Research Journal of

Environmental Toxicology

ISSN 1819-3420

Academic
Journals Inc.

www.academicjournals.com

Research Journal of Enviroumental Toxicology 3 (1): 56-59, 2009
ISSN 1819-3420

Effects of Oil Pollution on Body Size and Weight of the Sand Lizard *Acanthodactylus scutellatus* at the Greater Al-Burgan Oil Field in Kuwait

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Abstract: This study investigated the impact of oil pollution on morphological measurements in adult male and female sand lizards captured in locations with apparently different pollution levels. The results of this study confirmed that there is sexual dimorphism in body size, with males being generally larger than females at all the study sites. Adult male (but not female) lizards were generally bigger at the Tar mat and soot than the clear and control sites. The increase in body size and weight suggests that there is a greater availability of food for these somewhat territorial reptiles in both the Tar mat and soot sites. An alternative explanation is that the food resource is affected by oil pollution such that lizards consuming prey with high levels of fat accumulate more adipose tissue in their bodies.

Key words: Morphology, snout vent length, oil spill, terrestrial ecosystems, reptiles, deserts

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 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. Just as the oil fires were a source of pollution to land, sea and air, the oil lakes became a source of pollution *per se*. The formation of the lakes resulted from discharge of oil from damaged wells that acted as gushers and burning wells, whose discharge rate was greater than could be consumed by the flame (such that oil spray finally landed back on the ground). The oil subsequently collected on the ground and ran into streams, following slopes and contours of desert topography. Soon there were running streams followed by the formation of lakes (Al-Hassan, 1992).

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 only rarely been used as bioindicators of pollution for a variety of reasons, including difficulty in sampling sufficient numbers and their relative lack of economic importance (Loumbourdis, 1997). But, since invertebrates are the prey of most lizards, chemical contaminants ingested by invertebrates seem likely to be concentrated in the bodies of lizards in desert locations. These chemicals could also be taken in by the incidental ingestion of soil (small stones are often found in the digestive tracts of the lizards and are used to break up gut contents, as in bird gizzards). Lizards have consequently recently been seen as potential bioindicators of pesticides entering dry enviroments (Lambert, 1993).

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The Sand lizard (*Acanthodactylus scutellatus*) was chosen for this study because it has a wide distribution in this area. This species is a typical medium-sized lacertid with a cylindrical body with a reticulate pattern and with well-developed limbs (Leviton, 1992; Salvador, 1982). The tail is long and the head is wide, with an elongated pointed snout. A fringe of scales on the trailing edge of each (especially the 4th) toe, facilitates locomotion on loose sand and gives these animals their common name of fringe-toed lizards. This species is insectivorous, feeding maiuly on ants, flies, small beetles and insect larvae (Perry and Dmi'el, 1994).

The Greater Al-Burgan oil field has an area of 349.65 km^2 and lies 20 km to the south of Kuwait City. The land is solely used for oil and gas production and is fenced to prevent unauthorized entry. Types of contaminated soils were categorized as Tar mat, soot and clear on the basis of ground observations. The Tar mat areas had a soil surface that had been solidified by oil, forming a layer about 1 cm thick that could be peeled off the underlying clean soil. The soot areas were found as blackened layers within the upper layer of soil that could be a 1-8 mm in depth. Contamination was sometimes continuous and at other times discontinuous. The clear sites were within the same general area but had no visual evidence of soil pollution. Two sites for each category of contaminated soils were located. A control area (Sulaibiya) was located at the Agriculture Research Station at Kabd (established 1975). The research station covers a total area of 20 km^2, being 4 km (east to west)×5 km (north to south). Sulaibiya station is also fenced and permission is required to enter the site.

MATERIALS AND METHODS

The study was conducted in the field between 2002 and 2003 as part of a capture/recapture investigation. Ten adult males and 10 adult females were used from each site to measure body size and weight. Snout-Vent Length (SVL) and Vent-Tail Length (VTL) of all lizards captured during this study were carefully measured to the second decimal place in cm by placing the animals on their backs alongside a metal ruler. Body Weights (BW) to the second decimal place of g were determined by weighing the lizards in a plastic bag (of known weight) using Pesola spring balance (Parco-No. 142259, Pesola AG, Baar, Switzerland).

RESULTS

The VTL measure was found to add little, so the results are not reported here. Mean lizard SVL and BW for animals captured at the different study sites are shown in Table 1, 2.

Initial comparisons of SVLs and BWs were carried out between male and female lizards to see if there was any evidence of sexual dimorphism. The ANOVA test on male and female SVLs at all sites showed a very significant difference ($F_{1, 78}$ = 73.38, p<0.0001) with males being larger than females. A similar result was obtained between the male and female BWs at all study sites ($F_{1, 78}$ = 49.48, p<0.0001) with males being heavier than females. The ANOVA test also confirmed that males had longer SVLs than females at control ($F_{1, 18}$ = 12.23, p<0.003), clear ($F_{1, 18}$ = 37.12, p<0.0001), soot ($F_{1, 18}$ = 36.50, p<0.0001) and Tar mat ($F_{1, 18}$ = 18.29, p<0.0001) sites. The ANOVA test also

Table 1: Mean±SD of SVL (cm) of male and female *A. scutellatus* at the different study sites

Location (N = 10)	Sex	Mean±SD
Control	Male	55.70±0.67
	Female	52.70±2.62
Clear	Male	58.30±1.16
	Female	53.00±2.49
Soot	Male	59.50±2.55
	Female	53.80±1.54
Tar mat	Male	60.40±3.83
	Female	54.10±2.64

Table 2: Mean±SD of BW (g) of male and female *A. scutellatus* at the different study sites

Location (N = 10)	Sex	Mean±SD
Control	Male	4.74±0.25
	Female	4.23±0.48
Clear	Male	5.32±0.42
	Female	4.36±0.62
Soot	Male	5.78±0.84
	Female	4.34±0.41
Tar mat	Male	6.09±1.19
	Female	4.47±0.34

confirmed that males had greater Bws than females at control ($F_{1, 18} = 8.95$, $p<0.008$), clear ($F_{1, 18} = 15.75$, $p<0.001$), soot ($F_{1, 18} = 23.54$, $p<0.0001$) and Tar mat ($F_{1, 18} = 17.01$, $p<0.001$) sites.

The one-way ANOVA test showed significant variance between the study sites in the adult male lizard's SVL ($F_{3, 36} = 7.23$, $p<0.001$). This variation with respect to location was further analyzed using *post hoc* Scheffe' tests. The SVLs of male lizards at the control sites were shorter than subjects taken at the soot sites ($p<0.01$) and the Tar mat sites ($p<0.001$) but did not differ from counterparts collected at the clear sites ($p = 0.13$). No significant differences were observed in SVLs between the clear and soot sites, the clear and Tar mat sites, or the soot and Tar mat sites. The means of female SVL did not differ between the study sites ($F_{3, 36} = 0.77$, $p = 0.51$).

The ANOVA test showed a significant difference in the male lizard body weight between the different sites ($F_{3, 36} = 5.81$, $p<0.002$). Post hoc Scheffe' tests showed no significant difference between the male body BW at the control and the clear sites but the BW was lower in subjects from the control than these from the soot ($p<0.04$) or the Tar mat ($p<0.005$) sites. Mean BWs were greatest in male lizards caught at Tar mat sites and least in counterparts caught at the control sites. No significant difference was observed in the BW of adult female lizards between the study sites ($F_{3, 36} = 0.42$, $p = 0.73$).

DISCUSSION

The results of this study show that there is sexual dimorphism in body size with males being generally larger than females at all the study sites. Such sexual dimorphism is quite common in the animal kingdom (Krebs and Davis, 1993) and often seems related to the breading systems adapted by the species. In many animals the males have to fight for females or for access to sites where they are located. A larger body size gives them a competitive advantage in encounters with male conspecifics. Males of *A. scutellatus* appeared to be quite territorial being generally found in the same location by (Perry and D'miel, 1994).

The adult male lizards were bigger at the Tar mat and soot sites than the clear and control sites. This seemed counter-intuitive as it was thought that presumably severe oil pollution would decrease body size. Al-Hashem *et al*. (2007) showed, however, that the levels of measured HC pollutants in the tissues of these lizards and their ant prey were similar in all 3 categories from the polluted areas (but all elevated with respect to the control sites). The darkened Tar mat and soot areas, by increasing solar gain, appeared, however, to facilitate early morning emergence, basking and effective foraging behaviour of the sand lizards (Al-Hashem *et al*., 2008). Consequently, one obvious explanation for the present results is the greater availability of food for the territorial males in both the Tar mat and soot sites that would cause them to grow quickly. Such areas might even be preferred as larger males have a competitive sexual advantage. The females, being more prone to range widely, may not spend much time in the darkened areas. One cannot, however, rule out the alternative explanation that, at the Tar mat and soot sites, the food resource is directly affected by oil pollution such that lizards consuming prey with high levels of accumulated fat will store such material in adipose tissues in their bodies, especially the liver and tail (op. cit.).

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