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Taxonomy and Distribution of the White-Toothed Shrews (*Crocidura*) (Soricidae: Insectivora: Mammalia) of Turkey

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Abstract: A total of 359 samples were collected from different geographical regions in Turkey and the species boundaries of white-toothed shrews (genus *Crocidura*) in Turkey were defined using morphological and karyological characteristics. According to these characteristics, it was determined that *Crocidura leucodon* with karyotype of 2n = 28 and FN = 56 and *Crocidura suaveolens* with karyotype of 2n = 40 and FN =50 are distributed in Turkey. In both species, the shape of the skull, the shapes and positions of incisive (I^1), premolar (P^4), molar (M^3), tail length, dorsal and ventral side colours were used in morphological comparisons. In addition, brief information about the diagnostic key and ecologies of Turkey *Crocidura* species is given.

Key Words: *Crocidura leucodon, Crocidura suaveolens,* Taxonomy, Turkey

Türkiye'de *Crocidura* (Soricidae: Insectivora: Mammalia) Cinsinin Taksonomisi ve Yayılışı

Özet: Bu çalışmada, Türkiye' deki farklı coğrafik bölgelerden toplam 359 örnek toplandı ve Türkiye' deki *Crocidura* türlerinin tür sınırları morfolojik ve karyolojik özellikler kullanılarak belirlendi. Bu özelliklere göre, Türkiye' de 2n = 28 ve FN = 56 karyotipli *Crocidura leucodon* ve 2n = 40 ve FN = 50 karyotipli *Crocidura suaveolens*' in yayılış gösterdiği tespit edildi. Her iki türde, kafatasının şekli, ön kesici dişin (I^1), premoların (P^4) ve moların (M^3) pozisyonu, kuyruk uzunluğu ile dorsal ve ventral taraf renkleri morfolojik karşılaştırmalarda kullanıldı. Ayrıca, Türkiye *Crocidura* türlerinin teşhis anahtarı ve ekolojileri hakkında kısa bilgi verildi.

Anahtar Sözcükler: *Crocidura leucodon, Crocidura suaveolens,* Taksonomi, Türkiye

Introduction

The genus *Crocidura* is represented by more than 150 species in the world and this genus contains the most species of all mammalian genera, distributed in vast areas (1). It is rather difficult for the species of this genus to be diagnosed by morphological characters (2). Due to the morphological, karyological and biochemical analyses in the taxonomy of this genus, there were significant changes in both the taxonomic status of the taxa and their distribution (1). As a result of recent karyological studies, a new *Crocidura* species has been identified (3).

Thomas (4) carried out the first taxonomic study on *Crocidura* species distributed in Turkey. He also defined new subspecies of *Crocidura leucodon* (Hermann, 1780) and *Crocidura russula* (Hermann, 1780) in Turkey (*Crocidura leucodon lasius* Thomas, 1906 and *Crocidura russula monacha* Thomas, 1906). After a year, Thomas (5) changed *C. leucodon lasius* to *Crocidura lasia* Thomas, 1907. New subspecies in Turkey were defined by Satunin (6) and by Spitzenberger (7) (*Crocidura russula aralychensis* Satunin, 1914 and *Crocidura pergrisea arispa* Spitzenberger, 1971). Records of *C. russula*, *C. leucodon* and *C. lasia* of the *Crocidura* genus were reported by Ognev (8). While Van Den Brink (9) included Thrace in the distributional map of *Crocidura suaveolens* (Pallas, 1811), Kahmann and Çağlar (10) also suggested that *C. suaveolens* is distributed all along the Black Sea coastal stripe and in the Eastern Black Sea Region as far as Rize. Harrison (11) studied Saudi Arabian mammals and included Turkey in the distribution area of *C. leucodon* and *Crocidura lasiura* (Dobson, 1890). Harrison (11) also stated that *C. leucodon* and *C. lasiura* might be sibling species. Afterwards, several researchers (12-18)

gave new localities of record in Turkey for *C. lasia*, *C. leucodon*, *C. russula* and *C. suaveolens*. Lehmann (19) gave the first record of *Crocidura sicula* Miller, 1901 from Anatolia. Richter (20) suggested that *gueldenstaedtii* is a species and gave new localities of record in Turkey for *Crocidura gueldenstaedtii* (Pallas, 1811), *C. leucodon* and *C. suaveolens*. Corbet (21) revised the Palaearctic Region and he stated that *C. suaveolens* and *C. leucodon*, *C. russula*, *Crocidura pergrisea* Miller, 1913 and *C. lasia* were distributed in Turkey.

Şimşek (22) studied the most samples on taxonomy and distribution of the genus *Crocidura* in Turkey and stated that four species of *Crocidura* genus (*C. leucodon*, *C. russula*, *C. suaveolens* and *C. lasiura*) are also distributed in Turkey. As a result of morphological, karyological and biochemical analyses on the populations of *Crocidura* genus that are distributed in Turkey, it has been concluded that *C. russula* species is non-existent in Turkey and the karyotype of *C. suaveolens* and biochemical analyses results of the samples collected from several localities were given (23-25). Niethammer and Krapp (26) researched the taxonomy of European Mammals and they included Turkey on the distribution map of *C. suaveolens* and *C. leucodon*, as well. However, according to his distribution map of the *Crocidura* genus, Zaitsev (27) stated that *C. gueldenstaedtii* and *C. leucodon* are distributed in Turkey, but *C. suaveolens* and *C. russula* are not.

Hutterer (1) revised the Order Insectivora and stated that *C. leucodon*, *C. suaveolens* and *C. gueldenstaedtii* are distributed in Turkey. In most of the information given thus far (with the exception of Catzeflis et al. (23)) morphological methods have always been used for the solution of taxonomical problems of *Crocidura* populations in Turkey. However, no detailed karyological study has been carried out. In addition to morphological studies, Harrison (11) stated that karyological studies play an important part in the clarification of taxonomic positions of *Crocidura* populations. According to Harrison (11), these two areas of study might produce important and valuable results.

The aim of the present study was to determine the distribution and taxonomic status of *Crocidura* species in Turkey using karyological and morphological characteristics.

Materials and Methods

Field Method

For this study, 359 *Crocidura* samples were collected and field notes were taken from different geographical regions in Turkey from 1994 to 1997 (Figure 1 and Table 1). Samples were captured in the field and stuffed with standard museum material type to be used in morphological comparisons. Skulls, skins and karyotype preparations of the samples are kept at The Mammal Collection of the Department of Biology, Faculty of Arts and Science, Ondokuz Mayıs University, Samsun.

Karyotype Method

The "Colchicine-Hypotonic-Citrate" method was applied to samples captured alive and chromosome preparations from bone marrow were prepared (28). The chromosome preparations were performed on the samples in every locality in Turkey (Figure 1). The diploid number (2n), the fundamental number (FN) including female sex chromosomes (XX) and the number of

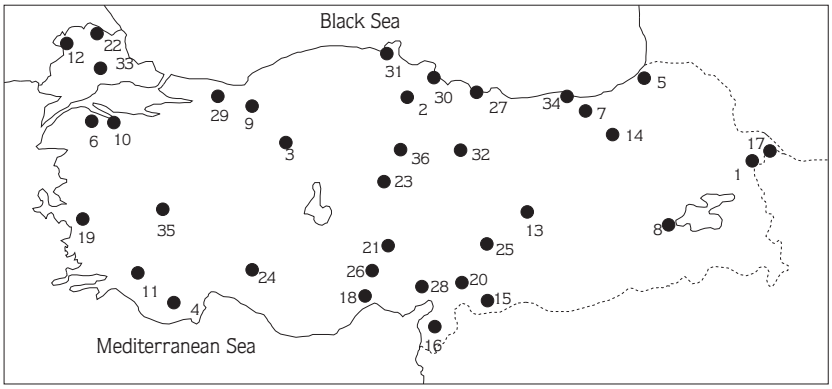

Figure 1. The Map of Turkey showing the distribution of *C. leucodon* and *C. suaveolens* where samples were collected.

Table 1. Number of captures of two *Crocidura* species from 36 localities in Turkey.

Locality	*C. suaveolens*	*C. leucodon*
1. Ağrı	4	
2. Amasya	12	
3. Ankara	2	1
4. Antalya	2	2
5. Artvin	3	
6. Balıkesir	10	2
7. Bayburt	2	
8. Bitlis	3	2
9. Bolu	2	1
10. Bursa	9	1
11. Denizli	6	
12. Edirne	5	3
13. Elazığ	2	
14. Erzurum	3	3
15. Gaziantep	2	1
16. Hatay	5	2
17. Iğdır	7	
18. İçel	7	
19. İzmir	5	2
20. K.Maraş	3	2
21. Kayseri	23	
22: Kırklareli	25	28
23. Kırşehir	7	
24. Konya	7	
25. Malatya	2	1
26. Niğde	27	
27. Ordu	7	
28. Osmaniye	2	
29. Sakarya	2	1
30. Samsun	67	2
31. Sinop	9	
32. Sivas	2	
33. Tekirdağ	5	3
34. Trabzon	17	
35. Uşak	2	1
36. Yozgat	2	1
Total:	300	59

autosomal arms (FNa) were determined by examining at least 50 complete metaphase cells for each animal. Chromosome morphology was categorized according to that of Levan et al. (29). Biarmed chromosomes with subequal arms were considered as metacentric (m), and those with arms of unequal lengths as submetacentric (sm). When the short arm was less than 50% the length of the long one, the chromosome was regarded as subtelocentric (st), and if only one pair of chromosomal arms was visible, as telocentric-acrocentric (a).

Morphological Method

For morphological comparisons, 21 internal character measurements and four external character measurements were taken with a digimetric calliper graduated to 0.1 mm. Comparisons of these samples including the position of incisive (I^1), the shape of premolar (P^4), the view of molar (M^3), dorsal and lateral view of the skull, dorsal and ventral colours of the skin and tail were made according to the data of other researchers (15,18,22,26,27).

Statistical Methods

t-test and Discriminant analysis were employed in comparisons among sample groups.

Results

Morphological Characteristics

Crocidura leucodon: In this species, the cranial measurements are the largest in Turkey (Table 2). Also the front incisive tooth (I^1) is large and convex, molars are larger than those of *C. suaveolens*, and the valley between the parastyle and paracone in premolar (P^4) is not wide. The lingual edge near the protocone is protrusive and angular. When compared with *C. suaveolens*, the premolar (P^4) is larger and the depth of molar side (M^3) is wider and deeper (Figure 2A). Compared with its paracone field, the parastyle field of molar (M^3) is smaller and it does not have the exact appearance of the letter "M" (Figure 2B). The body's colour is separated by a sharp border at the sides and the dorsal colour has a variation from greyish brown to reddish or brownish grey. The ventral colour is white or greyish white. The tail is always bicolour and has pigmentation approaching the dorsal and ventral pigmentation. In all the samples, the ratio of tail length to head and body length is less than 50 % (Table 2).

Crocidura suaveolens: In this species, the valley between the parastyle and paracone in premolar (P^4) is wider. The lingual edge near the protocone is not very protrusive and it is not angular. In comparison to *C. leucodon*, premolar (P^4) is smaller, the depth of molar (M^3) side is not deep and wide (Figure 3A). The incisive tooth (I^1) is not very large and convex. Molars are also smaller when compared with those of *C. leucodon*. The parastyle field of molar (M^3) is equal to the paracone field and has the appearance of the letter "M" (Figure 3B).

Table 2. External and cranial measurements (in mm) of *Crocidura* species from Turkey. Values are means ± standard deviation (and range).

Measurements	*C. suaveolens* (n = 219)	*C. leucodon* (n = 46)
Length of head and body	114.98± 6.68 (90 – 129)	110.14±5.96 (99 – 123)
Length of tail	43.46±3.13 (34 – 51)	35.60±2.14 (32 – 40)
As % of h & b	60±0.05 (48 – 80)	47±0.04 (39 – 55)
Length of hind foot	13.62±0.66 (12 – 15)	13.64±0.48 (13 – 14)
Length of ear	8.33±0.70 (7 – 10)	8.42±0.57 (8 – 10)
Greatest length of skull	18.93±0.60 (17.10 – 20.30)	20.25±0.47 (19.00 – 21.30)
Condylobasal length	18.04±1.47 (16.30 – 19.35)	19.08±0.49 (18.25 – 20.00)
Pospalatal length	7.72±0.33 (6.75 – 8.60)	8.17±0.29 (7.45 – 8.95)
Braincase length	10.37±0.33 (9.40 – 11.10)	10.89±0.23 (10.50 – 11.25)
Length of upper toothrow	8.27±0.32 (7.30 – 9.10)	9.05±0.26 (8.10 – 9.50)
Basal length	15.61±0.53 (13.90 – 16.85)	16.53±0.44 (15.70 – 17.60)
Length of lower toothrow	7.39±0.41 (6.05 – 8.20)	8.03±0.45 (6.85 – 8.55)
Length of mandible-1	9.97±0.37 (9.15 – 11.00)	10.60±0.28 (10.05 – 11.15)
Length of mandible-2	10.21±0.82 (9.10 – 11.05)	10.90±0.32 (10.15 – 11.45)
$M^1 – M^1$ length	4.14±0.19 (3.30 – 4.50)	4.51±0.16 (4.10 – 4.75)
Postglenoid breadth	6.08±0.19 (5.55 – 6.50)	6.51±0.20 (6.05 – 6.85)
Braincase breadth	8.72±0.32 (8.05 – 9.55)	9.16±0.18 (8.75 – 9.50)
Zygomatic breadth	5.84±0.32 (5.30 – 6.30)	6.30±0.16 (6.00 – 6.70)
Interorbital breadth	4.25±0.16 (3.90 – 4.65)	4.45±0.11 (4.25 – 4.75)
Anteorbital foramina breadth	3.44±0.15 (3.00 – 3.90)	3.68±0.14 (3.45 – 4.00)
Coronoid height	4.58±0.19 (4.20 – 5.20)	5.04±0.13 (4.70 – 5.30)
Skull height	5.27±0.18 (4.75 – 5.70)	5.25±0.18 (4.85 – 5.65)

Depending on the age, the front incisive tooth falls forward and this situation causes the front part of the premaxilla and front incisive tooth to look straight from upper to lower part when viewed from the sides. Dorsal colour has a wide variation ranging from greyish brown to dark brown and black. As for the ventral colour, it shows all tones of grey from light greyish to dark grey. In addition, the ventral colour ranges from yellowish brown to a colour similar to the dorsal colour (especially in Trabzon, Samsun, Ordu, Adana, Mersin and Hatay samples). Dorsal and ventral sides never form a sharp border at the sides as in *C. leucodon*. The tail has pigmentation approaching the dorsal and ventral colour and varies from a single colour to bicolour. The tail is usually long and the ratio of tail length to head-body length is higher than 50 % in 90 % of *C. suaveolens* samples studied (Table 2).

Karyological Characteristics

Crocidura leucodon : The diploid chromosome number (2n), the fundamental number (FN) and the number of autosomal arms (FNa) were determined to be 28, 56 and 52. The autosomes consist of four metacentric (1-4 m), four submetacentric (5-8 sm) and five subtelocentric (9-13 st) pairs. The X chromosome was a medium-sized submetacentric, and the Y chromosome was a small acrocentric (Figure 4).

Crocidura suaveolens: The diploid chromosome number (2n), the fundamental number (FN) and the number of autosomal arms (FNa) were determined to be 40, 50 and 46. The autosomes consist of a medium large metacentric (4 m), a medium large submetacentric (3 sm), a large and a medium large subtelocentric (1-2 st) and five large, five medium large and five small acrocentric (5-19 a) pairs. The X chromosome was a medium large submetacentric and the Y chromosome was a small acrocentric (Figure 5).

Ecology

C. leucodon usually occurs in uncultivated grasslands away from wet fields, in clover fields, in the grass in drained river beds, sympatric with *C. suaveolens*.

C. suaveolens likes wet fields and usually occurs widespread at river edges, around irrigation channels and at the edges of fields which are not far from water or where wet cultivation is practised, in clover fields and at the edges of walls or fences surrounding houses. Furthermore, they occur under bushes growing around damp forest edges.

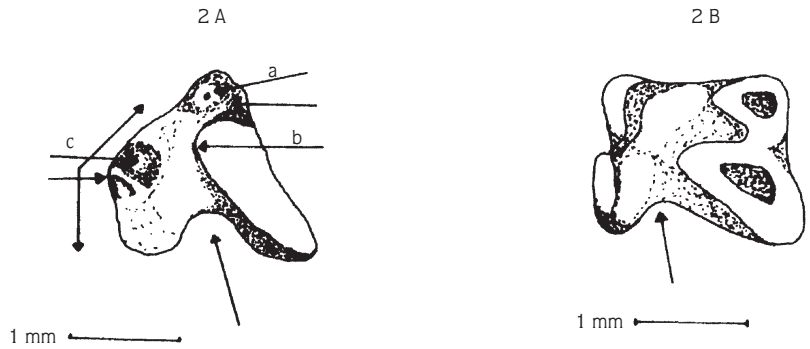

Figure 2. Dorsal view of premolar (P^4) (A) and molar (M^3) (B) (a: Parastyle; b: Paracone; c: Protocone) in *C. leucodon* (OMUMAC-770 ♂).

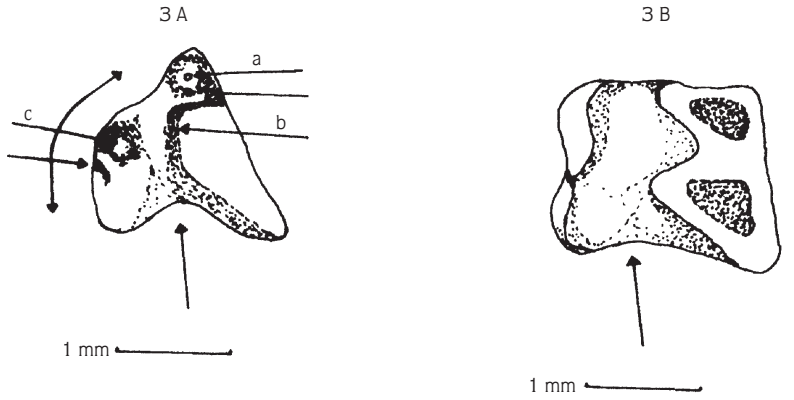

Figure 3. Dorsal view of premolar (P^4) (A) and molar (M^3) (B) (a: Parastyle; b: Paracone; c: Protocone) in *C. suaveolens* (OMUMAC-835 ♀).

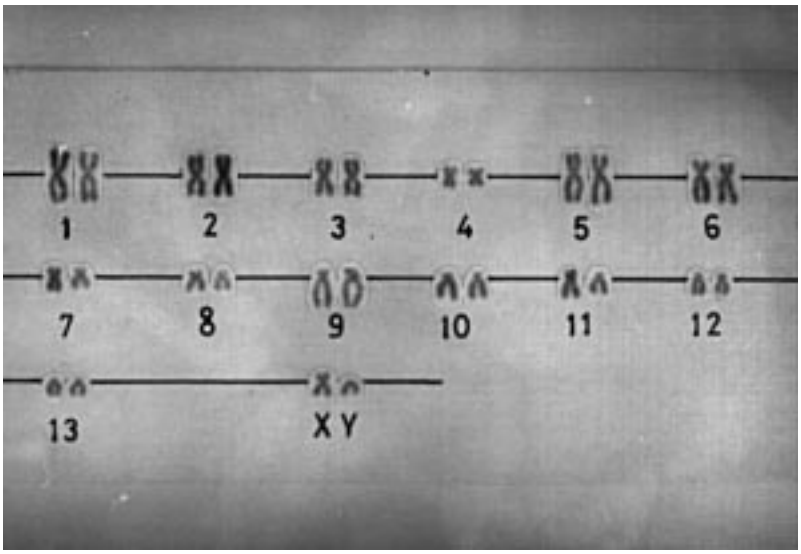

Figure 4. The karyotype of Manyas Lake side-Balıkesir sample of *Crocidura leucodon* male (2n = 28, NF = 56) (1-4 m; 5-8 sm; 9-13 st; X sm; Y a) (OMUMAC-987).

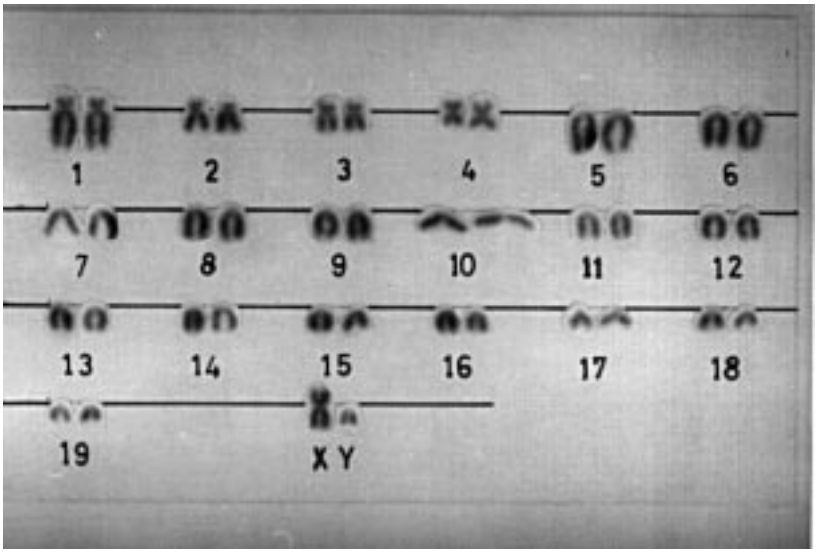

Figure 5. The karyotype of Maçka-Trabzon sample of *Crocidura suaveolens* male (2n = 40, NF = 50) (1-2 st; 3 sm; 4 m; 5-19 a; X sm; Y a) (OMUMAC-837).

Results of t-test and Discriminant analysis

The statistical evaluation of our data indicated that *C. suaveolens* has a significant amount of morphological variations in terms of individual and regional level. Thus, *C. suaveolens* in our study is most probably a polymorphic species. The evaluations have also shown that *C. leucodon* has larger measurements, but it is not a polymorphic species as *C. suaveolens*. In addition, the discriminant analysis results performed on the populations of *Crocidura* in Turkey also revealed out that these populations with 2n = 28 (*C. leucedon*) and 2n = 40 (*C. suaveolens*) karyotypes constitute two separate groups (Figure 6).

Key to Turkey *Crocidura*

1 (2) Dorsal and ventral colours of the body and the tail are always separated by a sharp line at the sides. Tail length to head-body length ratio in mature specimens is less than 55 %; upper frontal incisive teeth are large and protrusive; lingual edge near the protocone of premolar (P^4) is angular, 2n = 28 and NF = 56.....--*C. leucodon*.

2 (1) Dorsal and ventral colours of the body and the tail are not always separated by a sharp line at the sides. Tail length to head-body length ratio in mature specimens is higher than 55 %; upper frontal incisive teeth are not large and protrusive; lingual edge near the protocone of premolar (P^4) is not angular, 2n = 40, NF=50.....*C. suaveolens*.

Discussion

Crocidura leucodon

Thomas (4) collected samples from Trabzon-Maçka (Scalita) and compared them with European *C. leucodon* samples. He suggested that the body's ventral and dorsal colours do not form a border at the sides and described *C. leucodon lasius*. After a year, he suggested that these samples do not belong to *C. leucodon* species and defined *C. lasia*. Thus, Thomas (4) reported the first record of *C. leucodon* from Turkey. Some researchers have reported that *C. leucodon* was distributed in Iran and additionally in Turkey (8,11). Lehmann (19) captured three samples in Erzurum and Tatvan and he evaluated these samples as *C. sicula* according to the fact that dorsal and ventral side colours are distinguished from each other, and their skull characteristics. However, some researchers have stated that these samples reported as *C. sicula* actually belong to *C. leucodon* species (15,22,30). Many researchers collected samples from different localities in Turkey and stated that their dorsal and ventral side colours form a distinctive border at the sides, their tails are distinctively bicolour, skull measurements are large and front incisive teeth are distinctively protrusive forward. Therefore, they evaluated these samples as *C. leucodon* (15,17,22).

In this study, the colours of the dorsal and ventral sides of the samples collected from the Eastern Black Sea coastal stripe beginning from Samsun were determined to be not separated distinctly from one another at the

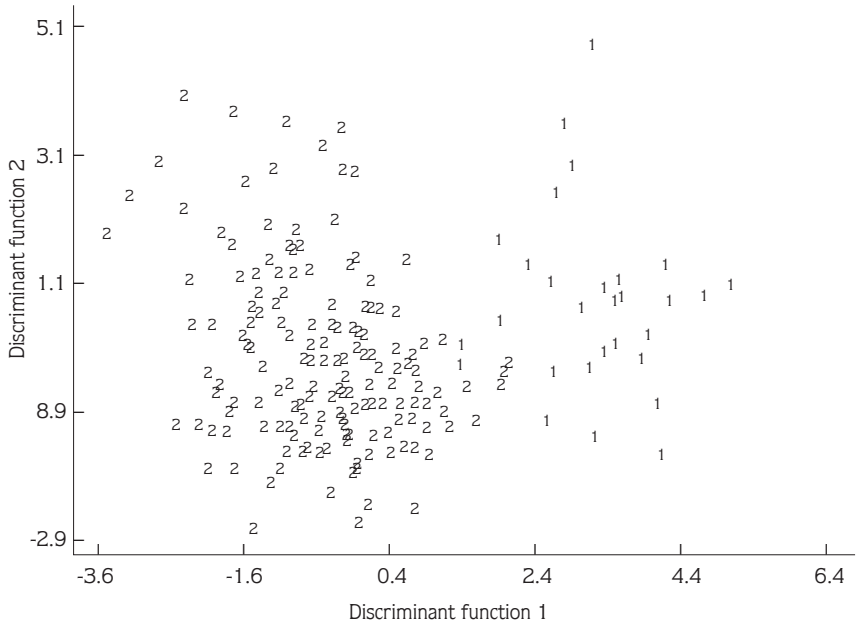

Figure 6. Discriminant analysis graph belonging to the populations of *Crocidura* in Turkey: *C. leucodon* (1) and *C. suaveolens* (2) samples.

sides. In contrast, dorsal and ventral side colours mix with each other. In addition, the karyotypes of the samples collected from this region are 2n = 40. However, the samples collected from other regions in Turkey, excluding the Eastern Black Sea region, were evaluated as *C. leucodon* because of their external and internal measurement characteristics. The dorsal and ventral side colours are distinctively separate from each other and the tails are bicoloured. These samples are similar to those described by other researchers (8,11,15,17,19,22). In addition to these, it was also determined that Erzurum and Tatvan samples do not belong to *C. sicula* with karyotype of 2n = 36 (31,32), on the contrary, it belongs to *C. leucodon* with 2n = 28 karyotype.

No study has been performed concerning the karyological characteristics of *C. leucodon* populations in Turkey. Only Catzeflis et al. (23) stated that the samples collected from Rize and Trabzon should be *C. leucodon lasia*, but the researchers have not given detailed information on the subject.

Meylan (33) gave the first karyotype characteristics of *C. leucodon* and stated that 2n = 28, FN = 56 and FNa = 52 in German *C. leucodon* populations because all of their autosomes are biarmed, the X chromosome is metacentric, and the Y chromosome is acrocentric. Later, Meylan and Hausser (34) obtained the same results in Swiss populations. Karyotypes of *C. leucodon* obtained from Czechoslovakia, Yugoslavia and Italy had values of 2n = 28, FN = 56, FNa = 52, where the X chromosome was submetacentric and the Y chromosome was small acrocentric. Many researchers (35-38) gave these results. However, Rimsa et al. (39) determined that the Y chromosome in Macedonian *C. leucodon* populations is submetacentric. Zima and Kral (38) stressed that the submetacentric Y chromosome given by Rimsa et al. (39) might be the result of a mistake. In addition to these, 2n = 28, FN = 56, X chromosome as metacentric and Y chromosome as acrocentric were given in Slovakia, Caucasus and Russian *C. leucodon* populations (40,41).

In this study, *C. leucodon* samples collected from other localities in Turkey, excluding the Eastern Black Sea region, were determined to have karyotype values of 2n = 28, FN = 56, FNa = 52, and the X chromosome was medium-sized submetacentric and the Y chromosome was small acrocentric (Figure 4). This karyotype characteristic is similar to the data of other researchers given as references. However, small differences were observed in the morphologies of the chromosomes. It was considered that this difference may be due to a misclassification of autosomes, but the Y chromosome morphology given by Rimsa et al. (39) was different from the results obtained from this study.

In addition, the most important point that has drawn our attention, we encountered *C. leucodon* samples abundantly in every suitable habitat in the Thrace-Turkey region but we were unable to find them in all suitable habitats in the Anatolia region where their populations exist in smaller numbers. This observation leads us to believe that there are ecological factors affecting the distribution of *C. leucodon* in Anatolia.

Crocidura suaveolens

Pallas (42) gave colour and external measurement characteristics of the samples collected from Crimea and described these samples as *C. suaveolens*. Brandt (43) studied Pallas's (42) paratype samples and stated that *C. suaveolens* is different from *C. leucodon* because of the fact that its first premolar corolla surface is larger. Thomas (4) defined *C. russula monacha* based on four external and three internal characteristic measurements of a sample that he collected from Trabzon-Maçka (Scalita). Satunin (6) defined *C. russula aralychensis* because of the dorsal side colour and the long tails of the samples collected from Iğdır-Aralık (previously Kars-Aralık). Kahmann and Çağlar (10) stated that *C. suaveolens* might be distributed all along the Black Sea coastal stripe as far as Rize. Çağlar (44) and Osborn (12) gave records of *C. suaveolens* from different localities in Turkey without making any comparisons. Richter (45) determined the samples whose ratio of tail length to head-body length is less than 60 % to be *C. russula*, and those whose ratio is higher than 60 % to be *C. gueldenstaedtii*. Richter (45) evaluated samples collected from Trabzon, Samsun, Artvin, Erzurum, Maraş, Hatay and Pozantı as *C. gueldenstaedtii*. Based on the criteria of Richter (45), Lehman (13) stated that *C. gueldenstaedtii* exists in Anatolia.

Richter (20) stressed that there is a tuberculum as a distinctive characteristic in uneroded forms at the lingual angle of the second premolar's frontal edge. He also stated that this tuberculum is situated in the middle of the second premolar in *C. suaveolens* and *C. gueldenstaedtii*, but in *C. russula* it is at the lingual angle of the second premolar's frontal edge. However, samples collected by several researchers from Turkey were evaluated within *C. suaveolens* and *C. russula* (according to dorsal and ventral side colours, and tail colours, and external and internal measurement characteristics and their distribution diagrams by Spitzenberger (15), Kock et al. (16) and Felten et al. (17)). Furthermore, *gueldenstaedtii* was also dealt with as a subspecies of *C. russula* (15).

Şimşek (22) collected the most samples from Turkey and concluded that the condylobasal length in *C. suaveolens* was shorter than 17.9 mm and suggested that the body's dorsal side of his samples shows different tones of brown, and the ventral side colour variation ranges from light ashy to different tones of brown, and especially these two colours mix with each other at the sides without forming a distinctive border. Catzeflis et al. (23) researched the Eastern Mediterranean *Crocidura* populations and compared Turkish samples with *C. suaveolens*, which are also distributed in Cyprus, Israel and the Greek Islands. According to Catzeflis et al. (23), Turkish samples had a condylobasal length of 18.03 – 18.60, which is considered high. Vogel et al. (24) stated that the Turkish *C. suaveolens* samples show similar features to samples from Switzerland, Greece and Cyprus as a result of their biochemical analyses on Turkish *C. suaveolens* samples collected by Catzeflis et al. (23). Niethammer and Krapp (26) divided *C. suaveolens* populations into two different categories according to condylobasal length. In Mediterranean populations (Southern populations), condylobasal length ranges from 17.2 to 18.4 mm and in Northern populations it ranges from 15.4 to 17.0 mm.

The external and internal measurements and colour characteristics given by previous researchers were determined to be within the variation limits of the samples evaluated as *C. suaveolens* in this research (Table 1). In addition, the ratio of tail length to head-body length was found to be above or below 60% in *C. suaveolens* collected from all over Turkey in this research. Since *C. russula* does not exist in Turkey (25), it is clear that this ratio cannot be used in distinguishing species. The samples collected had 2n = 40 and these samples were evaluated as *C. suaveolens*. The tuberculum in the second premolar was also found to be in the centre of the second premolar in 30 % of the samples collected for this study and defined as *C. suaveolens* and at the frontal edge's angle in 70 %. However, apparently this criterion cannot be used in distinguishing species since *C. russula* populations with 2n = 42 karyotype do not exist in Turkey. Condylobasal length of Turkish *C. suaveolens* did not always have high values (18.03 - 18.60 mm according to Catzeflis et al., (23), and it was observed to decrease to 17.00 mm. This study also indicated that Niethammer and Krapp's (26) findings, according to condylobasal length, were valid. Condylobasal length was

determined to be below 17.20 mm in only six out of 209 adult *C. suaveolens* samples collected for this study from Turkey.

Meylan (33) gave karyological characteristics of *C. suaveolens* and stated that there were 2n = 40, FN = 50 in this species. Meylan (33) also gave two pairs subtelocentric, two pairs meta or submetacentric in the karyotype and listed the other autosomes as acrocentric at varying sizes, the X chromosome as submetacentric at medium size, and the Y chromosome as small acrocentric. The same characteristics was also given by Rimsa et al. (39) from Yugoslavia, by Skolov et al. (46) from Russia, by Catzeflis (37) from Italy and by Zima and Kral (38) from Czechoslovakia. Meylan and Hausser (34) described the presence of one or two pairs of supernumerary chromosomes in *C. suaveolens* populations they studied from three localities in Switzerland - Tessin region. Ivanitskaya et al. (47) and Orlov et al. (48) reported the same information about the *C. suaveolens* populations that they studied from Tajikistan and Mongolia respectively where the X chromosome is acrocentric and a pair of autosomes is very large metacentric. Catzeflis et al. (23) studied karyotype characteristics of *C. suaveolens* from Turkey (İzmir, Samsun, Trabzon), Switzerland (Mendrisio), Israel (Tel Aviv) and Greece (Samos and Lesbos Islands). In this species, Catzeflis et al. (23) stated that 2n, FN, FNa were 40, 50 and 46, and the X chromosome was submetacentric, and the Y chromosome was small acrocentric and the largest pair out of four pairs of biarmed autosomes was subtelocentric. Grafodatsky et al. (41) also gave the same standard karyotype for Russian populations.

The karyotype characteristics of *C. suaveolens* given by different researchers were compared with those of Turkish *C. suaveolens* (Figure 5) and no differences were found (33,37,38,39,46). However, the supernumerary chromosome and acrocentric X chromosome were not found in Turkish *C. suaveolens* populations (34,47,48).

Consequently, the *Crocidura* in Turkey include two species according to the morphological (Figure 2, 3; Table 2), karyological (Figures 4 and 5) and statistical (Figure 6) data and these species distributed in Turkey were defined as *Crocidura leucodon* (2n = 28) and *Crocidura suaveolens* (2n = 40).

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