



Original Research

Ecological and biological studies on five-lined skink, *Trachylepis (= Mabuya) quinquetaeniata* inhabiting two different habitats in Egypt

Mohamed A. M. Kadry*, Hanan R. H. Mohamed, Mohamed Hosney

Zoology Department, Faculty of Science, Cairo University, Egypt

Correspondence to: ecokadry@yahoo.com

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Abstract: This study was carried out to study the diet type, genetic, morphometric and histological variations between two natural populations of *Trachylepis quinquetaeniata* inhabiting Abu-Rawash, Embaba, North Giza and Garfas-Senoures, El-Faiyum habitats. In this study, morphometric examination showed that *Trachylepis quinquetaeniata* is a typically ground-dwelling Skink and seems to be frequently associated with grass and below shrubs. Geographic variation in sexual size dimorphism (SSD) and head size dimorphism (HSD) with greater dimensions in Garfas-Senoures, El-Faiyum compared with Abu-Rawash, Embaba, North Giza might be correlated with spatial food availability and abundance or micro-evolutionary change or phenotypic plasticity. Also, the increase of body size and mass in individuals from Garfas-Senoures, El-Faiyum might be an adaptation to lower ambient temperature and hypoxia. Diet analysis showed that the bulk of gut contents were beetles, plant bugs, hymenopterans and dipterans. The remainder of the plant material was probably ingested secondarily. Moreover, the increase in the activity of *Ldh* in liver tissues of *T. quinquetaeniata* inhabiting Abu-Rawash, Embaba, North Giza could be confirmed by the significant increase in the accumulation of the total lipids in liver and muscle tissues than that in the other population. As well as, a marked degeneration, necrosis and desquamation of spermatogoneal cells lining seminiferous tubules in testes of *T. quinquetaeniata* inhabiting Garfas-Senoures, El-Faiyum than that in the other population inhabiting Abu-Rawash, Embaba, North Giza that could be attributed to the bioaccumulation of soil heavy metals in testes. Higher carbohydrate accumulation in the former lizards' population was confirmed by the high availability and diversity of diet in El-Faiyum habitat. Thus we concluded that *T. quinquetaeniata* inhabiting Abu-Rawash, Embaba, North Giza is more active, energetic and adaptable in its habitat than *T. quinquetaeniata* inhabiting Garfas-Senoures, El-Faiyum.

Key words: Morphometrics; Stomach content analysis; Lactate dehydrogenase; Histopathology; PAS stain; *Mabuya quinquetaeniata*.

Introduction

The Five-lined Mabuya (*Trachylepis quinquetaeniata*), a species of African Skink, is found in the Lygosominae subfamily. It was previously known as *Mabuya quinquetaeniata*, also known as Rainbow Mabuya, Rainbow Skink or blue-tailed Skink because of the blue tail. It's a medium sized lizard with a length of about 20 centimeters (7.9 inches) that has olive-brown or dark brown color with glossy scales and metallic reflection (1).

The genus *Trachylepis* has three subspecies: *T. quinquetaeniata*, *T. quinquetaeniata langheldi* and *T. quinquetaeniata riggenbachi*. *Trachylepis quinquetaeniata* Skinks are allocated in Angola, Benin, Burkina Faso, Cameroon, Central African Republic, Chad, DRC, Cote d'Ivoire, Djibouti, Egypt, Equatorial Guinea, Eritrea, Ethiopia, Gabon, Ghana, Guinea, Kenya, Mali, Niger, Nigeria, Senegal, Somalia, South Sudan, Sudan, Tanzania, Togo and Uganda (1).

The coloration of this species is completely changeable, depending on the gender and the age. Sexual dimorphism between males and females of a species is a common phenomenon in reptiles (2). In lizards, head size dimorphism (HSD) is used as weapons in male-male combats. Sexual dimorphism can have important ecological effects in animals as can evoke differences in foraging success (3).

Seasonal weather patterns may be key regulators of food diversity and abundance, and the resulting lizard dietary composition (3, 4). Diet is the main component of an organism's natural history and essential for the implementation of effective conservation and management strategies (4-6). Survival and reproduction depend on an individual's ability to successfully find and capture prey. In lizards, foraging mode is influenced by physiology, morphology, distribution, abundance of prey, predators, and competitors. Foraging mode is also linked to a set of coevolved traits. For example, active foragers are of slender body form and have a relatively low clutch mass (RCM) (7).

In reptile animals, as amniotic species, spermatogenesis process has a specific evolutionary interest between vertebrates because the development of germ cell acts as a strategy between the anamniotic clades (fishes and amphibians) and the other amniotic taxa (birds and mammals) (8-9). In reptiles, spermatogenesis process produces a single population of spermatozoa, which is secreted during a single spermiation event (8-11). Consequently, the analysis of physiological and morphological features of spermatogenesis process in reptiles serves as the basic aspect in understanding the evolution of male germ cell development in vertebrates.

Electrophoresis process is a vital biochemical technique to determine the genetic variation among species depending on the migration of the charged molecules,



Figure 1. Abu-Rawash, Embaba, North Giza, Egypt.

such as isoenzymes, in the presence of an electric field (12). Isoenzymes are several forms of a single enzyme, which often have various isoelectric points and so can be separated by electrophoresis process. Lactate dehydrogenases (*Ldhs*) isoenzymes are very appropriate systems for studying multiple metabolic, genetic, ecological characteristics, and are very important in systematic studies (13). *Ldhs* considered as a hydrogen transfer enzyme that catalyzes the oxidation process of L-lactate to pyruvate using nicotinamide-adenine dinucleotide (NAD)⁺ as hydrogen acceptor, the last step in the metabolic series of anaerobic glycolysis.

Therefore, the current study was performed to investigate the genetic, morphometric, diet type and histological variabilities between the two natural populations of *Trachylepis quinquetaeniata*, which inhabit Abu-Rawash, Embaba, North Giza and Garfas-Senoures, El-Faiyum habitats.

Materials and Methods

Study areas

The field work was carried out at two different habitats in Egypt. The first one was Abu-Rawash, Embaba, North Giza [29° 40' 16.32" N 31° 14' 12.77" E], in Giza governorate. Abu-Rawash was 8 km to the north of Giza. Its habitat was characterized by sandy soil with a relatively dense vegetation cover (grassy-herb vegetation) and some larger trees (Figures 1&3a).

The other habitat was Garfas-Senoures [29° 23' 55.84" N 30° 52' 32.64" E], in El-Faiyum governorate. It is one of the governorates of Egypt in the middle of the country. Its capital is the city of Faiyum, located about 81 mile (130 km) south west of Cairo. Garfas-Senoures is characterized by sandy soil with stones and vegetation cover was denser than in Abu-Rawash. Also Garfas-Senoures is located near the main road of Cairo-El-Faiyum desert road (Figures 2&3b).

Taxon sampling collections and analyses

The present study was approved by the Institutional Animal Care and Use Committee (CU-IACUC) of the Cairo University, Faculty of Science, Zoology Department (CU I F 77 17).

A total of 10 individuals of two natural populations of the five-lined Skink, *Trachylepis* (= *Mabuya*) *quin-*



Figure 2. Garfas-Senoures, El-Faiyum.

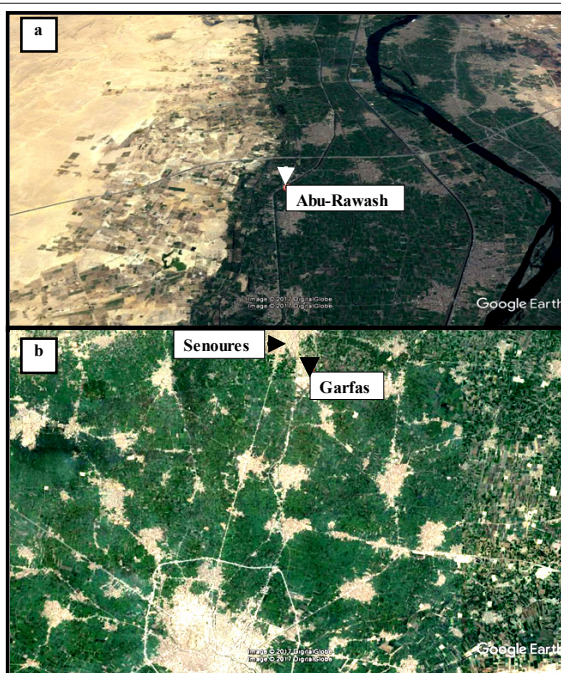


Figure 3. Satellite image of the study areas; Abu-Rawash, Embaba, North Giza (a) and Garfas-Senoures, El-Faiyum (b).

queteniata were collected from the two selected different habitats in Egypt.

Morphological identification and classification of the animals as well as scientific and common names of these species were identified according to (1).

The studied species: *Trachylepis* (= *Mabuya*) *quinquetaeniata* (Lichtenstein, 1823) (1,14).

Common name: African Five-lined Skink, Rainbow Mabuya.

The Five-lined Mabuya, *T. quinquetaeniata*, sometimes called Rainbow Mabuya, blue-tailed Skink (due to the blue tail). It is found in Egypt and southern Africa.

T. quinquetaeniata is a medium sized lizard reaching a length of about 20 cm (≈ 8 in). The coloration of this species is quite variable, depending on the gender and the age. The scales are glossy, with metallic reflections. The basic color is usually olive-brown or dark brown, sometimes with pearly whitish spots and with three light olive or dark brown stripes running from the head to the electric blue tail. These stripes may fade and become indistinct in the adults.

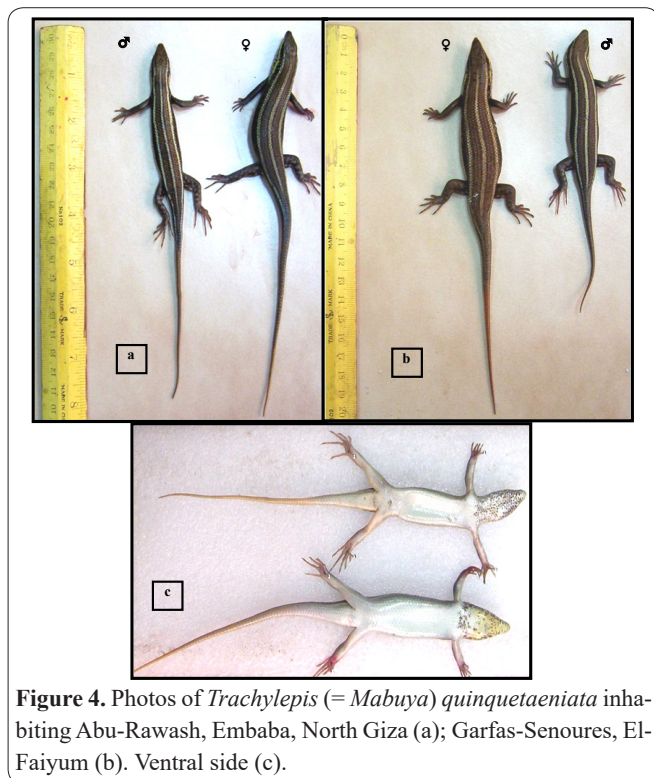


Figure 4. Photos of *Trachylepis* (= *Mabuya*) *quinquetaeniata* inhabiting Abu-Rawash, Embaba, North Giza (a); Garfas-Senoures, El-Faiyum (b). Ventral side (c).

The head shows a pointed snout and clearly visible ears holes. Just behind the ear opening, there are some black spots on chin which denser in males than in females. Legs are dark brown, short and strong, with relatively long toes. The flanks are mainly yellowish and the underside of the body is whitish (Figure 4).

Immediately upon collection of each lizard, we recorded the temperature of the air (T_a) [in °C], relative humidity of the air (RH_a) [in %] & substrate temperature (T_s) and temperature below shrubs (T_{bs}) using digital hygrometer thermometer dew point and mercury thermometer respectively.

We also recorded the type of micro-habitat for each lizard when first sighted. Microhabitat types were recorded according to three categories: a) on the ground; b) on grass and c) below shrubs.

Morphological traits

In the laboratory, the lizards were sexed, weighed to the nearest 0.1 g and fixed with 10 % formalin and later stored in 70% alcohol. The maximum head width (MHW), head height (HH), head length (HL), snout-vent length (SVL) and tail length (TL) of each individual were measured with a vernier caliper (to the nearest 0.1 mm).

Stomach content analyses

After excision, lizard stomachs were opened and their contents were spread in a Petri dish and examined under a dissecting microscope. Arthropodan preys were identified to the taxonomic level of order and family.

Isoenzyme assay

Tissue samples of liver from both lizards' populations were removed, immediately stored at $-80\text{ }^{\circ}\text{C}$ for laboratory use. For isoenzyme extraction, approximately 0.5 g of tissue was homogenized in 10 ml saline solution (PBS, pH=6.8) using a manual Homogenizer. The homogenates were centrifuged at 5000 rpm for

10 minutes and the supernatants were kept at $-20\text{ }^{\circ}\text{C}$ until use. The isoenzyme; Lactate dehydrogenase (*Ldh*) in liver supernatants were separated by discontinuous polyacrylamide gel electrophoresis (15,16).

Electrophoresis was carried out conveniently in discontinuous polyacrylamide gel. An amount of 50 μl of the clear supernatant of the liver homogenate of each sample was mixed with 20 μl of protein dye (1% bromophenol blue) and 20 μl of 2% sucrose. Thirty μl of the mixture per gel slot were used to be applied per each sample for isoenzymes electrophoresis. After electrophoresis, the gel was transferred into a staining solution (50-70 ml) according to (17) which was then replaced by a de-staining mixture of methanol, acetic acid and water (5:1:5 v/v/v). A potential gradient of high voltage electrode [(20 v/cm), anode] across the gel was applied for 4 h at 8°C for separation of the enzymes.

Concerning *Ldh*, after electrophoresis, the gel was soaked in 100 ml of 0.2 M Tris-HCl (pH 8.0) containing 30 mg NBT, 25 mg EDTA, 50 mg NAD, 10 mg L-Lactic acid and 2 mg PMS. 0.05 M Tris-HCl pH 8.5 was prepared by dissolving 0.605 g Tris in 50 ml distilled water. The pH was adjusted to 8.5 by HCl. Then the solution was completed to 100 ml by distilled water (18).

Metabolic study

Immediately after collection, lizards' were dissected. Pieces of liver and thigh muscles were removed and immediately weighed in grams (g) to the nearest 0.02 g. They were stored frozen at $-20\text{ }^{\circ}\text{C}$ till use. Livers and thigh muscles were processed for estimation of the total lipids according to the method of (19) using a kit of Biodiagnostics™ Company.

Histopathological and histochemical localization

Histopathology

For each male of both populations of the lizards, testes were removed immediately, washed and fixed in neutral buffered formalin (10%) for further processing by the ordinary routine work: dehydration, clearing, and embedding. The paraffin embedded blocks of the testes (including the epididymis) were cut by using microtome in 4 μm -thick tissue sections. Tissue sections were first stained by hematoxylin and eosin, and the slides were covered by using mounting media (Fisher Scientific) to check for the presence of spermatozoa using light microscopy.

Periodic Acid Schiff' (PAS) stain

For histochemical localization of carbohydrates, the muscle, liver and kidney tissues were stained using PAS staining method as described by (20). In brief: covered the tissue sections with periodic acid to oxidize compounds with free hydroxyl group (-OH group) or amino/alkyl amine group resulting in dialdehydes which interact with Schiff's reagent forming an insoluble magenta colored complex. Hematoxylin has been used as counter stain.

Statistical analysis

Student *t-test* in the PASW package v. 20 was used to calculate the significant difference of the total lipids between male and female lizards within each population.

Table 1. Morphological characteristics of adult *T. quinquetaeniata* inhabiting Abu-Rawash, Embaba, North Giza. Means are reported ± S.E. minimum and maximum values between parenthesis, n = number of individuals. *T-test* was used to test for sexual size dimorphism.

Morphological trait	<i>Mabuya quinquetaeniata</i> Abu-Rawash, Giza		df	<i>t-test</i>	
	Males (n = 5)	Females (n = 5)		t	P
Body weight	10.3±1.9 (5.0-15.5)	9.5±0.7*** (7.6-11.4)	9	10.389	< 0.001
Maximum head width	10.6±0.6 (9.1-12.2)	10.8±0.3*** (10.1-11.5)	9	36.277	< 0.001
Head height	6.8±0.2 (6.4-7.2)	6.8±0.3 (6.0-7.5)	9	44.913	> 0.05
Head length	17.8±1.0 (14.9-20.7)	17.0±0.5*** (15.7-18.4)	9	31.165	< 0.001
Snout-vent length	71.7±3.2 (62.8-80.6)	68.0±1.3*** (64.4-71.6)	9	40.096	< 0.001
Tail length	116.6±5.8 (91.6-141.7)	97.1±17.5*** (41.4-152.8)	9	10.145	< 0.001

Table 2. Morphological characteristics of adult *T. quinquetaeniata* inhabiting Garfas-Senoures, El-Faiyum, Means are reported ± S.E. minimum and maximum values between parenthesis, n = number of individuals. *T-test* was used to test for sexual size dimorphism.

Morphological trait	<i>Mabuya quinquetaeniata</i> Garfas-Senoures, Faiyum		df	<i>t-test</i>	
	Males (n = 5)	Females (n = 5)		t	P
Body weight	11.2±0.6 (9.6-12.8)	11.5±2.1*** (5.8-17.3)	9	11.175	< 0.001
Maximum head width	10.1±0.4 (9.1-11.1)	11.1±0.7*** (9.3-13.0)	9	27.027	< 0.001
Head height	7.2±0.2 (6.6-7.8)	7.2±0.3 (6.4-7.9)	9	43.388	> 0.05
Head length	16.8±0.6 (15.1-18.4)	16.3±1.0*** (13.4-19.2)	9	28.703	< 0.001
Snout-vent length	71.5±1.9 (66.3-76.7)	75.0±3.6*** (64.9-85.1)	9	36.312	< 0.001
Tail length	98.4±10.3 (53.9-142.9)	101.4±4.2*** (89.6-113.2)	9	23.525	< 0.001

Student *t-test* was applied to estimate the significant difference between male and female lizard populations in all studied morphological traits in each population. The levels of significance were $P < 0.01$ and $P < 0.001$.

Linear regression analysis was used to clear the effect of SVL on the other morphological traits among male and female lizards within each population.

Ethical considerations

Our Institutional Animal Care and Use Committee (IACUC) at Zoology Department, Faculty of Science, Cairo University has approved this study protocol from the ethical point of view and according to Animal welfare Act of the Ministry of Agriculture in Egypt that enforces the humane treatment of animals and the IACUC permit number is CU 1 F 77 17.

Results

Aerial factors

By recording the aerial factors in Abu-Rawash, Embaba, North Giza, it showed that T_a was 24.72 °C, RH_a was 20.37 % & T_s was 25 °C and T_{bs} was 21 °C. While in Garfas-Senoures, El-Faiyum, T_a was 26.69 °C, RH_a was 20.37 % & T_s was 26.69 °C and T_{bs} was 20 °C.

Morphological traits

The present data showed that the males of the natural population of *T. quinquetaeniata* inhabiting Abu-Rawash, Embaba, North Giza possessed a larger BW than females with a very highly significant difference, while within the other population that inhabiting Garfas-Senoures, El-Faiyum, female lizards revealed a very highly significant increase in their body weight than in males.

In both populations, while female lizards recorded a very highly significant increase in MHW compared to male lizards, both sexes revealed identical HH. Males of *T. quinquetaeniata* inhabiting Abu-Rawash, Embaba, North Giza showed a very highly significant increase in

HL, SVL and TL than in females. While the male lizards inhabiting Garfas-Senoures, El-Faiyum revealed a very highly significant increase in HL than in females, they recorded a very highly significant decrease in SVL and TL when compared to female lizards (Tables 1&2).

Linear regression analysis showed a strong positive correlation between SVL and all other morphological characteristics in male lizards inhabiting Abu-Rawash, Embaba, North Giza than in females, but in the natural population of the lizards inhabiting Garfas-Senoures, El-Faiyum, females revealed a strong positive correlation between all morphological characteristics when compared with SVL than in male lizards (Figures. 5&6).

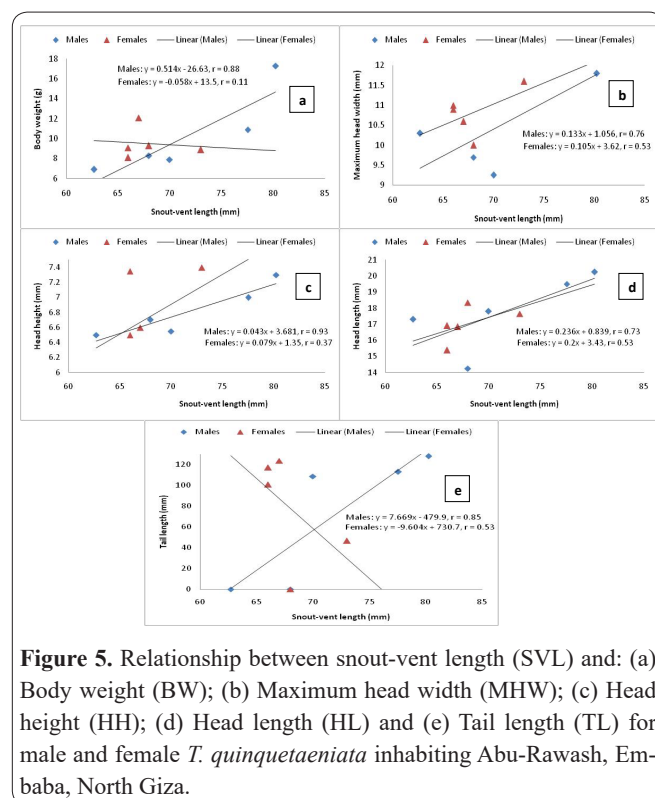


Figure 5. Relationship between snout-vent length (SVL) and: (a) Body weight (BW); (b) Maximum head width (MHW); (c) Head height (HH); (d) Head length (HL) and (e) Tail length (TL) for male and female *T. quinquetaeniata* inhabiting Abu-Rawash, Embaba, North Giza.

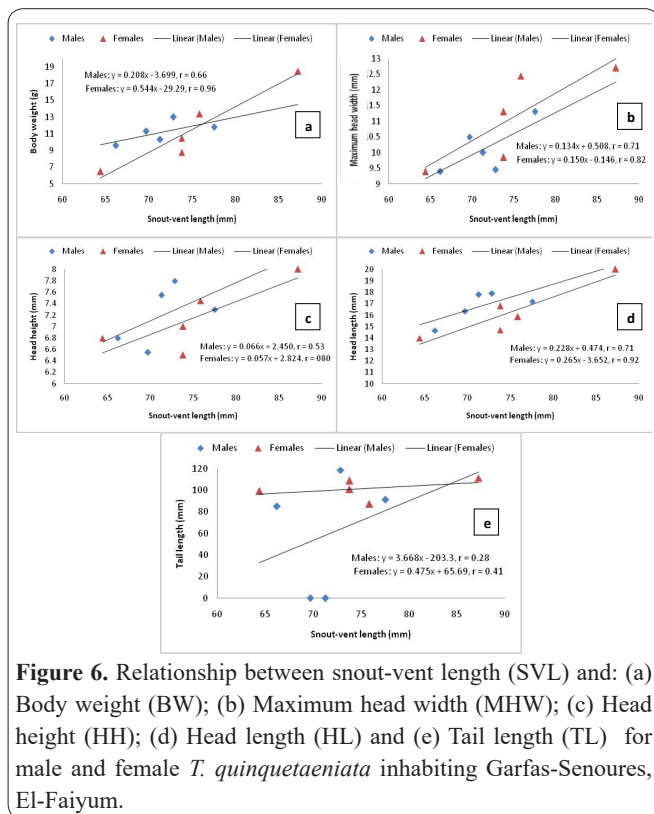


Figure 6. Relationship between snout-vent length (SVL) and: (a) Body weight (BW); (b) Maximum head width (MHW); (c) Head height (HH); (d) Head length (HL) and (e) Tail length (TL) for male and female *T. quinquetaeniata* inhabiting Garfas-Senoures, El-Faiyum.

Diet and stomach content analysis

A total of 10 lizard stomachs for each natural population (5 lizard stomachs/sex) were examined and contained about 17 prey items.

The natural population of *T. quinquetaeniata* inha-

biting Abu-Rawash, Embaba, North Giza consumed a little variety of prey taxa. Remnants of beetles were the dominant prey items for both sexes with a higher frequency of occurrence in females (60%) than in males (20%). The other prey items; *Spilostethus pandurus* (Hemiptera: Lygaeidae), remnants of plant bugs (Hemiptera: Miridae) and remnants of flies (Diptera) were detected only in 20% of male stomachs. Digested ant [head parts] (Hymenoptera: Formicidae) was recorded in 20% of male stomachs while green plant materials showed only in female lizards with 40% in their stomachs.

T. quinquetaeniata inhabiting Garfas-Senoures, El-Faiyum consumed a more variety of prey taxa. Remnants of beetles were the dominant prey items with a higher frequency of occurrence in males (60%) when compared to male lizards of the other population. Remnants of plant bugs ((Hemiptera: Miridae) and some plant parts were detected in 40% of male stomachs. Digested parts of beetles (Coleoptera), digested parts of several beetles (Coleoptera: Silphidae), calliphorid flies [iridescent abdomen and thorax] & Muscid fly (Diptera) and bulk mass of plant parts (rhizomes) were detected with a frequency of occurrence 20% only in males. Remnants of tenebrionid beetles (Coleoptera: Tenebrionidae) were found in 40% of female lizards' stomachs, while the remaining prey items; unidentified ants (Hymenoptera: Formicidae), digested parts of beetles & different beetles (Hymenoptera), bulk mass of plant parts (rhizomes) and unidentified plant parts were only detected in 20% of female stomachs (Table 3 & Figure 7).

Table 3. Food composition of adult lizard population; *T. quinquetaeniata* inhabiting two different habitats. Diet data come from stomach content. %f = frequency occurrence, %s = percentage of stomachs containing prey.

Prey taxon	<i>Mabuya quinquetaeniata</i> Abu-Rawash, Giza				<i>Mabuya quinquetaeniata</i> Garfas-Senoures, Faiyum			
	Males (n = 5)		Females (n = 5)		Males (n = 5)		Females (n = 5)	
	%f	%s	%f	%s	%f	%s	%f	%s
Animalia								
Insecta								
Hymenoptera								
Formicidae								
Digested ant (head parts)	-	-	20%	20%	-	-	-	-
Unidentified ants	-	-	-	-	-	-	20%	20%
Hemiptera								
Lygaeidae								
<i>Spilostethus pandurus</i>	20%	20%	-	-	-	-	-	-
Miridae								
Remnants of plant bugs	20%	20%	-	-	40%	40%	-	-
Coleoptera								
Remnants of beetles (and/or chitin)	20%	20%	60%	60%	60%	60%	-	-
Digested parts of beetles	-	-	-	-	20%	20%	-	-
Remnants of unidentified beetles	-	-	-	-	-	-	20%	20%
Different beetles	-	-	-	-	-	-	20%*	20%*
Tenebrionidae								
Remnants of tenebrionid beetles	-	-	-	-	-	-	40%	40%
Silphidae								
Digested parts of several beetles	-	-	-	-	20%	20%	-	-
Diptera								
Calliphorid flies (iridescent abdomen and thorax)	-	-	-	-	20%	20%	-	-
Muscid fly	-	-	-	-	20%	20%	-	-
Remnants of flies	20%	20%	-	-	-	-	-	-
Plant groups								
Green plant materials	-	-	40%	40%	-	-	-	-
Some plant parts	-	-	-	-	40%	40%	-	-
Bulk mass of plant parts (rhizomes)	-	-	-	-	20%	20%	20%	20%
Unidentified plant parts	-	-	-	-	-	-	20%	20%

* Vast abundance of different beetles based on size of undigested wings (5 species ?)

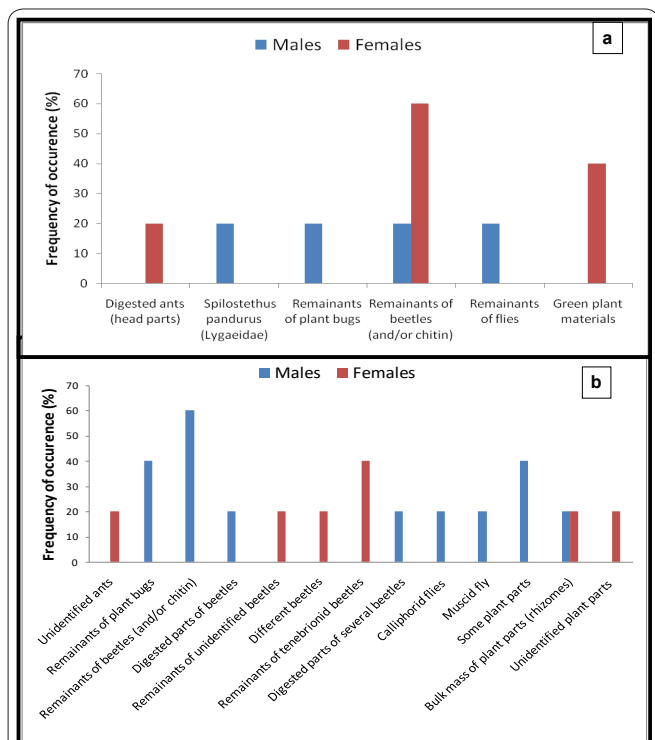


Figure 7. Numerical frequency of main prey categories in *T. quinquetaeniata*, by sex inhabiting Abu-Rawash, Embaba, North Giza (a) and Garfas-Senoures, El-Faiyum (b).

Isoenzyme assay

Six *Ldh* isoforms were observed in *Mabuya* lizards inhabiting both Abu-Rawash, Embaba, North Giza and Garfas-Senoures, El-Faiyum habitats. The activity of isoforms; *Ldh-1*, *Ldh-3* and *Ldh-5* were seemed to be higher in the natural population of *T. quinquetaeniata* inhabiting -Rawash, Embaba, North Giza than those in Garfas-Senoures, El-Faiyum. Such activity was seen through the greater density, thickness, and the relative front (RF) of the bands. The other isoforms were recorded a nearly similar activity in both lizards' populations (Figure 8).

Table 4 demonstrated the mean and standard error values of total lipids in liver and thigh muscle tissues of both populations of *Mabuya*. By comparing the total lipids of liver and thigh muscle tissues in the two lizards' populations, a highly significantly increase ($P < 0.01$) of the total lipids in liver and muscle tissues of *T. quinquetaeniata* in Abu-Rawash, Embaba, North Giza than that in Garfas-Senoures, El-Faiyum. Within each population, total lipids of liver and thigh muscles were significantly higher in males than in females ($P < 0.01$) in the lizard population of Abu-Rawash, Embaba, North

Giza. While the total lipids in liver of male lizards inhabiting Garfas-Senoures, El-Faiyum were significantly higher ($P < 0.01$) in males than in females, it showed a very highly significant increase ($P < 0.001$) in thigh muscles of males than in females.

Histopathological examination of testes

By examining the testes sections in both populations of *T. quinquetaeniata*, we found a marked degeneration, necrosis and desquamation of spermatogoneal cells lining seminiferous tubules in testes of *T. quinquetaeniata* inhabiting Garfas-Senoures, El-Faiyum when compared to the other population inhabiting Abu-Rawash, Embaba, North Giza (Figure 9).

Periodic Acid Schiff' (PAS) stain

As shown in Figure 10, the carbohydrate content was much higher in the *T. quinquetaeniata* inhabiting Garfas-Senoures, El-Faiyum as indicated by the observed strong positive reactivity of the PAS reaction in the liver and muscle tissue sections compared to moderate and slight positive reactivity of the PAS reaction observed, respectively, in the muscles and kidney tissues of the other population inhabiting Abu-Rawash, Embaba, North Giza. Furthermore, negative reactivity of the PAS reaction was observed in the kidney tissues of the *T. quinquetaeniata* population inhabiting Garfas-Senoures, El-Faiyum as well as in the liver tissues of the later population inhabiting Abu-Rawash, Embaba, North Giza.

Discussion

Any change in the genetic material of wild organisms also poses major threats to the persistence of

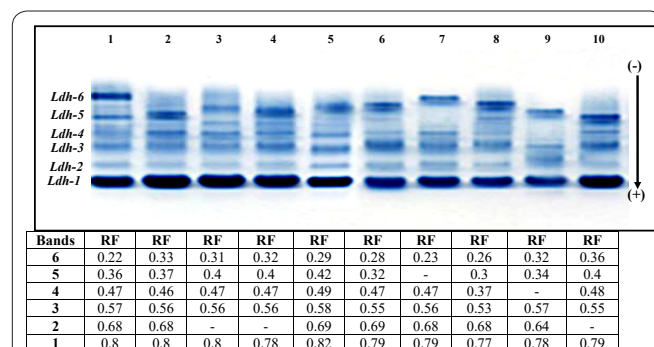


Figure 8. Electrophoretic profile of *Ldh* isoenzymes in liver tissues of *T. quinquetaeniata* inhabiting Abu-Rawash, Embaba, North Giza [Lanes 1-5] and Garfas-Senoures, El-Faiyum [Lanes 6-10].

Table 4. Comparison of total lipids in liver and muscle tissues of male and female *T. quinquetaeniata* inhabiting Abu-Rawash, Embaba, North Giza and Garfas-Senoures, El-Faiyum. Data are expressed as mean \pm standard error. Number of individuals between parentheses. t_1 : Student *t-test* to compare the liver and thigh muscle total lipids between male and female lizards within a population of Abu-Rawash, Embaba, North Giza, t_2 : Student *t-test* to compare the liver and thigh muscle total lipids between male and female lizards within a population of Garfas-Senoures, El-Faiyum, t_3 : Student *t-test* to compare the total lipids in liver and thigh muscles for each sex within each population.

Parameters	<i>Mabuya quinquetaeniata</i>					
	Abu-Rawash, Giza			Garfas-Senoures, Faiyum		
	Males	Females	t_1 -test	Males	Females	t_2 -test
Liver total lipids (mg/100 mg)	18.37 \pm 6.89 (5)	13.40 \pm 1.93 (5)	4.613**	14.82 \pm 4.11 (5)	6.02 \pm 1.01 (5)	4.213**
Thigh muscle total lipids (mg/100 mg)	13.86 \pm 3.62 (5)	9.44 \pm 3.49 (5)	4.740**	12.29 \pm 1.89 (5)	8.55 \pm 2.94 (5)	5.914***
t_3 -test	1.031	0.120	---	6.240***	4.779**	---

** Highly significant at $P < 0.01$, *** Very highly significant at $P < 0.001$

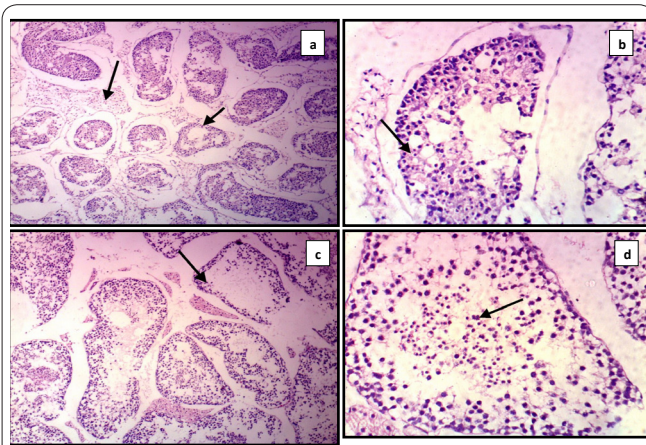


Figure 9. Photomicrograph of testis of *T. quinquetaeniata*. (a) & (b) inhabiting Abu-Rawash, Embaba, North Giza (H & E X 100 and H & E X 400 respectively); (c) & (d) inhabiting Garfas-Senoures, El-Faiyum (H & E X 100 and H & E X 400 respectively).

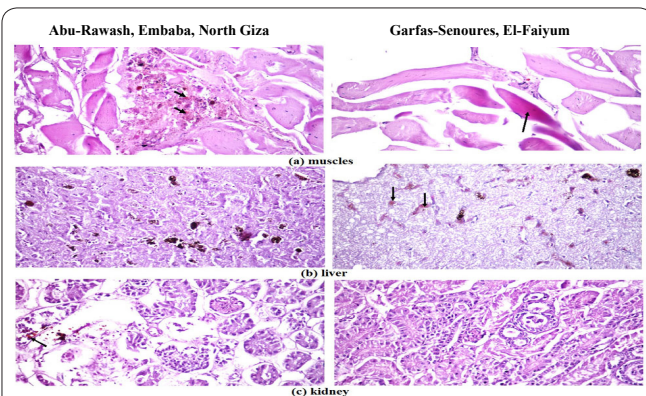


Figure 10. Histochemical localization of carbohydrates using PAS reaction in the muscle, kidney and liver tissues of *T. quinquetaeniata* inhabiting Abu-Rawash, Embaba, North Giza and Garfas-Senoures, El-Faiyum (arrows) (PAS X 400).

wild animal populations, thereby impairing the health of the ecosystem, genetic diversity and human society. Ultimately, it is very important to study morphological changes, diet, genetic and histological changes between two natural populations of *Trachylepis quinquetaeniata* inhabiting Abu-Rawash, Embaba, North Giza and Garfas-Senoures, El-Faiyum habitats (21-22).

Our study confirmed that *T. quinquetaeniata* inhabiting both studied habitats is a typically ground-dwelling Skink and frequently associated with grass and below shrubs as shown from the T_{bs} value that ranged from 20-21 °C. This frequent association of *M. quinquetaeniata* with grass and below shrubs provides the animals with protection from predators as well as with some advantages such as constituting a favorable substrate temperature for thermoregulation in accordance with the behavior of *Mabuya agilis* studied by (23).

Phenotypic analysis of sexual size dimorphism (SSD) revealed that females tend to be larger than males in small lizards species, males larger than females in large species (24) due to sexual differences in the growth rates, sexual selection, population density and territoriality (25-29). Our data revealed a very highly significant sexual size dimorphism in *M. quinquetaeniata* inhabiting Garfas-Senoures, El-Faiyum with females growing larger than males which were similar to that in *Mabuya agilis* reported by (23), but in the other population inhabiting Abu-Rawash, Embaba, North Giza, males were

possessed a larger body weights than in females.

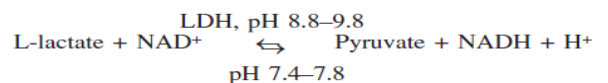
Type of food might be correlated with head size as stated in the study of (30). Individuals of *T. quinquetaeniata* from Garfas-Senoures, El-Faiyum had greater MHW those from Abu-Rawash, Embaba, North Giza. Additionally, analyses of sex difference within each area revealed greater mean MHWs in females than in males.

Herein, geographic variation in SSD and head size dimorphism (HSD) with greater dimensions in Garfas-Senoures, El-Faiyum compared Abu-Rawash, Embaba, North Giza might be correlated with spatial food availability and abundance or microevolutionary change or phenotypic plasticity. Increase body size and mass in individuals from Garfas-Senoures, El-Faiyum might be an adaptation to lower ambient temperature and hypoxia (3).

Our data obtained from the stomach content analysis of *T. quinquetaeniata* were in agreement with those found in *Mabuya agilis* reported by (24). Skinks consumed a wide variety of insects. The bulk of gut contents were beetles, plant bugs, hymenopterans and dipterans. The remainder of the plant material was probably ingested secondarily.

Beetles were the dominant food for the lizards and our results revealed that beetles were found in Abu-Rawash, Embaba, North Giza with a higher percentage of occurrences than in Garfas-Senoures, El-Faiyum which could be correlated with the high activity and energetics of that population.

Ldhs isozymes are very suitable systems for studying several metabolic, genetic, ecological features, and are very useful in systematic studies (13). *Ldhs* are a hydrogen transfer enzymes that catalyze the oxidation of L-lactate to pyruvate with nicotinamide-adenine dinucleotide (NAD)⁺ as hydrogen acceptor. The reaction is reversible and the reaction equilibrium strongly favors the reverse reaction, namely the reduction of pyruvate (P) to lactate (L):



Due to its ability to produce NADH, this enzyme is thought to be a key enzyme in lipid biosynthesis. The increase in the activity of *Ldh* in liver tissues of *T. quinquetaeniata* inhabiting Abu-Rawash, Embaba, North Giza could be confirmed by the significant increase in accumulation of the total lipids in liver and muscle tissues than in the other population. Thus we supposed that *T. quinquetaeniata* inhabiting Abu-Rawash, Embaba, North Giza is more active, energetic and adaptable in its habitat than *T. quinquetaeniata* inhabiting Garfas-Senoures, El-Faiyum.

The present work showed a marked degeneration, necrosis and desquamation of spermatogoneal cells lining seminiferous tubules in testes of *T. quinquetaeniata* inhabiting Garfas-Senoures, El-Faiyum than that in the other population inhabiting Abu-Rawash, Embaba, North Giza. This might be attributed to the bioaccumulation of soil heavy metals in testes which had been studied by (31, 32).

Our findings revealed a much higher glycogen accumulation in the *T. quinquetaeniata* inhabiting Garfas-Senoures, El-Faiyum as indicated by the observed

strong positive reactivity of the PAS reaction in the liver and muscle tissue sections compared to the moderate and slight positive reactivity of the PAS reaction observed, respectively, in the muscles and kidney tissues of the other population inhabiting Abu-Rawash, Embaba, North Giza. Such higher carbohydrate accumulation in the former lizards' population was confirmed by the high availability and diversity of diet in El-Faiyum habitat as showed in table (3) & Fig. 7b.

We concluded that *T. quinquetaeniata* inhabiting both studied habitats is a typically ground-dwelling Skink and it seems to be frequently associated with grass and below shrubs. Geographic variation in SSD and head size dimorphism (HSD) with greater dimensions in Garfas-Senoures, El-Faiyum compared Abu-Rawash, Embaba, North Giza might be correlated with spatial food availability and abundance or microevolutionary change or phenotypic plasticity. Increase body size and mass in individuals from Garfas-Senoures, El-Faiyum might be an adaptation to lower ambient temperature and hypoxia. *T. quinquetaeniata* inhabiting Abu-Rawash, Embaba, North Giza is more active, energetic and adaptable in its habitat than *T. quinquetaeniata* inhabiting Garfas-Senoures, El-Faiyum. The marked degeneration, necrosis and desquamation of spermatogoneal cells lining seminiferous tubules in testes of *T. quinquetaeniata* inhabiting Garfas-Senoures, El-Faiyum than that in the other population inhabiting Abu-Rawash, Embaba, might be attributed to the bioaccumulation of soil heavy metals in testes. The higher carbohydrate accumulation in the former lizards' population was confirmed by the high availability and diversity of diet in El-Faiyum habitat.

Conflict of interest

Authors declared no conflict of interest.

Author's contributions

All authors have equal efforts and contribution in this manuscript.

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