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The use of *Porcellio laevis* (Crustacea, Isopoda) as organism for the avoidance test in response to a metal contaminated litter

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Abstract
Terrestrial isopods have become tools for the ecotoxicological assessment of metal-contaminated litter and soil. This study aimed to determine the EC_{50} of *Porcellio laevis* individuals after their exposure to a contaminated *Quercus* litter by $CdCl_2$ and $ZnCl_2$.The net response was also calculated. All these results showed the potential of *P. laevis* which might be suggested as bio-indicator in litter quality assessment.

1. Introduction
Metals are naturally available in the environment, but since the industrial revolution, its amount has significantly increased (Hopkin, 1989). Metal pollution could be related to various anthropogenic sources such as mining, smelting and agricultural activities (Godet *et al.,* 2011). Isopods as soil organisms and as part of terrestrial ecosystems show promise as invertebrates used as bioindicators to assess environmental quality (Nannoni *et al.*, 2014). Among them, the species *Porcellio laevis* Latreille 1804 which have shown its ability to accumulate heavy metals under both laboratory exposure (Mazzei *et al*., 2014) and in heavily contaminated areas (Ghemari *et al.,* 2017). Among toxicity tests conducted under laboratory conditions, avoidance tests seem to be a useful complement to evaluate the toxicity of a substance and can be considered as a first evaluation (Römbke, 2003). It was first performed on earthworms *Eisenia fetida* and *Lumbricus terrestris* (Stephenson *et al*., 1997) and then for different organisms such as collembolans, enchytraeids, and isopods that might show a behavioral response (Amorim *et al*., 2008). The present study aimed to determine the EC_{50} and the net response of woodlice after their exposure to heavy metals under laboratory conditions.

2. Material and Methods
P. laevis individuals were collected from Wadi Joumin in Bizerte, Northern Tunisia (37° 0′ 37″ N and 009° 41′ 21″ E). *Quercus* leaves were prepared and contaminated with two salt solutions of Cadmium chloride ($CdCl_2$) and Zinc chloride ($ZnCl_2$) according to Köhler *et al.* (1996) and were presented as food for *P. laevis* individuals. For each metal, four concentrations (C_1, C_2, C_3, and C_4) were prepared with three replicates for each concentration and with 10 individuals per replicate. A control was also prepared in which the leaves were sprayed only with bi-distilled water. An aliquot of 40 g of uncontaminated soil was added to each replicate. The avoidance test consists on maintaining *P. laevis* individuals in rectangular plastic containers, divided into two equal compartments (A and B) by a removable plastic wall. The control leaf was placed in compartment A and the same amount was placed in compartment B. Animals were kept during 48 h defined as the test period. After this period, the plastic wall was reintroduced aiming to count individuals in each compartment. Dead specimens were linked to the contamination so were counted as they belong to compartment B. Concerning animals found in the wall which separates both of the compartments, they were considered regarding their head direction (A or B). The EC_{50} was calculated using a Probit regression conducted by *Xlstat* software. Results of the avoidance tests were represented in terms of average net response (NR) expressed as a percentage and calculated as follow NR= ((C-T) / N) * 100 according to Amorim *et al.* (2008).

Where C = individuals observed in the control litter; T = individuals observed in the tested litter; N = total number of individuals per replicate.

A positive (+) net response indicates avoidance and a negative net response (–) indicates a non-response (or attraction) to the metals.

3. Results and Discussion
The EC_{50} was estimated to 71.7 (95% CL, 2.5 - 494.3 mg L^{-1}) for $CdCl_2$ while it was estimated to 2503.4 (95% CL, 433.4 - 2844.7 mg L^{-1}) for $ZnCl_2$.
Conducting avoidance test on *Enchytraeus albidus*, the EC_{50} was estimated to 362 and 92 mg Kg^{-1} for Cd and Zn respectively (Amorim *et al.,* 2008).

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Furthermore, Loureiro *et al.* (2005), have calculated the EC_{50} regarding different types of contaminants between two models: *Porcellionides pruinosus* and *Elsenia andrei*. For Copper, the estimated EC_{50} was equal to 802.26 and 181.10 mg Kg^{-1} for *P. pruinosus* and *E. andrei*, respectively.
The net response was calculated and results were expressed in average values ± standard error in Table 1. The lowest $CdCl_2$ nominal concentration (60 mg L^{-1}) showed the highest positive net response with 53.33 ± 13.33 while by

Table 1: Results (average values ± standard error) of the net response of *P. laevis* individuals exposed to contaminated *Quercus* litter by $CdCl_2$ and $ZnCl_2$

	$CdCl_2$	$ZnCl_2$
C_1	53.33 ± 13.33	-53.33 ± 13.33
C_2	16.66 ± 14.52	-3.33 ± 44.84
C_3	33.33 ± 6.66	40 ± 11.54
C_4	-13.33 ± 43.71	60 ± 11.54

CdC_2 nominal concentrations (C_1=60, C_2=80, C_3=100 and C_4=120 mg L^{-1}); $ZnCl_2$ nominal concentrations (C_1=800, C_2=900, C_3=1000 and C_4=1100 mg L^{-1}).

increasing concentration, the net response decreased to a negative value with -13.33 ± 43.71. The inverse was observed in $ZnCl_2$; a negative response was obtained at the first nominal concentration (800 mg L^{-1}), then a positive is obtained at the last one (1100 mg L^{-1}) with 60 ± 11.54. A positive (+) net response indicates avoidance while a negative net response (–) induced a non-response (or attraction) to the saline soil (Owojori & Reinecke, 2009). In accordance with the Draft Guideline for the Earthworm Avoidance Text (ISO, 2006), the habitat function of soils was considered to be limited if an average (>80%) of worms were found in the control soil as shown for *Elseinia foetida* (Amorim *et al.,* 2008). Thus, considering the two studied metals, significant differences were observed in term of distribution of *P. laevis* specimens in the two compartments of the containers. In the present study, we obtained an avoidance response only with $CdCl_2$ suggesting that it might depend on the type of contaminant. As reported by Lukkari & Haimi (2005), a behavioral test was conducted on three different species where they were exposed to a mixture contamination but they don't exhibit the same response. It seemed that species did not react by the same way regarding contamination and developed their characteristics like chemoreceptive (Stephenson *et al.,* 1998), physiologic, morphologic (Edwards & Bohlen, 1996), ecologic and notably behavioral characteristics (Lukkari & Haimi, 2005).

4. Conclusion and Recommendations

Through low exposure, this study has shown the effect of contaminated litter by heavy metals on *P. laevis* individuals. The determinations of EC_{50} for $CdCl_2$ and $ZnCl_2$ will be useful to highlight this result by increasing nominal concentrations to obtain a clear gradient of dose-response.

References

Amorim MJ, Novais S, Römbke J, Soares AM (2008) *Enchytraeus albidus* (Enchytraeidae): A test organism in a standardized avoidance test? Effects of different chemical substances. *Environment International,* **34**: 363–371.
Edwards CA, Bohlen PJ (1996) Biology and Ecology of Earthworms. Chapman and Hall, London. pp. 426
Ghemari C, Waterlot C, Ayari A, Leclercq J, Douay F, Nasri-Ammar K (2017) Assessment of heavy metals in soil and terrestrial isopod *Porcellio laevis* in Tunisian industrialized areas. *Environmental Earth Sciences*, **76:** 223. DOI 10.1007/s12665-017-6946-5.
Godet JP, Demuynck S, Waterlot C, Lemière S, Souty Grosset C, Sheifler R, Douay F, Leprêtre A, Pruvot C (2011) Growth and metal accumulation in *Porcellio scaber* exposed to poplar litter from Cd, Pb and Zn contaminated sites. *Ecotoxicology and Environmental Safety*, **74:** 451–458.
Hopkin SP (1989) Ecophysiology of Metals in Terrestrial Invertebrates, Elsevier Applied Science, London, pp. 256–262.
ISO (2006) Soil quality – avoidance test for testing the quality of soils and the use of chemicals – test with earthworms (Eisenia fetida). International Standard Organization Guideline No. 17512-1.
Köhler HR, Hüttenrauch K, Berkus M, Graff S, Alberti G (1996) Cellular hepatopancreatic reactions in *Porcellio scaber* (Isopoda) as biomarkers for the evaluation of heavy metal toxicity in soils. *Applied Soil Ecology*, **3:** 1–15.
Loureiro S, Soares AMV, Nogueira AJA (2005) Terrestrial avoidance behaviour tests as screening tool to assess soil contamination. *Environmental Pollution,* **138:** 121–131.
Lukkari T, Haimi J (2005 Avoidance of Cu- and Zn-contaminated soil by three ecologically different earthworm species. *Ecotoxicology and Environmental Safety*, **62:** 35–41.
Mazzei V, Longo G, Brundo MV, Copat C, Oliveri Conti G, Ferrante M (2014) Bioaccumulation of Cadmium and Lead and its effects on hepatopancreas morphology in three terrestrial isopod Crustacean species. *Ecotoxicology and Environmental Safety*, **110:** 269–279.
Nannoni, F, Mazzeo R, Protano G, Santolini R (2015) Bioaccumulation of heavy elements by *Armadillidium vulgare* (Crustacea, Isopoda) exposed to fallout of a municipal solid waste landfill. *Ecological indicators,* **49:** 24–31
Owojori OJ, Reinecke AJ (2009) Avoidance behavior of two eco-physiologically different earthworms (*Eisenia fetida* and *Aporrectodea caliginosa*) in

ISSN 1737-3638

natural and artificial saline soils. *Chemosphere*, **75:** 270-283.
Römbke J (2003) Ecotoxicological laboratory tests with enchytraeids: a review: the 7th International Symposium on Earthworm Ecology— Cardiff-Wales-2002. *Pedobiologia*, **47:** 607–16.
Stephenson GL, Kaushik A, Kaushik NK, Solomon KR, Steele T, Scroggins RP (1997) Use of an avoidance-response test to assess toxicity of contaminated soils to earthworms. In: Sheppard, S.C., Bembridge, J.D., Holmstrup, M., Posthuma, L. (Eds.), *Advances in Earthworm Ecotoxicology*. SETAC, Pensacola, FL, pp. 67– 81.