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THERMAL TOLERANCE OF THE WEST AFRICAN FIDDLER CRAB *(UCA TANGERI)* TO HEATED EFFULENTS FROM GAS FLARE SITES

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ABSTRACT

Experiments were conducted both at the heated effluents discharge point of a gas flare station in the Niger Delta region and in the laboratory to determine the thermal tolerance of the West African fiddler crab (*Uca tangeri*). The critical thermal maxima (CTM) was 38°C. Time required for 100% recovery vary from 3 minutes - 50 minutes at temperature ranging 33°C - 37°C after 30 mins exposure. Mortality were observed from 38°C. Elevated temperature could therefore be a lethal factor which determines the distribution of *Uca tangeri* around heated effluents discharge point of a gas flare station.

Keywords: Thermal tolerance *Uca tangeri* Niger Delta

INTRODUCTION

Nigerian crude oil is rich in gas. (NEST 1991; Aston-Jones 1998). Much of the gas is not used but flared. For instance, from 1988 to 1996, Nigeria produced about 2.7 trillion tonnes of natural gas; out of this, only 19.5% was actually utilized. Thus, Nigeria ranks highest among the petroleum producing countries that flare their gas. (Mofat and Linden 1995).

Gas flaring produces high thermal discharges in the same manner as many Nuclear power plants. Thermal discharges from Nuclear Power plants cooling system often limit the distribution of marine organisms (Bamber & Spencer 1984; Ahmed *et. al.*, 1992, Suresh *et. al.*, 1992). Similar effect like the limitation of the distribution of marine organisms are expected when excavations containing heat effluents are discharged into a river system that, apart from causing elevated temperature of the water which now limits the distribution of marine organisms, gas flaring has a great impact on the environment.

The Niger Delta Basin is the region where most of Nigeria's crude oil is explored and exploited. Because of the swampy nature of this region, crude oil producing platforms are equipped with some what rectangular excavations with dykes ranging about 1.5m. The excavations are usually filled with water which cool the flare sites. The resultant effect is that the water becomes very hot. To ensure continuous cooling of the excavations, they are usually connected to a river system which ensures continuous flow of water. Water at the entrance of the excavation is usually steaming.

The elevated temperature at the point of discharge has a great effect on the physiology of marine life. Data collected in this regard is a

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necessary prerequisite for a proper environmental impact assessment. This paper intends, not only to assess the thermal energy from gas flare stations through measurement of its radiant heat, but also present results of a study on the lethal and sublethal responses of the West African fiddler crab (*Uca tangeri*) exposed to heated effluents from gas flaring stations.

MATERIALS AND METHODS

There are well over 300 flare sites located in various parts of the Niger Delta region of the country but for this study, only 10 sites were monitored.

Measurements were taken over a 24hr period to determine the heat energy flux. Heat energy from the gas flare was measured with a none - contact thermometer mounted on a tripod. The high thermal discharge from the flare will not permit any closer contact with these places hence the use of this thermometer.

Field experiments in the present study were conducted at the heated effluent discharge points of the flare sites at the Nembe Creek flow station. Two 20L plastic containers (30cm x 20cm x 50cm) were cut open and perforated. Adult fiddler crabs were collected in the field and acclimated at ambient temperature. Ten acclimated crabs were put in each of the perforated plastic containers and the tops were covered with a 240μm mesh net to prevent the crabs from escaping. The two cages were simultaneously left at the heated effluent discharge area and a point devoid of the heated effluents and retrieved 30mins after exposure. Animals were checked for physiological activities. Temperature reading were taken at the point of discharge of heated effluent.

To determine the thermal tolerance of the West African fiddler crab, other experiments were conducted. The critical thermal maxima (CTM) and Upper Incipient Lethal Temperature (UILT) was determined according to the methods by Rao and Ganapati, (1972a). The CTM was conducted from 30^{o}C to 39^{o}C while UILT was from 30^{o}C - 38^{o}C.

RESULTS

Data on the energy flux from gas flare stations are shown in Table 1. Mean Ambient temperature was 28.13^{o}C. Temperature at the flare station fluctuate.

Results of thermal tolerance of the crab to elevated temperature at the vicinity of flare site is presented in Table 2. The temperature ranges from 35^{o}C to 41^{o}C. The time required to attain 100% mortality of the crabs decreased with increasing temperature particularly between 37^{o}C to 40^{o}C. At the heated effluent discharge point, temperature above 35^{o}C had resulted in 100% mortality

Results on data on mortality of the crabs observed in the laboratory at different temperatures are presented in Table 3. Duration of exposure for 100% mortality decreased with any increase in temperature. At 34^{o}C we observed 100% mortality after 1260 minutes of exposure but at 38^{o}C, the time needed for exposure for 100% mortality was just less than 5 minutes. Experiments to determine critical thermal Maxima (CTM) and Upper Incipient Lethal Temperature (UILT) are also shown in Table 3. Between 30^{o}C to 32^{o}C, 100% of the animals were observed to recover immediately after exposure for up to 30 minutes. From 33^{o}C to 37^{o}C, the recovery time vary from 3 minutes 50 minutes. 70% - 100% lethality were observed at 38^{o}C to 40^{o}C respectively.

Table 1: Measurement of Flare Temperature

No	Mean Ambient Tem. (°C)	Max. Flare Tem. (°C)	Min. Flare Tem. (°C)	Mean Flare Tem. (°C)	Absolute Flare Tem. (°C)
21	29.1	1355	1248	1301.50	1570
32	28.5	1345	125 0	1297.50	1560
3	27.6	1354	1270	1312	1580
4	27.4	1260	1200	1230	1496
5	28.2	1259	1180	1214.50	1480
6	28.7	1310	1192	1251	1540
7	27.05	1270	1240	1255	1490
8	27.9	1298	1170	1234	1520
9	28.01	1300	1150	1225	1580
10	28.8	1350	1190	1270	1530
Mean	**28.13**	**1310.10**	**1209**	**1259.05**	**1534.60**

Table 2: Tolerance of Uca tangeri to elevated temperature at the vicinity of discharge of heated effluents.

Temp. (°C)	No. Exposed Crabs	No. Recovered after 30 mins.
34.5	10	10
35.6	10	10
36.1	10	10
37.5	10	7
38.6	10	0
39.0	10	0
40.8	10	0
41.5	10	0

Table 3: Tolerance of Uca tangeri to rising temperature after 30 mins (CTM)

Test Temp. (°C)	No. of Crabs Exposed	Activity of Crabs Observed
30	10	100% recovered immediately
31	10	100% recovered immediately
32	10	100% recovered immediately
33	10	100% recovered after 3mins
34	10	100% recovered after 10mins
35	10	100% recovered after 20mins
36	10	100% recovered after 20mins
37	10	100% recovered after 50mins
38	10	30% recovered.
38.5	10	No recovery
39	10	No recovery

DISCUSSION

Temperature changes in the marine environment are mainly due to the coincidence of low tide with high ambient temperature. Other well known sources are industrial waste heat discharges particularly from power generating plants like electricity generating stations and Nuclear Power Plants: To assess the environmental impact caused on the marine ecosystem by these discharges, thermal tolerance of dominant resident species need to be investigated. The mangrove swamp in the Niger Delta is an ecosystem that houses many species of crabs. One of such species is the West African fiddler crab (*Uca tangeri*). It is a dominant macrofauna of the Nembe Creek mangrove swamp and was used as an indicator organism in this study just as mole crab (*Emerita asiatica*), a dominant inhabitants of sandy beaches was used as an indicator organisms (Siegel and Wenner, 1995; Wenner, 1988).

Laboratory experiment on the thermal tolerance of fiddler crab showed that survival decreased with increasing temperature. The critical temperature was 38.5°C because evidently, no physiological action was observed in all the animals. Furthermore, crabs were exposed to elevated temperature. With an increment of 1°C after every 30mins, more activity was initially observed but ceased gradually. as the temperature increased above 35°C, to the critical thermal maxima. In the field, mortality was recorded within a few minutes of exposure above the CTM. Movement of crabs in the container was very rapid at temperatures between 33°C - 36°C. It suggested that crabs were attempting to avoid areas of high temperature.

Field experiments on thermal tolerance of *U. tangeri* show that high temperature (above 35°C) of the heated effluent could act as a stress factor to the crabs. Data on thermal tolerance using cage experiments at heated effluent discharges from power plants or flare stations are rare. While Langford (1983) concluded that predictions of ecological effects in the field based on laboratory experiments is of a limited use, Venables *et al.*, (1987) and Khoo and Chin (1984), underlined the need for thermal tolerance experiments of animals in the vicinity of the heated effluent discharges due to their value as fundamental criteria in the impact assessment of thermal effluents in the environment.

From the results of this study, it can be inferred that high thermal discharges from gas flare stations impact seriously on the environment. The under-utilization of the gas is probably due to lack of capacity to harness gases. Gas should be gathered, liquefied for export and domestic use.

The energy equivalent of flared gas is very significant. Gas flaring should therefore be stopped and the waste be converted for proper use in the country.

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