Macronanatomic and Morphometric Analysis of the Brown Bear (Ursus arctos horribilis) Mandible

Gülseren Kırbas Doğan¹; Iftar Gürbüz²; Yasin Demiraslan² & Ismet Tağıç¹


SUMMARY: Brown bear (Ursus arctos horribilis) is a wild animal from the bear (Ursidae) family. In this study, it was aimed to determine the morphometric values and anatomical structure of the brown bear mandible. After the superficial muscles of the mandible were dissected, the muscles were completely separated from the bones by boiling. 17 morphometric measurements were taken from the right and left mandible of each animal with the help of digital calipers. The mean and standard deviation values of the taken morphometric measurements were analyzed in the SPSS (20.0 version) package program. The mandible length was measured as 250.37 ± 9.75 mm on the right side and 246.83 ± 5.92 mm on the left side. The mandible height was determined as 105.76 ± 4.18 mm on the right and 108.62 ± 3.33 mm on the left. Consequently, the mandible was submitted to the results of the brown bear in the diversity of wildlife found in Turkey. We believe that the presented results will contribute to anatomical, surgical and archaeological studies.

KEY WORDS: Anatomy; Brown bear; Mandible.

INTRODUCTION

Morphometry is a method that allows statistical analysis in terms of numerical or graphical values of the length between two specific points or angles. The variety of geographical areas with habitats of organism, developmental stages, genetic and environmental effects can cause morphometric variations (Rohlf & Marcus, 1993). Bergmann (1847) reported that climatic conditions affect the size of the alive. Accordingly, a lives of larger size live in cold climates and smaller sizes in hot climates. Due to thermoregulation heat loss will be less and the body will not shrink. The studies conducted also support this rule (de Carlis et al., 2005).

Brown bears are among the largest land carnivores. It is classified under Carnivora genus, Ursidae family, Ursus arctos species, horribilis subspecies. It is one of the largest omnivorous animals on earth. Their size is between 1 and 3 meters. Brown bear is the only bear species living in Turkey. They have a large head, a long nose, and a powerful chin. They are distinguished by their fur color and body size. They have a better sense of smell and a longer mouth than black bears. Mouth shape and size are related to eating habits (Marshall Cavendish Corporation, 2010).

The mandible shapes the lower part of the facial skeleton. The mandible is two parts, corpus mandible and ramus mandible. The corpus mandible consists of pars incisiva, pars molaris and pars alveolaris. In carnivores, foramina mentalia lateralia are found on the lateral face of the corpus mandible. In the angulus mandible, only carnivores have processus (proc.) angularis. Fossa masseterica near the angulus mandible is deeper in carnivores compared to other animals (Dursun, 2008; Evans & de Lahunta, 2013; König & Liebich, 2015).

In the present study, macroanatomical and morphometric results of the mandible of brown bears, which established a habitat in Kars/Sarikamıs (Turkey) and a wild animal, were determined. We believe that these results will contribute to anatomical, surgical and archaeological studies.
MATERIAL AND METHOD

Ethical approval. The necessary permission for this study was obtained by the Ministry of Agriculture and Forestry (E.2242114/2018).

Animals. Three male brown bear mandibles were used in the study. The working material, the mandible, was obtained from the brown bears of the habitat in the Sarıkamış Allahuekber Mountains National Park. These brown bears were injured animals brought to Kafkas University Veterinary Faculty Clinics and Kafkas University Wildlife Rescue and Rehabilitation Center, but could not be saved despite all interventions.

Maceration and morphometric analysis. After the superficial muscles of the mandible were dissected, the bones were completely separated from the muscles by boiling. Sun-dried mandibles were photographed with Canon digital camera zoom lens 5X. 17. Morphometric measurements were taken from the right and left mandible of each animal with the help of digital calipers (0.00, BTS, UK).

Morphometric measurements (abbreviations). Morphometric measurements are shown in Figures 1 and 2.

- L1. Total length: length from proc. condylaris-infradentale
- L2. Length: the proc. angularis-infradentale
- L3. Length from the indentation between the proc. condylaris and the proc. angularis-infradentale
- L4. Length: the proc. condylaris-aboral margin of the canine alveolus
- L5. Length from the indentation between the proc. angularis and the proc. condylaris-aboral margin of the canine alveolus
- L6. Length: the proc. angularis-aboral margin of the canine alveolus
- L7. Length: the aboral margin of the alveolus of M3-aboral margin of the canine alveolus
- L8. Length of the cheektooth row, P4-M3, measured along the alveoli
- L9. Length of the molar row, measured along the alveoli
- L10 (L). Length of P4, measured at the cingulum
- L10 (W). Width of P4, measured at the cingulum
- L11 (L). Length of M1, measured at the cingulum
- L11 (W). Width of M1, measured at the cingulum
- L12 (L). Length of M2, measured at the cingulum
- L12 (W). Width of M2, measured at the cingulum
- L13 (L). Length of M3, measured at the cingulum
- L13 (W). Width of M3, measured at the cingulum
- L14. Height of the vertical ramus (Ramus mandibulae): basal point of the proc. angularis-coronion
- L15. Height of the mandible behind M2, measured on the buccal side
- L16. Height of the mandible between P4 and M1, measured on the buccal side
- L17. Length of canin tooth

Anatomical features. Anatomical features of the mandible were recorded based on Nomina anatomica veterinaria (International Committee on Veterinary Gross Anatomical Nomenclature, 2017).

Statistical analysis. The mean and standard deviation values of the morphometric measurements taken were determined in the SPSS (20.0 version) package program. In addition, the obtained morphometric values were compared with the "Independent-T" test according to the direction (right-left) (P <0.05).
RESULTS

Foramina mentalia lateralia usually consisted of 2-3 holes in the ventral of the midpoint of PM1 (premolar 1) and C (canine) teeth. Foramen mandibulae were located at the 27.30 mm caudomedial of the last grinding tooth (Fig. 3). The length of the margo interalveolaris was determined as 32.17 mm.

The ventral edge was convex approximately at the anterior 1/4, and the concave in the posterior 1/4 was flat. There were 3I (incisive), 1C, 4PM, 3M (molar) teeth in a single jaw half. Fossa masseterica was in the form of a deep pit on the ramus mandible. There was a distinct proc. angularis on the angulus mandible, which is the junction of the corpus mandible and the ramus mandible. The caput mandible of the proc. condylaris was convex. Proc. coronoideus was perpendicular to the horizontal plane and its upper edge was ventro-dorsally oriented.

Morphometric results of the mandible are presented in Table I. Mandible length, the mean was 250.37 ± 9.75 mm on the right and 246.83 ± 5.92 mm on the left. Mandible height, the mean was 105.76 ± 4.18 mm on the right side and 108.62 ± 3.33 mm on the left side.

When the morphometric parameters of the right and left mandible were compared, it was seen that there was no statistically significant difference (P> 0.05).

DISCUSSION

Previous morphometric values of the mandible were found in sheep, goat, roe deer (Onuk et al., 2013; Dalga et al., 2017), German shepherd dog (Onar et al., 1999), Tuj and Morkaraman sheep (Demiraslan et al., 2014), some species of rodents (Mohamed, 2018; Ren et al., 2019) have been reported. However, there are studies on mandibular

<table>
<thead>
<tr>
<th>Length</th>
<th>Right mean ± sd (mm)</th>
<th>Right mean ± sd (mm)</th>
<th>General mean ± sd (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>L1</td>
<td>250.37 ± 9.75</td>
<td>246.83 ± 5.92</td>
<td>248.60 ± 7.47</td>
</tr>
<tr>
<td>L2</td>
<td>243.73 ± 5.87</td>
<td>243.73 ± 5.69</td>
<td>243.73 ± 5.17</td>
</tr>
<tr>
<td>L3</td>
<td>227.10 ± 5.46</td>
<td>230.17 ± 9.75</td>
<td>228.63 ± 7.27</td>
</tr>
<tr>
<td>L4</td>
<td>216.88 ± 5.97</td>
<td>220.41 ± 9.70</td>
<td>218.65 ± 7.46</td>
</tr>
<tr>
<td>L5</td>
<td>210.33 ± 17.63</td>
<td>206.90 ± 5.54</td>
<td>208.62 ± 11.48</td>
</tr>
<tr>
<td>L6</td>
<td>217.20 ± 5.72</td>
<td>213.80 ± 5.80</td>
<td>215.50 ± 5.48</td>
</tr>
<tr>
<td>L7</td>
<td>119.13 ± 1.71</td>
<td>121.43 ± 7.44</td>
<td>120.28 ± 4.99</td>
</tr>
<tr>
<td>L8</td>
<td>39.96 ± 0.90</td>
<td>40.41 ± 1.26</td>
<td>40.18 ± 1.01</td>
</tr>
<tr>
<td>L9</td>
<td>39.17 ± 1.36</td>
<td>40.09 ± 1.84</td>
<td>39.63 ± 1.53</td>
</tr>
<tr>
<td>L10(L)</td>
<td>13.28 ± 2.16</td>
<td>13.20 ± 1.95</td>
<td>13.24 ± 1.84</td>
</tr>
<tr>
<td>L10(W)</td>
<td>10.16 ± 1.06</td>
<td>10.48 ± 1.47</td>
<td>10.32 ± 1.16</td>
</tr>
<tr>
<td>L11(L)</td>
<td>12.74 ± 0.84</td>
<td>9.81 ± 0.92</td>
<td>11.27 ± 1.79</td>
</tr>
<tr>
<td>L11(W)</td>
<td>12.92 ± 1.14</td>
<td>12.48 ± 0.74</td>
<td>12.70 ± 0.89</td>
</tr>
<tr>
<td>L12(L)</td>
<td>11.71 ± 2.60</td>
<td>12.18 ± 1.63</td>
<td>11.95 ± 1.89</td>
</tr>
<tr>
<td>L12(W)</td>
<td>12.69 ± 2.90</td>
<td>12.38 ± 0.56</td>
<td>12.53 ± 1.88</td>
</tr>
<tr>
<td>L13(L)</td>
<td>15.55 ± 4.81</td>
<td>15.49 ± 4.69</td>
<td>15.52 ± 4.25</td>
</tr>
<tr>
<td>L13(W)</td>
<td>13.70 ± 1.33</td>
<td>14.08 ± 1.49</td>
<td>13.89 ± 1.28</td>
</tr>
<tr>
<td>L14</td>
<td>105.76 ± 4.18</td>
<td>108.62 ± 3.33</td>
<td>107.19 ± 3.73</td>
</tr>
<tr>
<td>L15</td>
<td>48.34 ± 2.87</td>
<td>47.56 ± 4.2</td>
<td>47.95 ± 3.42</td>
</tr>
<tr>
<td>L16</td>
<td>46.75 ± 4.65</td>
<td>43.75 ± 2.39</td>
<td>45.25 ± 3.69</td>
</tr>
<tr>
<td>L17</td>
<td>33.78 ± 4.78</td>
<td>33.00 ± 5.03</td>
<td>33.39 ± 4.41</td>
</tr>
</tbody>
</table>

Sd: standard deviation, mm: millimeter, L: length, W: width
morphometry in cave bears (Baryshnikov & Puzachenko, 2020) and Malayan sun bear (Kalita et al., 2019). However, no evidence of a morphometric and macroanatomic study of male living brown bears mandible in Turkey. In the study, it was aimed to determine the macroanatomical values and morphometric parameters of the male brown bear mandible.

Kırbas, et al. (2017) reported that foraminae mentalia consists of 2 holes. Similarly, in brown bears, it was observed that foraminae mentalia consisted of 2-3 holes. Fossa masseterica was reported as shallow in cave bears (Perego et al., 2001), while it was deep in brown bears.

It has been reported that genetic variation (Ketani & Sagsöz, 2009) and gender factor (Onar et al.) are effective in the morphometric development of the mandible. In New Zealand rabbit where morphometric values were compared according to gender, it was reported that the total length of the mandible in males was greater than in females. Similarly, the length of the mandible in the Malayan sun bear was 146 mm in males and 86.63 mm in females (Onar et al., 2015), the mean male malakan horse 253.20 mm ± 4.56, female malakan horse 249.65 mm ± 0.99 mm (Gürbüz et al., 2016) was measured. In brown bears, it was determined as 105.76 ± 4.18 mm on the right and 108.62 ± 3.33 mm on the left. When the mentioned articles were examined, it was reported that although the morphometric values of mandible height showed millimetric differences on the right and left sides, this difference was not statistically significant (P> 0.05).

In the study of Marsika brown bear, P4 length was reported as 13.00 ± 0.50 mm in males and, 12.30 ± 1.10 mm in females (Loy et al., 2008). Similarly, the length of P4 in the study was measured as 13.24 ± 1.84 mm. The width of P4 was reported as 10.10 ± 0.6 mm in male Marsika brown bear and 8.90 ± 0.5 mm in female (Loy et al., 2008). In the study, the P4 width was determined as 10.32 ± 1.16 mm in accordance with the male Marsika brown bear (Loy et al.).

Mandibula height, 34.40 mm in male fox, 35.58 mm in female fox (Kırbas et al., 2015), 70 mm in Malayan Sun bear (Kalita et al., 2019), in male wolf right side 74.14 ± 9.09 mm, left at 73.86 ± 9.41 mm (Gürbüz et al., 2015), the mean male malakan horse 253.20 ± 4.56, female malakan horse 249.65 mm ± 0.99 mm (Gürbüz et al., 2016) was measured. In brown bears, it was determined as 105.76 ± 4.18 mm on the right and 108.62 ± 3.33 mm on the left. When the mentioned articles were examined, it was reported that although the morphometric values of mandible height showed millimetric differences on the right and left sides, this difference was not statistically significant (P> 0.05).

In American black bears, M3 length excavated from the excavation measured M2 length 27.83 ± 1.18 mm and M2 width as 17.02 ± 0.91 mm (Wolverton, 2008). In this study, M2 length was 11.27 ± 1.79 mm and, M2 width was 12.53 ± 1.88 mm. American black bears appear to have more teeth length and width than brown bears.

Table II. Comparison of some lengths taken from the right-left mandible according to different animal species.

<table>
<thead>
<tr>
<th>Animals</th>
<th>Direction</th>
<th>Length of mandibula (mm)</th>
<th>Height of mandibula (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bear brown</td>
<td>Right</td>
<td>250.37 ± 9.75</td>
<td>105.76 ± 4.18</td>
</tr>
<tr>
<td></td>
<td>Left</td>
<td>246.83 ± 5.92</td>
<td>108.62 ± 3.33</td>
</tr>
<tr>
<td>Wolf (Gürbüz et al., 2015)</td>
<td>Right</td>
<td>248.60 ± 7.47</td>
<td>107.19 ± 3.73</td>
</tr>
<tr>
<td></td>
<td>Left</td>
<td>180.45 ± 13.51</td>
<td>74.14 ± 9.09</td>
</tr>
<tr>
<td>Malayan sun bear</td>
<td>General</td>
<td>181.63 ± 13.51</td>
<td>73.86 ± 9.41</td>
</tr>
<tr>
<td>(Kalita et al., 2019)</td>
<td></td>
<td>146</td>
<td>70</td>
</tr>
<tr>
<td>Tiger</td>
<td>General</td>
<td>201 ± 18.33</td>
<td>107.19 ± 3.73</td>
</tr>
<tr>
<td>(Tiwari et al., 2011)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Koala</td>
<td>General</td>
<td>98 ± 56</td>
<td>-</td>
</tr>
<tr>
<td>(Saber, 2015)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wombat</td>
<td>General</td>
<td>127 ± 88</td>
<td>-</td>
</tr>
<tr>
<td>(Saber, 2015)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Sd: standard deviation

The male of American black bears excavated from the excavation measured M2 length 27.83 ± 1.18 mm and M2 width as 17.02 ± 0.91 mm (Wolverton, 2008). In this study, M2 length was 11.27 ± 1.79 mm and, M2 width was 12.53 ± 1.88 mm. American black bears appear to have more teeth length and width than brown bears.

In American black bears, M3 length was reported as 15.89 ± 0.92 mm, M3 width
as 13.21 ± 1.11 mm (Wolverton), while average length was determined as 15.52 ± 4.25 mm and width 13.89 ± 1.28 mm in brown bears. It seems that the results are similar.

Morphometric parameters of mandible length and height in some carnivora species are shown in Table II. According to the animal species compared, it was observed that the longest mandible was in the brown bear.

CONCLUSION

Consequently, the results of the mandible of a wild animal brown bears, which were obtained in Turkey/Sarkamıs. We believe that these findings will contribute to anatomical and archaeological studies. It is also thought to support surgical operations such as mandibulectomy in these animals (Mylniczenko et al., 2005).

REFERENCES


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