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Monitoring Population Abundance of the Sand Lizard *Acanthodactylus scutellatus* and their Ant Prey in Oil Polluted Soils at Kuwait's Greater Al-Burgan Oil Field

M. Al-Hashem
Department of Biological Sciences, Kuwait University, P.O. Box 5969, Safat, State of Kuwait

Abstract: Desert ecosystems in Al-Burgan oil fields of Kuwait were contaminated by heavy metals and petroleum hydrocarbons due to oil spill generated by the Gulf War in 1990. Studying sand lizard (*Acanthodactylus scutellatus*) population and their ant prey in the years 2002 and 2003 to detect the effects of oil pollution is now a focus of study. Polluted sites with apparently different degrees of pollution (namely tar mat, soot and clear sites) were compared with control sites outside this region. Total lizard numbers were recorded by using transect method. Number of ants was recorded by walking the transects and counting ants present. The results showed no difference in lizard population between the different study sites in 2002 and 2003 by applying the transect method. No difference in ant populations between the different study sites in 2002 and 2003. Although, the mean estimated lizard numbers were lower at the tar mat sites, the ant number in this location was greatest, meaning that food availability was highest at these sites. This suggests any reduction in the numbers of lizards is unrelated to low resource availability. The lizard numbers at the tar mat sites could be depressed by some property of the pollutants.

Key words: Desert lizard, transect, oil spill, Gulf war, Quadrat

INTRODUCTION

Burning of the oil wells at Burgan and Ahmadi in the 1990 Gulf war has had tremendous effects on the surrounding desert ecosystems (Al-Hassan, 1992; Omar *et al*., 2000). Because of the profound effect on the environment it was thought important, some 13 years later, to discover whether the contamination was still influencing lizard and ant populations within this environment. The oil fires released particles, organic and inorganic gases, hydrocarbons (HCs) and oil droplets (Al-Hassan, 1992). Oil spills, aerosol deposits and seawater (used in attempts to extinguish the flames) all had adverse effects on the desert ecosystem. The explosion of the oil wells in Burgan and Ahmadi produced enormous volumes of soot and unburned oil in the form of oil-mist that was carried to distant locations over an area of approximately 49.15 km^2 (Al-Ghunaim, 1997).

Lizards are important components of terrestrial ecosystems, forming an important link in food chains between invertebrate prey and predatory vertebrates such as birds and snakes (Lambert, 1997a, b). Lizards have rarely been used, as bioindicators of pollution for a variety of reasons, including the difficulty in sampling sufficient numbers and their relative lack of economic importance (Loumbourdis, 1997). Lambert (1993) has, however, strongly advocated using lizards as potential bioindicators of pesticides entering the environment and our previous studies (Al-Hashem *et al*., 2007, 2008; Al-Hashem and Brain, 2009a-c; Al-Hashem, 2009) suggested that reptiles can reveal valuable information about oil pollution in desert locations.

Populations of animals are rarely constant for any extended period of time. The apparent effects of pollutants on population size can be greatly influenced by many other factors. Exposure to a pollutant may coincide with decrease in population size of one or more species, but this does not show that the pollutant has necessarily directly altered populations of that species. Evidence that a pollutant has killed some individuals does not necessarily indicate that the population size will be affected. Low-level oil contamination of marine iguanas (*Amblyrhynchus cristatus*) appears to be a serious threat to wildlife (Romero and Wikelski, 2002). The apparent effects of pollutants on population size can be greatly influenced by many other factors. Population of marine iguanas (*Amblyrhynchus cristatus*) on Santa Fe Island suffered a massive 62% mortality in the year after the accident, due to a small amount of residual oil contamination in the sea (Wikelski *et al*., 2002). Luiselli and Akani (2003) conducted a study to evaluate the effects of oil spillage and consequent pollution on the abundance, complexity and functioning of freshwater turtle communities of the Niger Delta, by comparing the turtle fauna found in two areas with similar environmental characteristics, one unpolluted and the other polluted by a case of oil spillage in 1988. A total of 510 turtle specimens belonging to four different species (*Trionyx triunguis*, *Pelusios castaneus*, *Pelusios niger* and *Pelomedusa subrufa*) were captured in the unpolluted area, whereas 88 specimens, from two different species (*P. castaneus* and *P. niger*) were captured in the polluted area. The dominant species was *P. castaneus* followed by *P. niger* in the unpolluted area and *P. niger* in the polluted area. A marked shift in habitat use was observed in one species (*P. niger*) after the oil spillage event. The study revealed both direct and indirect effects of oil pollution on the complexity and habitat use of Nigerian freshwater communities of turtles. The main direct effect was a considerable reduction in the specific diversity of the turtles; 50% of species were lost after oil spillage and there was a very strong decline in the numbers of turtle specimens also for those species which were able to survive the catastrophic pollution event. The shift in habitat use after oil spillage by *P. niger* may have a significant effect on the long-term persistence of this species, independently of the pollution effects of the oil spillage event, because it considerably reduced habitat niche separation between this species and the closely related *P. castaneus*, a potential competitor. It is therefore stressed that eco-ethological modifications in populations of animals subjected to catastrophic events such as oil pollution should be taken into account when evaluating the long-term effects of these devastating phenomena.

Sand lizard populations were monitored to compare abundance in areas with apparently differing degrees or levels of oil-polluted soils. The intention was to establish whether monitoring this animal was useful in relation to oil pollution in a desert environment.

MATERIALS AND METHODS

The greater Al-Burgan oil field has an area of 349.65 km^2 and lies 20 km to the South of Kuwait City. This study was conducted in the years 2002 and 2003 and the types of contaminated soils have been categorized on the basis of simple ground observations. The types identified have been designated as tar mat, soot and clear. The tar mat areas have a soil surface that is solidified by oil forming a crust about 1 cm thick that can be peeled off the underlying apparently clean soil. The soot areas have particulate black hydrocarbon deposits within the upper layer of soil to a depth of 1-8 mm. The clear sites have no visual evidence of soil pollution. Contamination may be continuous or discontinuous. The control area (Sulaibiya) is an Agriculture Research Station at Kabd which was established in 1975. It is a fenced reserve protected from livestock and human interference.

The transect method intended to locate sand lizards and record them. Five permanent transect lines, each 25 m long and 5 m wide were installed randomly in the study sites and were plotted in a quadrat form. The lizards were recorded as numbers per 625 m^2 and the totals from most quadrats gave that number directly. Number of ants was recorded by walking the transects and counting ants present. The total number of ants was recorded as numbers per 625 m^2 because the quadrat was 25×25 m as advised by a consultant and then was calculated per km^2 for the entire study area. Estimates of lizard and ant numbers were then converted into populations per km^2. The lizards and ants on each quadrat were recorded by walking the rows in the manner indicated according to a schedule with respect to time and temperature, starting with sites where lizards emerge earlier in the morning and ending with sites where lizards take longer to emerge (Al-Hashem *et al*., 2008).

Transects were only carried out on warm and clear days during the periods of highest lizard activity (February-April). The transects were carried out 10 times in 2002 and 14 times in 2003 for each replicate of the study sites. The rate of travel on the transect was adjusted by the observer. Generally, the rate was 5-10 min per 625 m^2 of transect. Air temperature with substrate temperatures at start of walking the transect and when finished were recorded. During transect walks, lizard activity levels initially increased as the substrate temperature warmed, but decreased as the heat became excessive. All lizards seen while the investigator was inside the quadrat were plotted on the data sheets.

RESULTS

It was obvious (Table 1) that the control sites had the highest lizard numbers followed by the tar mat sites whereas the soot sites had the fewest lizards. The ant numbers were very high at the tar mat and the clear sites and were lowest at the control and the soot sites. The air and substrate temperatures at start and when finished walking the transects were very similar at the different sites of study. Similar search times were used on the different study sites.

The one-way ANOVA test of the data recorded for lizards and ants numbers using transect method for the year 2002 (Table 1) showed no significant variation in lizard number between the different study sites ($F_{3,4}$ = 1.06). Ant numbers also did not vary between the study sites ($F_{3,4}$ = 0.86). Air temperature showed a slight variance between the sites ($F_{3,4}$ = 15.53, $p<0.01$). The substrate temperature at the start ($F_{3,4}$ = 8.96, $p<0.03$) and finish ($F_{3,4}$ = 7.52, $p<0.04$) of the transect walk differed

Table 1: Mean±SD population sizes of lizards and ants, as well as air and substrate temperatures (°C) at the start and finish and mean search times recorded when walking the transects in 2002

Location	Mean lizard No. km^{-2} (N = 2)	Mean ant No. km^{-2}	Mean air temp.	Mean substrate temp. at start	Mean substrate temp. at finish	Mean search time (min)
		(N = 10)				
Control	4012±872.9	34259±436.5	24.4±0.11	30.1±0.41	31.2±0.46	9.7±0.14
Clear	2623±109.2	57407±3099.5	24.8±0.18	31.1±0.12	32.1±0.01	9.7±0.42
Soot	1741±155.6	32561±1113.4	24.6±0.13	32.0±0.43	32.9±0.45	9.4±0.14
Tar mat	3086±218.4	62500±3382.7	23.1±0.48	30.9±0.39	31.9±0.31	9.7±0.14

Table 2: Mean population sizes of lizards and ants, mean air and substrate temperatures at start and finish and the means of search time±SD recorded during walking the transects in 2003

Location	Mean lizard No. km^{-2} (N = 2)	Mean ant No. km^{-2}	Mean air temp.	Mean substrate temp. at start	Mean substrate temp. at finish	Mean search time (min)
		(N = 14)				
Control	5291.0±935.4	54122±1917.2	21.5±0.94	28.3±1.69	29.2±1.63	9.4±0.40
Clear	5731.9±249.2	81679±6874.5	22.8±0.48	28.9±0.88	29.6±0.91	9.4±0.30
Soot	4614.8±332.8	60846±2961.7	22.4±2.00	29.2±2.60	29.9±2.80	9.2±0.10
Tar mat	5180.8±358.4	113866±2447.4	21.4±1.20	29.5±1.21	30.2±1.41	9.7±0.01

slightly between the sites. No significant difference was shown in search time between the different study sites ($F_{3,4} = 0.75$).

The data using the transect method in 2003 (Table 2) show very high numbers of lizards in the clear sites followed by the control sites. The tar mat sites had lower lizard numbers than the clear and control sites but did not differ markedly from lizard numbers at the control sites. The numbers of ants were much higher at the tar mat sites than the other locations followed by the clear and soot sites. The control sites had the lowest number of ants of all the study sites. The air temperature and the substrate temperatures at the start and the finish of walking the transects showed similar values at the different sites of study. Search times used on the different sites were also similar.

The one-way ANOVA test did not show any significant variance in lizard numbers between the different study sites ($F_{3,4} = 0.08$) as assessed using the transect method in 2003. This was also true for the ant numbers ($F_{3,4} = 0.87$). Air temperatures did not differ between the sites ($F_{3,4} = 0.59$) and the substrate temperatures ($F_{3,4} = 0.18$) on starting and when finishing ($F_{3,4} = 0.11$) the transect walk showed no significant variation between the sites. This was also true for the search times which showed no significant variance between the sites ($F_{3,4} = 1.24$).

Two-way ANOVA test was used to contrast the measures obtained with the transect method in 2002 and 2003. A significant difference was observed in lizard numbers between years ($F_{1,15} = 6.53$, $p<0.03$), but no significant difference was found between sites ($F_{3,15} = 0.45$), or the interaction between year and site ($F_{3,15} = 0.21$). No significant difference was shown in ant numbers between years ($F_{1,15} = 3.48$), or between sites ($F_{3,15} = 1.56$), or the interaction between year and site ($F_{3,15} = 0.17$). The air temperature showed a significant difference between years ($F_{1,15} = 23.26$, $p<0.001$), but no significant difference was observed between sites ($F_{3,15} = 2.24$), or the interaction between year and site ($F_{3,15} = 0.27$). A significant difference was found in the substrate temperature at start between years ($F_{1,15} = 11.65$, $p<0.009$), but no significant difference was shown between sites ($F_{3,15} = 0.92$), or the interaction between year and site ($F_{3,15} = 0.19$). The substrate temperature at finish showed a significant difference between years ($F_{1,15} = 12.31$, $p<0.008$), but no significant difference was shown between sites ($F_{3,15} = 0.622$), or the interaction between year and site ($F_{3,15} = 0.17$). No significant difference was observed in the search times between years ($F_{1,15} = 2.01$), or sites ($F_{3,15} = 1.75$), or the interaction between year and site ($F_{3,15} = 0.28$).

DISCUSSION

The pitfall trap method (Al-Hashem, 2009) and transect method used in this study generated similar results for lizard and ant numbers. The means of both measures differed, however, slightly over the 2 years and with the type of method used. Sias and Snell (1998) studied the effects of oil and gas wells on sand dune lizard (*Sceloporus arenicolus*) abundance from 1995 to 1997. In 1995, they found a 39% reduction in lizard abundance on plots 0-80 m from wells compared to plots more than 190 m from wells. Based on these results, they expanded their study in 1996 and 1997 to examine effects of oil and gas wells on lizard populations at larger scales. This analysis found a negative relationship between well density and abundance of the sand dune lizard in both 1996-1997.

Luiselli *et al*. (2004) studied the diet of sympatric freshwater turtles at two study areas in the Niger Delta (Southern Nigeria), to test whether oil pollution affects the ecological relationships between free-ranging turtles. Four species of turtle (*Trionyx triunguis*, *Pelusios castaneus*, *Pelusios niger* and *Pelomedusa subrufa*), were captured in the unpolluted area, whereas only two species (*Pelusios castaneus* and *Pelusios niger*) were captured in the polluted area. At the unpolluted area, the taxonomic composition of the diets of *Pelusios castaneus* and *Pelusios niger* was similar, whereas the diets of *Pelomedusa subrufa* and *Trionyx triunguis* were very different from the other two species and one another. It was evident from this study that the two species that survived the oil spill event shifted considerably in their dietary preferences. In both species there was an obvious trend towards a reduction in the breadth of the trophic niche, with many fewer food categories eaten at the polluted area compared to the unpolluted area. It is suggested that such reduction in trophic niche breadth may depend directly on the reduced availability of most food sources in the polluted area.

Because environmental characteristics, resource availability and predation pressure vary between geographic regions or even localities within a region, they have influences on population numbers. Although, the mean estimated lizard numbers were lowest at the tar mat sites, the ant number in this location was greatest, meaning that food availability was highest at these sites. This suggests any reduction in the numbers of lizards is unrelated to low resource availability. The lizard numbers at the tar mat sites could be depressed by some property of the pollutants. The presence of large lizards at the tar mat sites could preclude other smaller lizards of the same species from these locations, reducing the total numbers.

The soot sites had higher numbers of lizards in 2002 which might be attributed to the warmer weather as compared to 2003, increased food availability or reduced predation. More predators were observed at the soot sites in 2003. Perhaps also the large lizards at the tar mat sites could preclude other lizards from these locations which will reduce the population size at these locations.

The adult lizards were bigger at the tar mat and soot sites than the clear and control sites. This was unexpected as it was thought that presumably severe oil pollution would decrease body size. One obvious explanation for this phenomenon is the great availability of food in both the tar mat and soot sites. Another explanation might be that the food resource is affected by oil pollution (Al-Hashem *et al*., 2007).

The variation in microhabitat characteristics may affect territorial behaviors such as aggressiveness which was clearly observed in animals from the tar mat sites, which were often conflict with members of their own species over control of a particular territory. In many occasions, especially during the breeding season, males were fighting and were using tail movements and perform different displays to defend territories. Chases in which one individual rapidly runs or jumps at the other individual and the latter rapidly runs and jumps away were also observed in male lizards from the tar mat sites.

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