

A taxonomic comparison of the Hardun, *Laudakia stellio* (Reptilia, Agamidae), populations of southern Turkey (Hatay) and Cyprus

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Abstract. The *Laudakia stellio* population in the Hatay region, on the southeast Mediterranean strip of Turkey, was investigated in detail by mapping morphometric and meristic characters as well as colour and pattern features. On the basis of the morphometric characters present in the population sample examined, we conclude that the Hatay population should be included in the subspecies *Laudakia stellio stellio*. Comparison of the Hatay population with *L. s. cypriaca* from Cyprus showed that these two populations represent two separate subspecies.

Kurzfassung. Im Hatay, dem mediterranen Gebiet in Südostanatolien, wurde die Population des Harduns, *Laudakia stellio*, detailliert im Hinblick auf morphologische Merkmale, Färbung und Zeichnungsmuster untersucht. Aufgrund von morphometrischen Eigenschaften folgern wir, dass die Hatay-Population am besten der Nominatform zuzurechnen ist. Der Vergleich dieser Population mit *Laudakia stellio cypriaca* von Zypern ergab, dass beide Populationen zwei separate Subspezies darstellen.

Key words. Morphology, taxonomy, systematics, Middle East, eastern Mediterranean.

Introduction

The Starred Agamas or Hardun, *Laudakia stellio* (Linnaeus, 1758), formerly *Agama stellio*, have long been known from southern Europe, northern Africa and the Middle East. In Turkey they inhabit suitable habitats, whether arid or vegetated, such as sand-dunes to ruins, crevices of terraces, stone walls and stones, the underside of large rocks, and crevices in tree-trunks. Except for the Black Sea coast, the distribution covers the western, southern, central and south-eastern regions of Turkey, including the islands on the Aegean strip in Anatolia (BARAN et al. 1989).

A number of subspecies, which differ in their pattern, colouration, body size, number and order of scales, are known from Europe, Anatolia and northern Africa. DAAN (1967) found a considerable amount of variation within the Levantine *Laudakia stellio*, especially in the southern part of the range where variation in colour pattern and scale arrangement appeared to be high. DAAN (1967) claimed that the species may be divided into five subspecies (*stellio* in Greece, Turkey, Syria, Lebanon, Israel and Jordan; *picea* in the black lava desert of Jordan; *cypriaca* on Cyprus; *brachydactyla* in the Negev, southern Sinai, Jebel'Aja; *vulgaris* in north-western Egypt), and considered the Anatolian population to represent *L. s. stellio*.

Subsequently, BEUTLER & FRÖR (1980) described a new subspecies, *L. s. daani*, from Ikaria Island in the Aegean Sea, based on the presence of blue scales on the dorsum and femur which differentiates this taxon from the nominate subspecies. This subspecies occurs in Anatolia as well as on the surrounding islands. BEUTLER & FRÖR (1980) considered all populations of the former *L. s. stellio*, except for those on some of the Aegean islands, to belong to the subspecies *L. s. daani*. However, BAIG (1992), who studied the *stellio* group of *Agama* by reviewing material from its entire distribution range, rejected the subspecies *daani* and recognized only four subspecies in addition to the nominate form (*stellio*, *cyprica*, *picea*, *brachydactyla*, and *vulgaris*).

In a detailed study of Turkish *Laudakia stellio* populations, BARAN & ÖZ (1985) stated that in terms of colour and pattern characteristics the western Anatolian populations are rather similar to *L. s. daani*, and they classified specimens from south-eastern Anatolia (Gaziantep and Şanlıurfa areas) as *L. s. stellio*. BARAN et al. (1989) summarized all previous distribution data.

DAAN (1967) had pooled specimens from the Hatay region in southern Turkey with those from Syria, concluding from their metric and meristic characteristics that they represent a homogenous population. However, BARAN & ÖZ (1985) found character similarities between Hatay specimens and individuals from south-eastern Anatolia, which they referred to *L. stellio stellio*. Both DAAN (1967) and BARAN & ÖZ (1985), who examined only a limited number of specimens from the Hatay, emphasised the complicated taxonomic status of this population. They also suggested that the populations from the Hatay region, which is divided by the Amanos (Nur, Gavur) Mountains, a recognized zoogeographic barrier, should be subjected to a detailed morphological examination.

Various researchers (GÖÇMEN et al. 1996, SCHÄTTI & SIGG 1985, BÖHME & WIEDL 1994) have drawn attention to shared herpetofaunal characteristics between the Hatay region and Cyprus. In the present study, therefore, we have not only examined *Laudakia stellio* specimens from the Hatay region with the aim of clarifying their subspecific status but have also compared them with the Cyprus populations.

Material and methods

A total of 53 *Laudakia stellio* specimens was examined: 26 of them (8 ♂, 11 ♀, 7 juveniles) from the Hatay region, and the remaining 27 specimens (4 ♂, 13 ♀, 10 juveniles) from northern Cyprus. All specimens examined were preserved, and are deposited in the museum of the Zoology Department of the Ege University (ZDEU). For each specimen examined, the sex, origin, collector, catalogue number and date of collection are given in Tab. 1. The localities where specimens were collected are shown in Fig. 1. In addition to colour and pattern characteristics, we also recorded the number of supralabialia (Sp) and sublabialia (Sb), and number of subdigitals on the right third finger (f3) and on the right fourth toe (p4). Three different morphometric measurements were taken (in mm) as follows: head length (H; distance from tip of snout to posterior end of jaw articulation); body (snout-vent) length (SV; distance between tip of snout to anterior edge of anus); and tail length (TL; distance from anterior tip of anus to end of tail). To compare the sexes, as well as specimens from Hatay and Cyprus, we utilised the head index ($100 \times H/SV$) and the tail ratio (TL/SV). For taxonomic inferences, we used MAYR'S (1969) formula of the Coefficient of Difference (CD).

Tab. 1. *Laudakia stellio* specimens used, listed by locality, collector(s), sex, date of collection and catalogue number (ZDEU= Zoology Department, Ege University İzmir). TR = Turkey, CYP = Cyprus.

locality	collector	sex	date	catalogue no.
Hatay, TR	unknown	2 ♂, 2 ♀, 3 juv.	10.10.1957	ZDEU-108/1957
Yayladağ-Hatay, TR	İ. Baran	1	29.06.1974	ZDEU-73/1974
Döver Village-Harbiye, Hatay, TR	M.Tosunoğlu, B.Aykaç	5 ♂, 9 ♀, 4 juv.	18.05.1997	ZDEU-54/1997
Lapta-Girne, CYP	B. Göçmen	2 + 2 juv.	23.07.1989	ZDEU-38/1989
Lapta-Girne, CYP	B. Göçmen	2 ♂, 1 ♀	25.06.1991	ZDEU-96/1991
Lapta-Girne, CYP	B. Göçmen	1 ♂, 1 ♀, 1 juv.	26.06.1991	ZDEU-96/1991
Lapta-Girne, CYP	B. Göçmen	1	29.07.1993	ZDEU-78/1993
Lapta-Girne, CYP	B. Göçmen, O. Sağlam	1 ♂, 3, 4 juv.	26.06.1991	ZDEU-38/1994
Bostancı-Güzelyurt, Lefkoşe, CYP	B. Göçmen, O. Sağlam	2	24.08.1994	ZDEU-39/1994
Salamis-G. Magosa, CYP	B. Göçmen	2 +3 juv.	27.08.1994	ZDEU-41/1994

Results

Pholidosis

We found no statistically significant differences between males and females for either morphometric or meristic characters. The sexes were therefore pooled for further analyses. Similarly, no significant differences were found between adults and juveniles after a separate examination of the juvenile samples. There, data derived from juveniles were also pooled with adult data for further analyses. The counts for sublabialia (sb), supralabialia (sp) and subdigitals (f3 and p4), as well as the computed values for relative head ($100 \times H/SV$) and tail lengths (TL/SV), are given in Tab. 2. CD for the relative tail length between the two populations investigated is 1.28.

Colour and pattern characteristics

Hatay. In general, the backside ground colouration shown by the Hatay specimens is brownish-grey (73.3%), but blackish-grey in a minority of specimens (26.7%). Almost all specimens (86.7%) have blue coloured scales on their heads and femora. In general (93.3%), the heads are laterally reddish-yellow or coppery-yellow in colour, particularly the outer eardrum area and areas towards the gular region. 60.0% of the individuals have four yellow or grey rhomboidal patches on the vertebral area, which extend from the gular region to the tail pedestal, whereas the rest (40%) have a yellow or greyish-yellow band-like pattern in this region.

The chins in the Hatay specimens usually have lighter spots (Fig. 2A) on a dark ground, similar to a mosaic (63.2%). However, by contrast, some specimens have longitudinal and fragmented dark stripes on a lighter background (36.9%) (Fig. 2B). In this geographic region, these patterns are concentrated mostly along the margins (93.3%). However, the median side of the chin is unspotted and greenish or reddish-yellow in all specimens.

Tab. 2. Descriptive statistics for the number of subdigitals in the third finger (F3) and fourth toe (t4), supralabiale (Sp), sublabiale (Sb), relative tail length (T/SV), and relative head length (100xH/SV) in *Laodakia stellio* from Hatay and Cyprus (SD = standard deviation, SE = standard error, N = number of specimens, * indicates that the CD value is 1.28).

HATAY SPECIMENS

	Males + Females					Juveniles					Adults + Juveniles				
	N	Range	Mean	SD	SE	N	Range	Mean	SD	SE	N	Range	Mean	SD	SE
F3	19	18-21	19.10	0.73	0.16	7	18-21	19.57	1.13	0.42	26	18-21	19.23	0.86	0.16
t4	19	23-26	25.10	0.99	0.22	7	24-27	25.57	1.13	0.42	26	23-27	25.23	1.03	0.20
Sp	19	10-13	11.26	0.93	0.21	7	10-12	10.57	0.78	0.29	26	10-13	11.07	0.93	0.18
Sb	19	9-12	11.21	0.97	0.22	7	9-12	11	1.00	0.37	26	9-12	11.15	0.96	0.10
T/SV	8	1.24-1.50	1.42	0.08	0.03	6	1.30-1.52	1.44	0.08	0.03	14	1.24-1.52	1.43*	0.08*	0.02
100xH/SV	19	24.8-33.5	29.89	1.96	0.45	7	29.6-33.3	31.31	1.30	0.49	26	24.76-33.50	30.27	1.89	0.37

CYPRUS SPECIMENS

	Males + Females					Juveniles					Adults + Juveniles				
	N	Range	Mean	SD	SE	N	Range	Mean	SD	SE	N	Range	Mean	SD	SE
F3	17	18-22	19.58	1.22	0.29	10	19-21	19.90	0.99	0.31	27	18-22	19.70	1.13	0.21
t4	17	23-27	25.29	1.35	0.32	10	23-27	24.60	1.43	0.45	27	23-27	25.03	1.40	0.26
Sp	17	11-14	12.52	1.12	0.27	10	11-12	11.90	0.31	0.10	27	11-14	12.37	1.00	0.19
Sb	17	11-14	12.58	1.12	0.27	10	12-14	12.30	0.67	0.21	27	11-14	12.44	0.93	0.18
T/SV	13	1.46-1.80	1.70	0.09	0.02	10	1.45-1.73	1.61	0.09	0.02	23	1.45-1.80	1.66*	0.10*	0.02
100xH/SV	17	25.9-32.3	29.13	1.88	0.45	10	28.8-32.2	30.02	1.04	0.33	27	25.9-32.3	29.46	1.66	0.32

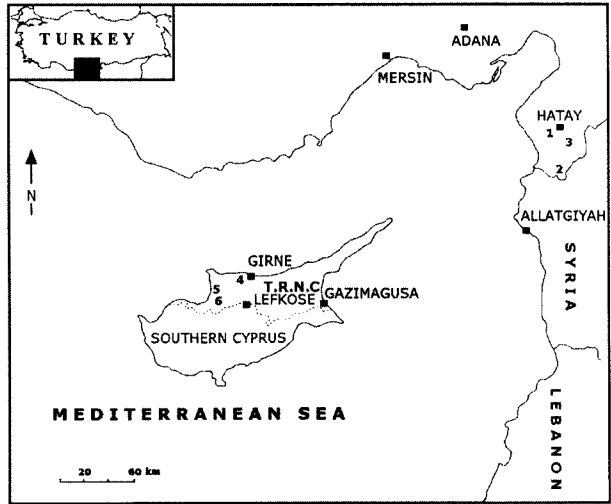


Fig. 1. The localities where the specimens were collected: 1.- Hatay; 2.- Yayladağı-Hatay; 3.- Harbiye-Hatay; 4.- Lapta-Girne; 5.- Güzelyurt-Lefkoşe; 6.- Salamis-Güzelyurt.

52.6% of the specimens examined do not have a patch or a spot on the reddish-cream coloured background of the abdomen, while 36.8% are partly patched, and a very few (10.52%) fully patched. However, the abdomen of all the juveniles examined has characteristic darker patches, resembling spots, in various densities.

Cyprus. The dorsal ground colouration of Cyprian specimens is blackish-grey. The heads, limbs and tails are dull olive-green in these specimens. The majority (83.0%) have a pale spotless chin (Fig. 2C). The remaining individuals, all juveniles, have their chins with longitudinal and interrupted dark stripes (Fig. 2B) on a lighter background. The dark blackish spots seen particularly on the anterior half of the body and collar area become gradually smaller posteriorly and disappear at the level of the rear limbs. This spot-like, greyish-yellow colouration extending from the neckline to the rear limbs is not present ventrally in the Cyprian specimens. However, one of the alcohol-preserved juveniles has a tape-like, pale colour pattern on the vertebral region, which is partly fragmented and scattered between the neck and rear limbs.

Although the background colour of the ventral body surface in specimens from Cyprus is generally light greenish or yellow, yellow is relatively dominant on the gular area and rear legs. In spite of the presence of scattered small black spots on the background in some specimens, the belly is light yellowish and almost unspotted. The reddish-brown colouration is evident on the lateral sides of the head, especially on the otic area, the dorsal head surface, and the base of the tail.

Discussion and conclusion

BARAN & ÖZ (1985) classified specimens from south-eastern and southern Anatolia (including Hatay) into three groups according to the type of patching they showed (categories in decreasing order of abundance): unpatched abdomen in the majority of individuals (54%),

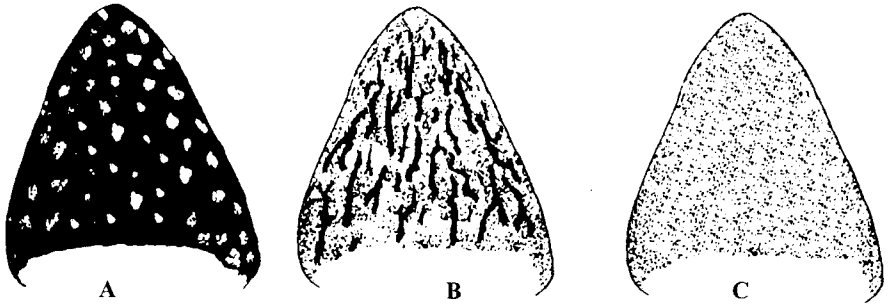


Fig. 2. Three different chin pattern types as found in *Laudakia stellio*: Type A: light mosaic-like spots on dark ground colour; Type B: dark interrupted strip-like spots on light-coloured background; Type C: unspotted.

scarcely visible patches in a considerable number of specimens (41%), and clear patches in rare cases (5%). These authors also mentioned the relatively frequent existence of light spots (87%) on a darker ground on the chin. In terms of both dorsal and ventral colouration and the occurrence of spots on the chin, therefore, the *Laudakia stellio* population from the Hatay region shows characteristics which are quite similar to those given by BARAN & ÖZ (1985) for the subspecies *L. s. stellio* from eastern Anatolia. As for the presence of blue-coloured patches on the dorsal side, head and femur, the relatively unspotted or unpatched abdomen (52.6%), and the mosaic-like spots frequently seen on the chins (63.2%) in our Hatay specimens, these individuals differ in these features from the characteristics typical for the western Anatolian *L. stellio* population as described by DAAN (1967). The four greyish-yellow rhomboidal patches, extending on the vertebral area from the neck to the rear legs, as seen in the Hatay specimens, were not present in the sample from Cyprus. The colour and pattern characteristics shown by our Cyprian specimens are quite similar to those listed by DAAN (1967) for *L. s. cypriaca*.

Descriptive statistics for morphometric and meristic characters derived from this study and from earlier studies by other researchers are given in Tab. 3. As can be seen, missing data (e.g., 100xH/HS) and pooled data (e.g., West Anatolia + Sporades, Hatay + Northwest Syria and Hatay + South-Central Anatolia + Northwest Syria) prevented us from comparing our data with those of DAAN (1967). However, our morphometric and meristic data are in congruence with those given by DAAN (1967) for Cyprus, and by BARAN & ÖZ (1985) for Hatay.

WERNER (1992) and DISI & AMR (1998) regard *L. s. picea* as being a Jordanian endemic. MORAVEC & MODRY (1994) listed the occurrence of *L. s. picea* as a new herpetological record for Syria. PANOV & ZYKOVA (1997) compared a total of 63 individuals from Central Negev, within the distribution range of *L. s. brachydactyla*, with an unnamed form (tentatively "Near-East rock agama") in NE Israel (Qyriat Shemona), and showed that the specimens from NE Israel apparently do not belong to the nominate subspecies *L. stellio* and should be regarded as yet another subspecies. These studies and our own results recommend a cautious approach to DAAN'S pooled data from Syria and Hatay, and raise the question

Tab. 3. Comparison of the results obtained from this study with those given by DAAN (1967) and BARAN & ÖZ (1985), for various population of *Laudakia stellio*; * indicates the pooled populations including West Anatolia + Sporades (Ikaria, Samos and Rhodes); ** indicates the pooled populations including Hatay + northwest Syria; *** indicates the pooled populations including Hatay + South-Central Anatolia + northwest Syria. References: 1- this study; 2- DAAN (1967); 3- BARAN & ÖZ (1985).

localities	refer.	f3	t4	T/SV	100xH/SV
Hatay	1	18-(19.2)-21	23-(25.23)-27	1.24-(1.43)-1.52	24.76-(30.27)-33.50
	2	16-(18.2)-22**	20-(23.50)-27**	1.19-(1.43)-1.57***	-
	3	15-(18.5)-21	21-(22.60)-24	1.38-(1.47)-1.62	28.95-(30.38)-31.14
Cyprus	1	18-(19.7)-22	23-(25.05)-27	1.45-(1.66)-1.80	25.96-(29.46)-32.32
	2	19-(20.1)-22	22-(25.80)-27	1.53-(1.73)-1.92	-
W. Anatolia	2	15-(16.4)-18*	20-(21.80)-24*	1.74-(1.44)-1.50*	-
	3	14-(16.3)-18	18-(20.20)-24	1.42-(1.48)-1.60	27.34-(30.27)-32.38
S. Anatolia	2	15-(16.6)-18	17-(21.20)-23	1.19-(1.43)-1.57***	-
	3	13-(15.9)-18	15-(19.10)-21	1.36-(1.45)-1.56	27.16-(29.83)-32.50
Ş. Urfa	3	14-(16.4)-19	17-(19.40)-22	1.25-(1.34)-1.45	27.21-(29.59)-32.16
Lebanon	2	14-(18.6)-22	19-(24.20)-27	1.29-(1.47)-1.69	-

of whether the Hatay population is an intermediate form between the nominate subspecies *L. s. stellio*, from the north, and the other still unnamed subspecies described by PANOVA & ZYKOVA (1997) from the more southern parts of the species' range.

Adding to this controversy, MAYR'S CD value of 1.28 (conventional level of subspecific difference, 75% rule) indicates that there is a difference between populations from Hatay and Cyprus (Tab. 2), but a close affinity between the Hatay population and the nominate subspecies inhabiting eastern and southeastern Anatolia (see BARAN & ÖZ 1985 for means and standard deviations). According to these morphometric, meristic, and colour and pattern characteristics, we have here two populations which are taxonomically distinct at the subspecies level. Consequently, according to the characteristics which we have compared in this paper, the Hatay *L. stellio* population resembles, and is taxonomically linked with, the one in eastern and south-eastern Anatolia, and we consider the Hatay population to represent the taxon *Laudakia stellio stellio*. As regards the differences found between *L. s. cypriaca* from northern Cyprus and the population in Hatay, we conclude that both populations represent two separate subspecies.

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