar and soil

1991

19/6/78 (Item 7 from file: 10)
DIALOG(R)File 10: AGRICOLA

2348072 84085580 **Holding Library:** AGL
Nematicides and field population of enchytraeids and earthworms (Oxamyl and phenamiphos, New Zealand)

1984

19/6/79 (Item 1 from file: 203)
DIALOG(R)File 203: AGRIS

02115065
1995
[Impacts of **pesticides** on zoocoenosis of a forest soil. Final report] (Auswirkungen von ausgewaehlten Pflanzenschutzmitteln auf die Zoozoenose eines Waldbodens. Schlussbericht)

19/6/80 (Item 2 from file: 203)
DIALOG(R)File 203: AGRIS

01942276
Sublethal toxicity test with the enchytraeid worm Cognettia Sphagnetorum (Vejdovsky, 1878), (Enchytraeidae: Oligochaeta)

1995
Progress report 1994 of SECOFASE: Third technical report: Development, improvement and standardization of test systems for assessing sublethal effects of chemicals on fauna in the

soil ecosystem

19/6/81 (Item 3 from file: 203)
DIALOG(R)File 203: AGRIS

01927932
1995
Pesticide research, 8: Effects of **pesticides** on meso- and microfauna in soil [ecotoxicology]

19/6/82 (Item 4 from file: 203)
DIALOG(R)File 203: AGRIS

01634507
From: heavy metals affect soil fauna to: choosing variables and organisms for a test system

1992
Proceedings of the international symposium on environmental aspects of **pesticide** microbiology 17-21 August 1992 in Sigtuna, Sweden

19/6/83 (Item 5 from file: 203)
DIALOG(R)File 203: AGRIS

01599200
The effect of Aldicarb and Aldicarb-Sulfone on soil mesofauna (Acari, Collembola, Enchytraeidae) in microcosms

1989
1st European conference on ecotoxicology: Conference proceedings: a SECOTOX regional conference

19/6/84 (Item 1 from file: 5)
DIALOG(R)File 5: Biosis Previews(R)

18322465 **Biosis No.:** 200510016965
Response of enchytraeid community (oligochaeta, enchytraeidae) to manipulation of microbial biomass

2005

19/6/85 (Item 2 from file: 5)
DIALOG(R)File 5: Biosis Previews(R)

17083426 **Biosis No.:** 200300040775
A survey of enchytraeid communities in grassland and horticultural soil: The enchytraeid community as a monitoring tool.

2002

19/6/86 (Item 3 from file: 5)
DIALOG(R)File 5: Biosis Previews(R)

16735610 **Biosis No.:** 200200329121
Statistical results and implications of the enchytraeid reproduction ringtest

2002

19/6/87 (Item 4 from file: 5)
DIALOG(R)File 5: Biosis Previews(R)

15964208 **Biosis No.:** 200100136047
[Acute and subacute effects of selected pesticides on Collembola inhabiting different strata]

Original Language Title: Akute und subakute Effekte ausgewaehlter Pestizide auf Collembolenarten unterschiedlicher Strata
2000

19/6/88 (Item 5 from file: 5)
DIALOG(R)File 5: Biosis Previews(R)

12616383 **Biosis No.:** 199598084216
Development of a standardized laboratory test with bait-lamina for ecotoxicological testing: Pretests

1994

19/6/89 (Item 6 from file: 5)
DIALOG(R)File 5: Biosis Previews(R)

11366631 **Biosis No.:** 199294068472
TERRESTRIAL MULTISPECIES TOXICITY TESTING 1. DESCRIPTION OF THE MULTISPECIES ASSEMBLAGE

1992

19/6/90 (Item 7 from file: 5)
DIALOG(R)File 5: Biosis Previews(R)

11066807 **Biosis No.:** 199243035398
THE SUBLETHAL ENCHYTRAEID TEST SYSTEM GUIDELINES AND SOME RESULTS

Book Title: ESSER, G. AND D. OVERDIECK (ED.). MODERN ECOLOGY: BASIC AND APPLIED ASPECTS. XXIX+844P. ELSEVIER SCIENCE PUBLISHERS B.V.: AMSTERDAM, NETHERLANDS; (DIST. IN THE USA AND CANADA BY ELSEVIER SCIENCE PUBLISHING CO., INC.: NEW YORK, NEW YORK, USA). ILLUS. MAPS
1991

19/6/91 (Item 8 from file: 5)
DIALOG(R)File 5: Biosis Previews(R)

10560060 **Biosis No.:** 199141072686
ULTRAHISTOPATHOLOGY OF ENCHYTRAEID OLIGOCHAETES ANNELIDA AFTER EXPOSURE TO PESTICIDES A MEANS OF IDENTIFICATION OF SUBLETHAL EFFECTS

1991

19/6/92 (Item 9 from file: 5)
DIALOG(R)File 5: Biosis Previews(R)

09004504 **Biosis No.:** 198835101609
SUBLETHAL DAMAGE IN ENCHYTRAEUS-MINUTUS OLIGOCHAETA ANNELIDA CAUSED BY THE INSECTICIDE PARATHION CHANGES IN THE ULTRASTRUCTURE OF THE CHLORAGOGEN CELLS AND GUT CELLS DEPENDING ON THE DURATION OF LOADING

1988

19/6/93 (Item 10 from file: 5)
DIALOG(R)File 5: Biosis Previews(R)

09004503 **Biosis No.:** 198835101608
SUBLETHAL DAMAGE OF TERRESTRIAL ENCHYTRAEIDAE OLIGOCHAETA ANNELIDA BY PLANT PROTECTION AGENTS CHANGES IN COCOON PRODUCTION AND EGG FERTILITY

1988

19/6/94 (Item 11 from file: 5)
DIALOG(R)File 5: Biosis Previews(R)

09004501 **Biosis No.:** 198835101606
COMPARATIVE ANALYSIS OF THE SUCCESSION OF AN ENCHYTRAEUS SYNUSIA AND SOIL MICROFLORA THE EFFECTS OF ALDICARB POLLUTION

1988

19/6/95 (Item 12 from file: 5)
DIALOG(R)File 5: Biosis Previews(R)

07185766 **Biosis No.:** 198477017677
SOIL FAUNA MICRO ARTHROPODS ENCHYTRAEIDS NEMATODES IN SWEDISH AGRICULTURAL CROPPING SYSTEMS

1983

19/6/96 (Item 13 from file: 5)
DIALOG(R)File 5: Biosis Previews(R)

06621721 **Biosis No.:** 198274038144
THE EFFECTS OF MICRO ARTHROPODS ON LITTER DECOMPOSITION IN A CHIHUAHUAN MEXICO DESERT ECOSYSTEM

1981

19/6/97 (Item 14 from file: 5)
DIALOG(R)File 5: Biosis Previews(R)

06196780 **Biosis No.:** 198171015739
THE INFLUENCE OF SALT CONCENTRATION ON AN ENCHYTRAEID POPULATION IN PINE PINUS-SYLVESTRIS LITTER

1980

19/6/98 (Item 15 from file: 5)
DIALOG(R)File 5: Biosis Previews(R)

04846980 **Biosis No.:** 197661013119
EFFECT OF 4 INSECTICIDES ON THE PASTURE ECOSYSTEM PART 4 ENCHYTRAEIDAE AND DIPTERA HEAT EXTRACTED IN WATER FILLED FUNNELS

1975

19/6/99 (Item 16 from file: 5)
DIALOG(R)File 5: Biosis Previews(R)

04377533 **Biosis No.:** 197457023388
INTERACTIONS BETWEEN BIOTIC COMPONENTS IN SOILS AND THEIR MODIFICATIONS BY MANAGEMENT PRACTICES IN CANADA A REVIEW

1973

19/6/100 (Item 17 from file: 5)
DIALOG(R)File 5: Biosis Previews(R)

0001856896 **Biosis No.:** 19684900015536
Pesticides and the soil fauna: Effects of aldrin and DDT in an arable field

1967

19/6/101 (Item 18 from file: 5)
DIALOG(R)File 5: Biosis Previews(R)

0001590954 **Biosis No.:** 19654600105170
Side effects of some soil-applies systemic insecticides

1965

19/6/102 (Item 19 from file: 5)
DIALOG(R)File 5: Biosis Previews(R)

0001590949 **Biosis No.:** 19654600105165
Some side-effects resulting from the use of persistent insecticides

1965

19/6/103 (Item 1 from file: 156)
DIALOG(R)File 156: ToxFile

520066 **NLM Doc No:** HAPAB/71/02731 **Sec. Source ID:** HAPAB/71/02731
(Insecticides as the cause of fish poisonings.)

1971

19/6/104 (Item 2 from file: 156)
DIALOG(R)File 156: ToxFile

519135 **NLM Doc No:** HAPAB/72/00201 **Sec. Source ID:** HAPAB/72/00201
Effects of herbicides on the soil fauna.

1970

19/6/105 (Item 3 from file: 156)
DIALOG(R)File 156: ToxFile

519084 **NLM Doc No:** HAPAB/71/02724 **Sec. Source ID:** HAPAB/71/02724
(The action of some pesticidal substances on soil nematodes and enchytraeidae.)

1970

19/6/106 (Item 1 from file: 40)
DIALOG(R)File 40: Enviroline(R)

00423174 **Enviroline Number:** 95-12479
Soil Fauna and Sustainable Land Use in the Humid Tropics

Sep 28-Oct 2, 92

19/6/107 (Item 1 from file: 41)
DIALOG(R)File 41: Pollution Abstracts

0000356493 IP Accession No: 8802913
Organic Residue Decomposition: The Minicontainer-System A Multifunctional Tool in Decomposition Studies

Publication Date: 1999

19/6/108 (Item 2 from file: 41)
DIALOG(R)File 41: Pollution Abstracts

0000231956 IP Accession No: 5523915
Bioaccumulation and elimination of super(14)C-lindane by Enchytraeus albidus in artificial (OECD) and a natural soil

Publication Date: 2002

19/6/109 (Item 1 from file: 117)
DIALOG(R)File 117: Water Resources Abstracts

0000245060 IP Accession No: 9105107
Baseline-Ecosystem Approach to the Analysis of Ecotoxicological Effects

Publication Date: 1990

19/6/110 (Item 1 from file: 34)
DIALOG(R)File 34: SciSearch(R) Cited Ref Sci

18771854 **Genuine Article#:** 398HN **Number of References:** 56
SINGLE- AND TWO-SPECIES TESTS TO STUDY EFFECTS OF THE ANTHELMINTICS IVERMECTIN AND MORANTEL AND THE COCCIDIOSTATIC MONENSIN ON SOIL INVERTEBRATES
(ABSTRACT AVAILABLE)
Publication date: 20090200

19/6/111 (Item 2 from file: 34)
DIALOG(R)File 34: SciSearch(R) Cited Ref Sci

15482316 **Genuine Article#:** 077VR **Number of References:** 63
Effects of sewage sludge and copper enrichment on both soil mesofauna community and decomposition of oak leaves (Quercus suber) in a mesocosm
(ABSTRACT AVAILABLE)
Publication date: 20061000

19/6/112 (Item 3 from file: 34)
DIALOG(R)File 34: SciSearch(R) Cited Ref Sci

10865202 **Genuine Article#:** 578NJ **Number of References:** 68
Interaction between humus form and herbicide toxicity to Collembola (Hexapoda)
(ABSTRACT AVAILABLE)
Publication date: 20020600

19/6/113 (Item 4 from file: 34)
DIALOG(R)File 34: SciSearch(R) Cited Ref Sci

05923706 **Genuine Article#:** XH072 **Number of References:** 29
Experimental studies on the reactions of Collembola to copper contamination
(ABSTRACT AVAILABLE)
Publication date: 19970600

19/6/114 (Item 5 from file: 34)
DIALOG(R)File 34: SciSearch(R) Cited Ref Sci

05592519 **Genuine Article#:** WJ525 **Number of References:** 28
Response of some soil meso- and macro-faunal populations to soil management during crop and fallow periods on a semi-arid tropical alfisol (India)
(ABSTRACT AVAILABLE)
Publication date: 19960000

19/6/115 (Item 6 from file: 34)
DIALOG(R)File 34: SciSearch(R) Cited Ref Sci

02107633 **Genuine Article#:** KB460 **Number of References:** 28
EFFECTS OF IRON POLLUTION ON MACROINVERTEBRATES PROMOTING ORGANIC-MATTER TRANSFORMATION IN SOILS OF PRESILA-COSENTINA (ITALY)

(Abstract Available)

19/6/116 (Item 7 from file: 34)
DIALOG(R)File 34: SciSearch(R) Cited Ref Sci

02077971 **Genuine Article#:** JZ337 **Number of References:** 96
MICROBIAL AND FAUNAL INTERACTIONS AND EFFECTS ON LITTER NITROGEN AND DECOMPOSITION IN AGROECOSYSTEMS
(Abstract Available)

19/6/117 (Item 8 from file: 34)
DIALOG(R)File 34: SciSearch(R) Cited Ref Sci

02037901 **Genuine Article#:** JW626 **Number of References:** 39
DO INCREASED COMMODITY PRICES LEAD TO MORE-OR-LESS SOIL DEGRADATION
(Abstract Available)

19/6/118 (Item 9 from file: 34)
DIALOG(R)File 34: SciSearch(R) Cited Ref Sci

01801839 **Genuine Article#:** JC083 **Number of References:** 32
HERBICIDE PROGRAMS IN NO-TILLAGE AND CONVENTIONAL-TILLAGE SOYBEANS (GLYCINE-MAX) DOUBLE CROPPED AFTER WHEAT (TRITICUM-AESTIVUM)
(Abstract Available)

19/6/119 (Item 10 from file: 34)
DIALOG(R)File 34: SciSearch(R) Cited Ref Sci

01801837 **Genuine Article#:** JC083 **Number of References:** 26
POPULATION-DYNAMICS AND CONTROL OF ANNUAL WEEDS IN CORN (ZEA-MAYS) AS INFLUENCED BY TILLAGE SYSTEMS
(Abstract Available)

19/6/120 (Item 11 from file: 34)
DIALOG(R)File 34: SciSearch(R) Cited Ref Sci

01484464 **Genuine Article#:** HC328 **Number of References:** 48

SOIL BIOTIC AND BIOCHEMICAL FACTORS IN A LONG-TERM TILLAGE AND STUBBLE MANAGEMENT EXPERIMENT ON A VERTISOL .2. NITROGEN DEFICIENCY WITH ZERO TILLAGE AND STUBBLE RETENTION
(Abstract Available)

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