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Distribution, taxonomy and biology of S*tenodactylus grandiceps* Haas, 1952 (Squamata: Gekkonidae) in Anatolia

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Abstract. To determine the distribution and obtain detailed information on *Stenodactylus grandiceps* in Anatolia, eight field studies were conducted to the regions of Eastern Mediterranean Anatolia and Southeastern Anatolia in 2007 and 2008, including the various habitat types. Collected 23 specimens (8 ♀♀, 5 ♂♂ and 10 juveniles) in the three different localities (one from Gaziantep and two from Kilis province) were examined morphologically and described in detail with some information on feeding and behavioral biology.

Key words: distribution, gecko, *Stenodactylus grandiceps*, taxonomy, Turkey.

Introduction

Stenodactylus grandiceps Haas, 1952 is distributed in Iraq, Jordan, Syria, North of Saudi Arabia and Southeast of Turkey (Haas 1952, Wettstein 1960, Eiselt 1976, Arnold 1980, 1986, Martens & Kock 1991, Martens 1993, Disi & Böhme 1996, Sindaco et al. 2000, 2006). The first record of *S. grandiceps* is based on four specimens (CHNM-19676-9) collected from Rutba (IRAQ) by Schmidt (1939). Even though Schmidt (1939) identified *S. sthenodactylus,* noted to significantly differ from the Egyptian specimens. Although Haas published the description of *S. grandiceps* in 1952, this term was first used by him in 1951 (Haas 1951) (Nomen nudum).

Wettstein (1960) examined a female specimen (NMW-18931) collected from the border of Gaziantep-Syria and he evaluated its name as *Stenodactylus sthenodactylus* and gave the first record from Anatolia. Eiselt (1976) revised the wrong identifications by Wettstein (1960) about *S. grandiceps* population in Turkey. Eiselt (1976) compared this sample with a paratype of *S. grandiceps* in FHMN (Field Museum of Natural History, Chicago) and indicated that all samples are totally concordant. Even though the species occupies a wide zoogeographical area including the South Anatolian region between the east part of the Mediterranean and Southwest Asia (Göçmen et. al. 2007), Except for the record which comprised only one female specimen from the area of Gaziantep border line near Syria, there is no information of this species' biology and distribution in Turkey.

Eight field studies have been conducted to determine the distribution range of *Stenodactylus grandiceps*, especially in the area where the species is known to live, giving attention to the active period of reptiles between April and September (2007) and in April (2008); in East Mediterranean and South Anatolia (Mersin, Adana, Osmaniye, Hatay, Kilis, Gaziantep, Kahramanmaraş, Şanlıurfa, Diyarbakır, Mardin). In this study, detailed information about distribution, morphology and ecology of the Anatolian population of *S. grandiceps* is given, as well as on its feeding and behavioral biology in captive conditions.

Material and Methods

Material examined in this paper which was collected between April-September, 2007 and in April, 2008 is deposited at ZDEU (The Zoology Department of Ege University, İzmir, Turkey). The material list, some ecological parameters and GPS logs are summarized in Table 1 and the localities where the specimens were collected are shown on the map (Fig. 1). Data on color patterns (and photos) were recorded from living animals. The caught specimens were kept alive for a short time, varying between a month and three month, in a terrarium for coloration analyses and photography, using Olympus C-5060WZ and Nikon Coolpix 5400 digital cameras. All specimens were etherized, then injected with 96% ethanol and stored in glass jars with 70% ethanol (Göçmen et al. 2007) to facilitate future DNA studies.

For meristic characters, we used both adult and juvenile individuals. Several meristic characters were examined bilaterally and right and left sides were compared to verify the possible presence of

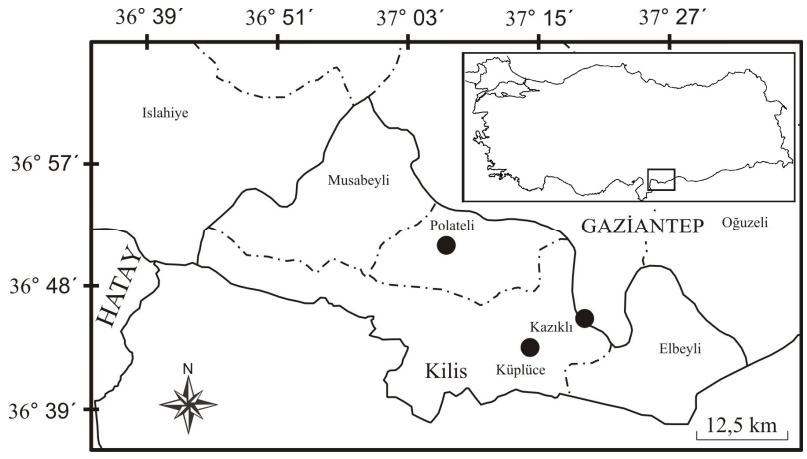

Figure 1. Map showing the localities where the specimens were collected (solid circles: localities of materials).

directional asymmetry (Werner et al. 1991, Werner & Seifan 2006). Further, individual means of the right and left sides were used. These characters are indicated by an asterisk (*) in the character list below. For metric characters we used only the adults, avoiding the effects of allometry (Moravec et al. 1999, Werner & Seifan 2006). Metric characters were measured using Mitutuyo digital calipers of 0.02 mm sensitivity, except rostrum-anus length and tail length which were measured by a millimetric ruler. Meristic and metric characters were counted and measured under a stereo microscope. Summarized statistics of these characters were conducted with "SPSS 15.0 for Windows". For comparison of both the meristic and metric characters between sexes, Student T test was used. Furthermore, to control the test results of raw data, data of raw metric characters were again exposed to Student's T-test, taking index values of PERCRA (percents of rostrum-anus length; [each metric character/ RA] × 100), according to Werner (1971). So, the evaluations on similarities or differences between the sexes were strengthened. The evaluations of all statistical analyses were based on the statistical significance level of "P≤0.05".

Meristic characters, measurements of body proportions ("metric") and their ratios follow previously published methods on geckos (Haas 1952, 1957, Lanza 1978, Arnold 1980, Werner & Sivan 1993, Tok et al. 1997, Disi et al. 2001, Kratochvil et al. 2001, Bauer & Pauwels 2002, Baha El Din 2005, Dakhteh et al. 2007). They are as follows:

- *Scales in contact with nasals (NSN)*; Scales between nasal and eye (NNS):* number of scales in the single row between 2nd nasal and anterior border of orbit;

- *Interorbital scales (I):* scales across the inter-orbital region at level of mid orbits, excluding palpebral folds;

- *Scales between posterior of eyes (SPE):* scales between posterior edges of eyes at dorsal aspect of the head;

- *Scales dorsally around eye (SDE):* dorsal scales in the single row from anterior to posterior of left eye at dorsum of the head;

- *Scales between eye and ear opening (SEE):* number of scales in the single row from posterior of left eye to anterior of ear opening at lateral aspect of the head;

- *Scales along the head (SAL)***:** scales in the single row between rostral plate and the level of the ear openings at dorsum of the head;

- *Supralabials (SPL)*; Sublabials (SL)*; Supralabials to subocular region (SSR1)*:* number of upper labials to the level of mid eye;

- *Sublabials to subocular region (SSR2)*:* number of lower labials to the level of mid eye;

- *Scales between sublabials (SBS):* scales at the single row between 3rd sublabials at venter of the head;

- *Dorsalia (D):* Number of dorsal scales across mid-body;

- *Ventralia (V):* Number of ventral scales across mid-body;

- *Gularia (G):* scales from posterior edge of the mentals to a line between ears at venter of the head;

- *Scales between mental and anus (SMA):* number of scales along median line between mental plate and anal opening at venter of the body;

- *Subdigital lamellae of the 1st finger (S1F)*:* number of lamellae under the 1st finger;

- *Subdigital lamellae of the 3rd finger (S3F)*:* number of lamellae under the 3rd finger;

- *Subdigital lamellae of the 4th finger (S4F)*:* number of lamellae under the 4th finger;

- *Subdigital lamellae of the 1st toe (S1H)*:* number of lamellae under the 1st toe ;

- *Subdigital lamellae of the 3rd toe (S3H)*:* number of lamellae under the 3rd toe;

- *Subdigital lamellae of the 4th toe (S4H)*:* number of lamellae under the 4th toe;

- *Cloacal tubercules (CT)*:* number of cone-shaped tubercles on each side of anal opening (oblig array);

- *Number of scales in contact with cloacal tubercles (SCT)*; Number of scales under the tail (NST):* number of scales in longitudinal single row from anal opening to tip of tail;

- *Rostrum-anus length (RA):* distance from tip of snout to cloaca;

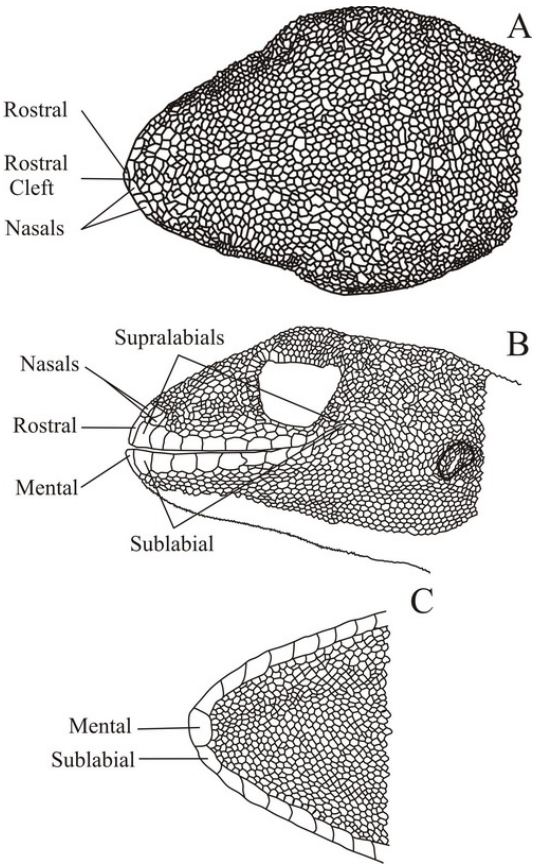

Figure 2. Dorsal (A), lateral (B) and ventral (C) aspects of head in *Stenodactylus grandiceps*

- *Tail length (TL):* from cloaca to tip of tail, if complete;

- *Total body length (TBL):* RA+TL;

- *Head length (HL):* distance from tip of snout to posterior edge of ear, measured parallel to long axis of body;

- *Head width (HW):* Greatest width of head;

- *Head depth (HD):* Greatest depth of head;

- *Mental length (ML); Mental width (MW); Rostral height (RH); Rostrale width (RW); Supranasal length (SNL):* Greatest length of supranasal;

- *Supranasal width (SNW):* Greatest width of supranasal;

- *Internarial length (IL):* Distance between inner sides of nostrils;

- *Horizontal diameter of eye (HDEy):* longest diameter of visible spectacle;

- *Horizontal diameter of ear (HDEa):* longest diameter of ear aperture;

- *Interorbital distance (ID):* distance between the level of mid eyes;

- *Interear distance (IE):* shortest distance between ear openings at dorsal of head;

- *Distance from anterior edge of eye to tip of snout (DES);Distance from posterior edge of eye to anterior edge of ear opening (DEE); Distance from posterior edge of ear opening to tip of snout (DEOS); Distance from tip of snout to base of forelimb (DSF); First toe length of forelimb (FLF):* From insertion of 1st toe, claw included;

- *Fourth toe length of forelimb (FTF):* From insertion of 4th toe, claw included;

- *Distance from base of forelimb to elbow (DFE); Distance from base of forelimb to wrist (DFW); Forelimb length (FLL)*: From axilla to tip of distal claw;

- *First toe length of hind limb (FFL):* From insertion of 1st toe; claw included;

- *Fourth toe length of hind limb (FTL):* From insertion of 4th toe; claw included;

- *Distance from base of hind limb to knee (DHK); Distance from base of hind limb to ankle (DHA); Hind limb length (HLL):* From groin to tip of

distal claw;

- *Cloacal width (CW):* the widest distance of transverse cloacal;
- *TL/RA index:* tail length/rostrum-anus length X100;
- *HL/ RA index:* head length/rostrum-anus length X100;
- *HL/ HW index:* head length/head width X100;
- *HDEy/HDEa:* dorsal, ventral and lateral aspects of head in *Stenodactylus grandiceps* are shown in Figure 2.

Results

Distribution and habitat

As a result of our comprehensive studies throughout the borders between our country and Syria, the species was found only in three localities in the provinces of Gaziantep and Kilis. These localities are as follows; Küplüce village (Kilis), Polateli County (Kilis) and Kazıklı village (Gaziantep) near the border between Gaziantep and Kilis (Fig. 1) (Table 1).

In April in 2007, 16 specimens were found in a valley on Bagita mount which is 2 km east of Küplüce village (Table 1) (Fig. 3a). 13 specimens were found under stones in a sunny and windy weather, at 14 °C between 13:00-15:00. The other three specimens were found at 13 °C between 20:30-22:00. Two of these specimens were caught while active and one under a rock. This region is a zone of volcanic basalt with locally karstic zones. The biotope in which the specimens were caught has a volcanic basaltic ground with sparse vegetation and rocky construction. In this locality, the amphibians and the reptiles living sympatrically with *Stenodactylus grandiceps* are: *Hyla Savignyi* Audoin 1827, *Pelophylax bedriagae* (Camerano 1882), *Pseudepidalea variabilis* (Pallas 1769), *Mediodactylus heterocercum* (Blanford 1874), *Stellagama stellio* (Linneaus 1758), *Trapelus lessonae* (De Filippi 1865), *Ablepharus budaki* Göçmen et al. 1996, *Eumeces schneiderii* (Daudin 1802), *Trachylepis aurata* (Linnaeus 1758), *Trachylepis vittata* (Oliver 1804), *Apathya cappadocica* (Werner 1902), *Ophisops elegans* Ménétriés 1832, *Eirenis rothii* JAN 1863, *Natrix tesellata* (Laurenti 1768), *Platyceps collaris* (Müller 1878), *Platyceps najadum* (Eichwald 1831), *Telescopus nigriceps* (Ahl 1924), *Leptotyphlops macrorhynchus* (Jan 1867), *Typhlops vermicularis* Merrem 1820 and *Macrovipera lebetina* (Linaeus 1758).

In May 2007, we caught one specimen in Kazıklı village (Gaziantep) at 19:56, 15 °C and two in Polateli County (Kilis) at 21:45 and 22:30 (Table 1), average 23 °C. In Kazıklı village, although the landscape was generally volcanic basalt, we collected the specimens in a valley with locally karstic ground. This area almost has a rocky structure without any vegetation (Fig. 3b). The biotope in which the specimens were collected in Polateli, was sparsely vegetated and rocky and had a ground with volcanic basaltic base (Fig. 3c). However, the part with lower altitude in this locality had a karstic ground. Both localities, we did not find any specimens during daylight. The reptiles which lived sympatrically with *Stenodactylus grandiceps* in Kazıklı village were: *Eumeces schneiderii* (Daudin 1802), *Trachylepis aurata* (Linnaeus 1758), *Ophisops elegans* Ménétriés 1832, *Apathya cappadocica* (Werner 1902), *Eirenis decemlineatus* (Dumeril- Bibron 1854) and *Walterinnesia morgani* (Mocquard 1905). In Polateli, the following sympatric species were observed: *Eumeces schneiderii* (Daudin 1802), *Ophisops elegans* Menetries 1832, *Telescopus nigriceps* (Ahl 1924), *Spalerosophis diadema* (Schlegel 1837).

No specimen was found between June and September in 2007. In June in 2007, in Küplüce, it was 38 °C at noon in the shade and 29 °C between the hours 20:00-21:30.

At the beginning of April in 2008, field studies were conducted in all three localities, one night per locality. 4 specimens from Küplüce, 2 specimens from Polateli and 2 specimens from Kazıklı were found and at the end of the observations, only one adult specimen was taken from each locality in order to avoid decreasing the population. During all of the field studies done in 2007-2008, it was observed that the species was active only when the temperature was between 14-23 °C in the months of April and May.

Morphology

All the meristic characters were examined in 23 specimens (8 ♀♀, 5 ♂♂ and 10 juveniles). Subdigital lamellae of the right 3rd toe in one female were not counted because it was damaged.

Nearly all of the head scales (except some scales in contact with Supralabials) are rugose and keeled. The scales in the nasal region are larger than the other head scales in dorsal view of the head (Figs 4a,b). Also some scales are larger than the others among the head scales (except nasal region). Supraocular regions are convex without an obvious bulge in dorsal view of head. There are two weak depressions on the median line in front and back of dorsal part of the head. Eyes are larger than ear opening (HDEy/HDEa=3.61±0.70) and pupil is vertical. The head is sharply set off from the neck. Temporal regions protrude outwards. Ear openings are small, oval or roundish (Fig. 2b). Body scales are homogenous, rugose and keeled (Fig. 4). Back (ridge) scales are smaller than belly scales (Figs 4c-f). The scales in dorsal aspect of fore and hind limb (Fig. 5a) are more distinctively keeled than the back (ridge) scales (Fig. 4c). No dentation or lateral expansion of toes (Fig. 5f). Claw is thick at base part, and tapers towards the end. In all the specimens, seven longitudinal dorsal scale rows on fingers and toes (Fig. 4e), One longitudinal scale row under the toes and the scales in this row are tricarinate (Fig. 5f). Fingers ranked by length, 3-2-4-5-1 from largest to smallest, and toes, 4-3-2-5-1.

Table 1. Geographic and some climatic information of localities, as well as their museum codes (The Zoology Department of Ege University, Ýzmir, Turkey).

Museum codes (ZDEU)	Localities	Altitude (m)	Latitude (DMS)	Longitude (DMS)	Collected specimens	Temp. (°C)
2006/205	Küplüce village	600	36° 44' N	37° 15' E	20.04.2006, 1 specimen (1 ♀)	18
2007/70					25.04.2007, 16 specimens (5 ♂♂, 3 ♀♀, 8 juv.)	14
2008/18					05.04.2008, 1 specimen (1 juv.)	15
2007/170	Kazıklı village	740	36° 46' N	37° 20' E	29.05.2007, 1 specimen (1 ♀)	23
2008/22					05.04.2008, 1 specimen (1 ♀)	15
2007/171	Polateli village	750	36° 50' N	37° 07' E	29.05.2007, 2 specimens (2 ♀♀)	23
2008/17					05.04.2008, 1 specimen (1 juv.)	17

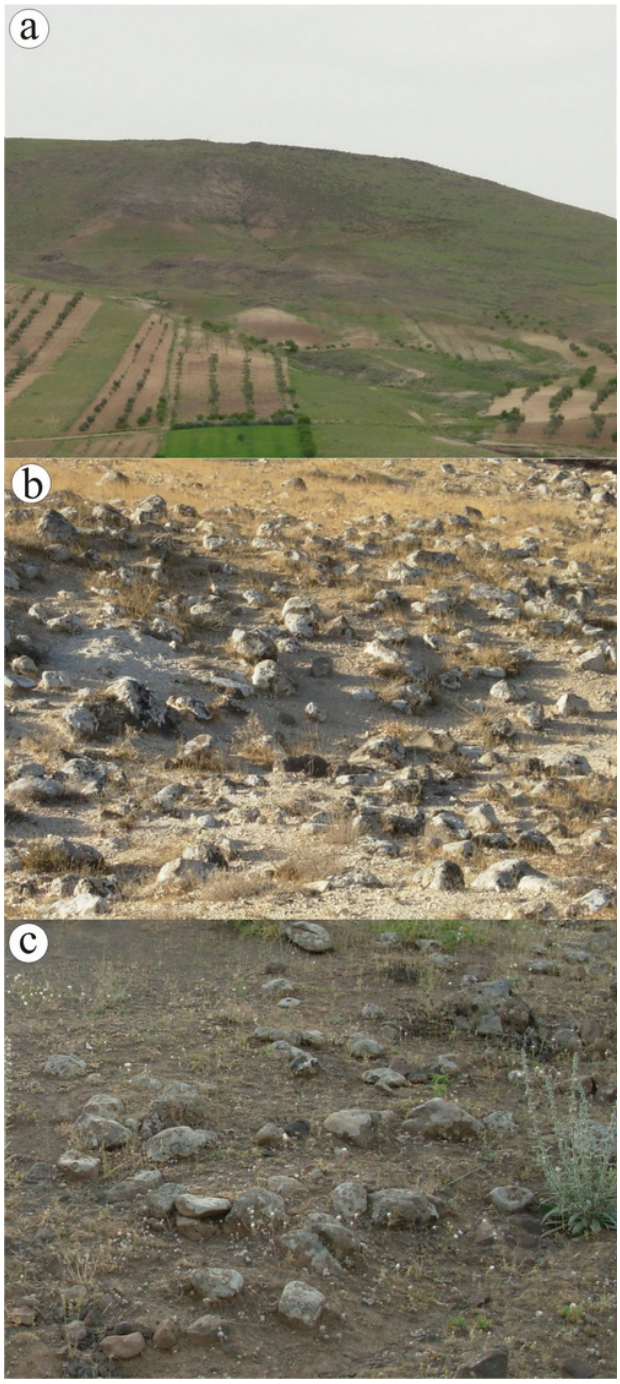

Figure 3. Views from biotopes of *Stenodactylus grandiceps* in Anatolia. a: Küplüce village (Kilis), b: Kazıklı village (Gaziantep), c: Polateli village (Kilis).

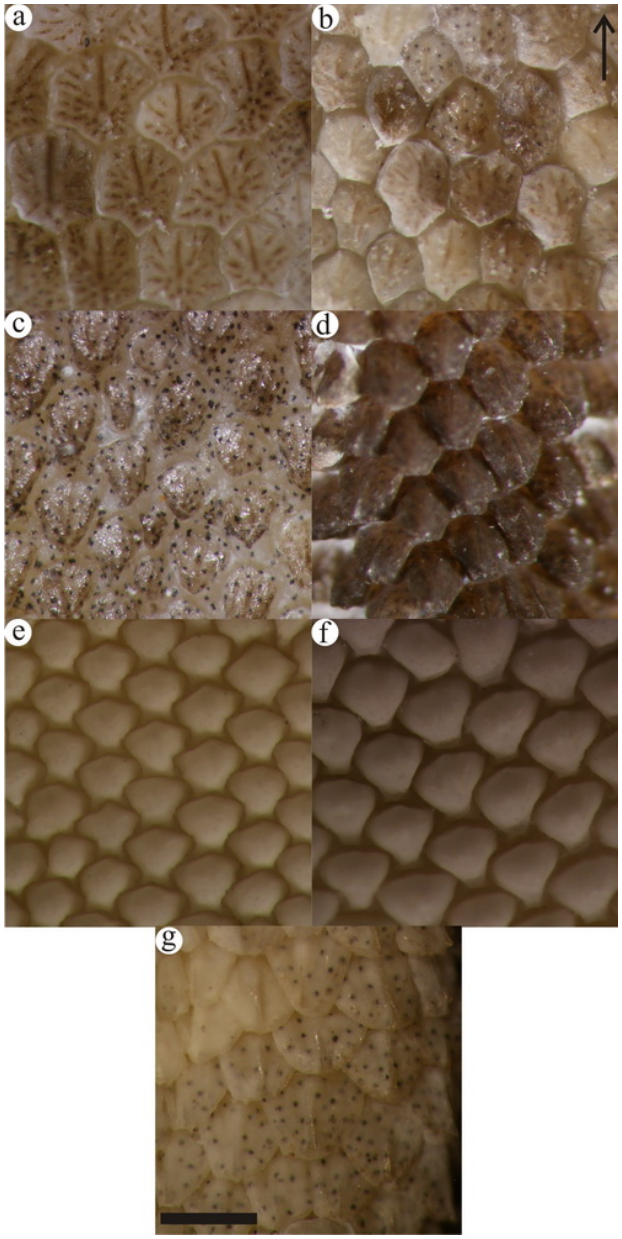

Figure 4. Photographs of scales from different parts of the body in an adult female *Stenodactylus grandiceps* (ZDEU 171/2007-2). **a:** Scales on the front of the head ; **b:** Scales on the back of the head **c:** Back scales; **d:** Scales on the dorsal of tail; **e:** Gulare scales; **f:** Belly scales; **g:** Scales on the ventral of tail. (*Note:* "↑" indicates anterior. Scale bar: 0.5 mm for all photos).

No femoral or preanal pores (Figs 6a,c); 2-4 conical tubercles on each side of the base of the tail forming an uninterrupted oblique series (Figs 6b,d), tubercles more distinct in the males (Fig. 6b). Cloacal region in males is more swollen than in females because of hemipenis (Figs 6a,c). The scales on the tail are more distinctly keeled than back (ridge) scales (Figs 4c,d).

There is a slight concavity on the dorsal part of the body, just on the head like on the cloacal zone. One can easily see the concavity when looking at it from the opposite direction in all specimens in which nostrils are examined. It is hidden by the supranasals. Also, It is in touch with rostral and nasals (one supranasal, two postnasal) (Figs 2a,b). There is no postmental (Fig. 2c). The supranasals are separated in 11 specimens by another scale, while they are in contact in 12 specimens (Fig. 7a,b). The number of nasals is 3 on the left side of 21 specimens (%91.32) and on the right side of 22 specimens (%95.56), but they are 4 on the left and right side of one specimen (%4.34). Moreover this number is 5 on the left side of only one specimen (%4.34).

The number of supralabials varies between 9-(11.20)-13: The number of left supralabiale is 10-12 in 21 (%91.30) of 23 specimens. Whereas this values is seen less frequently on the right of the examined specimens (%78.26). So there is some asymmetry of the number of supralabials.

The number of sublabials varies between 8-(10.00)-12 but

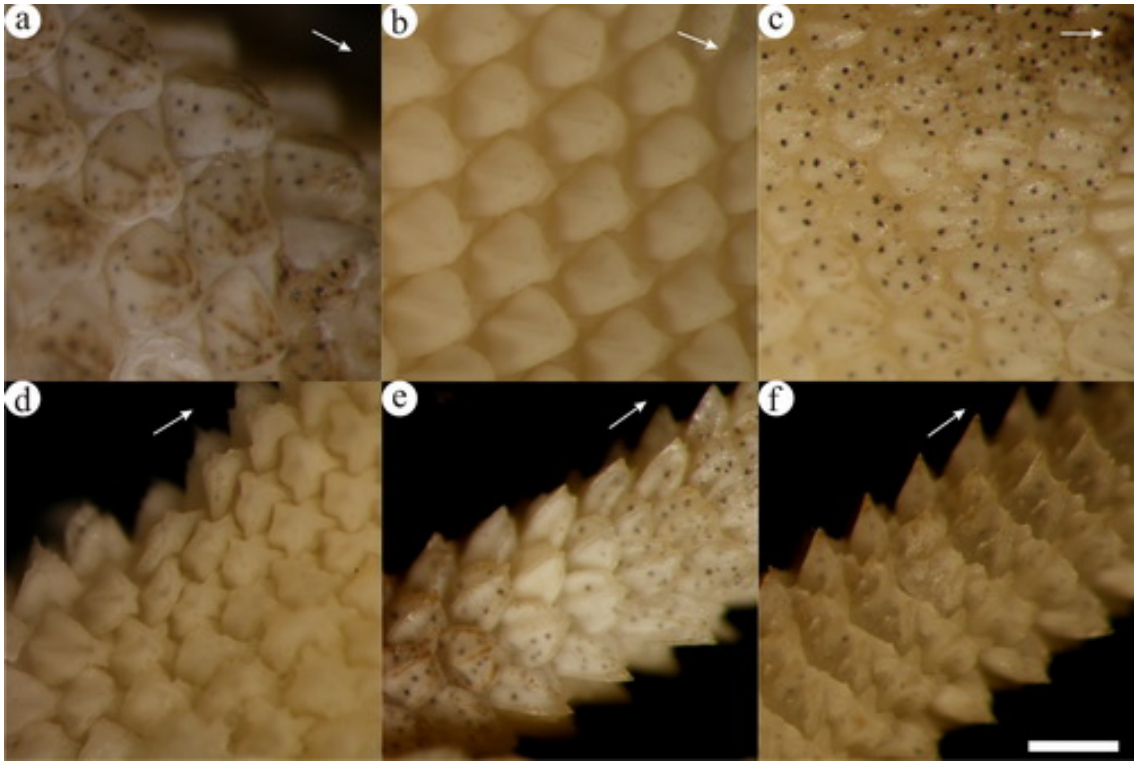

Figure 5. Hindlimb (a: Dorsal and b: Ventral view), foot (c: Dorsal and d: Ventral view) and finger (e: Dorsal and f: Ventral view) scales in an adult female of *Stenodactylus grandiceps* (ZDEU 171/2007-2) (*Not:* "↑" symbol indicates posterior. Scale bar: 0.5 mm for all photos).

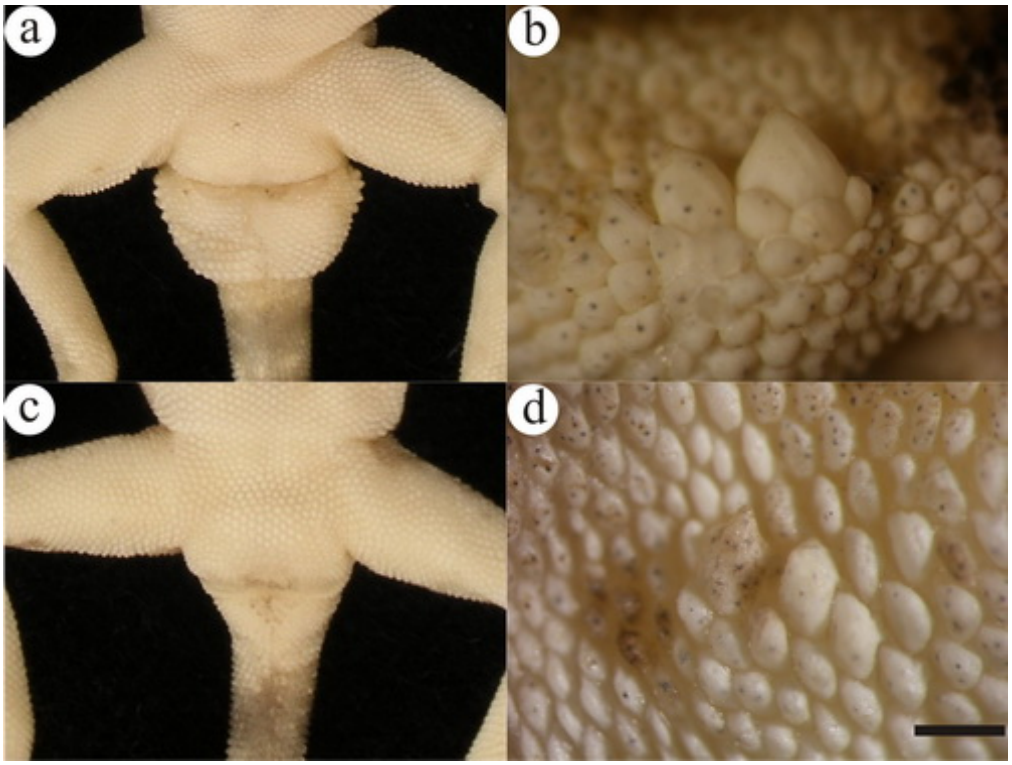

Figure 6. Cloacal regions and tubercules of male (a and b, ZDEU 70/2007-4) and female (c and d, ZDEU 171/2007-2) in *Stenodactylus grandiceps* (Scale bar: 0.5 mm for b and d).

generally between 9-11 on the right and left side (on the left %95.65, on the right %86.96).

The number of cloacal tubercles varies between 2-(2.70)-4. There is a significant asymmetry in this character. On the left, in all of the specimens, the number of cloacal tubercles is 2-3. On the right, in most of the specimens (%82.61), there are 2-3 cloacal tubercles. There are also 4 cloacal tubercles on the right in some specimens (%17.39) while this number is

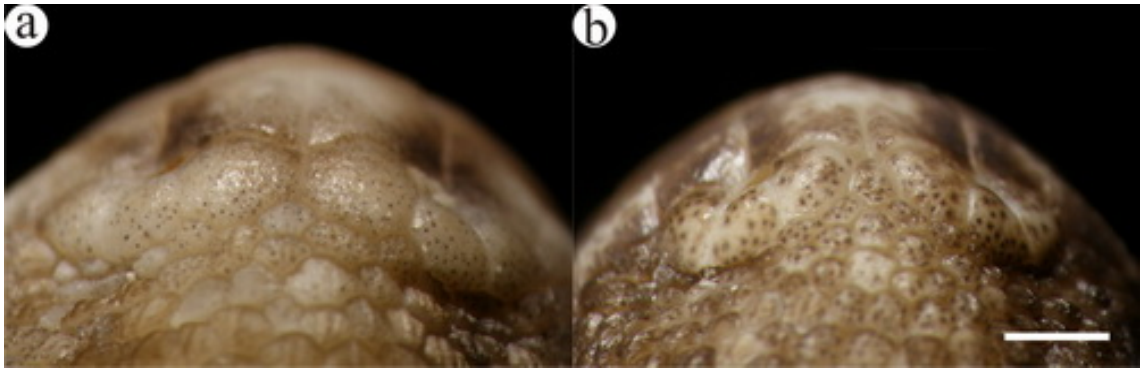

Figure 7. Contact condition of supranasals in dorsal view in an adult male and female of *Stenodactylus grandiceps* (Scale bar: 1 mm).

not seen on the left. The number of scales surrounding cloacal tubercles varies between 11-(14.11)-18. The descriptive statistics of all meristic characters are given in Table 2.

For presentation of the measurements adults (8 female, 5 male) and juveniles (10) are grouped and descriptive statistics are given separately. The tail length is not taken into consideration in a female and a male because it is regenerated. By Student T-test, there are significant differences between the sexes. Thus, characters are presented by regarding the male-female difference and later all together (except juveniles).

By the averages of the rostrum-anus length (♀♀:54.95 mm, ♂♂:47.30 mm), head length (♀♀:16.27 mm, ♂♂:14.65 mm), head width (♀♀:11.09 mm, ♂♂:9.57 mm) and depth (♀♀:8.52 mm, ♂♂:7.10 mm) the females are larger than the males. This is confirmed by the statistical analysis (Table 3).

According to student T-test between the males and females, some characters (HDEy, IE, DES, DEE, DEOS, FLF, FTF, DFE, DFW and FLL) were significantly larger (P≤0.05) in females (P≤0.05). Measurements of body proportions in *Stenodactylus grandiceps*, and their ratios are summarized in Table 3.

Table 2. Some meristic characters of the *Stenodactylus grandiceps*. N: number of specimens; SD: Standard deviation; the other abbreviations of characters were given in Material and Method.

Characters	All				
	N	Mean	Min.	Max.	SD
NSN*	23	8.80	8	12	0.91
NNS	23	19.61	17	22	1.23
I	23	23.48	20	29	2.09
SPE	23	34.26	27	39	2.54
SDE	23	32.22	28	38	2.50
SEE	23	20.78	16	24	2.04
SAL	23	42.74	36	54	4.67
SPL*	23	11.20	9	13	1.05
SL*	23	10.00	8	12	0.89
SSR1*	23	8.93	7	11	0.80
SSR2*	23	8.02	7	10	0.65
SBS	23	26.00	22	33	3.03
D	23	70.61	64	80	4.76
V	23	49.87	40	64	5.43
G	23	44.30	37	50	3.66
SMA	23	176.96	140	198	12.83
S1F*	23	12.85	10	15	1.19
S3F*	23	17.41	14	22	1.60
S4F*	23	16.74	14	20	1.34
S1H*	23	13.74	11	17	1.39
S3H*	23	19.58	16	23	1.45
S4H*	23	20.02	17	24	1.81
CT*	23	2.70	2	4	0.63
SCT*	23	14.11	11	18	1.99
NST	20	83.30	73	100	8.25
TST	22	29.95	28	34	1.59

Color and Pattern

In adult specimens, No difference has been observed in color and pattern between the male and female individuals of *Stenodactylus grandiceps*. The color of the dorsal of body is generally light brown in most of adult specimens (10 of 13 specimens, %76.92). In the older specimens (3 of the 13 specimens) the color of the dorsal of body changes into pinkish brown. On the ground-color of the dorsal part of the head, there are darker brown and little irregular white spots in the form of small dots. On the posterior of the head, larger scales usually tend to be white. Moreover, in most of the specimens (%61.54) interorbital zone is a bit grayish. The color of the scales surrounding anterior and posterior of the orbit on the dorsal of head are white. Nasals are lighter brown and pinkish in comparison with the coloration of the head. In all specimens, "Neck band" is U-shaped or like a half-crescent, extending backward from posterior part of the orbit and its brown color is darker than the ground color. There is a white spotted zone on the dorsal ground coloration, behind the neck band.

There are 4 transverse dark cross-bands on the body: One between the posterior of forelimbs, covering the dorsal ground of body and legs, one in the middle of the dorsal of the body, one between anterior of the hind limbs and the last between the posterior part of the hind limbs on the cloacal part. Between these cross-bands, there are transverse white spotted regular or irregular zones which vary in width, color and size. The front lateral parts of the first transverse dark cross-band forms two hill-like shapes, one is reach to the ear opening and the other is reach to the venter. In most specimens (%53.85), the cross-band is abreast to the ear going forwards and is combined or in touch with the band on the neck. The oblique protrusion of first transverse cross-band which is going towards the venter is a line up to the bottom part of the base of the forelimb. The first transverse cross-band forms a third hill-like shape in some specimens

Table 3. Some mensural characters (in mm) and ratios of the *Stenodactylus grandiceps*, together with the P values from Student T-test for the difference between the sexes, in bold if significant(P≤0.05). N: number of specimens; SD: Standard deviation; the other abbreviations of characters were given in Material and Method.

Characters	♀♀					T-test	♂♂					Juveniles					Adults				
	N	Mean	Min.	Max.	SD	P	N	Mean	Min.	Max.	SD	N	Mean	Min.	Max.	SD	N	Mean	Min.	Max.	SD
RA	8	54.95	47.00	61.00	5.17	**0.008**	5	47.30	43.00	51.00	3.27	10	38.17	36.00	42.00	1.72	13	52.01	43.00	61.00	5.85
TL	7	30.43	24.00	34.00	3.60	0.297	4	28.38	25.00	31.00	2.50	10	22.17	20.00	23.00	1.60	11	29.68	24.00	34.00	3.27
TVU	7	85.23	74.00	94.00	8.72	0.067	4	75.75	68.00	82.00	6.13	10	60.34	56.00	65.00	3.08	11	81.78	68.00	94.00	8.93
HL	8	16.27	14.17	17.57	1.38	**0.027**	5	14.65	13.54	15.90	0.90	10	11.57	10.57	13.02	0.85	13	15.64	13.54	17.57	1.43
HW	8	11.09	9.44	13.09	1.26	**0.015**	5	9.57	8.69	10.32	0.62	10	7.70	7.29	8.61	0.50	13	10.51	8.69	13.09	1.28
HD	8	8.52	7.31	9.81	0.83	**0.002**	5	7.10	6.59	7.62	0.42	10	5.80	5.33	6.51	0.48	13	7.98	6.59	9.81	0.99
ML	8	1.30	1.13	1.44	0.10	0.125	5	1.22	1.09	1.30	0.08	10	0.96	0.89	1.09	0.12	13	1.27	1.09	1.44	0.10
MW	8	1.62	1.20	1.95	0.24	0.826	5	1.59	1.39	1.89	0.21	10	0.93	0.79	1.00	0.08	13	1.61	1.20	1.95	0.22
RH	8	1.43	1.14	2.12	0.32	0.179	5	1.24	1.14	1.46	0.13	10	1.00	0.85	1.09	0.08	13	1.36	1.14	2.12	0.27
RW	8	1.89	1.46	2.39	0.36	0.712	5	1.83	1.50	2.00	0.19	10	1.30	1.13	1.42	0.12	13	1.86	1.46	2.39	0.30
SNL	8	0.80	0.63	0.90	0.10	0.090	5	0.70	0.61	0.79	0.07	10	0.51	0.40	0.59	0.09	13	0.76	0.61	0.90	0.10
SNW	8	0.71	0.52	0.86	0.13	0.840	5	0.72	0.62	0.80	0.08	10	0.46	0.36	0.52	0.06	13	0.71	0.52	0.86	0.11
IL	8	1.31	1.05	1.86	0.26	0.421	5	1.22	1.00	1.34	0.13	10	0.91	0.73	0.99	0.11	13	1.27	1.00	1.86	0.22
HDEy	8	4.43	3.69	4.96	0.38	**0.002**	5	3.70	3.41	4.00	0.25	10	3.14	2.99	3.37	0.17	13	4.15	3.41	4.96	0.49
HDEa	8	1.27	0.95	1.71	0.32	0.168	5	1.06	0.91	1.37	0.19	10	0.75	0.52	0.85	0.12	13	1.19	0.91	1.71	0.29
ID	8	5.42	4.57	6.51	0.70	0.224	5	5.02	4.56	5.51	0.40	10	3.98	3.61	4.44	0.32	13	5.27	4.56	6.51	0.61
IE	8	10.10	8.90	11.33	0.87	**0.008**	5	8.31	7.50	9.88	0.92	10	6.56	5.79	7.41	0.66	13	9.41	7.50	11.33	1.25
DES	8	6.06	5.56	6.83	0.44	**0.028**	5	5.50	5.15	5.99	0.34	10	4.34	4.00	4.71	0.27	13	5.84	5.15	6.83	0.48
DEE	8	5.10	4.22	5.88	0.57	**0.019**	5	4.46	4.23	4.85	0.24	10	3.75	3.44	4.07	0.24	13	4.85	4.22	5.88	0.56
DEOS	8	14.38	12.14	16.09	1.44	**0.017**	5	12.66	11.59	13.49	0.75	10	9.98	9.13	10.78	0.74	13	13.72	11.59	16.09	1.46
DSF	8	21.29	16.90	23.59	2.47	0.097	5	19.42	17.57	20.58	1.21	10	15.76	14.39	16.12	1.10	13	20.57	16.90	23.59	2.22
FLF	8	3.94	3.29	4.42	0.36	**0.003**	5	3.37	3.27	3.49	0.08	10	2.56	2.12	3.19	0.46	13	3.72	3.27	4.42	0.40
FTF	8	4.58	4.04	5.11	0.35	**0.029**	5	4.19	3.94	4.46	0.21	10	3.49	3.25	3.79	0.37	13	4.43	3.94	5.11	0.36
DFE	8	8.52	7.12	9.64	0.93	**0.019**	5	7.48	7.12	7.90	0.38	10	5.89	5.27	6.63	0.48	13	8.12	7.12	9.64	0.91
DFW	8	16.37	14.17	18.37	1.45	**0.006**	5	14.40	13.75	15.08	0.49	10	12.16	11.03	13.39	0.92	13	15.61	13.75	18.37	1.52
FLL	8	22.96	19.17	25.86	2.62	**0.011**	5	21.05	20.47	21.59	0.47	10	17.30	16.27	18.60	0.90	13	22.69	20.69	25.86	2.24
FFL	8	3.34	2.71	4.20	0.48	0.572	5	3.18	2.37	3.56	0.47	10	2.12	2.03	2.27	0.27	13	3.28	2.37	4.20	0.46
FTL	8	5.56	4.74	6.42	0.53	0.262	5	5.16	4.38	5.95	0.62	10	4.03	3.68	4.21	0.34	13	5.41	4.38	6.42	0.58
DHK	8	10.25	8.47	12.30	1.14	0.123	5	9.14	7.86	10.33	1.15	10	7.24	6.51	7.81	0.50	13	9.82	7.86	12.30	1.23
DHA	8	18.64	16.18	21.92	1.93	0.073	5	17.09	15.80	17.99	0.83	10	13.36	11.07	15.40	1.43	13	18.05	15.80	21.92	1.74
HLL	8	26.58	18.34	30.52	3.76	0.214	5	24.69	23.30	26.03	1.05	10	20.10	18.56	21.70	1.31	13	25.85	18.34	30.52	3.09
CW	8	4.22	3.30	5.43	0.65	0.727	5	4.38	3.48	5.43	0.84	10	2.73	2.30	3.08	0.27	13	4.28	3.30	5.43	0.70
TL/RA index	7	55.56	48.00	61.26	4.22	0.053	4	59.89	58.00	62.64	2.23	10	58.06	55.00	62.50	2.90	11	57.13	48.00	62.64	4.12
HL/ RA index	8	29.65	28.05	31.25	1.20	0.241	5	31.04	28.69	33.83	2.18	10	30.29	28.57	32.55	1.36	13	30.18	28.05	33.83	1.71
HL/ HW index	8	68.24	61.22	76.47	5.98	0.342	5	65.43	61.54	70.54	4.21	10	66.65	64.05	70.96	2.48	13	67.16	61.22	76.47	5.37
HDEy/HDEa	8	3.64	2.67	4.60	0.79	0.839	5	3.56	2.85	4.40	0.60	10	4.32	3.59	5.87	0.83	13	3.61	2.67	4.60	0.70

(%30.77) towards the posterio-ventral of the forelimb, which is also oblique shaped and half of the cross-band in width coming from back. Furthermore, in some specimens (%23.07) the upper parts of the limbs are darker in comparison to the other parts of the extremities. The specimens are grouped into two types according to the spots on the back and extremities are distinct or not.

(i.) The white spots on the back and extremities are distinct. (8 specimens, %61.54) (Fig. 8a)

(ii.) There are white spots on the back and extremities but they are not distinct. (5 specimens, %38.46) (Figs 8b,c)

The situation of the white spots, to be or not to be present , is not dependent on the sex. Moreover, it is regarded as a variation related to the body size (Fig. 9).

The ventral of the body is generally grayish white (%69.23) or yellowish white (%30.76) and unspotted (Figs 8e,f). The colourations of the ventral and dorsal parts of the body cannot be separated clearly. There are 4-5 dark rings on the tail which is darker than the dark bands on the head and chest. There are white spots between the tail rings (4 rows: %27.27; 5 rows: %72.73) which are sometimes big and sometimes small, and some rings merge with each other especially in young individuals.

In juvenile specimens, while it is observed that the coloring of the body is darker when compared with the adults. Especially the bands on the back and the tail are darker in color. Moreover, one can distinguish the greyish white zone in juveniles (Fig. 8d).

Behavior

Three pairs were taken into captivity and the females had more tendencies to form their own shelter than the males. In addition to this, 2 of the 3 ♂♂ took shelter in the nests which were formed by the females, and one formed his own nest. During the field studies, one specimen of each sex was found in its nest under a rock. The one interesting result is that only the nests which were formed by the females were shared. In this sense, the males can be the guests in the nests

Figure 8. Dorsal (a-d) and ventral (e-f) view in *Stenodactylus grandiceps* specimens (a: 70/2007-1 ♂; b: 70/2007-4 ♂; c: 171/2007-2 ♀ and d: 70/2007–16 Juvenile e: 70/2007-1 ♂ and f: 171/2007–1 ♀).

Figure 9. Color-pattern variation with relative size in a juvenile (rightmost), a subadult female (bottom), a adult female (left) and a adult male (top) in *Stenodactylus grandiceps*.

which were formed by the females. The formation of the nest is in this way: the soil is dug with front extremities and thrown away with back extremities. The entrance of the nest is put into right shape with the help of tail movements. Both in captivity and under natural conditions, the bottom of the nest is like gutter not like a tunnel throughout the rock (Fig. 10a). Generally the rocks whose bottom is even and which are not buried in the soil were chosen. The specimens which spend time inactively under the rocks in daytime were found in S-shaped form of body (Fig. 10a). The specimens

Figure 10. a) Excavated shelter by *Stenodactylus grandiceps* and position in the nest, b) Raising body and vocalizing at disturbance of a female (ZDEU-205/2006), c) Tail movement during food searching of a male (ZDEU-70/2007-5), d) Licking to clean around the mouth and eyes after feeding of a female (70/2007-7).

under captivity were observed to become active after sunset. This was observed under natural conditions in the field just after sunset. In general the active animals move very slowly and it was observed that they do not run or escape. Both in captivity and natural conditions, it was observed that the especially female individuals show reaction by bringing their legs to standing position and raising their body and turning their back to a hunchback when they are disturbed (Fig. 10b). In addition to these observations, when they were disturbed more, firstly they produce "i" sound 3-5 times and then they produce the gradually decreasing sound of "whiiiiiiip" "whiiiiip" "whiip" "whip". It was observed that they prefer the invertebrates having soft body and alive only as a food when they are in captivity. Although different insects collected from the nature were presented as food, they especially choose the larval phases of *Galleria mellonella* (Linnaeus, 1758) and *Pterotermes occidentalis* (Walker, 1853). This shows that they choose to eat the coleopter insects in their developmental phases and when they are distributed actively under natural circumstances. Additionally in the specimens which were examined for the contents of the stomach, we did not find residual wing parts of coleopter insects supporting this idea. During the time it looks for food in captivity and natural habitat, it was observed that the tail was raised over the body so as to take the "S" shape and after it aims at the prey and attacks, the tail is held horizontally and straight (Fig. 10c). In addition to these observations, it was observed that it caught the prey with abrupt and unique movement and after it swallowed the pray, it cleaned the eyes and around the mouth by licking (Fig. 10d). This kind of behavior was seen in the observations both in captivity and in nature.

Discussion

The three localities in our country where the specimens were collected (Polateli and Küplüce village in Kilis and Kazıklı village in Gaziantep) are similar as far as their volcanic rocky with karstic grounds are concerned. Additionally, looking at the geological construction of the assorted areas where the species is distributed, Iraq's population was reported to inhabit a region with limestone, lacustrine sediment, sulphur, phosphate, quartz sand,(Al-Juboury and Al-Hadidy 2007); as for Syria, lime Stone, gritstone, carbonated rocks (Al-Saad et al. 1992, Brew et al. 1992, 2001); as for Jordan, clayed limestone, volcanic basalt, and lacustrine limestone (Disi 1996). Schmidtler and Bischoff (1995) suggested that this kind of differences in the circumstances could be a reason for dividing into sub-species and basalt-limestone ground could be a reason why *Apathya cappadocica* population on the east of Fırat divided into two as *Apathya cappadocica schmidtlerorum* (in volcanic areas) and *A. c. muhtari* (in karstic regions). Additionally, the researchers also stated that the color of the ground could be a reason for the pattern on their back which is a sub-species character.

The 23 specimens studied in this study accorded with the diagnostic characteristics (dorsal scales have carinas, a wide

head and short tail) described by Haas (1952).

In all of the specimens, nostril, rostral plaque, 1st supralabial were in touch with nasal plaques. This is in accordance with the observations of Haas (1952), Khalaf (1960), Arnold (1980), and Disi (2002). Moreover, in the studied specimens, the fact that the rostral plaque has a medial hollow over half its height accords with the information which Haas (1952) provided about the holotype.

In the present study there was a scale behind the rostral plaque and between the supranasal in 11 of 23 specimens examined. But Haas (1952) highlighted in the description of the female holotype that supranasal are differently touching each other and it is different from the species *Stenodactylus sthenodactylus*. In some of the specimens (47.82%) contrary to Haas (1952), there was one scale between supranasals. Thus the characteristic mentioned is not a distinctive feature between the two species. But possibly this is a feature peculiar to the population in our country because there is no detailed information about *S. grandiceps* in other populations out of our country.

The number of supralabials ranges 9-(11.20)-13 in the Anatolian sample, was 10 in the holotype (Haas 1952), 11 in the Iraqi population (Nader and Jawdat 1976), and varied 11-13 in 11 specimens from many areas (Arnold 1980). Lastly Disi (2002) reported 10-16 in 10 specimens from Jordan. When all of these values are considered, it seems they overlap, so it can be said that the character has a wide range of variation. The same thing can be said for the supralabial. In our specimens, the number of supralabial range between 8-(10.00)-12. Haas (1952) expressed this value as 9 for the holotype and Nader and Jawdat (1976) said it was 10. Arnold (1980) said that the number of supralabials is 9-12 in 11 specimens and Disi (2002) said they are 10-14 in 10 specimens.

The number of the scales between the posteriors of the eyes ranges 27-(34.26)-39 in the Anatolian sample, was 25 in the holotype (Haas 1952). When all of these values are considered, it seems they different. But there is no detailed information about the population of this species out of our country. So more comprehensive research is needed in the areas where the species is distributed.

The number of longitudinal rows for the scales under the finger is 1 in the Anatolian sample, corresponding to the information given by Haas (1952), Nader and Jawdat (1976), Arnold (1980), Disi et al. (2001) and Disi (2002). In addition that, Arnold (1980) expressed that this species has some similarities to *Stenodactylus sthenodactylus* as far as their characters are concerned. Moreover, in all of the specimens of *S. grandiceps* in Turkey, the fact that the scales under the finger are tricarinate shows that there is affinity with the other members of the species which has 3 rows under the finger (*S. slevini* and *S. affinis*).

The number of scales under the fourth finger of hind limb ranges 17-22 in most of the Anatolian sample (%95.65 on the left, %91.30 on the right), and varied 18-19 in the Jordan (Disi 2002). When all of these values are considered, it seems they overlap, so it can be said that the character has a wide range of variation.

Haas (1952) expressed that cloacal tubercles are more apparent in males than in females taking the holotypes and paratypes into consideration. The same situation was observed by us. However, there is no detailed information about this character in the other populations of the species except in Turkey and Iraq. At least, as far as the populations in Turkey and Iraq are taken into consideration, it is understood that there is a sexual dimorphism based on this characters.

Rostrum anus length, tail length, total body length, head length and head width, in the Anatolian sample show similarity to the information given by Haas (1952). The HL/RA index ranges 28.05-(30.18)-33.83 in the Anatolian sample and varied 26.32-(27.39)-28.85 in the Iraq (Haas 1952). When all of these values are considered, it seems they overlap, so it can be said that the character has a wide range of variation. The reason for the wide range of the character could either be the low number of specimens included in the study of Haas (1952) or the different places where the measurements were taken. The same thing can be said for the TL/RA and HW/HL indexes. In our specimens, the characters range respectively between 48.00-(57.13)-62.64 and 61.22-(67.16)-76.47 respectively. Haas (1952) expressed these values as 54.39-(60.30)-72.38 and 78-(81.43)-84.35 respectively.

At the end of the test which was performed in order to find if there is any sexual dimorphism in pholidosis and metric characters, we observed no difference in pholidotic character except gularia number. But among the body measurements, proportions and indexes of these measurements, significant differences were observed in 14 different body measurements (Table 3). There was no significant sexual difference (Table 4) in PERCRA index values. So taking these data into consideration, it was reckoned that the 14 metric characters change isometrically in the other word, to the degree how much the animals grew, but it difference in proportions between the male and female.

The partial pholidolial differences and the increase in the limits of variations which were seen at the end of the comparison of the data taken from the literature and the data collected in this study can result from different valuation methods or it could be the geographical variations which are seen in the species in interaction with the local ecology. Similar difference was given by Göçmen et al. (2002) and Tok et al. (1997) about the populations of two gecko species *Eublepharis angramainyu* and *Asaccus elisae* in our country and abroad.

Arnold (1980) expressed that the tip of the tail in *Stenodactylus grandiceps* and *S. leptocosymbotes* juveniles is a light color. The same thing was observed in the juveniles in Anatolia.

As to taxonomy, it is impossible to comment whether there is any differentiation of subspecies, because there is no detailed research about the populations of the species in their other distribution areas. In order to make this kind of distinction, we need specimens from different distribution areas of the species or more comprehensive revisional studies.

There are no natural boundaries between Syria and Turkey and so there is almost no endemism in this region. (Disi 1996, Disi and Böhme 1996, Göçmen et al. 2002) The South-eastern Anatolia region where the species is distributed play an important role for the herpetofauna of the Eastern Mediterranean region together with Syria. The South-eastern Anatolia and Syria form a region of connection between Afrotropical and Palearctic faunal elements. Because of the

Table 4. Summarized statistics for *Stenodactylus grandiceps* specimens of PERCRA index of metric characters, with P values from Student T-test in bold when the difference between the sexes in the same population is significant (P≤0.05). (N: number of specimens. SD: Standard deviation, SE: Standard error of the mean) (The details of the characters were given in "Material and Methods").

Characters	♀♀					T-test	♂♂					All*				
	N	Mean	Min.	Max.	SD	P	N	Mean	Min.	Max.	SD	N	Mean	Min.	Max.	SD
TL	7	55.56	48.00	61.26	4.200	0.053	4	59.89	58.00	62.64	2.200	11	57.13	48.00	62.64	4.100
TVU	7	155.60	148.00	161.30	4.200	0.053	4	159.90	158.00	162.60	2.200	11	157.10	148.00	162.60	4.100
HL	8	29.65	28.10	31.25	1.200	0.241	5	31.04	28.70	33.83	2.200	13	30.18	28.10	33.83	1.700
HW	8	20.21	18.50	23.89	1.800	0.958	5	20.25	19.00	21.19	0.800	13	20.23	18.50	23.89	1.400
HD	8	15.55	13.90	17.77	1.200	0.548	5	15.08	13.20	16.60	1.400	13	15.37	13.20	17.77	1.300
ML	8	2.38	2.08	2.81	0.200	0.132	5	2.58	2.40	2.84	0.200	13	2.45	2.08	2.84	0.200
MW	8	2.96	2.37	3.40	0.400	0.400	5	3.39	2.78	4.40	0.600	13	3.12	2.37	4.40	0.500
RH	8	2.60	2.03	3.79	0.600	0.092	5	2.64	2.24	2.92	0.300	13	2.62	2.03	3.79	0.500
RW	8	3.43	2.71	4.19	0.600	0.220	5	3.87	3.30	4.37	0.400	13	3.60	2.71	4.37	0.600
SNL	8	1.45	1.13	1.68	0.200	0.892	5	1.49	1.22	1.68	0.200	13	1.47	1.13	1.68	0.200
SNW	8	1.29	0.93	1.48	0.200	0.144	5	1.52	1.32	1.71	0.100	13	1.38	0.93	1.71	0.200
IL	8	2.37	2.04	3.10	0.300	0.687	5	2.57	2.33	2.79	0.200	13	2.45	2.04	3.10	0.300
HDEy	8	8.09	7.32	9.31	0.700	**0.031**	5	7.86	7.16	9.30	0.800	13	8.00	7.16	9.31	0.800
HDEa	8	2.30	1.70	2.90	0.500	0.209	5	2.24	1.86	2.74	0.300	13	2.28	1.70	2.90	0.400
ID	8	9.89	8.16	11.40	1.200	0.624	5	10.63	9.70	11.47	0.600	13	10.17	8.16	11.47	1.000
IE	8	18.44	16.40	20.81	1.400	0.789	5	17.55	16.00	19.37	1.400	13	18.10	16.00	20.81	1.400
DES	8	11.05	10.20	12.09	0.600	0.169	5	11.66	10.70	13.26	1.000	13	11.28	10.20	13.26	0.800
DEE	8	9.28	8.24	10.04	0.700	0.283	5	9.45	9.00	10.35	0.600	13	9.35	8.24	10.35	0.600
DEOS	8	26.21	23.80	29.53	2.000	0.262	5	26.82	25.20	28.51	1.500	13	26.44	23.80	29.53	1.800
DSF	8	38.71	35.50	41.95	2.400	0.630	5	41.07	40.10	42.60	1.000	13	39.62	35.50	42.60	2.300
FLF	8	7.20	6.55	8.24	0.600	0.543	5	7.15	6.61	7.60	0.400	13	7.18	6.55	8.24	0.500
FTF	8	8.39	7.13	9.68	0.900	**0.034**	5	8.86	8.57	9.16	0.300	13	8.57	7.13	9.68	0.700
DFE	8	15.51	14.00	17.11	1.100	0.855	5	15.91	14.00	18.35	1.800	13	15.66	14.00	18.35	1.300
DFW	8	29.86	26.00	31.79	2.000	0.183	5	30.59	27.00	35.07	3.000	13	30.14	26.00	35.07	2.300
FLL	8	41.96	34.20	48.70	4.900	0.665	5	44.65	41.50	48.07	2.800	13	42.99	34.20	48.70	4.300
FFL	8	6.13	4.84	8.30	1.100	0.643	5	6.74	5.21	8.02	1.000	13	6.37	4.84	8.30	1.100
FTL	8	10.18	9.08	12.69	1.300	0.231	5	10.97	9.37	13.84	1.800	13	10.48	9.08	13.84	1.500
DHK	8	18.68	16.70	20.94	1.600	0.567	5	19.41	15.90	22.67	3.000	13	18.96	15.90	22.67	2.100
DHA	8	34.00	29.40	37.98	2.700	0.327	5	36.30	33.60	41.84	3.500	13	34.88	29.40	41.84	3.100
HLL	8	48.76	30.10	53.26	7.800	0.420	5	52.43	48.30	60.53	4.900	13	50.17	30.10	60.53	6.800

reason that there is no geographical difference between our country and Syria, the syroeremic *Cyrtopodion scaber, Assaccus elisae, Acantyhodactylus boskianus, Platyceps ventromaculatus, Eirenis coronella* and *Spalerosophis diedema,* and *Iranoeremic Eublepharis angramainyu* forms were taken from the places close to the Syrian borders (Göçmen et al. 2002, Baran und Atatür 1998). So it is not astounding to find *Stenodactylus grandiceps* occurs in the partially desert biotopes in Mesopotamia. In light of the literature available and our studies, it is understood that *S. grandiceps* is distributed in isolated population from Wadi Araba region in the South of Jordan to Syria, from the South of Gaziantep and Kilis to Dicle River in Iraq. Although Arnold (1986) expressed that the species is distributed throughout the North of Saudi Arabia, there has been found no proof on its existence in the region.

As a result of our comprehensive studies throughout the borders between our country and Syria, it was understood that this species is distributed only in the South of Kilis and Gaziantep. At the end of this study, some detailed information about the population of the species in our country from the point of view of morphology, ecology and biology (feeding and behavior) is provided by collecting 23 specimens from the areas they are distributed.

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