# A Comparative Morphological and Karyological Study on Hedgehogs, *Erinaceus concolor* Martin, 1838 and *Hemiechinus auritus* (Gmelin, 1770) (Erinaceomorpha: Mammalia) in Diyarbakır Province*

**Servet ULUTÜRK[1], Yüksel COŞKUN[2]**
[1]Batman Üniversitesi Fen-Edebiyat Fakültesi Biyoloji Bölümü, Batman
[2]Dicle Üniversitesi Fen Fakültesi Biyoloji Bölümü, Diyarbakır

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**Abstract:** In this study, we examined the morphological and karyological characteristics of *Hemiechinus auritus* and *Erinaceus concolor* (4 male, 3 female) in Diyarbakır province. The karyotypes of E. *concolor* (2n = 48) and *H. auritus* (2n = 48) were found similar and but distinctly all the autosomal chromosomes of both species were determined to be biarmed in contrast to the some previously published accounts.
There are obvious differences on the tooth roots that could be used in key to genera between *Hemiechinus* and *Erinaceus* are determined by the results of this study.
**Key words:** *Erinaceus concolor*, *Hemiechinus auritus*, Karyotype, Diyarbakır, Turkey.

**Diyarbakır Yöresi *Erinaceus concolor* Martin, 1838 ve *Hemiechinus auritus* (Gmelin, 1770) (Insectivora: Mammalia) Kirpileri Üzerine Karşılaştırmalı Morfolojik ve Karyolojik Bir Çalışma**

**Özet:** Bu çalışmada, Diyarbakır yöresi kirpileri, *Hemiechinus auritus* (8 erkek, 4 dişi) ve *Erinaceus concolor* (4 erkek, 3 dişi) türlerinin karşılaştırmalı morfolojik ve karyolojik özellikleri incelenmiştir. Her iki türün karyotipi, *E. concolor* (2n = 48) ve *H. auritus* (2n = 48) benzer bulunmuş olup, önceki çalışmalardan farklı olarak bütün otozomların çift kollu oldukları saptanmıştır. Diğer taraftan, *Hemiechinus* ve *Erinaceus* cinslerinin ayırt edilmesinde anahtar karakter olarak kullanılan diş kök yapıları bu çalışmada da benzer bulunmuştur. Örneklerin baş iskeleti ve postları Dicle Üniversitesi Fen Fakültesi Biyoloji Bölümünde korunmaktadır.
**Anahtar Kelimeler**: Insectivora, *Erinaceus concolor*, *Hemiechinus auritus*, Karyotip.

## INTRODUCTION

The family Erinaceidae widely distributed throughout Eurasia is represented by two genera, *Erinaceus* and *Hemiechinus* in Turkey, (Corbet 1978; Corbet and Hill, 1991). Of species belonging to these genera, *Erinaceus concolor* Martin 1838 was described on the basis of specimens collected by Abbot from Trabzon-Turkey, but it was considered as *Erinaceus europaeus concolor*, a subspecies of *E. concolor* (Ellerman and Morrison–Scott, 1951).

Some authors reported that there is only one species of *E. europeus*, distributed in Turkey (Danford and Alston, 1877; 1880; Felten et al. 1973; Misonne, 1957; Steiner and Vauk, 1966), while Bannikova et al. (2002) and Santucci et al. (1978) reported that *E. concolor* is distributed in Eastern Europe and these species have distinct karyotype.

Doğramacı and Gündüz (1993) stated that there were three subspecies, *E. concolor concolor*; *E. concolor transcaucasicus* and *E. concolor drozdovskii* found in Turkey and they also determined that the 2n, NF and NFa of these subspecies were 48, 94 and 90, respectively. According to these authors, *E. concolor drozdovskii* was a new record for the Turkish mammal fauna. Arslan et al. (2008) studied the C-heterochromatin variation in the karyotype of *E. concolor* specimens, collected from seven different localities in Turkey which they have 2n = 48, NF = 94 and NFa = 90 karyotype.

Harrison and Bates (1991) indicated that there are two subspecies of *Hemiechinus auritus* (Gmelin 1770), *H. a. calligoni* and *H. a. aegyptius*, recognized in Arabia. However, there are not any considerable criterions for the distinction of these subspecies. Kryśtufek and Vohrálik (2001) expressed that the subspecies of *H. auritus calligoni* was distributed in Turkey. Kryśtufek (2002) noticed the diverseness of the lacks of fronto-premaxillary sutures with the nasals on the morphotypes of *E. concolor*. Çolak et al. (1997) recorded *H. auritus* from Nizip, Kilis, Harran, Ceylanpınar and Aralık in Turkey. The C-banded karyotype and NORs patterns of *H. auritus* were reported by Arslan et al. (2009), also specimens were collected from Şanlıurfa (Ceylanpınar) and Kilis province.

In the previous studies on the karyology of *H. auritus*, the diploid chromosome number was described to be 2n = 48. However, there are differences on the morphology of chromosomes (Kamali, 1976; Mandahl, 1978; Bhatnagar and El-Azami, 1978; Doğramacı and Gündüz, 1993; Çolak et al., 1997; Kefelioğlu, 1997). In this paper it is aimed to compare the morphological and karyological characteristics of the species *E. concolor* and *H. auritus* in Diyarbakır province of Southeast Anatolia.

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Correponding author: Coşkun, Y., yukselc@dicle.edu.tr

## MATERIAL AND METHODS

Twelve specimens of *H. auritus* (8 male, 4 female) and seven specimens of *E. concolor* (4 male, 3 female) specimens were collected from Diyarbakır province (Fig. 1).

Firstly, all animals were weighed, their external measurements were taken and their sexual condition was determined. Secondly, chromosomal examinations were made standard direct treatment of bone marrow cells, with the use of colchicine, potassium chloride hypotonisation, fixation in Carnoy's mixture, and preparation of flame-dried slides stained subsequently by giemsa (Ford and Hamerton, 1956).

The slides were used to determine the diploid chromosome number (2n), the fundamental number (NF) and the number of autosomal arms (NFa). The measurements of cranial characters were taken from each specimen by a calliper with accuracy of up to 0.1 mm according to Kryśtufek (2002). The skulls and skins are deposited at the Department of Biology, Faculty of Science Dicle University in Diyarbakır.

## RESULTS

***Erinaceus concolor***

The specimens of *E. concolor* had a white patch on the throat and chest, spreading to the belly. The rest of the ventral side was brown, with grey hairs. The hair of the ears was blackish grey and long (Fig. 2A). Head and body lengths of the specimens were between 229.0 and 330.0 mm. The hind food length was 33.0-49.5-62.0 mm in *E. concolor*. The external measurements of the specimens were given in Table 1.

The skull was large (40.30-47.23-57.60 mm) and narrower across to the front. Nasal bones which crossed the premaxillary and maxillary sutures, concluded sharply in the frontal (Fig. 3).

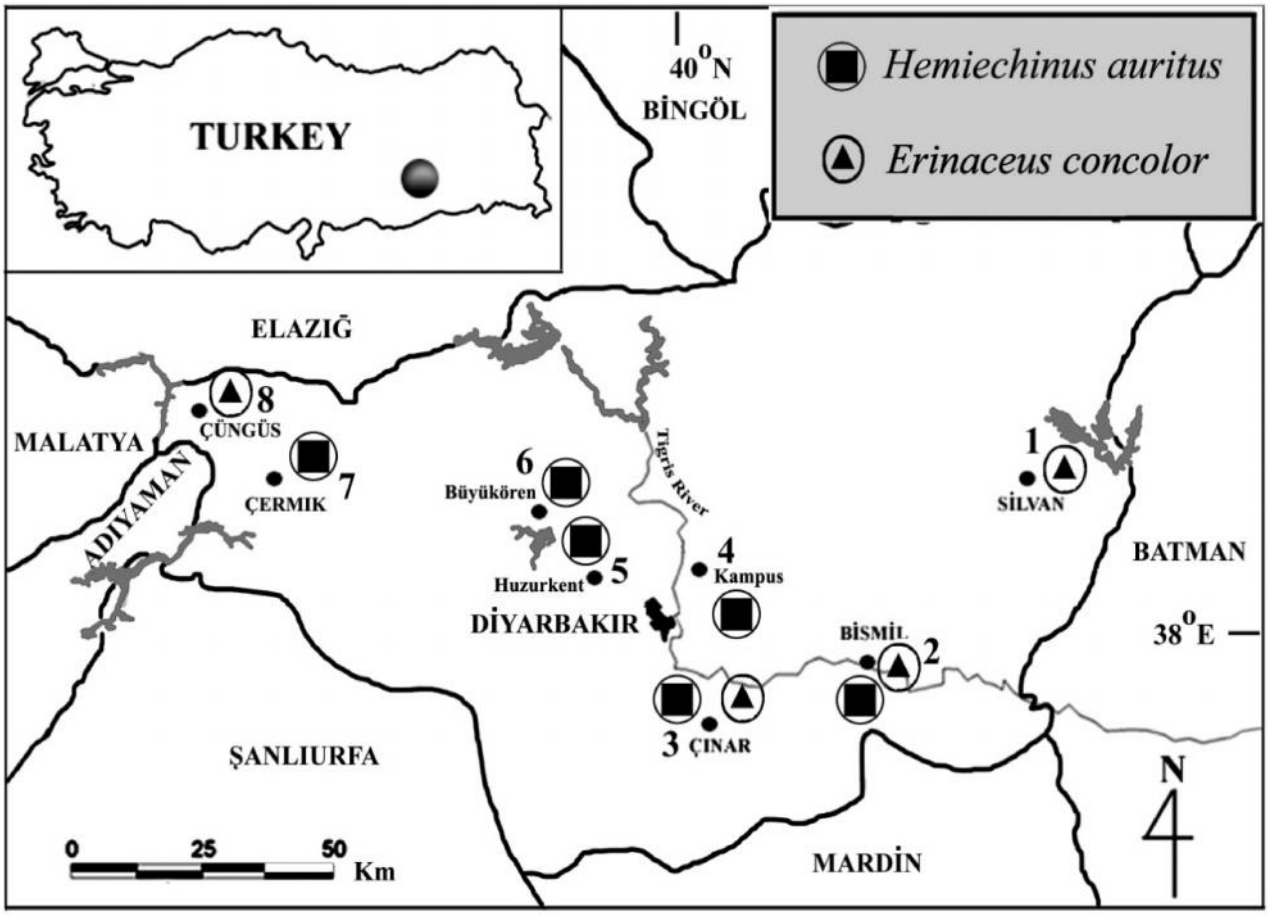


Figure 1. The collecting localities of hedgehogs. *E. concolor:* 1. Silvan (1 ♂♂) 2. Bismil (1 ♂♂, 1 ♀♀) 3. Çınar (1 ♂♂, 1 ♀♀) 8. Çüngüş (1 ♂♂, 1 ♀♀); *H. auritus* 2. Bismil (1 ♀♀) 3. Çınar (4 ♂♂, 3 ♀♀) 4. Kampüs (1 ♂♂) 5. Huzurkent (1 ♂♂) 6. Büyükören (1 ♂♂) 7. Çermik (1 ♂♂).


Figure 2. A) *E. concolor* (Diyarbakır – Silvan; no: 231, ♂) and B) *H. auritus* (Diyarbakır - Huzurkent; no: 317 ♂).

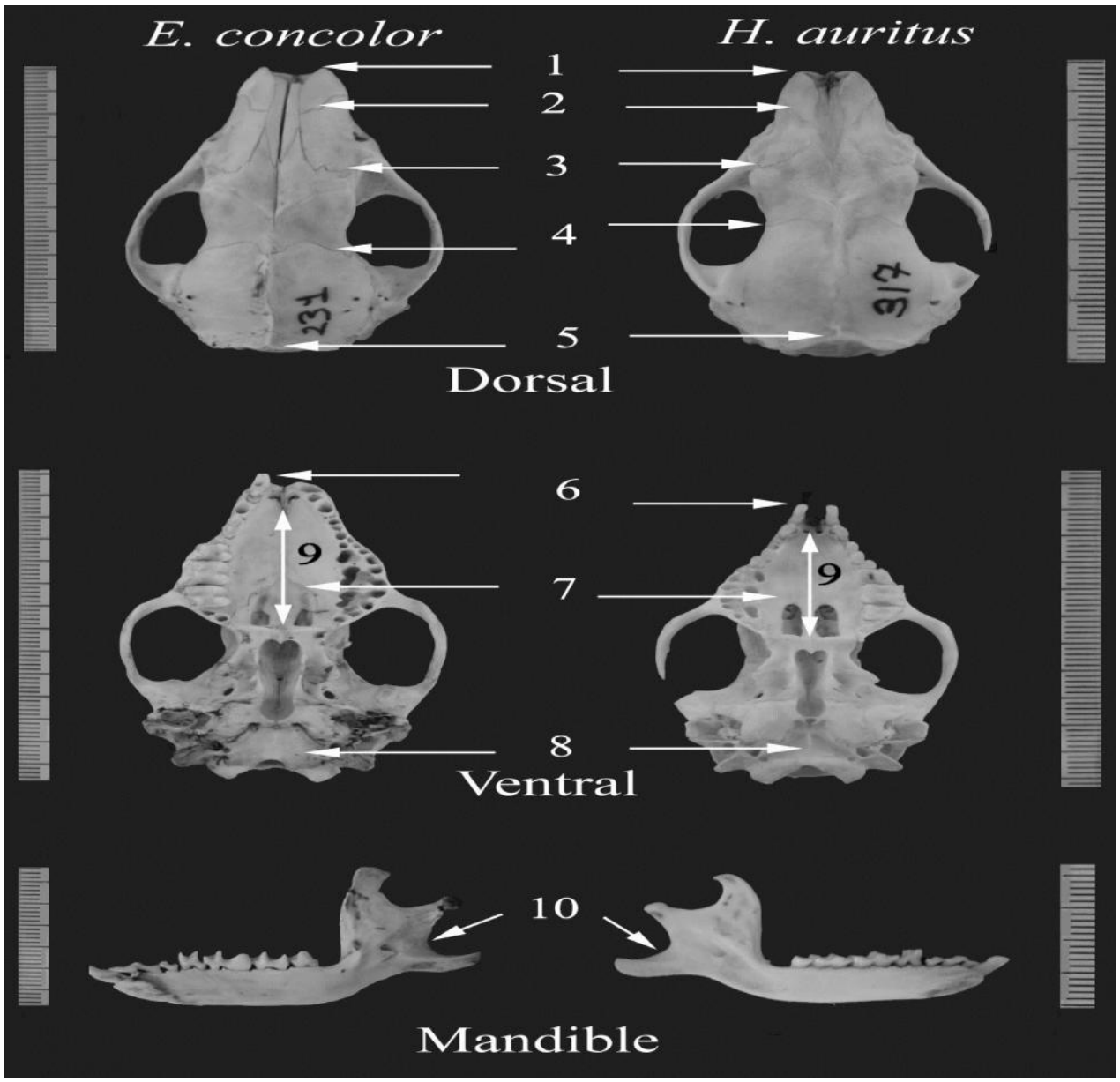


Figure 3. Comparative skull characters of *E. concolor* (Diyarbakır - Silvan; no: 231, ♂♂) and *H. auritus* (Diyarbakır - Huzurkent; no: 317 ♂♂). Arrows indicated the differences between *E. concolor* and *H. auritus*.

Table 1. The external and cranial measurements (mm) and weights (g) of *H. auritus* and *E. concolor* (n: the number of the specimens and Sd: standard deviation).

| Characters | *E. concolor* | | | *H. auritus* | | |
|---|---|---|---|---|---|---|
| | n | Range | Mean ± Sd | n | Range | Mean ± Sd |
| Total length (mm) | 7 | 229.0 – 330.0 | 263.0±38.3 | 9 | 158.0-213.0 | 180.8±15.4 |
| Tail length (mm) | 7 | 21.0 – 32.0 | 27.5±3.9 | 9 | 18.0-24.0 | 22.4±2.3 |
| Ear length (mm) | 7 | 28.0 – 32.0 | 29.8±1.5 | 9 | 23.0-36.0 | 31.3±3.7 |
| Hind food length (mm) | 7 | 33.0 – 62.0 | 49.5±9.6 | 9 | 31.0-34.0 | 32.9±1.1 |
| Weight (gr) | 7 | 780.0 – 898.0 | 824.0±49.4 | 9 | 98.0-216.0 | 153.4±48.8 |
| Interorbital width | 7 | 13.7-18.0 | 15.3±1.9 | 10 | 11.6-14.5 | 13.1±1.1 |
| Maxilla width | 7 | 15.2-21.4 | 18.8±2.6 | 10 | 14.5-19.2 | 16.1±1.3 |
| $M^2$-$M^2$ width | 7 | 15.7-21.0 | 19.0±2.3 | 10 | 14.1-16.6 | 15.6±0.9 |
| $P^4$-$P^4$ width | 7 | 11.2- 16.9 | 13.8±2.4 | 10 | 9.3-12.8 | 11.4±1.0 |
| $P^1$-$P^1$ width | 7 | 5.2-7.8 | 6.6±1.1 | 8 | 4.5-9.6 | 6.1±1.6 |
| Upper premolars length | 7 | 6.6-10.9 | 8.3±1.8 | 9 | 6.6-8.5 | 7.6±0.7 |
| Upper molars length | 7 | 11.1-15.1 | 14.0±1.9 | 10 | 10.0-14.6 | 11.4±1.3 |
| Upper diastema length | 7 | 19.3-28.9 | 24.0±3.9 | 9 | 18.9-22.9 | 21.0±1.3 |
| Braincase height | 7 | 16.4-21.0 | 18.9±1.9 | 10 | 14.6-17.4 | 16.2±0.9 |
| Upper toothrow length | 7 | 17.5-26.1 | 22.4±3.6 | 9 | 17.9-23.3 | 19.1±1.6 |
| Condylo-coronoid height | 7 | 9.9- 13.4 | 10.9±1.7 | 10 | 8.4-10.7 | 9.5±0.8 |
| Mandible length | 7 | 31.2-43.7 | 36.5±5.2 | 10 | 28.1-35.7 | 31.2±2.2 |
| Lower toothrow length | 7 | 17.0-23.9 | 21.7±2.9 | 10 | 14.9-23.2 | 17.2±2.4 |
| Coronoid process height | 7 | 14.2- 20.8 | 16.9±2.8 | 10 | 12.6-16.6 | 14.6±1.4 |

In contrast to *H. auritus*, the anterior parts of premaxillar bones were oval; the rostrum was wide and rounded in the anterior; the premaxilla and maxilla bones were rectangular; the frontal sutures located at the end of the orbital cavity; the occiputs and first upper incisive ($I^1$) were not visible above; post palatine had a triangular shape; diastema was longer and the angle between the angular and condyloid process on mandible was wide in *E. concolor* (Fig. 3).

The zygomatic arches were expanded (25.80-30.01-35.95 mm). Supraorbital bones were not covered orbits. Sagital crest was well developed in adults. In contrast to *H. auritus* the tympanic bullae was small. The palate was wide and styloid process was present (Fig. 3). The incisive foramina were small and extended to the anterior level of the second lower incisive ($I_2$). Palatal foramina were wide and located between the first ($M^1$) and third upper molar ($M^3$). The length of palatal foramina was more than the half-length of the molar tooth row. The skull measurements of specimens are given in table 1.

The premaxillar suture was at the same level of the 3rd incisor ($I^3$) and the alveoli between the 3rd incisor and canin teeth is not wide as in *H. auritus*. While the last lower premolar had a metaconid in all specimens of *E. concolor*, it was absent in specimens of *H. auritus* (Fig. 4).

$I^2$ was the smallest incisor and lean against to the $I^3$. Canin was long and had two roots. $M^1$ and $M^2$ had three roots and larger than $M^3$ which has two roots. While first upper premolar ($Pm^1$) has one root, the second ($Pm^2$) and third upper premolar ($Pm^3$) had three roots and $Pm^3$ is larger than the others (Fig. 4).

All of the lower molars had two roots. The first lower molar ($M_1$) was in squarely shape and the second lower molar ($M_2$) were larger than the third lower molar ($M_3$). The triangular first lower premolar ($Pm_1$) had one root and was smaller than the second lower premolar ($Pm_2$) which has two roots. Canin tooth was projected forward as coating the second incisor in contrast to *H. auritus* (Fig.4).

The 2n, NF and NFa of *E. concolor* specimens were 48, 96, and 92, respectively. Karyotype of *E. concolor* consists of 12 pairs metacentric and 11 pairs submetacentric autosomes. X chromosome was large metacentric and the Y was small metacentric (Fig. 5).

***Hemiechinus auritus***

The spines were usually banded with dark brown and white. The basal parts of spines were generally whitish. The cheeks and forehead were white and the ventral part was dirty cream. The rostrum and ears were covered with brownish yellow hairs. However, the hairs of the ears were not long as in *E. concolor* (Fig. 2B).

The length of the head and body of the specimens was varied between 158 - 213 mm. The skull was smaller than *E. concolor* (Table 1). Rostrum was tapered anteriorly. In contrast to *E. concolor* zygomatic

arches were not expanded markedly. The occiput was seen clearly from the dorsal side. Parietal bones exceeded into the frontals and sagital crest was weakly developed. The palate was narrow and styloid process was present (Fig. 3).

The dentition of *H. auritus* was different from *E. concolor*. $Pm^1$ and $I^3$ have two roots, $M_3$ was one rooted in *H. auritus* but in the specimens of *E. concolor* $Pm^1$ and $I^3$ were one rooted and $M_3$ had two roots. $I^1$ was strongly projected forwards and the metaconid is absent on $Pm_2$ in contrast to *E. concolor* (Fig. 4).

The diploid chromosome number of *H. auritus* specimens that we examined is 2n = 48, NF = 96 and NFa = 92. The karyotype consist of 12 pairs metacentric and 11 pairs submetacentric autosomes. X chromosome is large submetacentric and the Y is small submetacentric (Fig. 5).

**DISCUSSION**

According to Harrison and Bates (1991), *H. auritus* have large ears projecting above the spines in contrast to *E. concolor* and no median bare patch dividing the spines on the forehead. These peculiarities are same with our materials.

The structure of the spine bands is the same in both species of *H. auritus* and *E. concolor* which determined by some authors (Doğramacı and Gündüz, 1993; Harrison and Bates, 1991; Kryštufek and Vohrálik, 2001).

There are five tubercules in the hind foot and the sole is naked as determined by Harrison and Bates (1991) in both *E. concolor* and *H. auritus*. $Pm_2$ has a metaconid on chewing surface in *E. concolor* while it is absent in *H. auritus* specimens.

In this study, the length of the head and body of *E. concolor* was more than 190 mm and the skull length was more than 50 mm in contrast to *H. auritus* (except one specimen). These peculiarities are similar those of Harrison and Bates (1991) and Kryštufek and Vohrálik (2001).

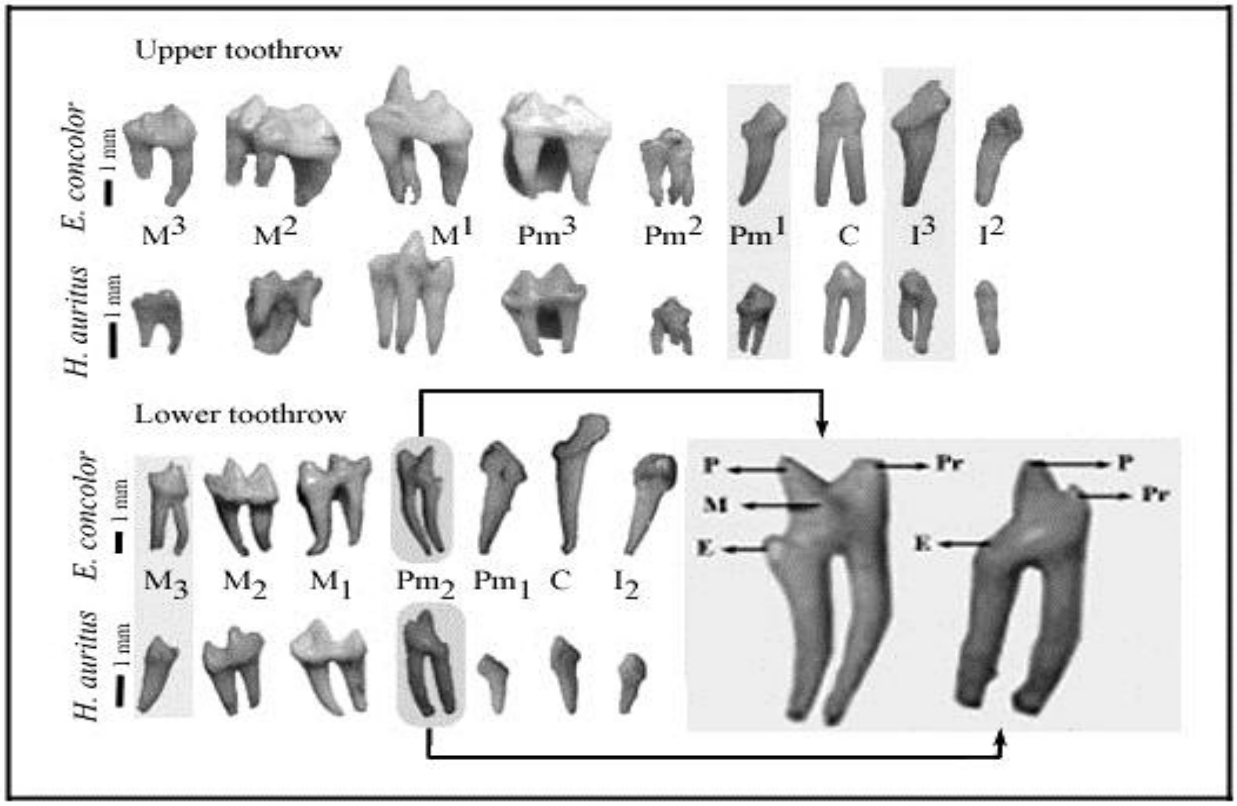


Figure 4. The upper and lower teeth structure of *E. concolor* (Diyarbakır - Silvan; no: 231, ♂♂) and *H. auritus* (Diyarbakır - Çınar; no: 361 ♂♂), Pr = proconid, P = paraconid, M = metaconid and E = entoconid.

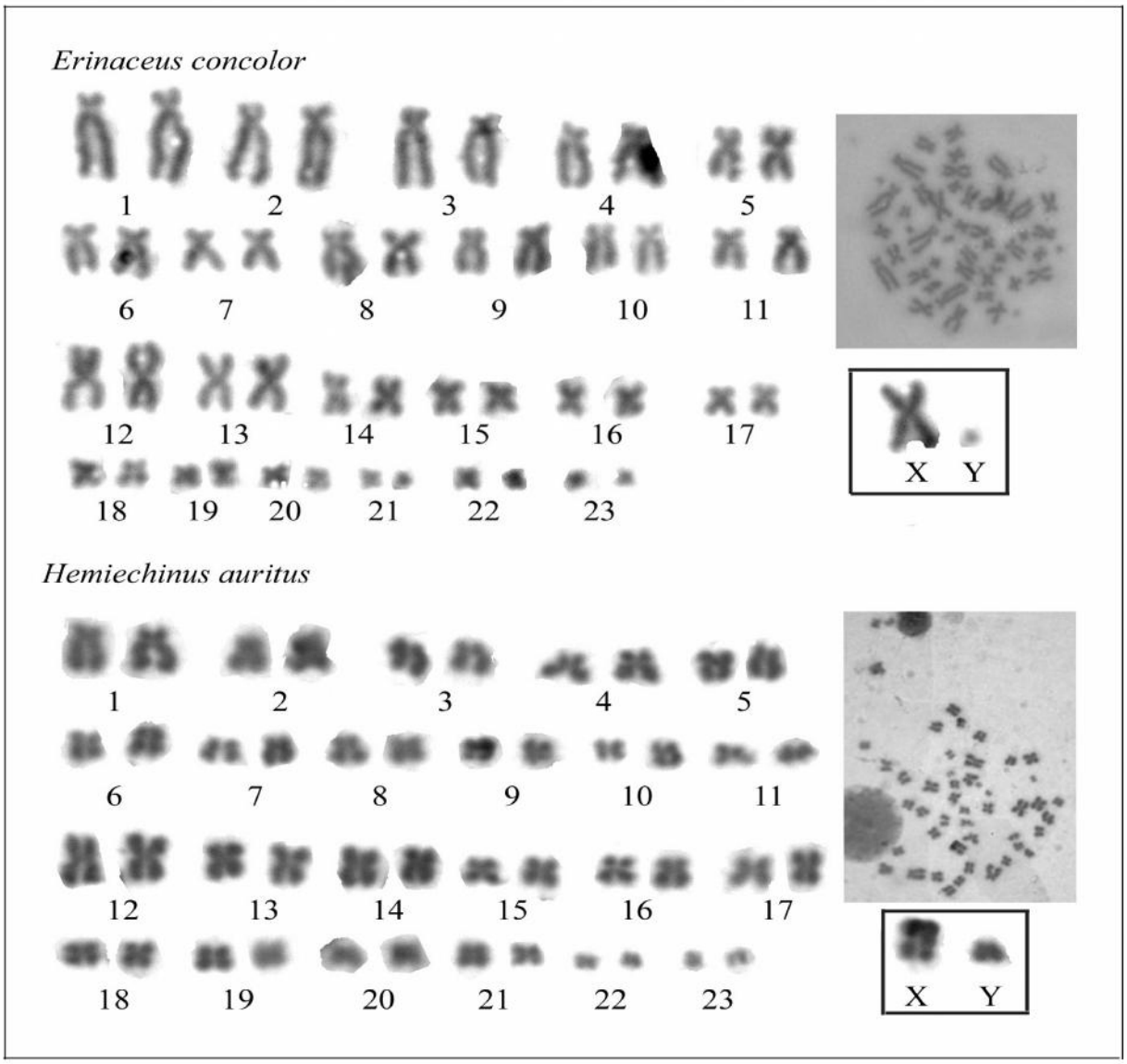


Figure 5. The karyotypes and metaphase plates of *E. concolor* (Diyarbakır - Silvan; no: 231, ♂♂) above, and *H. auritus* (Diyarbakır - Çınar; no: 361 ♂♂) below.

The structure of the fronto-premaxillary sutures of *E. concolor* which is described by Kryśtufek (2002) is different as on the material examined in this study.

Infraorbital foramens are well developed and the incisive foramens are too small and existed to the anterior level of the $I_2$. Zygomatic arches are expanded in *E. concolor* but these characters are different in *H. auritus*. These aspects are similar with those of Harrison and Bates (1991; Kryśtufek and Vohrálik (2001).

The banding structure of spines and the external and cranial measurements of *E. concolor* specimens are similar with the measurements given by Doğramacı and Gündüz (1993) for the topotype of *E. c. transcaucasicus*.

In all the species of hedgehogs has studied so far, in general, present quite a stable karyotype, have 2n= 48 chromosomes. The diploid chromosomes number of *E. concolor* is 2n = 48 which is the same those of Doğramacı and Gündüz (1993)'s results, while the gonosome morphology of the sex chromosomes and the number of the autosomal chromosome arms have differences. In *E. concolor* a karyotype of 2n=48, NF=94, NFa=90 chromosomes has one pair of acrocentric (Arslan et al. 2008), all autosomal chromosomes are biarmed in our materials.

While the karyological aspects of *H. auritus* specimens examined by us are similar with Bhatnagar and El-Azami, 1978, Çolak et al. 1997 and Arslan et al. 2009, It is showed differences by the number of autosomal and the fundamental chromosome arms those of Kefelioğlu (1997) and Kryśtufek and Vohrálik (2001). And our specimens showed similarities with Kamali (1976)'s results except the morphology of X chromosome.

Compared with *H. auritus* and *E. concolor* in respect to the diploid chromosome number is very similar,

while the sex chromosome morphology is different with each other.

Although the diploid chromosome number and the morphological and cranial peculiarities of both *H. auritus* and *E. concolor* show similarities with the previous studies, the morphology of the chromosomes seems to be different. Especially, the smallest autosomal chromosome pair of *E. concolor*, which is metacentric, indicates that this species showed differences with the species of *E. europaeus* which has an acrocentric chromosome pair reported by Hsu and Benirschke (1968). In the other hand, the cranial characters and the structures of the teeth showed that there are considerable differences between the species of *E. concolor* and *H. auritus,* by the results of this study.

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