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Acute toxicity of Nigerian crude oil (Bonny Light) to *Desmocaris trispinosa* (Crustacea, Palaemonidae)

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Abstract. The acute toxic effects of a Nigerian crude oil (Bonny Light) to freshwater shrimp, *Desmocaris trispinosa* were studied in toxicity bioassay. The test organisms were exposed to crude oil in a static renewal bioassay for 96 hrs. There was an initial range-finding test to determine the concentrations of crude oil to be administered on the test organisms in the definitive test. Five concentrations of the crude oil were prepared in the definitive test as 40, 80, 160, 240 and 320 mgL^{-1} and a control experiment (0 mgL^{-1}). The median lethal concentration (LC_{50}) at 24-hr, 48-hr, 72-hr and 96-hr was 0, 0, 281.84 and 120.23 mgL^{-1} respectively. The median lethal time (LT_{50}) at crude oil concentrations of 160 mgL^{-1}, 240 mgL^{-1} and 320 mgL^{-1} were 89.5hrs, 80.7hrs and 53.3hrs respectively while the LT_{50} at concentrations of 40 mgL^{-1} and 80 mgL^{-1} was 0hr. Mortality increased with increase in crude oil concentration and the difference was significant ($p<0.05$). The present findings indicates that Bonny Light crude oil have mortality effects on *D. trispinosa* and may adversely affect other aquatic organisms.
Key Words: Bioassay, freshwater shrimp, median lethal concentration, median lethal time.

Résumé. Les effets toxiques aigus d'un pétrole brut du Nigeria (Bonny Light) à la crevette d'eau douce, *Desmocaris trispinosa* ont été étudiés dans bioessais de toxicité. Les organismes d'essai ont été exposés à du pétrole brut dans un essai biologique de renouvellement statique pour 96 heures. Il y avait une première gamme de trouver de test pour déterminer les concentrations de pétrole brut à être administrés sur les organismes d'essai dans le test définitif. Cinq concentrations de pétrole brut ont été préparés dans le test définitif de 40, 80, 160, 240 et 320 mgL^{-1} et une expérience de contrôle (0 mgL^{-1}). La concentration létale médiane (CL_{50}) à 24h, 48h, 72h et 96hr a 0, 0, 281,84 et 120,23 mgL^{-1} respectivement. Le temps létal (TL_{50}) à des concentrations de pétrole brut de 160 mgL^{-1}, 240 mgL^{-1} et 320 mgL^{-1} ont été 89.5hrs, 80.7hrs et 53.3hrs respectivement, tandis que l'TL50 à des concentrations de 40 mgL^{-1} et 80 mgL^{-1} a 0 heures. Une mortalité accrue avec l'augmentation de la concentration du pétrole brut et la différence était significative ($p<0,05$). Les résultats actuels indiquent que l'huile de Bonny brut léger ont des effets de la mortalité sur *D. trispinosa* et peut nuire à d'autres organismes aquatiques.
Mots-clés: Test biologique, crevettes d'eau douce, concentration létale médiane, la médiane du temps létal.

Introduction. Oil spillage as a result of petroleum industry activities is a regular occurrence in oil-producing Niger Delta region of Nigeria. The spillage is often caused as a result of pipe-line vandalization by saboteurs, who are mostly youths of the oil-producing regions clamouring for remediation of their polluted aquatic environments among other things. There have been over 3,854 reported cases of oil spillage in Nigeria from 1986 to 2000 (Adeyemi 2004). Acute toxicity bioassay are widely used to assess the effects of pollutants on one or more organisms usually based on the determination of acute lethal toxicity and sub-lethal toxicity test using sensitive species or organisms based on their economic and ecological importance, availability and ease of handling (Fuller et al 2004). Although, the tests are laboratory based, simple, of single variable and do not necessarily simulate the field situations, they nonetheless provide useful information on the potential of the pollutant to harm the biota (Akbari et al 2004). The objective of this study is to investigate the acute toxicity of Nigeria crude oil (Bonny Light) to the freshwater shrimp, *Desmocaris trispinosa* (Aurivillius, 1898) with a view to

ascertaining their level of tolerance and suitability as a bio-indicator in freshwater environment.

Material and Method. Bioassay was conducted in the laboratory of the Department of Wildlife and Fisheries Management, University of Ibadan, Nigeria, between February and August 2007 to investigate the toxicity of Nigerian crude oil (Bonny Light) to *D. trispinosa*. The method of bioassay employed was the one outlined by APHA (1998).

The test specimens of *D. trispinosa* were collected from Epe, Lagos, Nigeria in thick transparent polyethylene bags with artificial oxygen to sustain the freshwater shrimp during transportation to the laboratory. The shrimps were held in glass tanks (60 x 30 x 45cm^3) for 14 days prior to the start of the experiment (Omitoyin et al 2006). Each acclimatization tank had the habitat water from where the shrimps were collected. The habitat water in the tanks was replaced every 2 days. During acclimatization, the temperature was maintained at 29±2^{o}C while aeration was continued throughout the period with aquarium pumps. The photo-period was 12 hour light and 12 hours darkness.

A range-finding test was carried out as described by Rahman et al (2002) to determine the concentrations of Bonny Light crude oil used in the definitive test.

The following concentrations of Bonny Light crude oil were used for the definitive test: 0 mgL^{-1} (control), 40 mgL^{-1}, 80 mgL^{-1}, 160 mgL^{-1}, 240 mgL^{-1}and 320 mgL^{-1}.

One hundred and twenty (120) specimens of *D. trispinosa* of mean length 4.03±0.34 cm and mean weight 5.54±1.64 g were randomly assigned in equal number (20) into six test tanks (60 x 30 x 45 cm^3) separately containing the definitive concentrations (0 mgL^{-1}, 40 mgL^{-1}, 80 mgL^{-1}, 160 mgL^{-1}, 240 mgL^{-1} and 320 mgL^{-1}) of Bonny Light crude oil. Each of these experimental units (test tanks) was replicated thrice to give a total of eighteen (18) experimental units containing 360 specimens of *D. trispinosa*. The control (0 mgL^{-1}) contained only 20 individuals of *D. trispinosa* from Epe, Lagos without the crude oil. During the bioassay, the test solution in each tank was renewed every 24 hours. Dead shrimps were promptly removed and mortality was specifically recorded at 24, 48, 72 and 96 hours of exposure time as described by Odiete (1999).

Statistical Analysis. Each test concentration was converted into a logarithm and the corresponding percentage (%) mortality was transformed into probit (Sprague 1973). The median lethal concentration (LC_{50}) and median lethal time (LT_{50}) were determined according to the method described by Finney (1971). Significant differences in the number of survivors in the concentrations of the crude oil were tested using analysis of variance (ANOVA) and where there is significant variation, Fisher's Least Significant Different (LSD) was used.

Results and Discussion. The results of the bioassay showed that the 24-hr and 48-hr LC_{50} of Bonny Light crude oil to *D. trispinosa* was 0 mgL^{-1} while the 72-hr and 96-hr LC_{50} values of Bonny Light crude oil to *D. trispinosa* was 281.84 mgL^{-1} and 120.23 mgL^{-1} respectively (Fig. 1). These results agree with the study of Daka & Ekweozor (2004), which tested the toxicity of Nigerian crude oil (Egbogoro Liner II) to Mangrove Oyster, *Crassostrea gasar* Adanson, 1757 and obtained a LC_{50} of 135 mgL^{-1}. However, this study disagrees with earlier studies by Akbari et al (2004) and Fuller et al (2004). Akbari et al (2004) tested the acute toxicity of Malaysian crude oil to *Penaeus monodon* Fabricius, 1798 (black tiger shrimp) and obtained a LC_{50} value of 8.52 mgL^{-1} while Fuller et al (2004) tested the toxicity of Arabian medium crude oil to the shrimp *Americamysis bahia* (Molenock, 1969) (former *Mysidopsis bahia*)and obtained 0.62 mgL^{-1}. The reasons for this variation in toxicity of crude oil to aquatic organisms may be due to variety in species, age and habitat of test organisms, duration of exposure, bioassay system, type of crude oil used in the test, and the analytical methods applied in the assay (Akbari et al 2004).

The acute toxicity of Bonny Light crude oil to *D. trispinosa* was assessed over a 96 hour period and mortality was recorded every 24 hour. The results showed that mortality increased as the crude oil concentration increased (Fig. 1) and these differences were significant ($p<0.05$) (Table 1). This result agrees with the study of Olaifa (2005) which

studied the toxicity of Nigerian Qua Iboe Light crude oil to *Clarias gariepinus* (Burchell, 1822). The predictive equations for the 48-hr, 72-hr and 96-hr test periods were Y = 4.4746X – 6.3368, Y = 2.1748X – 0.3461 and Y = 2.1589X – 0.5577 respectively, and the coefficient of determination (r^2), which in all cases was strong and positive except for the 24-hr, which was 0, were (r^2 = 0.82, N = 5, α = 0.05), (r^2 = 0.84, N = 5, α = 0.05) and (r^2 = 0.98, N = 5, α = 0.05) for 48-hr, 72-hr and 96-hr respectively.

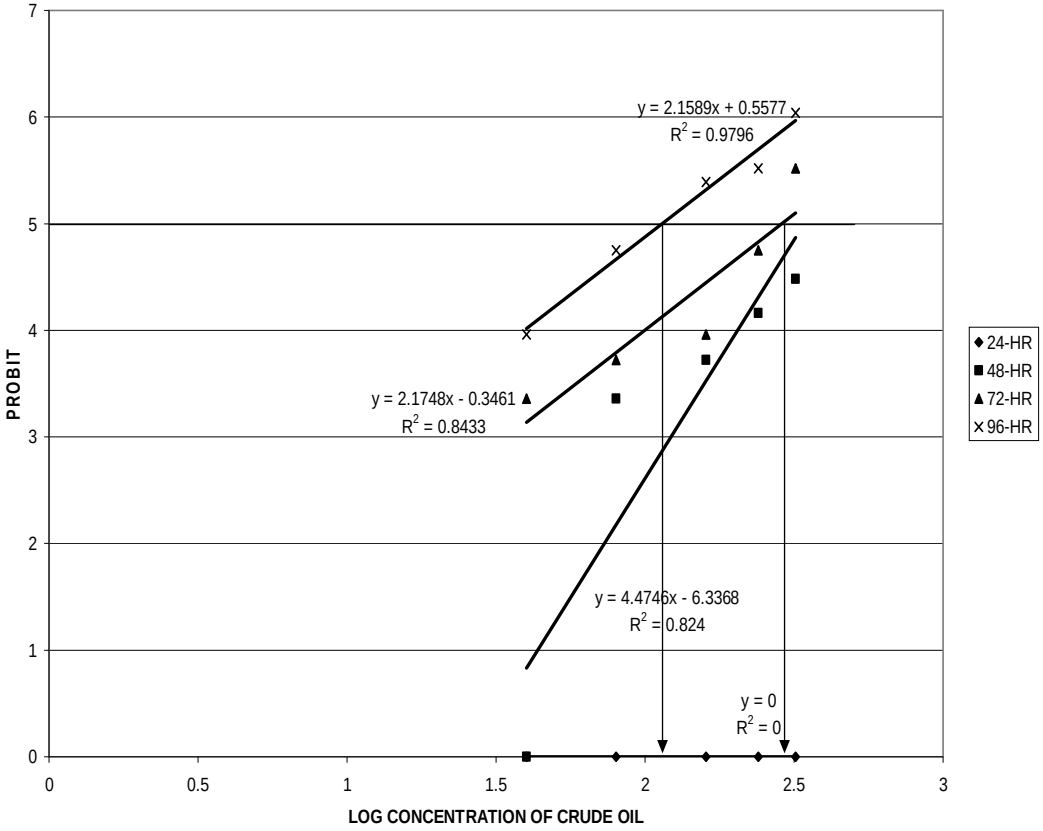

Figure 1. Median lethal concentration (LC_{50}) of Bonny Light crude oil to *D. trispinosa*.

Table 1

Survivors of *D. trispinosa* exposed to different concentration (mgL^{-1}) of crude oil

Crude oil concentration	*Survival*
Control (0)	20.00 ± 0.00^{a}
40	16.67 ± 0.33^{b}
80	11.67 ± 0.33^{c}
160	6.33 ± 1.15^{d}
240	5.63 ± 0.33^{e}
320	2.33 ± 0.58^{f}

The median lethal time (LT_{50}) of Bonny Light crude oil to *D. trispinosa* at crude oil concentrations of 160 mgL^{-1}, 240 mgL^{-1} and 320 mgL^{-1} were 89.5hrs, 80.7hrs and 53.3hrs respectively (Fig. 2).

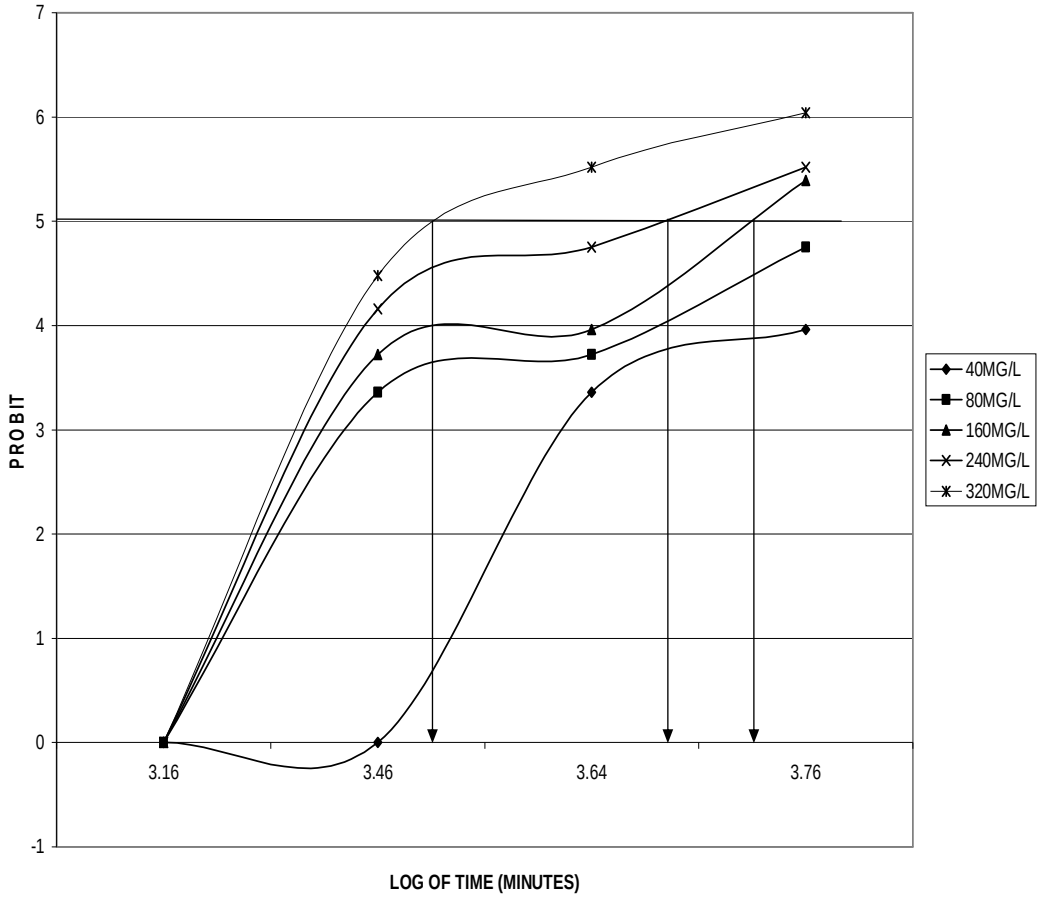

Figure 2. Median lethal time (LT50) of Bonny Light crude oil to *D. trispinosa*.

The LC_{50} value of crude oil to *D. trispinosa* decreased as the exposure time increased. This result agrees with earlier study by Akbari et al (2004). Comparison between the slope function (4.4746, 2.1748 and 2.1589) of probit mortality in *D. trispinosa* at different time intervals in the present study and the values (3.4455, 5.1689 and 5.3227) obtained in *P. monodon* by Akbari et al (2004) shows that the regression lines of *D. trispinosa* are flatter than those of *P. monodon*. According to Rand & Petrocelli (1985), these differences indicate that *D. trispinosa* absorb the toxic components of crude oil slower than *P. monodon*.

Conclusions. Crude oil spillage, which is a regular occurrence in oil-producing Niger Delta, Nigeria has been a source of worry for the government and people of Nigeria. It has resulted in youth restiveness among other social and environmental problems. The indigenes have complained ceaselessly about the impacts of oil exploration and exploitation on their environment especially on fisheries, which is the main occupation of the oil-producing areas before the discovery of crude oil. Crustacean, to which *D. trispinosa* belongs, are one of the groups threatened by the actions of the oil companies.This study has shown that oil spillage can cause fish mortality as well, which can lead to loss in fish species diversity and even extinction.

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