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Feeding Behaviour and Food Selection of Dhab *Uromastyx microlepis* From Wild Vegetation

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سلوك الغذائية وانتقاء الغذاء من النباتات البرية للضب

منصور عطية الحازمي

تمت دراسة سلوك الغذائية وانتقاء الغذاء للضب *Uromastyx microlepis* في براري القصيم لمدة عام كامل. والتي تعد من المناطق الحارة القاحلة تحت الظروف الطبيعية، حيث تركت الضباب تتجول لانتقاء غذائها من النباتات البرية، وتم تسجيل ٥٤ نوع من النباتات تنتمي إلى ٢٤ عائلة وتبين أنه يوجد ٣٧ نبات تفضله الضباب في الأكل، تختلف من موسم إلى أخر، والضباب نباتية التغذية، تفضل الجزء الخضري من النبات مثل الأوراق والزهور والبراعم والثمار للشجيرات المنتشرة في منطقة الدراسة، دلت محتويات المعدة على وجود حشرات وبعض الحصى الصغير أحياناً، كما دلت الدراسة على وجود فرق معنوي في وزن الجسم خلال فترة العام، حيث سجلت أكبر الأوزان في شهر يونيو وأقلها في شهر فبراير.

Key Words: feeding behaviour; food selection; wild vegetation; *Uromastyx microlepis*

ABSTRACT

The present study deals with the food selection and feeding behaviour of *Uromastyx microlepis* 'dhab' spiny tailed lizard during a period of one complete year inhabiting AL-Gassim desert area. Climatically the area can be classified as a hyper arid region. The behaviours of Dhab were studied under natural conditions, when left to roam freely and chose its food from wild vegetation. 54 plants species, belonging to 24 families were recorded, among which 37 plants species were recognized as preferred host plants for *U. microlepis*. Palatability of the vegetation may vary with the seasons. Dhab is a herbivorous animal preferring tender leaves, shoots, flowers, buds and fruits of shrubs widely spread in the area. Stomach contents revealed that Dhab may also take insects and stones (gravel) at times. There were significant differences in lizard body weight over the year. The maximum body weighs were recorded in the months of June and February respectively.

INTRODUCTION

Food and feeding behaviour have been studied in many species of lizards (Loumbourdis & Hailey, 1991; Al-Anzy, 1996; Zari, 1998), Birds (Nagy, 1987) and Ungulate (AL-Hazmi, 1999). Food selection in reptiles is most commonly determined by indirect methods, but it has been measured directly in several studies (Kevork & Al-Uthman, 1972, Loumbourdis & Hailey, 1991; AL-Anzy, 1996; Zari, 1998). Various factors modify the food and feeding behaviour of lizards such time of day, season, rainfall, food availability and quantity (Proseer & DeVillez, 1991; AL-Anzy, 1996; Zari, 1998).

The herbivorous desert lizard *Uromastyx microlepis* inhabits the middle and northern east regions ofSaudi Arabia (Al-Ogily & Hassain, 1983; Arnold, 1986; Al-Anzy, 1996). Until recently there was no published information on food and feeding habits of this species which is widely prevalent in Al-Gassim deserts of Saudi Arabia. In order to assess the herbivory of this oviparous lizard in hyper desert region and to verify any distinct responses to food availability and quantity based on feeding behaviour and food selection, a study was made under different environments of *U. microlepis*.

MATERIALS AND METHODS

Study area and animals

The study area covers a desert triangulation of 49 sq. km (25° 9' 42V 52' E), lying SW of AL-Rass province (120 km) in AL-Gassim region. The soil is relatively deep, consisting of alternate layers of alluvium with different textures. Almost continuous granite ridges as well as gravel, bordering the area and on the north is surrounded by three mountains. The plains are covered with compact sand, rich in gypseous contents and with marl, and the gravelly topsoil appearing as extensive monotonous plans with relatively sparse vegetation. The dry depressiosn and shallow wadis extended further north of this area, while sand-dunes are restricted to a few pociets and enclaves, such as a small area about 8 km north and south of the study area.

Climatically the area canbe classified as a hyper arid region. The climate is distinguished by three seasons autumn, winter and spring with a main growing season extending from January to May. Rainfall is mostly between late October and March and normally low amounts not exceeding 35.5 mm. The overall annual rainfall generally varies from 0.0 to 117.1 mm, with a minimum January temperature about 12°C. The dominant climatic factor in such arid regions is characterized be a limited humid period, which occurred during ten years (1989-1998) based on data recorded by AL-Gassim Meterological station, Lat. 26 18, Alt 646.71 meters above see level (Fig (1).

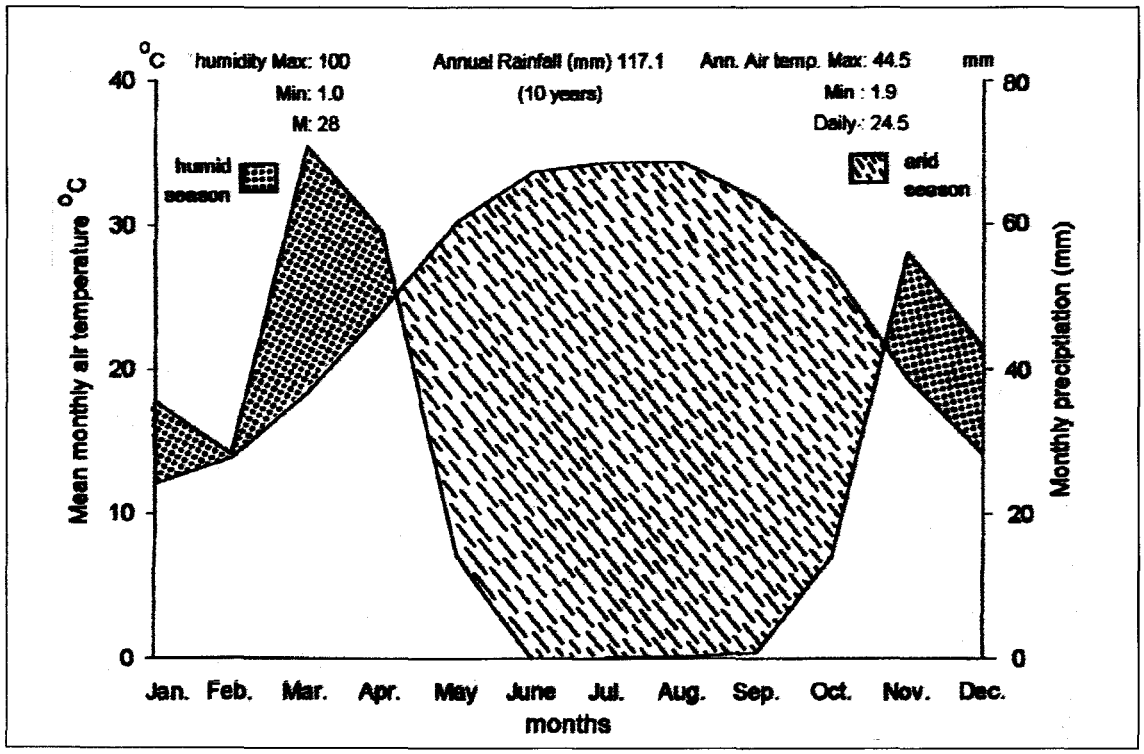

Fig. 1: Climatic diagram of AL-Gassim Region according to the method of water (1973) (Data collected from AL-Gassim Meterological station, lat. 26° 18 , Alt 646.71 m.a.s.l.) Saudi Arabia from 1989 to 1998

The presence of a relatively large sand expanse to the north of the study area has a great effect on summer temperatures, with low relative humidity, which is greatly affected by constant wind blowing from N-NE directions. Therefore, themean mid-day temperature in summer is around 48°C, while it may reach as high as 49.5°C in mid-summer, with a comparable rise in surface sand temperature of about 58-65°C, a prime factor determining most diurnal animal activity in most deserts. The average daytime temperature in summear (May to early February) usually varies between 30 to 38°C, and diurnal animals choose this optimum range for their best activity.

Both sexes of Dhab (N=100) were carefully observed during the study of feeding behaviour and food selection for one year. Male and female animals (N=40) were weighed montly during the whole year. They were kept within living premises of the study area in-groups of mixed sexes and each animal was tagged by given a special number and mark for quick easy recognition.

Behavioural tests

The animalswere sstudied in groups of 20 males and 20 females. Data were collected twice daily (early morning and late afternoon), during which time the test animals roam freely choosing their food from wild vegetation.

Plant Cover

A collection of the plant species existing the study area was made throughout a period of twelve months. Feeding records were obtained by carefully inspecting the area in which individual lizards had recently been grazing. All plants and plant parts that has been fed upon were recorded. Some food records were also obtained from direct observations with the aid of wetzlr 40 x 60-dialyte scope. These records were however verified later by a visual closer inspection. Plant samples from the available vegetation cover within the study area were collected and identified according to Migahid (1978); Collenette (1985) and Miller & Cope (1996).

Statistical analysis of stomach contents were carried out by using oneway analysis of variance (ANOVA) with repeated measurements. The *t*-test was conducted to determine the difference between seasons (Howell, 1982). The collected data of body weight were analyzed using a two way difference between months in body weight (Howell, 1982).

Plant cover estimating

The vegetation of the study area exhibits an appreciable variety of plant species some of them are present all over the year (perennilas) and others are present only during the rainy season, recorded as annuals. According to methods used by Kevork & Al-Uthman (1972) and AL-Hazmi (1999), the recorded plant species based on visional damage were categorized into two classes: eaten and not eaten. The eaten species are further categorized (each category designated a given number) into three classes: preferred (1), occasionally (2) and rarely(3).

The study was conducted for a period of twelve months. Feeding records were obtained by carefully inspecting an area in which an individual Dhab had recently been grazing by using AL-Hazmi method (1999). All plants and plant parts that had been fed upon were recorded. Some feeding records were also obtained from direct observations with the aid of a Wetzlzr 40 x 60-dialyte scope. These records were however verified later by closer inspection. Plant samples from the available vegetation cover within the study area were collected and identified according to Migahid (1978), Collenette (1985) and Miller and Cope (1996).

RESULTS

Plant cover

Fifty four plant species were recorded in the study area (Table 1) belonging to 24 families. Thirty seven eaten plant species were recorded as food plants for Dhabs to which they showed a continuum of food preferences. The most important plants in terms of biomass consumed, and preference ratings were ephemeral species, which are plentiful during the wet season. The value of the utilized plant species is given in Table 1.

Table (1)

Food preference of the diffeent plant species recorded in the study area.

Family	Species	Growth from	Eaten category ♦	Parts eaten
ACANTHACEAE	Blepharis ciliaris (L) B. L. Burtt *	Perennial	1	Buds & Leaves
AIZOACEAE	Aizoon canariense L. *	Annual	1	shoots
	Aizoon hispanicum L. *	Annual	1	shoots
APOCYNACEAE	Rhazya stricta Decne.	Perennial	-	-
BORAGINACEAE	Moltokiopsis ciliata (Forssk.) I. M. ohnst. *	Perennial	1	Leaves, flowers & fruits
CARYOPHYLLACEAE	Gypsophila sp.	Annual	-	-
	Paronychia arabica (L.) DC.	Annual	-	-
CISTACEAE	Halianthemum salicifolium (L.) Miller	Annual	3	Leaves
	Anabais setifera Moq.	Perennial	-	-
	Haloxyon salicornicum (Moq.) Boiss.	Perennial	-	-
CHENOPODIACEAE	Salicornia europaea L.	Annual	-	-
	Salsola kali L.	Annual	-	-
CLEOMAEAE	Cleome arabica L.	Annual	3	Flowers & buds
	Anthemis deserti (Boiss.) Eig. *	Annual	1	Leaves
	Anvillea garcini (Burm.) DC.	Annual	1	Leaves
	Artemisia sp.	Perennial	2	Leaves
COMPOSITAE	Centaurea sp.	Annual	-	
	Launaea arabica Boiss. *	Perennial	3	Flowers & leaves
	Launaea capitata (Spreng.) Dandy	Perennial	3	Flowers & leaves
	Convolvulus lanatus Vahl *	Perennial	2	Buds, tender
CONVOLVULACEAE	Convolvulus oxyphyllus Boiss	Perennial	1	leaves Buds, tender leaves
CRUCIFERAE	Anastatica hierochuntica L.	Annual	3	Flower & Leaves
	Sisymbrium irio L.	Annual	1	shoots
CUCURBITACEAE	Citrullus colocynthis (L.) Schrad *	Annual	3	Few seeds
EPHEDRACEAE	Ephedra alata Decne.	Perennial	3	Buds
EUPHORBIACEAE	Chrozophora tinctoria (L.) Raf.	Annual	-	-
	Aeluropus lagopoides (L). Trim Ex Thwaites	Perennial	1	Shoots & spikes
	Aristida pennie Chiov.	Perennial	2	Shoots & spikes
	Cutandia sp.	Annual	-	-
	Panicum turgidum Forssk.	Perennial	1	Shoots & spikes
GRAMINEAE	Schismus arabicus Nees	Annual	-	-
	Stipa capensis Thunb.	Annual	-	-
	Stipagrostis obtusa (Delile) Nees	Perennial	1	Shoots & spikes
	Stipagrostis plumosa (L.)	Perennial	1	Shoots & spikes
	Munro ex T. Anderson			
LIBIATAE	Teucrium oliverianum Ging. Ex Benth.	Annual	1	Flowers & leaves
	Alhagi graecorum Boiss.	Perennial	1	Flowers & buds
LEGUMINOSAE	Astragalus vogelii (webb) Bronum.	Perennial	2	Tender leaves & pods
	Astragalus spinosus (Forssk.) Musch.	Perennial	3	Leaves
	Cassia senna L.	Perennial	-	-

Family	Species	Growth from	Eaten category ♦	Parts eaten
NEURADACEAE	Neurada procumbens L. *	Annual	1	Shoots & Fruits
NITRARIACEAE	Nitraria retusa (Forssk.) Asch.	Perennial	-	-
OROBANCHACEAE	Orobanche aegyptiaca Pers.	Annual	2	Shoots
	Cistanche phelypaea(L.) Cout. *	Annual	-	Shoots
POLYGONACEAE	Polygonium aviculare L.	Annual	-	-
SCROPHULARIACEAE	Scrophularia hypericifolia Wydler	Perennial	2	Shoots, buds & fruits
SOLANACEAE	Lycium shawii Roem. X Schult. *	Perennial	2	Shoots, buds & flowers
	Fagonia bruguieri DC.	Perennial	2	Shoots, buds & fruits
	Fagonia glutinosa Delile	Perennial	1	Shoots, buds,
ZYGOPHYLLACEAE				flowers & fruits
	Peganum harmala L.	Perennial	-	-
	Tribulus macropterus Boiss.	Annual	-	-
	Zygophyllum coccineum L.	Perennial	3	Shoots, buds & fruits

♦ preferred (1), occasionally (2), rarely (3) and non-eaten (-). * more abudant.

Further, it should be pointed out that; relative abundance of a certain plant species does not necessarily make it one of the main sources of the lizard's diet. Plant species which are preceeding by an astrix (*) in Table 2 was found more abundant in the study area including *Aizoon canariense - Aizoon hispanicum - Anthemis deserti - Blepharis ciliaris - Cistanche phelypaea - Citrullus colocynthis - Convolvulus tanatus - Launaea arabica - Lycium shawii - Moltokiopsis ciliata - Neurada procumbens*. The most important plants in terms of biomass consumed, and preference rating were ephermal species, which are plentiful during the wet season. Relative numbers of food preference of the different plant species recorded in the study area was given in Table (2). Among the recorded species 29.41% are non-eaten plants. However, 70.59% eaten plant species were recognized: preferred (31.37%), occasionally (19.60%) and rarely (19.60).

Table 2

Relative numbers of food preference of the different plant species recorded in the study area.

Species	Preferred	Occasionally	Rarely	Not-eaten
Actual numbers	16	10	10	15
Relative numbers	31.37%	19.60%	19.60%	29.41%

However, from direct observation of perennials plant general like *Artemisia, Convolvulus, Fagonia* and *Moltokiopsis* were found to be the most approached and eaten plants, due to their dominant abundance in the area even late in the season, but less preferred whenothers were readily available. Fragments of stomach contents of captuered lizards revealed a number of these plants (Table 3). Altogether, forty lizards (both sexes) were collected each season for re-examination.

Table 3

Relative food in the digestive tract of *U. microlepis* (mean) weight during the feeding

Length of lizard (including tail) (cm) (N=160)	Mean weight of whole digestive tract (g)	Mean whole Weight of whole stomach and its contents (g)	Mean weight of stomach (g)	Mean net weight of stomach contents (g)
42-49	189.g	125.5	10.5	115.0
Percentage from whole digestive tract weight (189.8)		66.12%	5.53%	60.64%

Feeding behaviour

The mean and standard error of the stomach contents (both sexes) of Dhabs are given in Table 3 & 4. From our studies of stomach contents, supplemented by field observations, *U. microlepis* was found to be a purd herbivorous reptile throughout the year, while they were at times showed to be insectivorous based on the presenceof the remains of insects in the gut, but these were insignificant as they formed only about 4.0-4.5 percent of the lizard's overall food intake. The stomach contents over the test seasons were assessed statistically using one-way analysis of variance with repeated measurements. The analysis of variance test between seasons, showed a high variation between seasons in stomach contents, including seeds (seasons $F=33.9$, $p<0.001$), Leaves (seasons $F=28.6$, $p<0.001$) and stone (gravel) (seasons $F=27.6$, $p<0.001$). There were no significant differences in the remains of insect within the lizard gut, which might reflect a low level of carnivory. On the other hand, seeds weight (stomach content) in spring was higher than summer ($t=4.8$, $P<0.001$) and autumn ($t=7.9$, $P<0.001$) according to t-test. Leaves weight in autumn was higher than spring ($t=6.8$, $P<0.001$) and summer ($t=9.0$, $P<0.001$). In addition, stones weight in spring was higher than summer ($t=5.5$, $P<0.001$) and autumn ($t=11.3$, $P<0.001$), which may be attributed to higher levels of seeds feeding during spring season. During winter season it showed no significant differences, whichmay be due to the lizards been in their underground burrows with minimal activity during their dormancy and or (aestivation). Two way analysis of variance was conducted to determine whether there are any differences betweenmales and females body weight over the year. There were no significant differences obtained between bothmales and females. But there was a significant difference between months of the year ($F=4.76$ $P<0.001$) (Fig.2). However, the lizards increased their body weight during May than during February (t-3.58, $P<0.001$), March ($t=2.87$, $P<0.01$), April ($t=1.85$, $P<0.05$), July ($t=2.53$, $P<0.01$), August ($t=2.94$, $P<0.01$), October ($t=2.9$, $P<0.01$), September ($t=3.6$, $P<0.001$) and November ($t=3.64$, $P<0.0010$, according to t-test. In addition to that, the lizards get maximum body weights in June when compared to February ($t=2.86$, $P<0.01$), March ($t=1.97$, $P<0.01$), April ($t=1.76$, $P<0.05$), July ($t=2.01$, $P<0.05$), August ($t=2.11$, $P<0.025$) September ($t=2.45$, $p<0.001$) and October ($t=2.43$, $P<0.01$). This may be due to longer photophase and suitable temperature for feeding. The lowest temperature in early morning and in the afternoon during May and June were 22°C, 43,4°C respectively.

Table 4

Relative food in the digestive tract of U. microlepis (mean with S.E.) weight and percentage during the year. N=40 from both sexes in each season

Stomach contents		Seasons			
		Spring	Summer	Autumn	Winter
Seeds	M	4.80	42.30 g	11.00 g	0.00 g
	±	±	±	±	±
	S.E.	2.84	2.40	1.2	0.00
	Percentage	8.26%	72.81%	18.93%	0%
Leaves	M	65.40g	62.30 g	9.80 g	0.00 g
	±	±	±	±	±
	S.E.	4.14	2.90	2.70	0.00
	Percentage	47.56%	45.31%	7.12	0.00%
Insects	M	1.80 g	1.20 g	2.00 g	0.00 g
	±	±	±	±	±
	S.E.	0.42	0.36	0.53	0.00
	Percentage	36%	24%	40%	0.00%
Stone (gravel)	M	2.30 g	1.10 g	0.80 g	0.00 g
	±	±	±	±	±
	S.E.	0.20	0.18	0.00	0.00
	Percentage	54.76%	26.19%	19.04%	0.00%

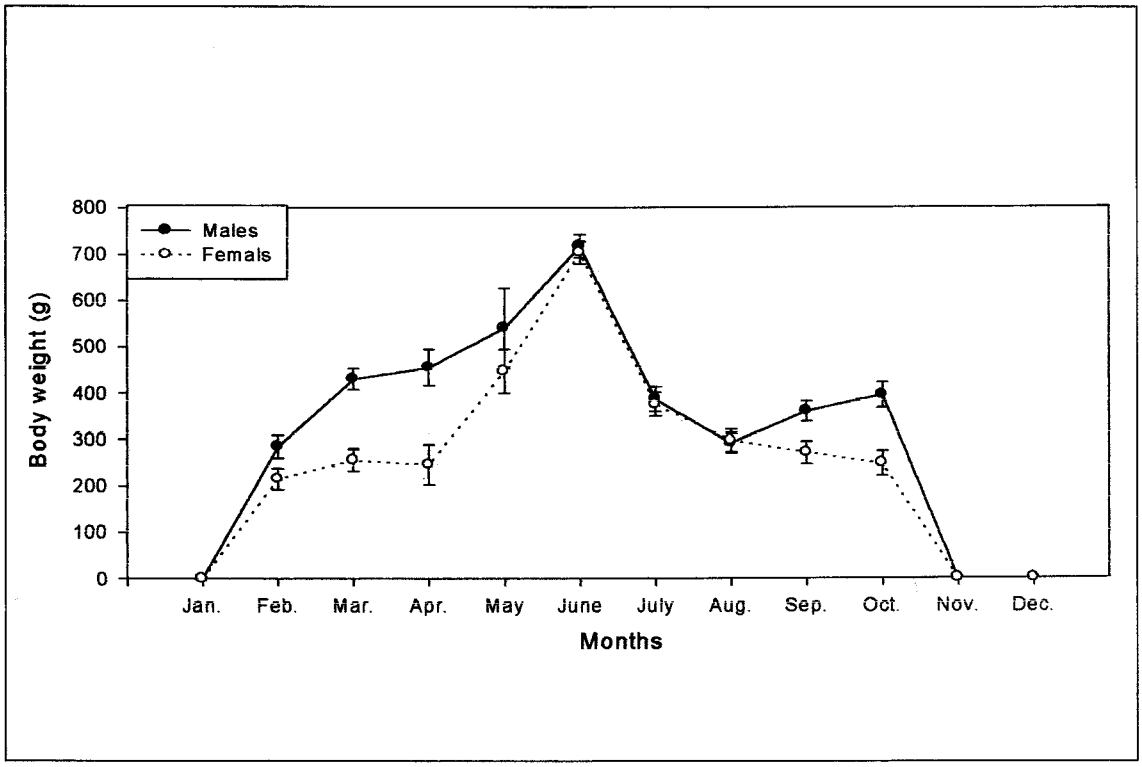

Figure 2: Monthly changes in Dhab s body weight during the year. Each point on the graph represents the mean of body weight of 50 Dhabs from each sex. Bars on the top and bottom of each point on the graph represent standard errors of the body temperature of 50 Dhabs from each sex.

DISCUSSION

The feeding behaviour of U. microlepis was found to have a daily as well as a seasonal cycle. The latter covers a period between late February and late November. Winter season is passed underground with minimal activity. Lizards in deserts may not be able to feed during winter as a result of temperature limitations on their activity or the activity of their prey and food availability (Kevork & Al-Uthman, 1972; George, 1986; AL-Anzy, 1996). The feeding tempo gradually declines as the annual and especially perennial plants become over-grazed by other animals (camels goats and sheep) in the area (Kevork & Al-Uthman, 1972). Meanwhile, *U. microlepis* feeds within a home burrow range governed by relative abundance of food including grasses or herbs closest to their burrows. *U. microlepis* was observed to be very selective, it usually starts to nibble showing neither signs of hurry nor voracious feeding – except when disturbed. It chooses mostly flowers, buds and tender leaves, which are normally considered preferred diets. It may, however, stop for a short time, eyeing around motionless and recommencing to feed again or to move to another food plant. When not feeding or wandering, U. microlepis usually remains close to the vicinity of its burrow. The feeding is comparably much less in the afternoon than during morning period during summer. *U. microlepis* takes to its burrows and goes into seclusion or retreat in later autumn when the average air temperature drops below 22°C and emerges in the beginning of spring when the air temperature begins to exceed 25°C threshold. In their adaptation to hyper arid condition, the majority of desert animals, and especially lizards have come to reduce to a minimum both their water intakes as well as their water loss. This phenomenon is very pronounced in case of *U. micrlepis*, which was not observed nor reported to drink water (Kevork & Al-Uthman, 1972). Hence, most of the body's water seems to come from food, which contained appreciable moisture as well as from the process of metabolic oxidation (Schmidt-Nielsen, 1964 and Zari, 1998).

It is well known that the spiny-tailed lizard (*Uromastyx*) is essentially phytophagous in habit. Besides the fact that the nature of vegetation governs the kind and relative abundance of lizards in any region hence, the type of vegetation and terrain may be used as a clue to the distribution of certain animal species and communities, as is the case with the spiny-tailed lizard. Most studies attribute this phenomenon to the adult species of *Uromastyx* a strictly vegeterian diet (Kevork & Al-Uthman, 1972; Zari, 1998), though some adults and youngs in general may occasionally take insects as well. Mandaville (1965) listed eight plant species recovered from stomach of U. microlepis and added that the lizard may also take locusts at times. Krishna & Dave (1956) reported that, the herbivorous nature of *U. hardwickii* in India, preferring grasses and seeds, and rarely resorting to other types of food in nature. In this study as seen from (Table 1) thirty seven plant species found in the area are utilized to a greater or lesser extent by *Uromastyx microlepis* as food sources. Thus, in terms of vegetation, only the perennials and perhaps late annuals are the grave importance, while the rich ephermeral flora of mid-winter mean nothing to it. This result is in agreement with what was earlier reported by Kevork & Al-Uthman (1972). In addition to that, the abundance of some plant species in this study area does not not necessarily make it one of the main sources of the *U. microlepis* diet, since some adults and youngs in certain time may eat insects as mentioned earlier. Perennial plant species such as *Artemisia, Convolvulus, Fagonia* and *Moltokiopsis*, were found to be the most sought plants, based on their abundance in the area even late in the season though not less preferred when other plant species were readily available (Kevork & Al-Uthman, 1972; Al-Ogily and Hussain, 1983; AL-Anzi, 1996). The distribution of the various plant speciesand their composition show a clear dependence on geological substrate, land form, soil conditions, water supply as well as anthropozoogenic influences. The present studyindicates that, there is an obvious relationship between vegetation scattering and prevailing climatic conditions. However, *U. microlepis* body weight is increased in response to available quantity or quality of food plants. Dominant males have larger and more body weights when compared to other males. Thismay be due to longer territory home range governed by a relative abundance of food taking.

Analysis of the stomach contents demonstrated the selective preference and food intake of this lizard. The result obtained showed that U. microlepis is a pure vegetation reptile throughout the year, though some adults and youngs were at times found eating insects such as ants, carabids and mantis. Early studies by Kevork and Al-Uthman (1972) reported that, adult *U. aegyptius* was found to be a pure vegetarian, while the very young ones were at times found with remains of insects in their guts. This difference may bedue to the different desert regions. As for *U. lorictu* from Adhaim desert, the stomachs of

adult lizards revealed traces of insect remains too and proportionately more in case of juveniles (Kevork & Al-Uthman, 1972). In addition to that, and as reported by Kevork & Al-Uthman, (1972) leaves, seeds as well as tiny pebbles or gravel, half size of a wheat grain and occasionally larger were always present when stomach full with seeds, prohably due to the nature of terrain, although other reasons for their presence may be attributed to aiding digestion and help in grinding the seeds.

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