Asian Badger

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Meles leucurus is an Asian badger. This report discusses the Asian badger's 1) Classification, phylogenetic relationships, and the history of *Meles* genus emergence; 2) Geographic range and habitat; 3) Physical description; 4) Diet and adaptations related to diet; 5) Ecomorphology; 6) Interactions with/Importance to humans.

Keywords: Asian badger; *Meles leucurus*; phylogeny; physical description; geographic range; habitat; diet; adaptations; ecomorphology

Classification

Meles leucurus is an Asian badger whose classification, based on the Animal Diversity Web created by the Zoology Museum at the University of Michigan is:

Kingdom: Animalia

Phylum: Chordata (those that have a notochord)

Subphylum: Vertebrata (those who have a backbone)

Class: Mammalia (those who can milk offspring)

Order: Carnivora

Suborder: Caniformia (according to Koepfli et al. 2017)

Infraorder: Arctoidea (according to Koepfli et al. 2017)

Superfamily: Musteloidea (according to Koepfli et al. 2017)

Family: Mustelidae (badgers, ferrets, weasels, otters, martens, wolverines, ermines)

Genus: Meles (Badgers)

Species: *Meles leucurus* (Asian badger)

According to Koepfli et al. (2017), the first representatives of the Carnivora order emerged in the Late Palaeocene or Early Eocene (these epochs refer to the Cenozoic era), and they looked like weasels, but the difference is that these early carnivores were totally arboreal, however well-known modern weasels are not totally arboreal (although they can climb trees). Then, in the early Oligocene in Europe (≈33 million years ago), the first representatives of Musteloids appeared (Musteloids is a superfamily, i.e., in the classification chain, the Musteloids superfamily is before the Mustelidae family). In the Early Miocene, savannas became prevalent and rodent populations grew, meaning that carnivores were obliged to adapt to a terrestrial lifestyle (due to savannas where trees are rare and due to hunting for rodents). Mustelidae diverged from Procyonidae 28.5 million years ago (Sato et al. 2003, 253). This date falls under the Late Oligocene/Early Miocene. Within the Mustelidae family, the representative of *Arctonyx* genus and the representative of *Meles* genus separated in Asia ≈ 4.4 -3.6 million years ago (Madurell-Malapeira et al. 2009, 963). This date falls under the Pliocene. Finally, *Meles leucurus* and *Meles meles* separated from their ancestor *Meles thorali* 1.8 million years ago corresponding to the Middle-Late Villafranchian age, i.e., Late Pliocene/Early Pleistocene

(Madurell-Malapeira et al., 2011). Nowadays, according to Koepfli et al. (2017), there are 4 species of *Meles* genus: *Meles leucurus* (lives in continental Asia), *Meles meles* (lives in Europe), *Meles anakuma* (lives in Japan), *Meles canescens* (lives in southwestern Asia).

Koepfli et al. (2017) provided a cladogram that shows the position of Mustelidae in the phylogenetic relationships of Carnivora animals (Figure 1). The ancestor of the whole Carnivora order gave roots to Feliformia (cat-like) and Caniformia (dog-like) suborders. Caniformia is divided into Cynoidea and Arctoidea infraorders based on the difference in morphology of petrosal auditory bulla. Ivanoff (2001) provided a more detailed explanation in the different morphology of petrosal auditory bulla between Cynoidea and Arctoidea: there is no septum (or almost no septum) in Arctoidea auditory bulla, but Cynoidea has the septum (although it is not fully developed). Figure 2 provided by Ivanoff (2001) shows the difference between a fully developed septum, which is marked A, a not fully developed septum (Cynoidea's) which is marked B, and the absence/nearly absence of a septum (Arctoidea's) which is marked C.

The Cynoidea infraorder consists of the Canidae family. The Arctoidea infraorder consists of the Ursidae (bears) family, Pinnipedia superfamily and Musteloidea superfamily. Among Musteloidea superfamily, Procyonidae (racoons) and Mustelidae families are sister taxa, whereas Mephitidae (skunks) is outgroup relatively to the sister taxa, while the Ailuridae (red pandas) is closely related to the sister taxa.

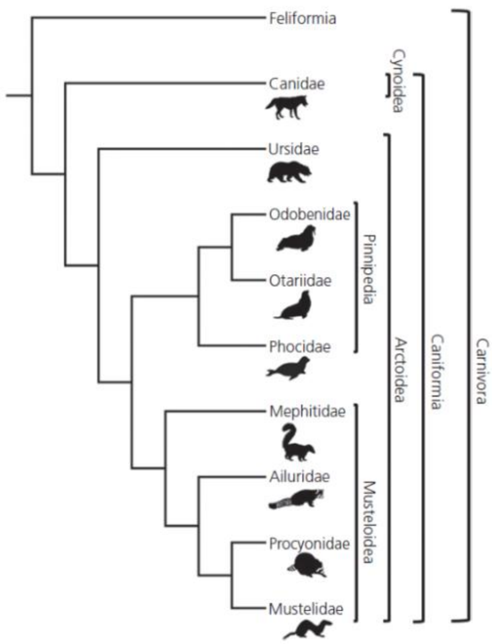

Figure 1. Phylogenetic relationships among carnivorous animals.

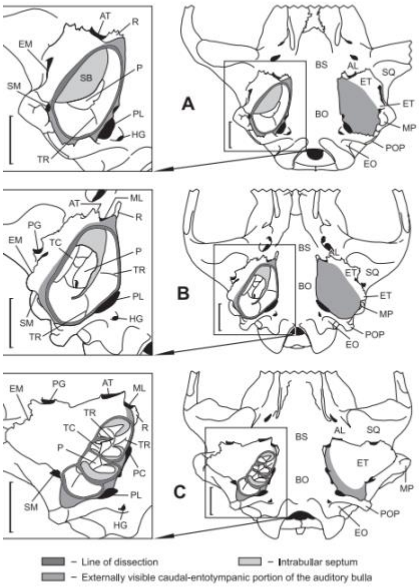

Figure 2. Differences in septum (SB) in petrosal auditory bullae.

Geographic Range and Habitat

Asian badgers can be met in Russia, Kazakhstan, Kyrgyzstan, Uzbekistan, Mongolia, China, and Korea (Abramov 2015, 2). Figure 3 provided by Abramov (2015) demonstrates the geographic range on the map: from the Volga River covering the Ural and Western Siberia to South Siberia in Russia; the whole Kazakhstan, Uzbekistan, Kyrgyzstan, and Tajikistan; the Northern part of Mongolia; South and North Korea; from Tian Shan to the Eastern part of China without covering Tibet. According to the Animal Diversity Web created by the Zoology Museum at the University of Michigan, along the Volga region (which is the boundary between Russia and Europe) the Asian badger (*Meles leucurus*) is sympatric with the European badger (*Meles meles*).

Figure 3. Geographic range of Asian badger.

Moreover, according to the Animal Diversity Web, Asian badgers' habitat can include various landscapes: steppes, forests, mountainous areas, tundra, semi-deserts. Asian badgers live in shelters/dens called setts which consist of tunnels underground and have many entrances (Bae et al. 2021, 1). The setts are engineered by badgers themselves – they are very skilled diggers and tunnel makers. Moreover, Asian badger's choice of sett's location depends on several factors: 1) the level of access to vegetation; 2) slope; 3) altitude; 4) the type of forest (if a badger plans to create a den in a forest); 5) conditions of the terrain (whether objects that can disguise the den or be an insulator from heat loss are present or not); 6) disturbance by humans (Bae et al. 2021). The study by Bae et al. (2021) showed that Asian badgers prefer to set dens in deciduous forests than in pine (coniferous) forests due to the larger amount of vegetation/ food resources (fruits, for example) that can be found in deciduous forests (although badgers can adapt to various terrains). Also, due to the denser vegetation in deciduous forests than in pine forests, this vegetation can be used as bedding/coverage for the shelter's entrances for disguise and for insulation to avoid heat loss (especially during cold times). Regarding the slope, badgers prefer to set a shelter on the steeper slope because when the snow melts or when the rain goes, the water does not stay on the steep slope, i.e., drainage is better on the steep slopes. Plus, it is easier for a badger to remove soil during the digging process from the slope, so this is another reason for steep slope preference. Asian badgers consider the presence of rocks, trees and other objects on the location that can serve as protection/disguise/bedding for the shelter. In addition, badgers choose an altitude for the den in which human disturbance is absent, i.e., badgers avoid places where people can do their activities: if people are present on low altitude, the badger will set a den on higher altitudes, if people are on high altitudes, then badgers will set a den on lower altitudes.

Dens/setts of badgers are inhabited by generations, badgers adhere to their home and pass it from generation to generation, and the dens are called underground towns because they are engineered cleverly town-like with tunnels, ventilation holes, multiple entrances, and chambers (Abduraupov et al. 2023, 852). Badgers are neat, they clean their home by carrying rubbish out of it.

Physical Description

Figure 4 below taken from Wikipedia comparatively shows the appearances of 3 *Meles* species: the European badger (*Meles meles*), the Asian badger (*Meles leucurus*), and the Japanese badger (*Meles anakuma*).

Figure 4. Comparative demonstration of 3 species from *Meles* genus.

Figure 5. *Meles leucurus* (Asian badger).

Figure 6. *Meles leucurus* (Asian badger).

Figure 7. *Meles leucurus* (Asian badger).

Figure 5 (taken from Animal Database[1]), Figure 6 (taken from Animal Diversity Web), and Figure 7 (taken from Animal Diversity Web) show the appearance of *Meles leucurus.* It can be seen that the fur on the head is white with two black stripes that run over the eyes. The ears are covered with white and black fur, and they are small relatively to the trunk size. The trunk is covered with a mix of grey, yellow, and white colours. Paws are covered with black fur, and claws are present. The eyes are small. The tail is a little broom-like, and it consists of white, yellow, and grey colours. According to Abduraupov et al. (2023), the length of badger's body is 60-90 cm; the length of the tail is 20-24 cm; the weight varies up to 24 kilograms, however in fall before hibernation the weight is up to 34 kilograms (852).

In Figure 4, we can see that *Meles leucurus* looks transitional between *Meles meles* and *Meles anakuma*, because the fur of *Meles meles* is grey and white, and the fur of *Meles leucurus* has an additional yellow shade, whereas *Meles anakuma* is much yellower, i.e., the gradation can be noticed. Moreover, it can be noticed that the frontal lobe of the *Meles meles* and *Meles leucurus* craniums is concave, whereas *Meles anakuma's* frontal lobe is more convex. The paws of all 3 species are black and have claws.

Abramov and Puzachenko (2005) provided a photo of *Meles leucurus* skulls (Figure 8). The first 2a belongs to a male, and the second 2b belongs to a female. It can be seen that the dental formula

[1] *Asian Badger*. Animal Database. https://animals.fandom.com/wiki/Asian_Badger?file=17084983748_5707c478f7_b.jpg.

of the upper jaw is 3:1:2:2. Regarding the lower jaw, from the lateral view, the number of incisors cannot be seen, but the dental formula for the lower jaw can be deduced to be 3:1:3:3. Also, the teeth are carnassial, especially the second and third premolars on the lower jaw, and the second premolar and first molar on the upper jaw.

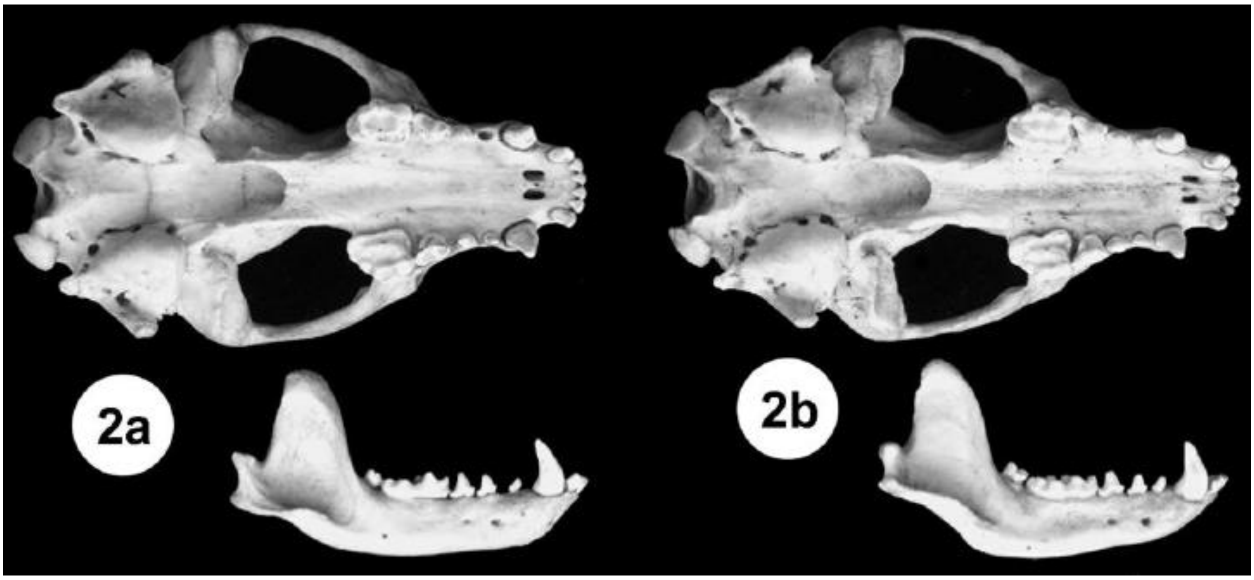

Figure 8. Skulls of a male (2a) and a female (2b) Asian badger.

Without measuring the sizes of the skulls' elements to define the presence or absence of sexual dimorphism, it can be deduced that there is no sexual dimorphism because the skulls look very similar (only lengths of upper canines cannot be seen from that occlusal view, but the lengths of lower canines look similar). However, Abramov and Puzachenko (2005) measured elements of female and male skulls (not only those on the photo, but n=111 males and n=44 females), and the results show that on average sizes of male skull elements are bigger (not significantly, but bigger). Figure 9 from Abramov and Puzachenko (2005) shows what skull elements were measured. Figure 10 from Abramov and Puzachenko (2005) shows the table of results. However, the number of male individuals was much larger (n=111) than the number of females (n=44), that is why the mean values of male skull elements are bigger in the results. So, I would not state that Asian badgers have sexual dimorphism in craniological characters.

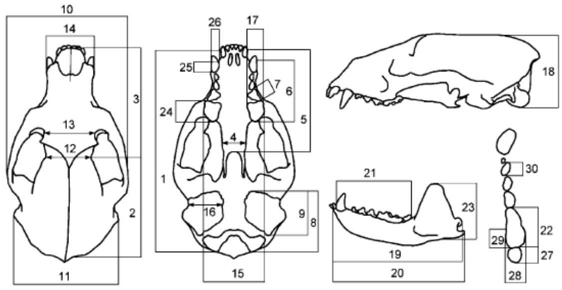

Fig. 2. Measurements taken of the badger skulls: 1: condylobasal length, 2: neurocranium length, 3: viscerocranium length, 4: minimum palatal width, 5: palatal length, 6: maxillary tooth-row length, 7: length of upper carnassial tooth Pm^4, 8: greatest length between oral border of the auditory bulla and aboral border of the occipital condyle, 9: length of the auditory bulla, 10: zygomatic width, 11: mastoid width of skull, 12: postorbital width, 13: interorbital width, 14: width of rostrum, 15: greatest palatal width, 16: width of the auditory bulla, 17: width of upper molar M^1, 18: cranial height, 19: total length of the mandible, 20: length between the angular process and infradentale, 21: mandibular tooth-row length, 22: length of lower carnassial tooth M_1, 23: height of the vertical mandibular ramus, 24: length of upper molar M^1, 25: length of upper canine, 26: width of upper canine, 27: length of lower molar M_2, 28: width of lower molar M_2, 29: talonid length of lower carnassial tooth M_1, 30: length of lower premolar Pm_2.

Figure 9. What was measured in skulls.

##	Characters	*Meles meles*								*Meles leucurus*			
		European sample				Transcaucasian sample				Siberian sample			
		Male $n = 72$	Female $n = 59$	$\Delta S,S$	p	Male $n = 48$	Female $n = 29$	$\Delta S,S$	p	Male $n = 111$	Female $n = 44$	$\Delta S,S$	p
1	Condylobasal length	131.5, 4.24 119.3–140.1	129.2, 3.43 119.0–136.0	2.2, 0.8	0.044	122.3, 4.61 112.9–132.1	116.3, 3.20 110.7–122.5	6.0, 2.5	0.012	122.9, 4.56 114.0–133.0	120.3, 3.64 112.9–128.4	2.7, 1.1	0.000
2	Neurocranium length	68.9, 2.33 63.1–73.7	67.3, 2.23 63.0–74.0	1.6, 1.2	0.056	65.1, 2.27 61.2–69.4	62.7, 1.90 59.6–67.0	2.5, 1.9	0.009	67.6, 2.70 61.5–74.0	66.1, 2.21 62.0–71.4	1.5, 1.1	0.023
3	Viscerocranium length	84.4, 3.62 76.8–93.7	82.9, 2.81 76.4–91.0	1.6, 0.9	0.114	74.6, 4.76 65.8–87.4	71.1, 3.46 65.5–78.4	3.6, 2.4	0.188	74.5, 3.97 65.7–84.0	71.8, 3.22 65.0–77.4	2.7, 1.9	0.002
4	Minimum palatal width	15.9, 0.95 13.7–18.2	16.0, 0.92 14.1–17.9	−0.1, −0.3	0.486	15.6, 0.97 13.4–17.8	15.3, 0.67 13.9–16.5	0.4, 1.1	0.392	15.1, 1.01 12.8–18.0	15.1, 1.11 12.3–17.7	0.0, 0.0	0.146
5	Palatal length	73.2, 2.32 67.5–78.8	71.9, 2.36 67.0–78.0	1.3, 0.9	0.043	68.2, 3.03 62.2–74.7	65.3, 2.29 62.3–70.8	3.0, 2.2	0.041	67.2, 2.41 61.2–73.0	66.2, 2.25 61.7–72.2	1.0, 0.7	0.000
6	Maxillary tooth-row length	43.8, 1.54 40.0–47.60	43.1, 1.42 39.8–46.5	0.7, 0.8	0.178	41.0, 1.81 37.4–46.2	38.9, 1.51 36.0–42.0	2.2, 2.7	0.041	39.7, 1.39 36.7–43.4	39.1, 1.71 36.2–42.8	0.6, 0.7	0.102
7	Length of upper carnassial tooth Pm^4	8.6, 0.45 7.6–9.6	8.6, 0.39 7.7–9.3	0.0, 0.0	0.382	7.9, 0.58 7.0–9.5	7.5, 0.56 6.7–9.1	0.5, 2.9	0.024	7.9, 0.50 6.7–9.1	7.9, 0.52 6.7–9.0	0.1, 0.5	0.489
8	Greatest length between oral border of the auditory bulla and aboral border of the occipital condyle	37.4, 1.51 33.6–41.2	37.4, 1.4 34.0–39.7	0.0, 0.0	0.650	34.8, 1.62 32.0–39.1	33.2, 1.20 31.5–37.0	1.6, 2.3	0.001	36.9, 1.88 32.2–40.4	36.3, 1.50 33.7–39.0	0.6, 0.8	0.310
9	Length of the auditory bulla	28.3, 1.24 25.3–30.6	28.0, 1.27 24.4–30.5	0.2, 0.4	0.207	26.3, 1.41 23.7–29.9	25.2, 1.06 23.0–27.6	1.0, 2.0	0.188	27.9, 1.52 23.5–31.0	27.6, 1.31 25.4–30.7	0.3, 0.6	0.180
10	Zygomatic width	80.9, 4.23 71.9–89.4	77.7, 3.77 68.4–86.2	3.3, 2.0	0.044	75.5, 4.29 65.2–84.0	70.8, 3.81 62.9–80.4	4.7, 3.2	0.188	74.6, 4.45 60.4–85.0	71.4, 3.79 62.9–81.2	3.2, 2.2	0.000
11	Mastoid width of skull	62.7, 2.57 56.8–68.9	61.6, 2.34 55.6–66.8	1.1, 0.9	0.090	60.5, 2.33 56.5–65.2	57.1, 2.53 53.5–62.6	3.4, 2.9	0.041	63.1, 3.23 54.8–70.0	61.6, 2.63 57.7–67.3	1.5, 1.2	0.033
12	Postorbital width	23.9, 1.39 20.7–27.3	23.5, 1.30 21.4–26.5	0.4, 0.8	0.073	23.0, 1.35 19.4–25.4	22.7, 1.54 19.1–26.1	0.3, 0.7	0.947	22.7, 1.63 19.2–26.5	22.3, 1.68 19.3–25.8	0.4, 0.8	0.537
13	Interorbital width	31.2, 1.69 27.8–34.2	30.1, 1.65 27.0–34.1	1.1, 1.8	0.004	27.7, 2.48 23.9–34.7	26.3, 1.56 24.1–30.3	1.4, 2.6	0.188	26.9, 1.61 23.0–30.6	26.4, 1.69 23.6–30.7	0.5, 0.9	0.255
14	Width of rostrum	32.2, 1.49 28.5–35.1	30.8, 1.45 27.0–34.4	1.4, 2.2	0.003	29.4, 1.61 26.0–32.6	27.8, 1.36 25.3–30.6	1.7, 2.9	0.188	29.3, 1.52 25.0–32.5	27.6, 1.45 24.9–32.1	1.8, 3.1	0.000
15	Greatest palatal width	42.3, 1.74 37.4–46.2	41.7, 1.52 36.9–45.2	0.5, 0.6	0.814	40.7, 1.88 35.7–44.0	39.4, 1.41 37.2–43.7	1.2, 1.5	0.188	38.9, 1.57 35.7–43.4	38.2, 1.79 34.0–42.2	0.7, 0.9	0.024

##	Characters	*Meles meles*								*Meles leucurus*			
		European sample				Transcaucasian sample				Siberian sample			
		Male $n = 72$	Female $n = 59$	$\Delta S,S$	p	Male $n = 48$	Female $n = 29$	$\Delta S,S$	p	Male $n = 111$	Female $n = 44$	$\Delta S,S$	p
16	Width of the auditory bulla	22.8, 1.31 20.0–25.7	22.2, 1.22 19.5–24.6	0.6, 1.3	0.054	22.1, 1.1 19.8–25.3	21.1, 1.04 19.4–23.1	1.0, 2.3	0.553	22.6, 1.26 19.3–25.2	21.9, 1.01 19.2–23.9	0.7, 1.6	0.044
17	Width of upper molar M^1	11.7, 0.64 9.9–13.3	11.5, 0.55 10.4–13.0	0.2, 0.9	0.968	11.4, 0.59 10.0–12.7	10.8, 0.75 9.6–13.0	0.6, 2.5	0.550	10.8, 1.05 9.0–14.8	11.3, 1.55 9.8–14.7	−0.5, −2.2	0.569
18	Cranial height	53.7, 2.83 47.9–59.8	52.9, 2.51 47.2–59.4	0.8, 0.8	0.428	49.1, 2.99 43.0–55.8	46.3, 2.79 42.6–53.4	2.8, 2.9	0.041	51.3, 2.98 44.6–59.1	49.7, 2.91 44.4–58.9	1.6, 1.6	0.012
19	Total length of the mandible	91.3, 2.78 84.5–97.0	89.4, 2.60 84.2–94.3	1.9, 1.1	0.014	83.9, 3.77 77.1–91.1	79.9, 3.07 75.8–88.2	4.0, 2.4	0.081	82.7, 3.22 76.0–90.8	80.9, 2.35 75.7–86.3	1.9, 1.2	0.000
20	Length between the angular process and infradentale	92.2, 2.91 85.0–97.7	90.4, 2.69 84.3–95.8	1.8, 1.0	0.014	83.9, 4.08 77.2–93.7	80.1, 3.30 75.7–89.0	3.8, 2.3	0.081	83.4, 3.10 76.5–91.2	81.5, 2.26 78.2–86.8	1.9, 1.1	0.000
21	Mandibular tooth-row length	51.4, 1.58 47.7–54.5	50.4, 1.23 47.6–53.0	1.0, 1.0	0.070	48.5, 1.92 45.0–53.2	45.7, 1.70 43.0–49.5	2.8, 3.0	0.013	47.4, 1.56 44.5–51.6	46.7, 1.58 43.5–49.9	0.7, 0.8	0.208
22	Length of lower carnassial tooth M_1	13.9, 0.80 12.4–16.0	13.7, 0.72 11.9–15.30	0.3, 1.2	0.263	14.5, 0.81 12.2–16.1	13.7, 0.88 12.0–15.9	0.8, 2.8	0.041	13.6, 0.86 11.8–15.6	12.9, 0.73 11.7–14.4	0.6, 2.3	0.013
23	Height of the vertical mandibular ramus	38.9, 1.83 33.3–43.1	38.1, 1.7 33.4–42.30	0.8, 1.0	0.044	35.8, 2.54 29.1–41.7	33.6, 1.87 29.8–37.5	2.3, 3.3	0.081	33.9, 2.24 28.3–39.7	32.3, 1.66 29.7–35.9	1.7, 2.6	0.000
24	Length of upper molar M^1	16.3, 0.72 14.8–17.7	15.9, 0.66 14.5–17.6	0.4, 1.1	0.114	15.7, 0.88 14.0–17.3	15.1, 0.80 13.7–16.6	0.5, 1.8	0.138	15.8, 0.92 13.7–17.7	15.6, 0.94 14.0–17.4	0.2, 0.5	0.657
25	Length of upper canine	8.6, 0.49 7.6–9.8	7.9, 0.41 6.7–8.8	0.7, 4.4	0.000	7.6, 0.54 6.5–9.2	6.8, 0.45 6.0–8.0	0.8, 5.8	0.012	7.7, 0.55 6.7–9.0	7.1, 0.53 6.1–8.1	0.6, 4.2	0.001
26	Width of upper canine	6.3, 0.44 5.40–7.30	5.9, 0.39 4.9–7.2	0.5, 3.7	0.000	5.8, 0.40 5.1–6.7	5.2, 0.31 4.5–6.3	0.6, 5.7	0.001	5.8, 0.42 5.0–6.8	5.2, 0.29 4.7–6.0	0.6, 5.9	0.000
27	Length of lower molar M_2	5.48, 0.44 4.5–6.5	5.4, 0.42 4.4–6.8	0.1, 0.6	0.523	5.8, 0.60 4.8–6.9	5.6, 0.57 4.7–7.0	0.2, 2.1	0.980	5.4, 0.51 4.2–6.6	5.1, 0.49 4.0–6.2	0.4, 3.3	0.145
28	Width of lower molar M_2	7.4, 0.36 6.4–8.2	7.2, 0.44 6.2–8.2	0.2, 1.4	0.760	7.3, 0.42 6.0–8.0	7.1, 0.36 6.4–8.1	0.2, 1.3	0.332	6.9, 0.41 5.9–7.9	6.6, 0.43 6.0–7.4	0.3, 1.9	0.406
29	Talonid length of lower carnassial tooth M_1	7.3, 0.52 6.0–8.9	7.1, 0.49 6.1–8.4	0.2, 1.3	0.642	7.5, 0.53 6.3–8.9	7.3, 0.42 6.6–8.0	0.2, 1.3	0.135	6.9, 0.59 5.7–8.2	6.6, 0.55 5.6–7.7	0.3, 2.3	0.388
30	Length of lower premolar Pm_2	4.6, 0.30 3.9–5.3	4.6, 0.32 3.8–5.1	0.1, 0.8	0.502	4.2, 0.36 3.4–5.0	3.9, 0.39 3.2–4.9	0.2, 2.8	0.081	3.3, 0.38 2.5–4.1	3.09, 0.34 2.4–3.6	0.2, 2.7	0.627

Figure 10. Results for Siberian *Meles leucurus.*

According to Abduraupov et al. (2023), the sexual dimorphism is indeed little: males' height and weight are insignificantly bigger than females', males have wider heads, and the angle of transition from forehead to nose is bigger in males whereas in females, forehead transitions to nose smoothly, upper canines of males are bigger than females' upper canines. Females have fluffier tails, plus their white undercoat is more prominent than in males.

The Figure 11 (taken from Wikipedia and then labelled) demonstrates the skeleton of the European badger (*Meles meles*), and as the European badger is a close relative of the Asian badger (*Meles leucurus*), this skeleton is applicable to the Asian badger (plus on the Figure 4 it can be seen the extent to which these two species look alike).

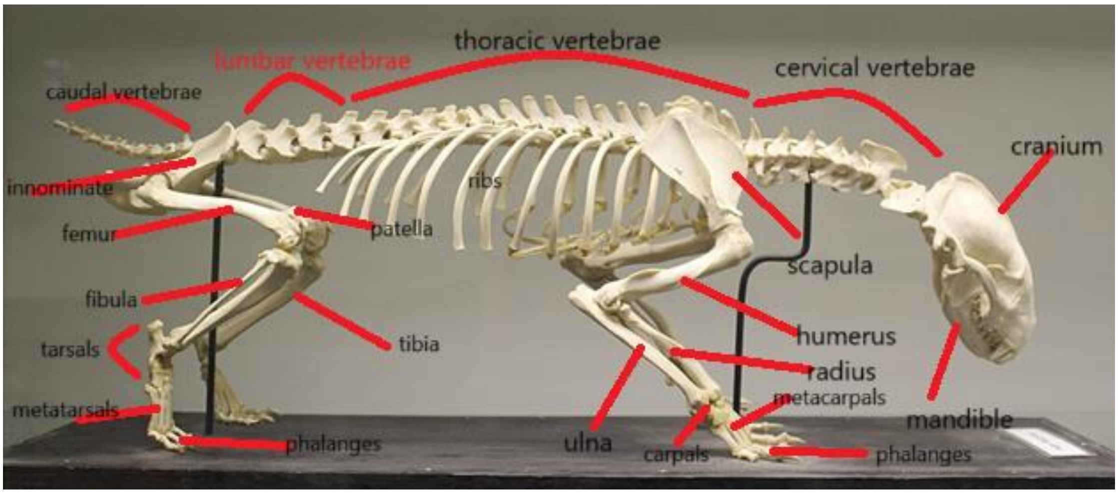

Figure 11. Skeleton of *Meles meles.*

Diet and Adaptations Related to Diet

According to Zagainova and Markov (2011), badgers are omnivores: they can eat both plants and other animals. The frequency of certain foods in the Asian badger's diet depends on the region in which he/she lives. For example, in Middle Ural, the Asian badger's diet mainly consists of insects, amphibians, mammals; in Southern Ural 72% of the diet consists of earthworms; in Kazakhstan the badger's diet consists of insects, earthworms, fruits, reptiles, molluscs, mammals (Zagainova and Markov, 2011, 414). Zagainova and Markov (2011) conducted their own study about the diet of Asian badgers in the Samarovskii Chugas Nature Park which is located in Western Siberia. The faecal analysis showed the presence of pine nuts (it is the most frequent component of the diet), berries, larvae and adult insects (hymenopterans, beetles), earthworms, reptiles, amphibians, birds, fishes, and mammals (voles, mice, shrews) in the Asian badger's diet (Zagainova and Markov, 2011, 415).

As shown on the Figure 11, badgers have claws that are used for digging (digging/engineering their own setts and digging out earthworms, rodents from their shelters, and other animals who try to hide underground). So, claws are adaptations for digging. Figure 12 (taken from the Internet and then labelled) shows a paw[2] of *Meles meles* (European badger). It can be seen that besides claws, the badger's paw has thick finger pads and a thick metacarpal pad. These pads must be another one adaptation for digging, because they protect the badger's paw from wounds while he/she digs, so the

[2] *Badger, paw, Lower Saxony, Germany (Meles meles)*. Alamy Images. https://www.alamy.com/badger-paw-lower-saxony-germany-meles-meles-image557069581.html.

paw is like a bulldozer – can effectively dig the soil which can contain rocks. Moreover, Powell et al. (2024) provided a photo that captured Asian badger climbing a tree (Figure 13 taken from that paper is provided below). So, it can also be deduced that the pads on the paws and claws effectively attach to the bark of trees. Highly likely, the wild badger from Figure 13 climbed the tree to catch a bird or to take a bird's eggs from the nest. So, it can be deduced that claws and thick pads on paws are adaptations for digging and for climbing/attachment to surfaces.

Figure 12. Paw of *Meles meles.*

Fig. 2. A still from camera-trap footage of a wild Asian Badger *Meles leucurus* climbing a Korean Oak *Quercus dentata* in Gyeongsangnam-do, South Korea, on 18 May 2022. (Photo: Chad R. Dobson.)

Figure 13. Photo of an Asian Badger climbing a tree.

Moreover, as was mentioned in the physical description section, the eyes of the badger are small. The highly probable reason for that is to decrease the chance of soil getting into the badgers' eyes while digging. Pei et al. (2024) found out that both wild and captive Asian badgers have Firmicutes, Proteobacteria and Actinobacteria in the large intestine in both summer and winter seasons. According to the website of Rupa Health company, the Actinobacteria of the animals' gut help to resist pathogens. This is a good adaptation, especially when an animal is omnivorous. Moreover, Pei et al. (2024) concluded that the gut microbiota of wild badgers in summer is more diverse than in captive badgers (3). This is because captive badgers are fed by farmers with a fixed menu, whereas wild badgers' menu is more diverse, therefore, wild animals need to have more diverse microbiota to digest diverse food.

Ecomorphology

During the winter cold, badgers sleep in their shelters – this is hibernation (Anufriev et al. 2016, 2). According to Anufriev et al. (2016), when sustainable colds end, badgers wake up (but the end of colds does not necessarily coincide with the end of the winter season) (2). Plus, according to Pei et al. (2024), hibernation is an adaptation to survive in the cold season when there is a food shortage and heat loss (6). Anufriev et al. (2016) conducted an experiment – they measured the badger's body temperature for 7 months (from October till May, including the hibernation period, which lasted from December/end of November till March). The results showed that in October the body temperature started to decrease, and in December the temperature reached its absolute minimum, which is 16,31°C. In February it started to increase, and in May it reached 33,76±0,16 °C. So, during cold times the badger's body temperature decreases to keep energy/prevent its intensive loss and therefore to survive. Also, the experiment showed that during the hibernation period the badger lost 25% of the body mass (that is more than 3 kilograms). So, although during cold times the badger's body temperature is decreased to save energy/fat, the weight during hibernation still can be lost (Pei et al. 2024, 6-7). The structure of paws, the small size of eyes, and the presence of certain organisms in the gut microbiota mentioned in the previous section can also be related to the ecomorphology.

Li and Jiang (2014) watched two Asian badgers via infrared cameras and found out that they went out from their sett in the evening between 20:00-23:00 and came back to the sett between 4:00-7:00. This means that Asian badgers can follow a nocturnal lifestyle. However, according to photos that were taken in the daylight (not in Li and Jiang (2014) study, but in Figures 6-8 and other photos on the Internet), Asian badgers can do activities not only at night. So, Asian badgers can do things both at night and in the daytime. Moreover, in the video from Facebook[3] (which was apparently recorded at night) it can be seen that the eyes of the Asian badger shine – this is the action of tapetum lucidum. It helps to better see at night, so it is an adaptation to the nocturnal lifestyle.

[3] *Video of the Day! This is the Asian Badger (Meles...* (n.d.). https://www.facebook.com/roylesafaris7/videos/video-of-the-day-this-is-the-asian-badger-meles-leucurus-also-known-as-the-sand-/436533084074890/.

Interactions with Humans

In the section titled "geographic range and habitat," it was written that badgers avoid people, however, according to the video[4] on YouTube called "Country house badger. Domestication #23" where the badger visits the particular country house village and is accepting food from the people who live there and is very close to these people, it can be deduced that the domestication of wild badger is possible. The badger from the video is curious and even rises onto the human's knees to get the food from the human's hands, so he feels safe and realizes that these people help him by feeding him. The badger is not afraid of these people and is even used to them and to the space of the country house. There are many more videos on this channel where the badger visits this country house and accepts food provided by these kind people. Usually, the badger visits the country house in the evening or at night. It is interesting that the badger got used to these people and knows that they will not bring harm to him. Probably, there were not enough food resources in the wild, so the badger visited the country house from time to time to accept food from the people. Good to know that there are kind people who take care of the badger.

Badgers play a role in symbolism by associating persistence, determination, and confidence (Symbolopedia, 2023). Moreover, according to Symbolopedia (2023), badgers play a role in mythology: in Celtic folklore, badgers represent wisdom and connection with the underworld; in American folklore, badgers represent bravery, determination, strategic thinking, and healing due to badgers' connection with the soil. People even have totems[5] with badgers' image. According to the description on the totem shop website,[6] the Badger totem teaches you to: 1) pay no attention to what others say about you; 2) to stop hiding and to start coming out of the shadow (for example, to become more active at work/ to start a new project). Also, according to the description, the Badger will help to stay on feet in any situation, i.e., to stay persistent in any situation, to be a confident, independent, and resilient person. This means that symbolism lets people believe that they can get or improve their qualities of character: based on badgers' traits and habits, people associate this

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[4] *Евгений Демьяненко. 2019. "Дачный барсук. Приручение #23."* Video. *YouTube*. https://www.youtube.com/watch?v=6JSTzsFDfa0.

[5] *Totemica. n.d. "Ювелирные украшения с барсуком купить - Totemica*." Totemica. https://totemica.shop/totem/barsuk/.

[6] *Totemica. n.d. "Ювелирные украшения с барсуком купить - Totemica*." Totemica. https://totemica.shop/totem/barsuk/.

amazing animal with certain character qualities (persistence, for example), and to be persistent like a badger people wear totems of the badger by believing that the badger will give them power of will or any other trait; this belief instils the acquisition or improvement of the desired quality of character.

Badger's fat is valuable in medicine because it contains vitamin A and vitamin B which help to overcome infections and strengthen the immune system, so the badger's fat can be consumed in the form of liquid or in the form of pills (Abduraupov et al. 2023, 855). Moreover, badger's fat is useful in fighting skin diseases (psoriasis, dermatitis, eczema), burns and wounds because the fat also contains vitamin E and alpha tocopherol which have regeneration and anti-inflammation effects on skin (Abduraupov et al. 2023, 855). Badger meat is of good quality and is used in cookery - it is fried or boiled with vegetables (Abduraupov et al. 2023, 855). According to Abduraupov et al. (2023), the consumption of badger meat is spread in Uzbekistan (855).

Archaeological evidence from the Unikoté Cave in France suggests that people practice badger (*Meles meles*) meat consumption at least from the Mesolithic period, because butchery marks were identified on remains of badgers in the 2nd unit of the site, plus lithic artifacts were excavated on this site (Mallye, 2011, 27). On badger remains from another accumulation, marks left by hyenas were identified, so the Unikoté Cave likely was used by hyenas too (it was their den), but it is stated that hyenas inhabited the site before humans, so humans occupied the site after hyenas (Mallye, 2011). Another accumulation of badger remains does not have marks left by humans or other carnivores, so this accumulation is probably a cemetery of badgers who died due to their natural death (Mallye, 2011, 32). So, there are 3 accumulations of badger (*Meles meles*) remains found in the Unikoté Cave: one of the accumulations has butchery marks, another one has marks from hyenas' teeth, and one has no marks. Figure 14 below (taken from Mallye 2011) demonstrates badgers' remains with butchery marks, and Figure 15 (taken from Mallye 2011) demonstrates badgers' remains with carnivore marks.

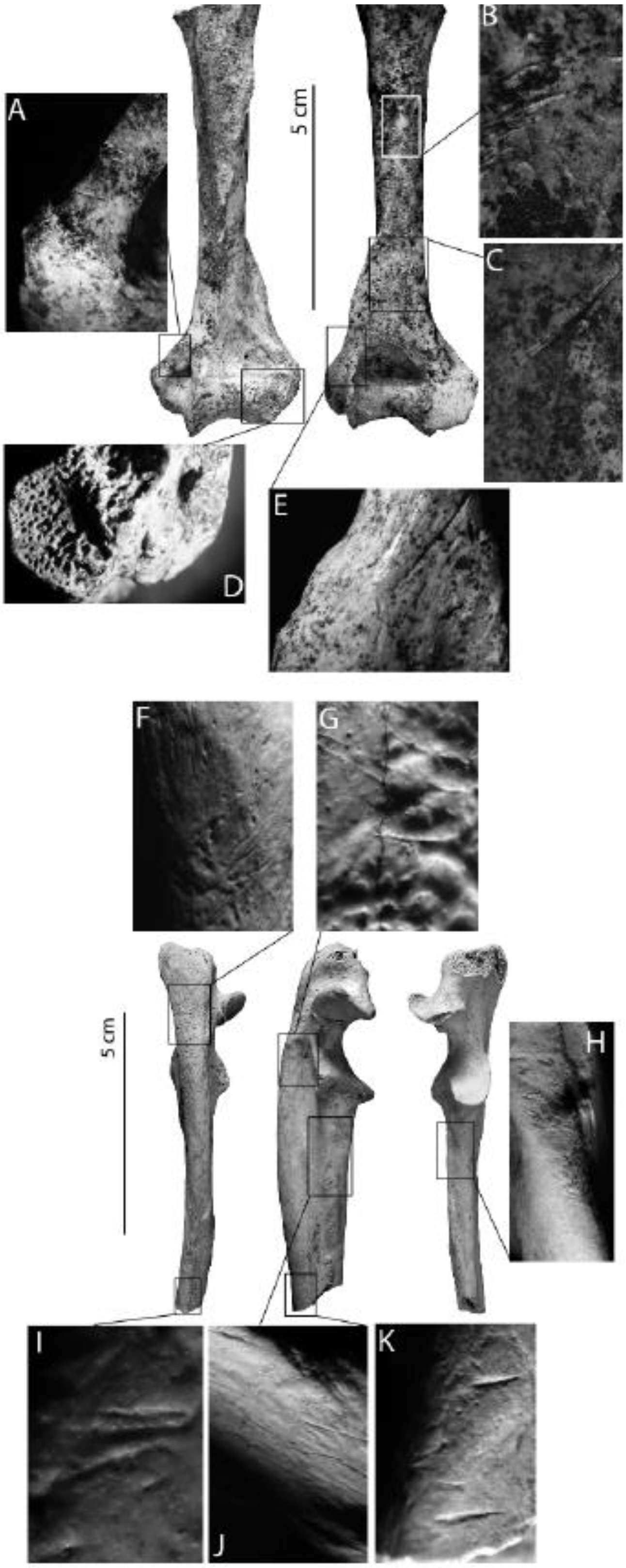

Figure 14. Badger remains with butchery marks.

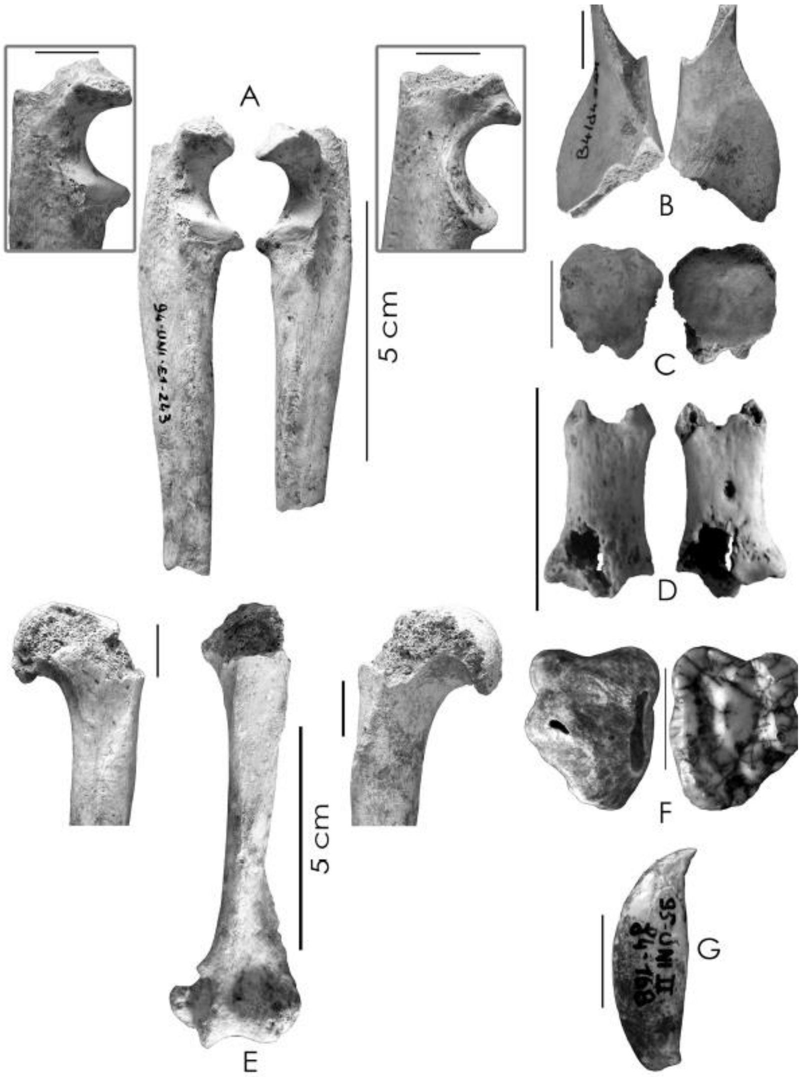

Figure 15. Badger remains with carnivore marks.

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Bibliography

Abduraupov, Timur V., Olim K. Khojimatov, and Rainer W. Bussmann. 2023. "Meles canescens canescens Blanford, 1875, Meles leucurus leucurus Hodgson, 1847 - MUSTELIDAE." *Ethnobiology of Uzbekistan*, 851–55. https://doi.org/10.1007/978-3-031-23031-8_91.

Abramov, Alexei V., and Andrey Yu. Puzachenko. 2005. "Sexual dimorphism of craniological characters in Eurasian badgers, Meles spp. (Carnivora, Mustelidae)." *Zoologischer Anzeiger* 244 (1): 11–29. https://doi.org/10.1016/j.jcz.2004.12.002.

Abramov, Alexei V. 2015. “IUCN Red List of Threatened Species: Meles leucurus.” *IUCN Red List of Threatened Species*. March 3, 2015. https://www.iucnredlist.org/species/136385/45221149.

“Actinobacteria | Rupa Health.” n.d. Rupa Health. https://www.rupahealth.com/biomarkers/actinobacteria.

Anufriev, Andrey I., Nikita G. Solomonov, and Valeriy F. Yadrikhinsky. 2016. “Температура тела барсука (meles leucurus) в период зимней спячки.” *КиберЛенинка*. 2016. https://cyberleninka.ru/article/n/temperatura-tela-barsuka-meles-leucurus-v-period-zimney-spyachki.

Bae, Ho-Kyoung, Jae-Kang Lee, Tae-Kyung Eom, Dong-Ho Lee, and Shin-Jae Rhim. 2021. “Ecological factors influencing the selection of sett location by the Asian badger Meles leucurus.” *Wildlife Biology* 2021 (4). https://doi.org/10.2981/wlb.00910.

Contributors to Wikimedia projects. 2005. “Барсук.” April 3, 2005. https://ru.wikipedia.org/wiki/%D0%91%D0%B0%D1%80%D1%81%D1%83%D0%BA#/media/%D0%A4%D0%B0%D0%B9%D0%BB:European_badger_(Meles_meles)_skeleton_at_the_Royal_Veterinary_College_anatomy_museum.JPG.

Elves-Powell, Joshua, Chad R. Dobson, Jan C. Axmacher, and Sarah M. Durant. 2024. “Records of climbing by Asian Badger Meles leucurus in the Republic of Korea.” March 5, 2024. https://smallcarnivoreconservation.com/index.php/sccg/article/view/5752.

Feng, Li, and Jiang Zhigang. 2014. “Is nocturnal rhythm of Asian badger (Meles leucurus) caused by human activity? A case study in the eastern area of Qinghai Lake.” *Biodiversity Science* 22 (6): 758. https://doi.org/10.3724/sp.j.1003.2014.14182.

Ivanoff, D. V. 2001. “Partitions in the carnivoran auditory bulla: their formation and significance for systematics.” *Mammal Review* 31 (1): 1–16. https://doi.org/10.1046/j.1365-2907.2001.00069.x.

Koepfli, Klaus-Peter, Jerry W. Dragoo, and Xiaoming Wang. 2018. *The evolutionary history and molecular systematics of the Musteloidea*. *Oxford University Press eBooks*. https://doi.org/10.1093/oso/9780198759805.003.0002.

Madurell-Malapeira, Joan, Andrés Santos-Cubedo, and Josep Marmi. 2009. “Oldest European occurence of Meles (Mustelidae, Carnivora) from the Middle Pliocene (Mn16) of Almenara-Casablanca-4 Karstic Site (Castellón, Spain)." *Journal of Vertebrate Paleontology* 29 (3): 961–65. https://doi.org/10.1671/039.029.0322.

Madurell-Malapeira, Joan, Bienvenido Martínez-Navarro, Sergio Ros-Montoya, Maria Patrocinio Espigares, Isidro Toro, and Paul Palmqvist. 2011. "The earliest European badger (Meles meles), from the Late Villafranchian site of Fuente Nueva 3 (Orce, Granada, SE Iberian Peninsula)." *Comptes Rendus Palevol* 10 (8): 609–15. https://doi.org/10.1016/j.crpv.2011.06.001.

Mallye, Jean-Baptiste. 2011. "Badger (Meles meles) remains within caves as an analytical tool test the integrity of stratified sites: The contribution of Unikoté Cave (Pyrènèes-Atlantiques, France)." *Dialnet*. 2011. https://dialnet.unirioja.es/servlet/articulo?codigo=4606435.

Pei, Jianchi, Yu Guan, Wenhong Xiao, Jianping Ge, Limin Feng, and Haitao Yang. 2024. "The comparison of gut microbiota between wild and captive Asian badgers (Meles leucurus) under different seasons." *Scientific Reports* 14 (1). https://doi.org/10.1038/s41598-024-69277-8.

Sato, Jun J., Tetsuji Hosoda, Mieczyłlaw Wolsan, Kimiyuki Tsuchiya, Masahiko Yamamoto, and Hitoshi Suzuki. 2003. "Phylogenetic Relationships and Divergence Times among Mustelids (Mammalia: Carnivora) Based on Nucleotide Sequences of the Nuclear Interphotoreceptor Retinoid Binding Protein and Mitochondrial CytochromebGenes." *Zoological Science* 20 (2): 243–64. https://doi.org/10.2108/zsj.20.243.

Symbolopedia. 2023. "Badger Symbolism & Meaning - Symbolopedia." *Symbolopedia*. 20 June. https://symbolopedia.com/ru/badger-symbolism-meaning/.

Wikipedia contributors. 2024. "Asian badger." Wikipedia. December 25, 2024. https://en.wikipedia.org/wiki/Asian_badger.

Zagainova, O. S., and N. I. Markov. 2011. "The diet of Asian badger, Meles leucurus Hodgson, 1847, in Samarovskii Chugas Nature Park, Western Siberia." *Russian Journal of Ecology* 42 (5): 414–20. https://doi.org/10.1134/s1067413611050158.