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A study on the skull of the striped hyaena (*Hyaena hyaena*: Hyaenidae, Carnivora)

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Abstrac: Striped hyena one of the rapidly declining carnivore in Turkey (near threatened worldwide). Field studies have been carried out since 2013 in order to determine the current status and ecology striped hyaena in Hatay and Şanlıurfa provinces. During our field surveys, four skulls and mandibulae of striped hyena were found. The muscles and skin parts were cleaned in the laboratory, skulls were kept in 1% sodium hypochlorite solution for 24 hours and then washed with water. Examination and measurements were made on the skulls and photographs were taken. Fascial length, Cranial length, Skull width, Cranial width, Skull base and Palatal length measurements of skulls; total length, total height, candular height and length of dental series on the mandible were respectively measured. The anatomical structures of skulls was photographed from the top, bottom and sides. Because of lack of information about the anatomical measurements and structure of the skull of the striped hyena, this study was needed. Additionally, factors impacting the population of striped hyena in Hatay and Şanlıurfa countryside are briefly given. If we look at the purpose of this study after, the detailed information gathered, now calls for prioritization of detailed studies on the skull that have not been conducted so far. The ecology of the striped hyena also needs to be studied in Turkey. The study is also an effort to intive the attention of the researchers to focus on the research regarding the rapidly deterioraing population of the striped hyena and determining the current status.
Keywords: Striped Hyaena; *Hyaena hyaena*; Hyaenidae; Carnivora

Çizgili sırtlan (Hyaena hyaena: Hyaenidae, Carnivora) kafatası üzerine bir çalışma

Özet: Türkiye'de sayıları hızla azalan carnivorlardan biri olan çizgili sırtlanların Hatay ve Şanlıurfa illerindeki mevcut durumunu ve ekolojisini belirlemek amacıyla 2013 yılından beri arazi çalışmaları yapılmaktadır. Arazi çalışmaları süresince toplam dört tane çizgili sırtlana ait kafatasları ve alt çeneleri bulunmuştur. Laboratuvarda kas ve deri parçaları temizlenen kafatasları %1'lik sodium hypochlorite çözeltisinde yaklaşık 24 saat bekletildikten sonra su ile yıkanmıştır. Kafataslarının üzerinde incelemeler ve ölçümler yapılarak fotoğrafları çekilmiştir. Kafataslarının sırasıyla Fascial length, Cranial length, Skull width, Cranial width, Skull base, Skull width ve Palatal length ölçümleri; mandible üzerinde de Total length, Total height, Candular height ve Length of the dental series ölçümleri yapılmıştır. Kafataslarının üstten, alttan ve yandan fotoğrafları çekilerek anatomik yapıları fotoğraf üzerinde gösterildi. Çizgili sırtlana ait kafatasının anatomik ölçümleri ve yapısı hakkında bilgi eksikliği olduğu için bu çalışmaya ihtiyaç duyulmuştur. Çalışmaya ek olarak, Hatay ve Şanlıurfa kırsalındaki çizgili sırtlanlara yönelik en büyük tehdit unsurları kısaca verilmiştir. Çizgili sırtlan hakkında verilen ayrıntılı bilgilerden sonra bu çalışmanın amacına bakarsak, şu ana kadar incelenmemiş olan kafatasına öncelik vermekti. Buna ek olarak, Türkiye'de sayıları hızla azalan çizgili sırtlanların Türkiye'deki araştırmacıların dikkatini bu canlılara çekmektir.
Anahtar Kelimeler: Striped Hyaena; *Hyaena hyaena*; Hyaenidae; Carnivora.

1. Introduction

Being a large set of carnivores, the hyena family is represented by only four species on earth (*Hyaena hyaena, Parahyaena brunnea, Crocuta crocuta, Proteles cristata*) (Mills and Hofer 1998; Koepfli et al. 2006; Yıldırım 2010; Sheng et al. 2014; Atay et al. 2017). Regarding their general characteristics, striped hyenas have similar natural distributions; they prefer steppes, semi-deserts, rocky fields and valleys with sparse trees (Mills and Hoffer 1998). They avoid deserts, high altitude areas, dense bushes and forests. Striped hyena prefers living inside caves (Mills and Hoffer 1998; Yıldırım 2010; Atay et al. 2017). Just like the rest of the world, these animals strive for survival with humans in their co-habitation. These animals also contribute to the health of ecosystem by eating dead and decaying animal

carcasses (Mills and Hofer 1998; Bunaian et al. 2001; Singh, 2008; Stein et al., 2013). Dietary preferences of the species include spined (Bon et al. 2012) and non-spined animals, various fruits, vegetables and human-sourced organic wastes (Wagner, 2006). Being a dietary opportunist, hyenas are omnivore carcass eaters. When starved, they can feed on melons, watermelons, grapes and some other vegetables (Mills and Hoffer 1998; Yıldırım 2010).

Striped hyena lives in rocky mountains and valleys located in semi-deserts, steppes, bushes and crooked pine forests of Turkey (Yıldırım 2010). Striped hyaena is a carnivore with dog-like posture (Abi-Said, 2004). The back is inclined to the tail with vertical black stripes on sides of the body. Overall body colour is pale-gray or beige. There are 5 - 9 prominant vertical stripes on the body, vertical and horizontal light-black stripes on front and hind legs. Body mass is around 26-41 kg in males and 26-34 kg in females (Mills and Hofer 1998; Yıldırım 2010; Atay et al. 2017). The striped hyena gives birth one to four (average three) off springs after approximately 90 days of pregnancy (Wagner 2006). The offspring begins feeding on meat after 30 days. They are reported to be fed on mother's milk until they are four to five months old. In Turkey, striped hyenas mate in January and February. They give birth in April and May and females are mature for mating when they are almost two - three years old (Mills and Hofer 1998; Wagner 2006; Yıldırım 2010; Atay et al. 2017).

The species is distributed over North and Middle Africa, Anatolia, Arabian Peninsula, Middle East, Caucassia, Middle Asia and India (Rieger 1981; Mills and Hofer 1998; Bunaian et al. 2001; Wagner 2006; Yıldırım 2010). Kumerloeve (1982) reported the first information on the presence of striped hyenas in Central, East, West and South-East Anatolia. Kasparek et al. (2004) indicated that the striped hyena has a non-uniform distribution in Turkey and has been recorded in Çanakkale, İzmir, Antalya, Hatay and South-East Anatolia (Şanlıurfa) of Turkey in the last 25 years. According to their distribution over a wide range of areas, regional adaptations and morphological changes, striped hyaena is represented by the following species; *Hyaena hyaena barbara* (Northwest Africa), *Hyaena h. dubbah* (Northeast Africa), *Hyaena h. sultana* (Arabian Peninsula), *Hyaena h. syriaca* (Syria, Anatolia and Caucassia), *Hyaena h. hyaena* (India) (Rieger 1981; Mills and Hofer 1998; Qarqaz et al. 2004; Singh 2008; Yıldırım 2010; Atay et al. 2017).

The International Union for the Conservation of Nature (IUCN) has classified the striped hyena as Near Threatened (Abidsaid and Dloniak. 2015). Despite the important role of the striped hyena in ecosystems, little effort has been devoted in studying them. Habitat changes across their range seem a possible cause of declining populations (Ripple et al. 2014). Evaluation of the population status and their habitat features at the local and regional level is essential for planning a conservation plan for viable populations. Monitoring these animals in their habitats appears to be a better strategy for such conservation approaches. Only a few studies have looked into the ecology of striped hyena (Singh 2008; Yıldırım 2010; Atay et al. 2017).

Because of the lack of information on the anatomical measurements and structure of the skull of the striped hyena, this study was undertaken.

If we look at the purpose of this study after the detailed information given about the striped hyena, it should give priority to the skull that has not been study so far. Another purpose is to provide the ecology of the striped hyena in Turkey. In addition, the striped hyena is declining rapidly in Turkey, by the work we would like to take attention of the researchers to these creatures.

2. Materials and Method

Field studies have been carried out since 2013 in order to determine the current status and ecology of Hatay and Şanlıurfa provinces. Field studies were conducted in Antakya, Altınözü, Kırıkhan and Yayladağı districts in Hatay province; Birecik and Halfeti districts in Şanlıurfa province.

In this study, backpack, 5 camera traps (Bushnell), Canon EOS 70D digital camera, laptop (Hp), digital caliper, Olympus sterio microscope, petri dishes and pliers of various sizes were used.

Four striped hyena skulls were found in field studies. The skulls were brought to the laboratory with the mandibles. The extraneous material such as soil and mud on the skulls was washed with water and then left in 1% sodium hypochlorite solution for 24 hours. Then, the remains of soft tissues such as skin and muscles on the skull were cleaned with scalpel and forceps. After washing the skulls with plenty of water, skulls were allowed to dry. Fallen or swinging teeth on the maxilla and mandibula of the skull were fixed in place.

Measurements were taken on the skulls and mandibula using digital callipers to determine anatomical structures. The measurements made on the skull are given in Table 1. Fascial length, cranial length, skull width, cranial width, skull base and palatal length measurements of skulls; total length, total height, candular height and length of dental series were measured on the mandible. The anatomical structure of skulls were photographed from the top, bottom and sides. The anatomical structure were shown in the image.

3. Results and Discussion

Four striped hyena skulls were found during field surveys in Antakya, Altınözü, Kırıkhan and Yayladağı districts of Hatay province and Birecik and Halfeti districts of Şanlıurfa province. One female killed in a car crash in the Küncülü Strait near Enek village of Antakya district of Hatay province in 2014, two skulls were found in the area near the Syrian border in 2015 and 2016. The fourth skull was found in the rocky area near Sucu village of Kırıkhan district near the Syrian border in 2019.

Anatomic measurements are given in Table 1. As the skulls worn out under field conditions, some teeth were missing from maxilla and mandible. Six incisors, two canines, four premolars and two molars teeth on Maxilla, and six incisors, two canines, three premolars and two molars on the mandible were still present.

Dorsal and ventral views of skull showing craniometric points; bones of the skull, dorsal and ventral aspects, cranial sutures, dorsal and ventral aspects; skull and mandible anatomy; maxilla and mandible teeth series were exhibited in this research (Figures 1, 2, 3, 4, 5, 6, 7, 8, 9, 10).

Four skulls were gathered off dead animals from 2014 to 2019. One female was killed in 2014 in a road accident, another shot as traced by hunting dog in 2015, the third found dead in a village near Syrian border in 2016, and the fourth was found in the rocky area near Sucu village near the Syrian border in 2019, killed by a pack of shepherd dogs as was apparent from numerous lethal deep tooth marks found on its throat. Killing of two striped hyena by shepherd dogs was in March 2019 in a rocky area at a location near the Syrian border and another from Adıyaman countryside in April 2019 (Figure 11 A, B, C, D). Such events represent the greatest threat to the striped hyena generation.

In Şanlıurfa (Birecik and Halfeti), striped hyena generally prefers caves around semi desert fields and sparsely vegetated fields with rocky and steep surroundings. There are eight actively used caves. Although the definite number is not certain, 20 individuals are thought to be living in this region. An image of a mother and baby striped hyena obtained near the Syrian border of the Kırıkhan district of Hatay. (Figure 12).

Table 1. The anatomical measurements of the mandibles and skulls of the Striped Hyaena.

Morphometric Parameters	Sample 1 (Female)	Sample 2 (Sex unkn)	Sample 3 (Sex unkn)	Sample 4 (Sex unkn)	Average (mm)
Skull Base	189	168	178	183	178
Skull Width	160	122	149	154	146
Palotal Length	114	99	105	111	107
Fascial Length	73	63	68	70	69
Cranial Length	160	133	148	153	149
Cranial Width	62	56	58	59	59
Total Length (TL)	172	148	168	165	163
Total Height (TH)	86	75	80	82	81
Candular Height (CH)	55	44	50	53	51
Length of the Dental Series (LDS)	105	95	100	102	111

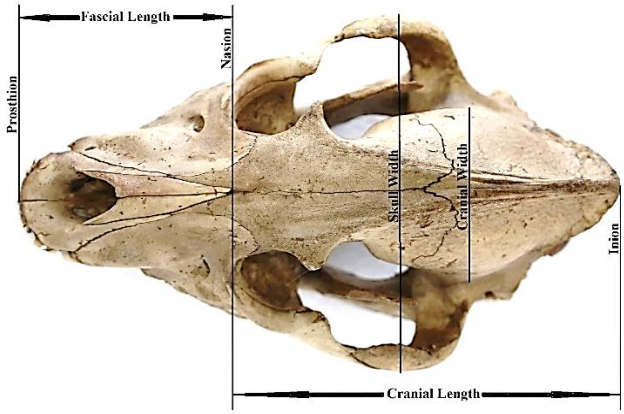

Figure 1. Skull, dorsal view showing craniometric points.

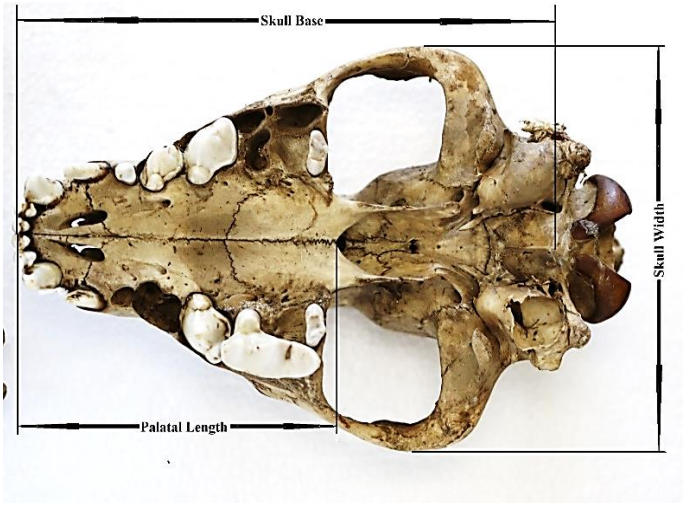

Figure 2. Skull, ventral view showing craniometric points.

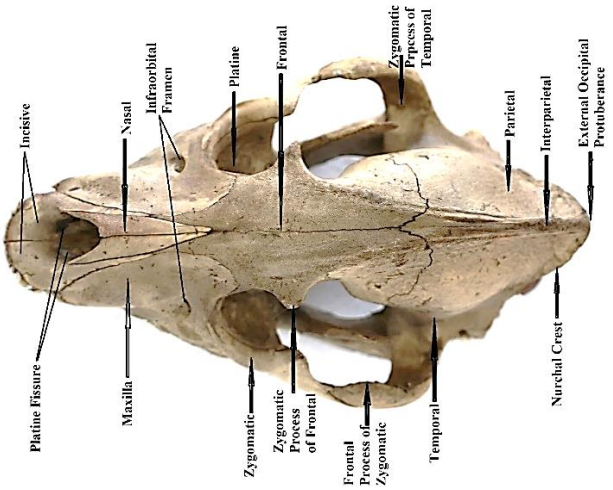

Figure 3. Bones of the skull, dorsal aspect.

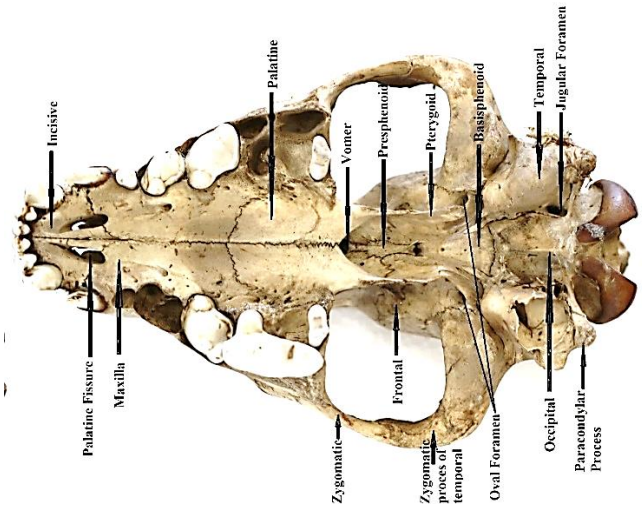

Figure 4. Bones of the skull, ventral aspect.

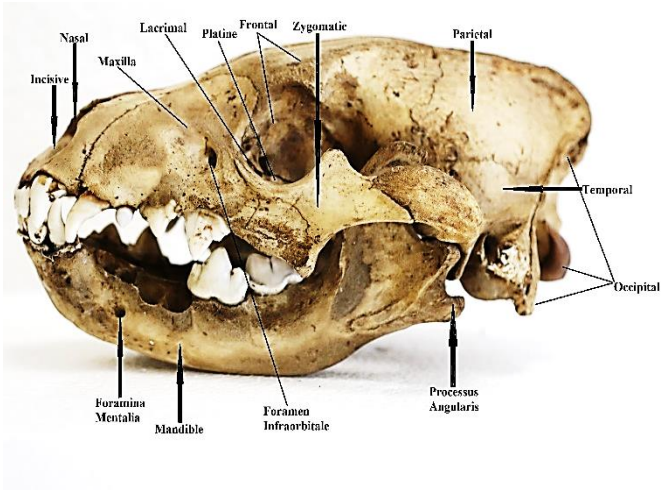

Figure 7. The Striped Hyaena skull anatomy, lateral aspect.

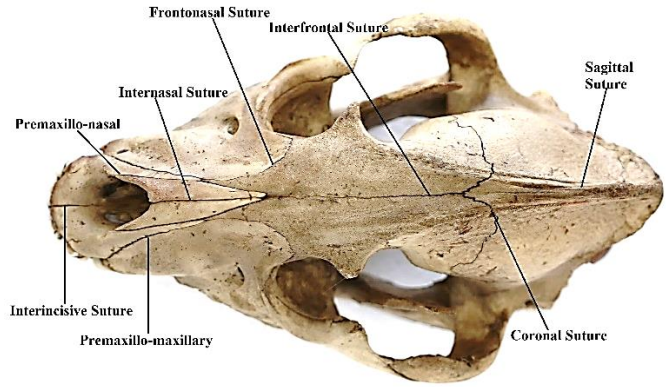

Figure 5. Cranial sutures, dorsal view.

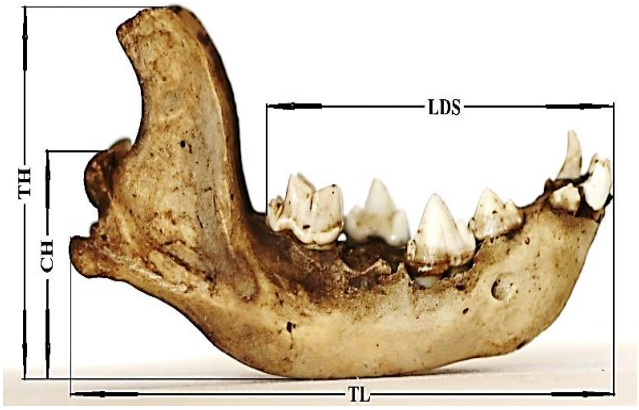

Figure 8. Mandible of the Striped Hyaena (mandible lateral view: total length = TL, total height = TH, candular height =CH and length of the dental series = LDS).

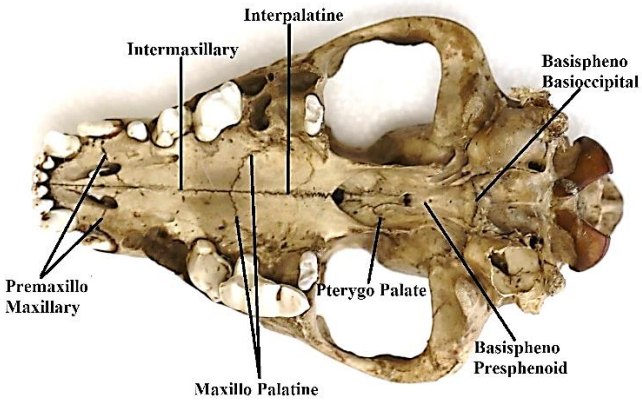

Figure 6. Cranial sutures, ventral view.

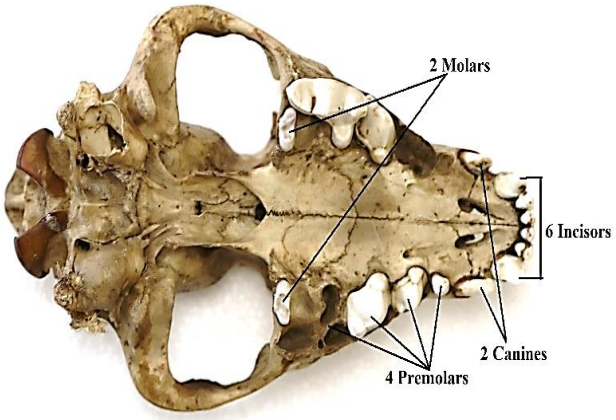

Figure 9. The maxilla teeth series of the Striped Hyaena

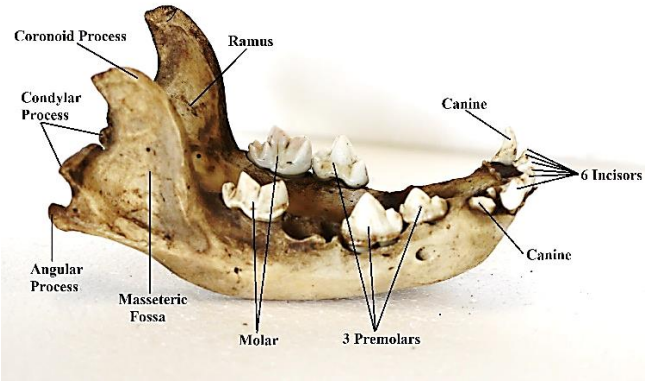

Figure 10. The mandible teeth series of the Striped Hyaena.

Figure 11. A. Female hyena killed hitting a vehicle in Enek Village in Hatay (2014), B. A hyena killed in a vehicle crash on the Gaziantep-Şanlıurfa Highway (January 2017), C. A hyena killed by shepherd dogs, Kırıkhan District of Hatay (April 2019), D. A striped hyena shredded by shepherd dogs in the Adıyaman countryside (2019).

Figure 12. A female and her baby in the Syrian province of Hatay. (Nisan 2019).

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