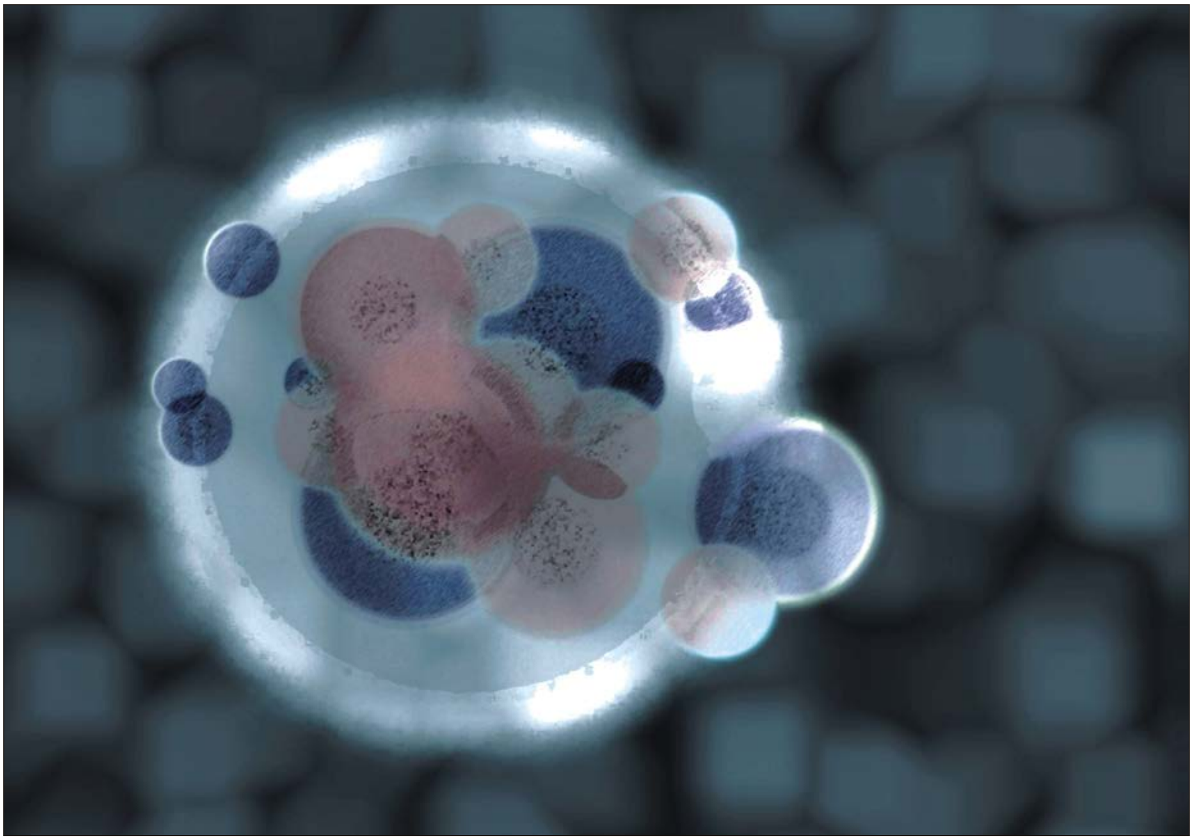

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Effects of Oil Pollution on the Population Size of the Desert Lizard *Acanthodactylus scutellatus* and their Ant Prey at Kuwait's Al-Burgan Oil Field

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Abstract: Desert locations in Al-Burgan oil fields of Kuwait were subjected to oil pollution generated by the Gulf war in 1990. Studying sand lizard (*Acanthodactylus scutellatus*) population and their ant prey in the years 2002 and 2003 to monitor the effects of oil pollution was thought to be useful in an area damaged by oil spill. Sites with apparently different levels of pollution, namely tar mat, soot and clear sites were compared with control sites outside this area. Live specimens of *A. scutellatus* were collected by drift fence and pitfall traps and were marked by toe clipping and painting bands before they were released. Ant population was collected by removal methods using vacuum. The mark-recapture Schnabel method of population estimation was used. The results revealed no difference in lizard population sizes between the different study sites in 2002 and 2003. A slight difference was observed in ant population sizes between the sites in 2002 but no difference was detected between the sites in 2003. 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.

Key words: Sand lizard, mark-recapture, Schnabel method, drift fence, pitfall traps

INTRODUCTION

The impact of oil well fires at Burgan and Ahmadi in the Gulf war of 1990 on the surrounding desert ecosystems have been well documented (Al-Hassan, 1992; Omar *et al*., 2000). The most severe element in Kuwait's environmental crisis was the burning of oil wells. The oil fires caused the release of particles, organic and inorganic gases, hydrocarbons (HCs) and oil droplets (Al-Hassan, 1992). Oil spills, aerosol deposits and seawater use have all had adverse effects on the desert ecosystem. The explosion of 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 areas. Such catastrophe led to severe degradation of the environment and it was thought important, some 13 years later, to establish whether the contamination was still influencing organisms within this environment.

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. However, Lambert (1993) has 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, 2009) suggested that reptiles can reveal valuable information about oil pollution in desert locations. Low-level oil contamination of marine iguanas (*Amblyrhynchus cristatus*) appears to be a serious threat to wildlife (Romero and Wikelski, 2002). The sand lizard *Acanthodactylus scutellatus* was chosen for the present studies in Kuwait because of its wide distribution and its life-style.

Populations of animals are rarely constant for any extended period of time. Adult population density had a small but significant effect on adult survival of marine iguana (*Amblyrhynchus cristatus*), but there was a greater effect of juvenile population density on juvenile survival, indicating competition for food within gross size-classes (Lauri and Brown, 1990). 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). 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. Conversely, a pollutant that kills no individuals but has sublethal effects on a significant proportion of individuals could have a severe impact on its viability (Moriarty and Walker, 1987).

Generally, the most noticeable and publicized effect of oil spills is from the oil slick itself. Sea birds become covered with oil and die. It is difficult to estimate numbers but it is reasonably certain that, in the seas around North-Western Europe, spilt oil kills many seabirds annually (Dunnet, 1982). However, there is little evidence that the populations of these seabirds are reduced by this mortality, even though many of these species have relatively low breeding rates and do not breed until they are several years of age. If environmental conditions become less favourable, however, oil pollution might well have an adverse effect on these species. Factors such as climatic change appear to be largely responsible of species decline (Clark, 1984). Habitat vulnerability and species susceptibility both influence the effects of an oil spill. One of the basic difficulties in scientific studies of oil pollution is that one cannot readily quantify the duration of exposure or the dose.

Sand lizard and ant 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 km² and lies 20 km to the South of Kuwait City. The study sites in Al-Burgan oil fields were selected according to the apparent degree of pollution. 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 clear sites have no visual evidence of soil pollution. Two sites were chosen in each pollution category, a trapping unit was installed at each. Two comparable areas well outside the oil field were used as controls. 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.

This study has been conducted in 2002 and 2003. Drift fences and pitfall traps were used to catch sand lizards. At each of the studied sites, a 40 cm high 18 m drift fence was set. Fences were made of canvas, leading to sunken buckets from which lizards could not escape. These were permanent installations which were checked daily when they were in use. When they were not in use, the entrances were sealed and bricks were kept over the seals in case strong winds occurred. Pitfall traps consisted of 5 gallon (22.7 L) green buckets (28 cm diameter, 30 cm depth). Pitfall traps were set at 3, 6, 9, 12 and 15 m from either end of the drift fences and were numbered in sequence from 1 to 5. It was necessary to install mesh filters at the bottom of traps to enable various taxa to avoid each other.

Live specimens of sand lizards were permanently marked by toe clipping and temporarily (for easy visual recognition) by painting bands on the animal's back using nail polish. Toe clipping followed specific manner by numbering the toes in the order 1-5, starting with the left forelimb (lizard on its abdomen), the right forelimb, the left hind limb and finally (if necessary) the right hind limb using sharp fingernail scissors.

Ant numbers were estimated by counting them in all 5 traps in the 2 replicates of each study site. Air and substrate temperatures were recorded during this study according to a timed schedule starting with sites having higher air and substrate temperatures. The live specimens were then released about 10 m from the traps.

The Schnabel method of population estimation was used in this study. A series of samples were used in which there is a 2nd, 3rd, 4th, ………,nth sample. Individuals caught at each sample were first examined for marks, then marked and released. Marking occurred at each sampling session. Only a single type of mark was used (Krebs, 1999), since there was a need to distinguish only two types of individuals namely, marked (signifying caught in one or more prior samples) and unmarked (signifying never previously caught).

An estimation of population size (N) was given by:

$$N = \frac{\sum_t (C_t\ M_t)}{\sum_t\ R_t}$$

Where:

C_t = Total No. of individuals caught in the sample$_t$

R_t = No. of individuals already marked when caught in sample$_t$

M_t = No. of marked individuals just before sample$_t$ was taken

RESULTS

One-way ANOVA showed no difference in lizard population sizes ($F_{3,4}$ = 1.15, p = 0.43) between the different study sites using pitfall method in 2002 (Schnabel method). A slight difference was observed in ant population sizes between the sites ($F_{3,4}$ = 6.39, p = 0.05). Air ($F_{3,4}$ = 3.93, p = 0.10) and substrate ($F_{3,4}$ = 3.99, p = 0.10) temperatures did not vary significantly between the sites.

The data of lizard and ant population sizes by using the pitfall trap method in 2002 showed very high numbers of lizards at the soot and control sites whereas the tar mat

Table 1: Mean±SD population sizes of lizards and ants km^{-2} and air and substrate temperatures (°C) recorded whilst monitoring the pitfall traps in 2002

Location	Mean population size of lizards km^{-2} (N = 2)	Mean No. of ants km^{-2}	Mean air temperature (°C)	Mean substrate temperature (°C)
		(N = 12)		
Control	5658±318.9	30666.0±1338.80	23.4±0.62	32.4±1.40
Clear	3170±308.4	169933.0±18545.5	24.1±0.11	33.5±0.42
Soot	6239±130.4	35479.0±1678.20	24.8±0.88	35.5±0.54
Tar mat	2432±206.3	398533.0±51100.2	25.2±0.37	35.6±0.55

Table 2: Mean±SD population sizes of lizards and ants km^{-2} and the means of air and substrate temperatures (°C) recorded whilst monitoring the pitfall traps in 2003

Location	Mean population size of lizards km^{-2} (N = 2)	Mean No. of ants km^{-2}	Mean air temperature (°C)	Mean substrate temperature (°C)
		(N = 13)		
Control	6396±235.5	34215±1932.3	21.4±0.82	28.37±1.50
Clear	5080±402.7	144184±5813.8	22.8±0.79	29.20±1.18
Soot	2811±253.6	33413±1482.2	22.8±0.96	29.20±0.81
Tar mat	3599±318.5	230153±3829.5	20.7±1.18	26.70±1.62

sites showed the lowest numbers of lizards, followed by the clear sites. The mean number of ants km^{-2} also varied between the sites. The highest numbers of ants were at the tar mat sites and the lowest numbers were at the control sites. The mean air temperatures recorded during monitoring of pitfall traps showed very close values between the different sites. The same results were obtained for the means of substrate temperatures recorded during monitoring the pitfall traps (Table 1).

The Jolly-Seber method was further applied to the existing data set of pitfall trap in 2002. One-way ANOVA showed no significant difference in lizard population size between the study sites ($F_{3,4}$ = 1.32) by using the pitfall method in 2002.

One-way ANOVA showed no significant difference in lizards population size between the study sites ($F_{3,4}$ = 0.63) by using the pitfall method in 2003 (Schnabel method). No significant variance was found in ant population size between the study sites ($F_{3,4}$ = 2.70). Air ($F_{3,4}$ = 2.54) and substrate ($F_{3,4}$ = 1.56) temperatures did not show a significant difference between the sites.

The data in Table 2 for the pitfall trap method in 2003 showed that the control sites had very high numbers of lizards, followed by the clear sites. The soot sites had the fewest lizards compared to the other study sites with the tar mat sites having slightly more lizards. The ant population size was highest at the tar mat sites and lowest at the soot sites. The mean air and substrate temperatures recorded during monitoring of pitfall traps showed very similar values at the different study sites (Table 2).

One-way ANOVA showed no significant difference in lizard population size between the different study sites ($F_{3,4}$ = 0.54) by using the pitfall method in 2003 (Jolly-Seber method).

Two-way ANOVA test was used to contrast the measures obtained with the pitfall trap method in 2002 and 2003 (Schnabel method). No significant difference was observed between years ($F_{1,15}$ = 0.01), or sites ($F_{3,15}$ = 0.88), or the interaction between year and site ($F_{3,15}$ = 0.82) in lizard population sizes. Ant population sizes revealed no significant difference between years ($F_{1,15}$ = 1.15), but a significant difference was observed between sites ($F_{3,15}$ = 8.87, $p<0.01$) and the interaction between year and site showed no significant difference ($F_{3,15}$ = 0.82). The air temperature showed a significant difference between years ($F_{1,15}$= 37.61, $p<0.0001$), but no significant difference was observed between sites ($F_{3,15}$ = 3.39) and the interaction between year and site was not significant ($F_{3,15}$ = 2.43). The substrate temperature revealed a significant difference between years ($F_{1,15}$ = 92.05, $p<0.0001$), but no significant difference was observed between sites ($F_{3,15}$ = 1.9) and the interaction between year and site showed no significant difference ($F_{3,15}$ = 3.25).

Two-way ANOVA test was used to contrast the measures obtained with the pitfall trap method in 2002 and 2003 (Jolly-Seber method). No significant difference was observed between years ($F_{1,15}$ = 0.034), or sites ($F_{3,15}$ = 1.03), or the interaction between year and site ($F_{3,15}$ = 0.383) in lizard population sizes.

DISCUSSION

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.

Population monitoring by drift-fence and pitfall traps are the most common methods of assessing lizard numbers. Predation within the traps was a potential problem. The Sand viper (*Cerastes cerastes*) was found eating small lizards three times during the field work. This indicates that this type of predator can easily enter the traps, eat the contained prey and then often exit without leaving a trace of their victims. Since, it is likely that traps are attacked deliberately, one cannot readily remove the bias they create. For this reason, a pitfall trapping protocol involving checking traps less than once per day is likely to produce unacceptable errors in this type of monitoring of live animals. Even with daily trap-checking (as in this present study), there will be some undetected mortality in the traps.

The pitfall traps of the present study were 30 cm deep, which was reasonably safe for quantitative monitoring of sand lizards and arthropods of a variety of sizes. Mark-recapture results revealed that the number of lizards at the tar mat sites was almost half of that at the control sites. The presumably most polluted sites (the tar mat and soot locations) were actually highly vegetated. Since 12 years the oil spill, the desert habitats appeared dominated by a variety of small shrubs and grasses which encouraged arthropod abundance in some of the study sites. Having a mat of tar at particular sites essentially provided cover that preserved moisture and organic matter in the underlying soil. These conditions will encourage desert plant seeds to germinate, producing local concentrations of desert plants even if the weather is generally dry. This, in turn, generates a very high local density of invertebrates including ants in these presumably highly polluted sites.

Both the Schnabel (designed for closed populations) and Jolly-Seber (designed for open populations) methods were applied to the existing data. The two methods generated similar results at 2002 and 2003 by using the pitfall trap method suggesting that the population estimates were correct for both years. Although, the applied methods were designed for different kinds of populations, the statistical analyses were similar indicating that the Schnabel method showed good results. These results were supported with Jolly-Seber method which gives more biologically realistic situation of open populations. Most populations are constantly changing in size because of births, deaths, immigration and emigration.

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.

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.

REFERENCES

Al-Hashem, M., P.F. Brain and S. Omar, 2007. Effects of oil pollution at Kuwait's Greater Al-Burgan Oil Field on polycyclic aromatic hydrocarbon concentrations in the tissues of the desert lizard *Acanthodactylus scutellatus* and their ant prey. Ecotoxicology, 16: 551-555.

Al-Hashem, M.A., P.F. Brain and S.A. Omar, 2008. Effects of oil pollution at Kuwait`s greater Al-Burgan oil field on the timing of morning emergence, basking and foraging behaviors by the sand lizard *Acanthodactylus scutellatus*. Pak. J. Biol. Sci., 11: 589-594.

Al-Hashem, M. and P. Brain, 2009. Effects of oil pollution on body size and weight of the sand lizard *Acanthodactylus scutellatus* at the greater Al-Burgan oil field in Kuwait. Res. J. Environ. Toxicol., 3: 56-59.

Al-Hassan, J.M., 1992. Iraqi Invasion of Kuwait: An Environmental Catastrophe. Fahad Al-Marzouk Publishers, Kuwait.

Clark, R.B., 1984. Impact of oil pollution on seabirds. Environ. Pollut., 33: 1-22.

Dunnet, G.M., 1982. Oil pollution and seabird populations. Phil. Trans. Roy. Soc. Lond. B, 297: 413-427.

Krebs, CH.J., 1999. Ecological Methodology. Addison-Wesley Educatinal Publishers, Longman, Inc., California, CA.

Lambert, M.R.K., 1993. Effects of DDT ground-spraying against tsetse flies on lizards in NW Zimbabwe. Environ. Pollut., 82: 231-237.

Laurie, W.A. and D. Brown, 1990. Population biology of marine iguanas (*Amblyrhynchus cristatus*). 3. Factors affecting survival. J. Anim. Ecol., 59: 545-568.

Luiselli, L., G.C. Akani, E. Politano, E. Odegbune and O. Bello, 2004. Dietary shifts of sympatric freshwater turtles in pristine and oil-polluted habitats of the Niger Delta, Southern Nigeria. Herpitol. J., 14: 57-64.

Moriarty, F. and C.H. Walker, 1987. Bioaccumulation in food chains-a rational approach. Ecotoxicol. Environ. Safety, 13: 208-215.

Omar, S.A., Y. Al-Mutawa and S. Zaman, 2000. Vegetation of Kuwait: A Comprehensive Illustrative Guide to the Flora and Ecology of the Desert of Kuwait. Kuwait Institute for Scientific Research, Kuwait.

Romero, L.M. and M. Wikelski, 2002. Severe effects of low-level oil contamination on wildlife predicted by the corticosterone-stress response: Preliminary data and a research agenda. Spill Sci. Technol. Bullet., 7: 309-313.

Sias, D.S. and H.L. Snell, 1998. The sand dune lizard *Sceloporus arenicolus* and oil and gas in Southwestern New Mexico. Final Report of Field Studies 1995-1997. Department of Biology, University of New Mexico. Submitted to Endangered Species Program, New Mexico Department of Game and Fish.

Wikelski, M., V. Wong, B. Chevalier, N. Rattenborg and H.L. Snell, 2002. Galapagos islands: Marine iguanas die from trace oil pollution. Nature, 417: 607-608.