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# ON THE TURKISH POPULATIONS OF DRYOMYS NITEDULA (PALLAS, 1779) AND DRYOMYS LANIGER FELTEN AND STORCH, 1968 (MAMMALIA: RODENTIA)

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*Dryomys nitedula* occurring in Turkish Thrace and Anatolia, and *Dryomys laniger* were morphologically and biometrically compared to each other. In addition, the blood serum proteins of *D. nitedula* and *D. laniger* were examined by the SDS – PAGE technique. There are very small morphological differences among the populations of *D. nitedula*, but the shapes of the braincase, tympanic bullae and mandible morphologically distinguished *D. nitedula* from *D. laniger*. In pair-wise biometric comparisons, nine biometric characteristics were found to differ statistically between *D. nitedula* (Thrace) and *D. nitedula* (Anatolia), 16 characteristics between *D. nitedula* (Turkish Thrace) and *D. laniger*, 11 characteristics between *D. nitedula* (Anatolia) and *D. laniger* ($p < 0.05$). UPGMA cluster analysis established links between *D. nitedula* (Turkish Thrace) and *D. nitedula* (Anatolia) with a distance of 0.042, and *D. laniger* was connected to this cluster with a distance of 0.084. In the patterns of blood serum proteins, eight or nine bands were identified in the globulin zone, one band in the post-albumin and albumin zones and one or two bands in the pre-albumin zone of both species.

Key words: taxonomy, SDS – PAGE, serum, *Dryomys*, Turkey

## INTRODUCTION

The genus *Dryomys* is widely distributed in the Palaearctic region, and is represented by two species in Turkey (CORBET 1978, WILSON & REEDER 1993, MITCHELL-JONES *et al.* 1999). Of these species, *Dryomys nitedula* (PALLAS, 1778) occurs widely in Turkey, but *Dryomys laniger* was first described by FELTEN and STORCH (1968) from Çığlıkara – Elmalı (Antalya), and is endemic to Turkey. *Dryomys nitedula phrygius* THOMAS, 1907 was first described from Uşak province (Turkey), and the population of *D. nitedula* occurring in Asiatic Turkey, Syria and Israel was assigned to this subspecies. In addition to the Turkish subspecies, *Dryomys nitedula wingei* (NEHRING, 1902), and *Dryomys nitedula robustus* (MILLER, 1910) were described from Greece and Bulgaria, respectively. Later, the second subspecies was considered synonymous with the nominate race. In addition to these subspecies, three others, namely *Dryomys nitedula pictus* (BLANFORD, 1875) from N Iran, Armenia and south-eastern Turkey, *Dryomys nitedula*

*tichomirovi* SATUNIN, 1920 from Armenia and Kurdistan, and *Dryomys nitedula ognevi* HEPTNER et FORMOSOV, 1928 from southern Dagestan seem to be the nearest subspecies to *D. n. phrygius*. *D. n. pictus* was also considered a separate species by MURSALOĞLU (1973). However, the differences among these subspecies are not clear, and depend on slight colour variations. The taxonomic status of populations in Turkish Thrace is also unclear, and this population should be compared with Greek subspecies to elucidate subspecific status. In spite of the wide distribution of *D. nitedula*, the distribution border of *D. laniger* is still undetermined. Karyologic studies were performed for these species by DOĞRAMACI & KEFELİOĞLU (1990) and KIVANÇ *et al.* (1997) in Turkey. According to these studies, *D. nitedula* has 2n = 48 (DOĞRAMACI & KEFELİOĞLU 1990) and *D. laniger* 2n = 46 (KIVANÇ *et al.* 1997). Allozymic and biometric comparison between populations of *D. nitedula* were also performed by FILIPUCCI *et al.* (1994). Up to now, there are no data available for comparison of blood serum proteins of both species. In the present study, the aim was to determine variations in morphological, biometric and blood serum proteins between *D. nitedula* and *D. laniger*, and also to contribute to the knowledge on subspecific status.

## METHODS

Specimens collected from 10 different localities in Turkey (Fig. 1) were examined with respect to their morphological and biometric characteristics, and serum proteins (SDS – PAGE method). External and cranial measurements (mm) along with weight (g) were taken for adult specimens (nail length was included in hind foot measurements), and all specimens were skinned in the standard museum manner. The skulls were carefully drawn under a binocular microscope in order to examine and compare morphological structures. The biometric comparison was performed using t-test (Microsoft Excel *t-test* Two-sample Assuming Unequal Variance), and the similarity coefficients, and UPGMA dendogram were computed by using NTSYS-pc computer programme (ROHLF 1989). The skins and skulls have been deposited at the University of Ankara, Faculty of Science.

SDS – PAGE (Sodium dodecyl sulphate polyacrylamide gel electrophoresis) analysis was performed on live specimens caught in different localities within the known distribution areas of *Dryomys* in Turkey (Fig. 1). Globulin (G) and albumin (A) regions with subzones were assayed in all specimens. The globulin region was considered without separating subzones, but the albumin region was subdivided into post-albumin (PsA), albumin (A) and prealbumin (PA) zones. Blood was taken by cardiac puncture from the animals, which had been anaesthetised with ether. After blood clotting, the separated sera were centrifuged at 12.000 rpm for 3 min. The sera were mixed with a sample buffer as described by LAEMMLI (1970). The final concentration of sera was adjusted to 5%. Samples were boiled for 3 min and stored at –70°C until electrophoresis. Electrophoresis was carried out using Consort E863 model vertical slab gel electrophoresis apparatus. SDS – polyacrylamide denaturing gels (separating gels "7.5 %" and stacking gels "4 %"), were prepared as described by SAMBROOK *et al.* (1989). The amount of protein loaded to gel was semi-quantitatively determined according to ESEN's method (ESEN 1978). Electrode buffer solution was made up of 0.025 M Tris, 0.192 M

glycine and 0.1% SDS at pH 8.3 (SAMBROOK *et al.* 1989). A sample of 15 µl and 5 µl Molecular Weight Marker (Sigma MW-SDS – 200, carbonic anhydrase: 29000, egg albumin: 45000, bovine albumin: 66000, phosphorylase B: 97400, beta-galactosidase: 116000, myosin: 205000) were applied to gels in the experiments. Constant voltage (8 V/cm) was applied to the stacking gel. After the tracing dye reached the separating gel, the voltage was adjusted to 15 V/cm. After electrophoresis, gels were stained with 0.25% Coomassie Brilliant Blue R250 (CBB) in methanol, water, glacial acetic acid (45:45:10) solution, and destained in the same solution without CBB.

Abbreviations used in the text: TBL: Total body length, TL: Tail length, HFL: Hindfoot length, EL: Ear length, T × 100 / HB: Tail length percentage to head and body length, W: Weight, ZB: Zygomatic breadth, IC: Interorbital constriction, GLS: Greatest length of skull, ONL: Occipitonasal length, BL: Basal length, NL: Nasal length, NW: Nasal width, LFR: Length of facial region, LBC: Length of braincase, MAB: Mastoid breadth, OW: Occipital width, DL: Diastema length, PL: Palatal length, IFL: Incisiva foramina length, HBB: Height of braincase with bullae, HBWB: Height of braincase without bullae, LTB: Length of tympanic bullae, MAL: Mandible length, LUTR: Length of upper tooth row, LUPM: Length of upper premolar LLTR: Length of lower tooth row, LLPM: Length of lower premolar.

## RESULTS AND DISCUSSION

*Distribution and habitat.* In Turkey, *D. nitedula* is distributed in mixed and oaks forests, especially along river banks with shrubs. Recording localities are presented in Figure 1 and in addition to our own record localities, STORCH (1978), KRYŠTUFEK and VORHALÍK (1994) provided many other localities for *D. nitedula* in Turkey. This species is usually abundant in the gardens near to mixed forest. *D.*

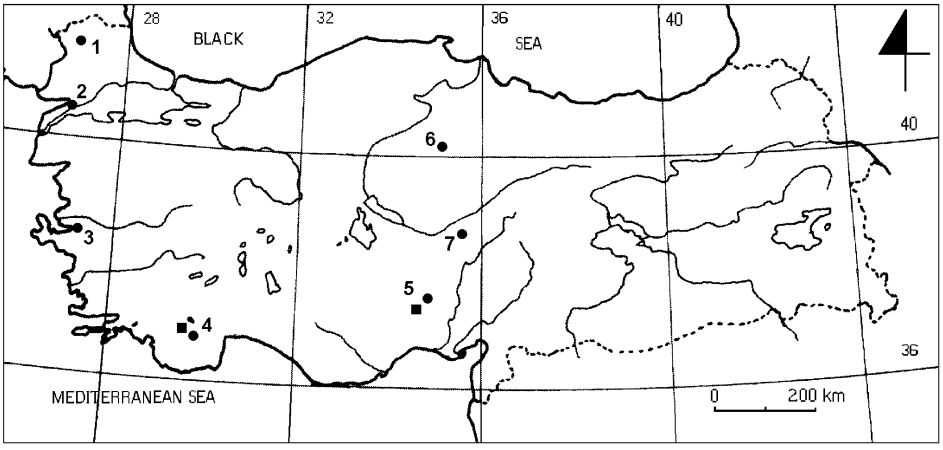


**Fig. 1.** Recording localities of *D. nitedula* (l) and *D. laniger* (n) in Turkey, 1: Edirne, 2: Gelibolu / Çanakkale, 3: İzmir, 4: Elmalı / Antalya, 5: Ulukışla / Niğde, 6:Çorum, 7. Kayseri

*laniger*, an endemic species, ranges from south-western Turkey to central Anatolia (Fig. 1). The habitat is dominated by Cedar (*Cedrus libani*), Juniper (*Juniperus excelsa*, *J. foetidissima*, *J. oxycedrus*), Cypress (*Cupressus sempervirens*), Fir (*Abies cilicica*) and Oak (*Quercus cocciferae*) in south – western Turkey. Vegetation cover within the distributional range is sparse in central Anatolia, and the ground is almost completely stony or rocky. This species was found over 1000 m above sea level in the study area. These findings are similar to those of FELTEN and STORCH (1968) and SPITZENBERGER (1976).

*External characteristics*: *D. nitedula* (Turkish Thrace): The maximum TBL and TL were 210 mm and 110 mm, respectively (Table 1). The tail length is equal to 96.7% of head and body length and the dorsal colour is generally yellowish brown, but highly reddish in some specimens. The dorsal fur becomes paler towards the muzzle. The black band surrounding the eyes and extending to just in front of the ears is a very distinctive characteristic. The flank is yellowish. The ears, both internally and externally, are covered with very sparse and short hairs. The tail colour is very different from the dorsal fur, and the hairs of the tail are longer than the dorsal hairs. The tail is bicoloured, the dorsal surface being greyish with a yellow tinge, and the yellowish colour in the ventral fur is dominant in the general appearance. In contrast to our findings, HARRISON and BATES (1991) reported that the tail is uniformly coloured in Arabian specimens. There is long and pale yellowish hair at the tip of the tail.

The dorsal body colour extends half way down the legs, but becomes pale yellowish or dirty white on the fore and hind feet. The line of demarcation is very distinct, and the ventral fur is pale yellow. The bases of dorsal hairs are dark grey, but they vary between dark greyish or pale yellowish. These descriptions are similar to those reported by ONDRIAS (1966) and STORCH (1978).

*D. nitedula* (Western Asiatic Turkey): The maximum TBL was measured at 240 mm, TL 110 mm, HFL 22 mm, EL 16 mm. The ratio of tail to head body length averaged 87.5% (Table 1). Our external characteristics lie within the range of measurements given by HARRISON and BATES (1991). The pelage characteristics are the same as in the population of Turkish Thrace, but there is a small and distinct brownish patch located below and just in front of the ear. This characteristic is weakly distinguishable in the population of Turkish Thrace. In addition to the variations among Turkish specimens, ONDRIAS (1966) stated that the pelage coloration is very varied, young specimens being much greyer than adults. MURSALOĞLU (1973) considered specimens from around Hakkari (south-eastern Turkey) as a separate species; *D. pictus*. She noted that *D. pictus* has more greyish dorsal fur than *D. nitedula*. We had a opportunity to examine Iranian specimens of *Dryomys*, and the specimens referred to *D. pictus* are very different in respect of the dor-

**Table 1.** The measurements of external and cranial characteristics with weights of *Dryomys* species

| Characteristics | *D. nitedula* (Turkish Thrace) (n= 24) Mean ± SD (Min – Max) | *D. nitedula* (Western Anatolia) (n= 8) Mean ± SD (Min – Max) | *D. laniger* (n= 10) Mean ± SD (Min – Max) |
|---|---|---|---|
| TBL | 186 ± 10.74 (172 – 210) | 195 ± 29.80 (150 – 240) | 150 ± 7.28 (153 – 170) |
| TL | 92 ± 7.90 (73 – 110) | 87.0 ± 18.0 (59 – 110) | 73 ± 7.73 (53 – 75) |
| HFL | 21 ± 0.76 (19 – 22.5) | 21.50 ± 1.50 (18 – 22) | 18 ± 1.11 (16 – 19) |
| EL | 14.0 ± 0.71 (11 – 15) | 14.50 ± 1.91 (11 – 16) | 14.1 ± 1.96 (12.1 – 17.0) |
| T × 100 / HB | 96.7 ± 7.83 (89.7 – 111.8) | 87.50 ± 14.50 (57 –97) | 79 ± 11.66 (53 – 89) |
| W | 28.0 ± 4.17 (17 – 35) | 22.50 ± 3.63 (15 – 25) | 20 ± 5.33 (17 – 32) |
| ZB | 15.8 ± 0.45 (15.1 – 16.6) | 15.40 ± 0.58 (14.3- 16.2) | 14.4 ± 0.54 (13.8 – 15.2) |
| IC | 4.1 ± 0.15 (3.8 – 4.4) | 4.15 ± 0.12 (4.0 – 4.4) | 4.3 ± 0.14 (4.2 – 5.4) |
| CBL | 24.4 ± 0.52 (23.6 – 25.4) | 24.0 ± 0.47 (23.0 –24.8) | 24 ± 0.52 (23.1 – 26.7) |
| GLS | 27.0 ± 0.60 (25.9 – 27.5) | 26.40 ± 0.78 (25.4 – 26.7) | 26.6 ± 0.73 (25.7 – 27.5) |
| BL | 22.5 ± 0.72 (20.7 – 23.7) | 22.0 ± 0.41 (21.6 – 22.6) | 22 ± 0.39 (21.9 – 23.0) |
| NL | 8.6 ± 0.47 (7.7 – 10.0) | 8.80 ± 0.41 (8.6 – 9.0) | 8.5 ± 0.25 (8.4 – 8.7) |
| NW | 2.7 ± 0.19 (2.6 – 3.0) | 2.40 ± 0.16 (2.2 – 2.7) | 2.4 ± 0.18 (2.3 – 2.8) |
| LFR | 11.8 ± 3.35 (11.0 12.1) | 11.60 ± 0.47 (10.8 – 12.4) | 11.4 ± 0.38 (10.4 – 11.5) |
| LBC | 13.8 ± 0.33 (12.2 – 14.5) | 13.50 ± 0.47 (12.6 – 13.9) | 13.3 ± 0.40 (12.7 – 13.8) |
| MAB | 8.3 ± 0.30 (7.9 – 9.0) | 8.0 ± 0.37 (7.8 – 8.9) | 7.9 ± 0.26 (7.7 – 8.5) |
| OW | 13.1 ± 0.25 (12.5 – 13.3) | 12.5 ± 0.19 (12.3 – 12.9) | 12.9 ± 0.50 (11.8 – 13.6) |
| DL | 6.5 ± 0.31 (5.9 – 7.2) | 6.7 ± 0.26 (6.4 – 7.2) | 6.2 ± 0.38 (5.7 – 6.7) |
| PL | 9.2 ± 0.36 (8.9 – 10.1) | 9.15 ± 0.31 (8.9 – 9.8) | 9.3 ± 0.66 (8.4 – 10.3) |
| IFL | 3.4 ± 0.26 (2.9 – 3.94) | 3.16 ± 0.22 (2.89 – 3.60) | 3.4 ± 0.30 (2.89 – 3.68) |
| HBB | 11.0 ± 0.38 (10.5 – 11.9) | 10.95 ± 0.35 (10.4 – 11.6) | 10.2 ± 0.27 (9.8 – 10.6) |
| HBWB | 9.0 ± 0.30 (8.5 – 9.6) | 9.0 ± 0.32 (8.6 – 9.6) | 8.2 ± 0.13 (8.0 – 8.4) |
| LTB | 7.4 ± 0.39 (6.8 – 8.4) | 7.63 ± 0.67 (6.8 – 7.6) | 8.4 ± 0.58 (7.36 – 9.2) |
| MAL | 14.4 ± 0.47 (13.7 – 15.5) | 13.75 ± 0.72 (12.7 – 14.9) | 13.7 ± 0.44 (12.8 – 13.9) |
| LUTR | 3.9 ± 0.15 (3.68 – 3.94) | 3.68 ± 0.17 (3.4 – 3.9) | 3.55 ± 0.08 (3.50 – 3.68) |
| LUPM | 0.78 ± 0.07 (0.66 – 0.79) | 0.69 ± 0.07 (0.6 – 0.78) | 0.65 ± 0.07 (0.52 – 0.66) |
| $M^1$ | 0.92 ± 0.07 (0.90 – 1.05) | 0.92 ± 0.06 (0.9 – 1.05) | 0.92 ± 0.08 (0.84 – 1.10) |
| $M^2$ | 1.0 ± 0.07 (0.90 – 1.05) | 1.0 ± 0.05 (0.90 – 1.05) | 1.0 ± 0.05 (0.90 – 1.10) |
| $M^3$ | 0.79 ± 0.07 ( 0.78 – 1.05) | 0.79 ± 0.04 ( 0.79 – 0.92) | 0.79 ± 0.05 ( 0.78 – 0.92) |
| LLTR | 3.94 ± 0.15 (3.68 – 4.20) | 3.68 ± 0.22 (3.42 – 4.20) | 3.4 ± 0.19 (3.15 – 3.68) |
| LLPM | 0.66 ± 0.08 (0.52 – 0.79) | 0.70 ± 0.08 (0.52 – 0.79) | 0.55 ± 0.07 (0.50 – 0.66) |
| $M_1$ | 0.99 ± 0.08 (0.90 – 1.20) | 1.02 ± 0.06 (0.90 – 1.05) | 0.99 ± 0.07 (0.90 – 1.10) |
| $M_2$ | 0.99 ± 0.08 (0.90 – 1.20) | 1.03 ± 0.06 (0.90 – 1.05) | 0.99 ± 0.08 (0.90 – 1.10) |
| $M_3$ | 0,82 ± 0.07 ( 0.78 – 1.05) | 0.79 ± 0.09 (0.79 – 1.05) | 0.79 ± 0.10 ( 0.78 – 1.05) |

sal colour, the black ring surrounding the eyes especially differs from that of *D. nitedula*.

*D. laniger*: External measurements are smaller than in *D. nitedula*. The maximum TBL measured was 170 mm, TL 75 mm, HFL 19 mm and EL 17 mm. The tail is markedly shorter than head and body length (Table 1). FELTEN and STORCH (1968) reported similar results to ours. The dorsal colour is greyish with pale yellowish and blackish tinges. The dorsal hairs are tricoloured, with the base of the hairs being dark greyish, the mid-zones pale yellowish or whitish, and their tips are black and dirty white or pale yellow. The yellowish appearance of the dorsal colour disappears towards the tail, and the dorsal colour of the tail is greyer than the dorsal colour of the body. The flank colour becomes gradually paler ventrally. The ear is the same as in *D. nitedula*. The hairs on the tail become longer towards its tip, and the tail is markedly bicoloured, being greyish above, and pale yellowish or dirty white below. The ventral fur is dirty white, and its base is greyish. The upper sides of both fore and hind feet are dirty white, but the soles are completely naked. The line of demarcation along the flanks is fairly distinct.

*Cranial characteristics*: *D. nitedula* (Turkish Thrace): The maximum CBL and GLS were measured at 25.4 mm and 27.5 mm, respectively (Table 1). The skull exhibits general characteristics of the genus *Dryomys*, and the cranial definitions are generally consistent with the findings of HARRISON and BATES (1991). The rostrum is broad, and the nasal bones project beyond the incisors. The brain case is narrow and posteriorly curved in the parietal and interparietal region of the skull (Fig. 2*a*). The zygomatic arches are delicate. Their squamosal parts do not touch the anterior rim of the meatus, and are slightly tilted outwards. There are no ridges on the skull. The posterior tips of the occipital condyles are invisible in dorsal view of the skull. The incisiva foramina are relatively long, but their posterior ends are far from the premolars. The anterior part of the tympanic bulla nearly touches the tip of the pterygoid process. The tympanic bulla is of moderate size, and slightly inflated ventrally. The mandible is slender. The coronoid process is markedly separated from the condlyoid process, and slightly bent inwards. The premolar and molar surfaces are as described by HARRISON and BATES (1991). Upper and lower premolars bear three and one roots respectively. However, upper molars bear three roots, lower molars two.

*D. nitedula* (Western Asiatic Turkey): The maximum CBL and GLS were 24.8 mm and 26.7 mm, respectively (Table 1). Our measurements are consistent with those of HARRISON and BATES (1991). The cranial peculiarities are the same as in the population of Turkish Thrace.

*D. laniger*: The maximum CBL and GLS were 26.7 mm and 27.5 mm, respectively (Table 1). The cranial peculiarities were similar to those given by

FELTEN and STORCH (1968). When compared with *D. nitedula*, the rostrum is more slender. Although there is no statistically significant difference between the nasal lengths among taxa ($p > 0.05$), the nasal bones of *D. laniger* extend further from the incisor than in the previous species. The braincase is smoother and broader than in *D. nitedula* (Fig. 2*b*). The zygomatic arches are similar in both species, but there is no outward tilt by the squamosal parts. The mandibles are almost similar to those of *D. nitedula* but the coronoid processes are relatively slender, and do not bend internally. The roots of premolars and molars are the same as in *D. nitedula*.

*Biometric comparisons*: Pair-wise comparisons were performed between *D. nitedula* (in Turkish Thrace) and *D. nitedula* (Western Anatolia), *D. nitedula* (in Turkish Thrace) and *D. laniger*, *D. nitedula* (Western Anatolia) and *D. laniger*. According to the results of *t*-tests, for T × 100 / HB, W, ZB, NW, LBC, OW, IFL, MAL, LUTR statistically significant differences were found between *D. nitedula* (in Turkish Thrace) and *D. nitedula* (Western Anatolia), for TL, HFL, T × 100\HB, W, ZB, IC, NW, MAB, HBB, HBWB, LTB, MAL, LUTR, LUPM, LLTR, LLPM between *D. nitedula* (in Turkish Thrace) and *D. laniger*, and for TBL, TL, HFL, ZB, IC, DL, HBB, HBWB, LUPM, LLTR, LLPM between *D. nitedula* (Western Anatolia) and *D. laniger* ($p < 0.05$). In addition to *t*-tests, biometric data were analysed using NTSYS-pc. Data were first standardised (Sort SY, Substs: Min), then distance matrices were calculated by Manhattan coefficient, and UPGMA cluster analysis was performed in accordance with the symmetric matrix. In the cluster analysis, the populations of *D. nitedula* in Turkish Thrace and Western Anatolia were close to each other (D: 0.042), and *D. nitedula* was connected to this cluster with a distance of 0.084 (Fig. 3). In addition, the distances between *D. nitedula* (Turkish Thrace) and *D. laniger*, *D. nitedula* (Western Anatolia) and *D. laniger* were calculated as 0.087 and 0.081, respectively. This finding showed that *D. nitedula* (Western Anatolia) is biometrically closer to *D. laniger* than the popula-

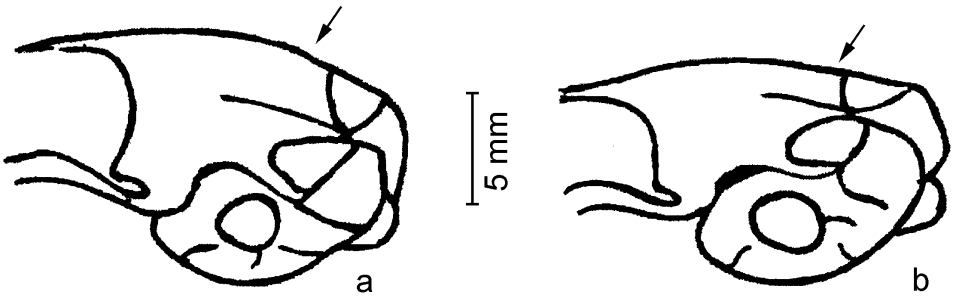


**Fig. 2.** Comparison of the braincases of *D. nitedula* (a) and *D. laniger* (b) (lateral view), arrows indicate the curving on the parietal and interparietal bones

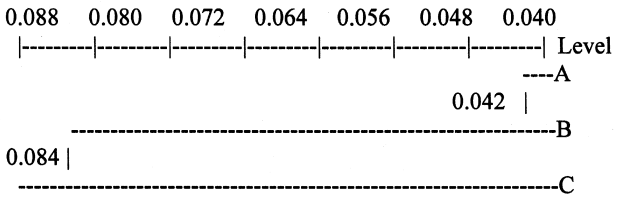


**Fig. 3.** UPGMA dendrogram showing the distance between the populations of *D. nitedula* and *D. laniger* (A: *D. nitedula* from Turkish Thrace, B: *D. nitedula* from Western Anatolia, C: *D. laniger*)

tion of *D. nitedula* (Turkish Thrace). Apart from this, FILIPUCCI *et al.* (1994) revealed that the genetic distances between *D. nitedula* (Edirne, Turkey) and *D. nitedula* (Israel), *D. nitedula* (Edirne, Turkey) and *D. nitedula* (Macedonia) were 0.227 and 0.027, respectively. Although statistically proven differences in the mean values of any trait were not found, MARKOV (2001) stated that specimens possessed well-expressed sexual dimorphism of cranial characters. Unlike MARKOV (2001), we found that many cranial characteristics were statistically different in Turkish specimens (Table 2). This finding suggests that *D. nitedula* from Western Anatolia belongs to the subspecies *phrygius* being somewhat different from the nominate subspecies of *D. nitedula* from Turkish Thrace.

*Electrophoretic comparisons*: Serum proteins of 10 specimens of the genus *Dryomys* "*D. nitedula* (n= 6), *D. laniger* (n = 4)" captured from Turkey were examined by SDS – PAGE method (Fig. 4). Male and female specimens were evalu-

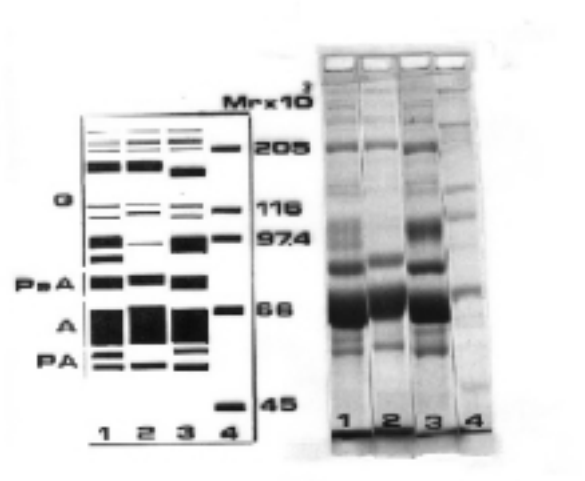


**Fig. 4.** Variations in the pattern of blood serum proteins of *D. nitedula* (lines 1, 2) and *D. laniger* (line 3), Marker (line 4). G: globulin, PsA: postalbumin, A: albumin, PA: prealbumin

**Table 2.** Pair-wise biometric comparisons of *D. nitedula* (Turkish Thrace), *D. nitedula* (Asiatic Turkey), *D. laniger* (Asiatic Turkey) by means of Student t – test (+: $p < 0.05$, – $p > 0.05$)

| Characteristics | *D. nitedula* (Turkish Thrace) vs *D. nitedula* (Western Anatolia) | *D. nitedula* (Turkish Thrace) vs *D. laniger* | *D. nitedula* (Western Anatolia) vs *D. laniger* |
|---|---|---|---|
| TBL | - | - | + |
| TL | - | + | + |
| HFL | - | + | + |
| EL | - | - | - |
| T × 100 / HB | + | + | - |
| W | + | + | - |
| ZB | + | + | + |
| IC | - | + | + |
| CBL | - | - | - |
| GLS | - | - | - |
| BL | - | - | - |
| NL | - | - | - |
| NW | + | + | - |
| LFR | - | - | - |
| LBC | + | - | - |
| MAB | - | + | - |
| OW | + | - | - |
| DL | - | - | + |
| PL | - | - | - |
| IFL | + | - | - |
| HBB | - | + | + |
| HBWB | - | + | + |
| LTB | - | + | - |
| MAL | + | + | - |
| LUTR | + | + | - |
| UPM | - | + | + |
| $M^1$ | - | - | - |
| $M^2$ | - | - | - |
| $M^3$ | - | - | - |
| LLTR | - | + | + |
| LPM | - | + | + |
| $M_1$ | - | - | - |
| $M_2$ | - | - | - |
| $M_3$ | - | - | - |

ated together as there are no differences between the sexes. Globulin (G) and albumin (A) regions were assayed in specimens.

*D. nitedula*: Eight (n = 3) or nine (n = 3) bands were determined in the globulin region, and this variation resulted from the patterns of the fastest migration bands. In three specimens, the eighth band in the line of the marker protein of 97400 D was strongly stained, but the ninth band was weaker than these. The other specimens have eight globulin bands; the eighth bands in the line of the marker protein of 97400 D was weakly stained. Post-albumin (PsA) and albumin (A) zones were monomorphic and strongly stained in all specimens. In the PA zone of *D. nitedula*, there were two phenotypes. One of the phenotypes had a fast PA band, and the other had two PA bands with equal density. The latter phenotype was probably in a heterozygous state (Fig. 4).

*D. laniger*: Eight bands without variation were observed in the globulin region. The bands in the globulin region usually stained weakly, except for the fifth and eighth bands. The fifth bands in the globulin region was almost between the marker proteins of 205000 D and 116000 D, but the eighth, forming markedly dense globulin band, was in the line of the marker protein 97400 D. PsA and A zones were the same as in the previous species. In the PA zone of *D. laniger*, there were two bands and the rapidly- migrated bands were stronger than the slow- migrated bands. In the PA zone, the two- banded phenotype was somewhat different from those of *D. nitedula* (Fig. 4).

In studies performed on patterns of blood serum protein of Turkish rodents, it was determined that the A zone consistently has one band, and other zones such as G, PsA and PA showed interspecific variations; G zone with 7 – 12 bands, PsA zone 1 – 4 bands, PA zone 1 – 4 bands (VERIMLI *et al.* 2000*a*, *b*, VERIMLI *et al.* 2001, YİĞİT *et al.* 2001, ÇOLAK *et al.* 2002, ÇOLAK 2002, ÇOLAK & ÖZKURT 2002). Similar variations were also found in *D. nitedula* and *D. laniger*.

## CONCLUSION

Although *D. nitedula* and *D. laniger* are easily distinguishable from each other via external morphology, the shapes of the braincase, tympanic bullae and mandible have also separeted *D. nitedula* from *D. laniger*. In addition to these, many biometric charactersitics were found to be importance among taxa. UPGMA cluster analysis established links between *D. nitedula* (Turkish Thrace) and *D. nitedula* (Anatolia) with a distance of 0.042, and *D. laniger* was connected to this cluster with a distance of 0.084. Globulin (G) and albumin (A) regions with subzones of both species showed similar variations to other Turkish rodent. In this

respect, it can be said that the patterns of blood serum proteins have not taxonomic importance for these taxa.

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