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RESEARCH ARTICLE

MORPHOLOGICAL CHARACTERISTICS OF ADULT MALE WEASEL "*MUSTELA SUBPALMATA*, HEMPRICH AND EHRENBERG, 1833" FROM DIFFERENT REGIONS IN EGYPT

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ABSTRACT

Most of the characteristics explaining the variability between populations or species were those directly connected with their morphological measurements. Many studies have dealt with morphological measurements among mammalian skulls, but few have dealt in detail with morphological measurements of cranial and dental characters. Forty one adult male specimens of the weasel, *Mustela subpalmata*, were collected from four different regions in Egypt; Alexandria, Giza, Beni Suif, and Sharquiya. Twenty-eight absolute morphometric characters (body mass + 4 external + 23 cranial and dental) and 23 selected morphological ratios were undertaken. All of these measurements showed no significant difference, except the upper molar M^1 breadth/maxillary tooth row length (MuB/MxtL) ratio which showed a significant difference between these four studied regions. The complete external description and coloration of the Egyptian weasel pelage were analyzed in detail. The dental characters showed highly correlation with each other and were highly correlated with the cranial characters, which are also highly correlated with each other. Standing on 28 morphological and 23 selected ratio characters, the Egyptian weasels collected from Beni Suif region differ from those of Alexandria, Giza, and Sharquiya regions. The similarity index between the Egyptian weasels collected from Alexandria and Sharquiya regions is very high. The cluster of each of Alexandria and Sharquiya is somewhat close to Giza cluster.

INTRODUCTION

Working on geographic variation of the weasel has got a great biological attention because of its wide and diverse distribution, habitats and ecological specialization, and comprehensive morphological changeability expressed throughout the geographic range of this species[1,2]. These three mentioned parameters of weasel biology have caught the eye of ecologists, who have tried to find interpretations for the shapes of geographic variation relying on the interactions between the same species, habitat, behavior, or competition with other species[3,4]. The generality of mammal classifications is relying on the analysis of a limited number of morphological parameters such as external features, skull, and dental structure. Several studies have been done on the relationships between

Palearctic species of *Mustela* depending on cytogenetic and biochemical characteristics[5].

The common weasel, *M. nivalis*, is distributed in temperate and arctic regions. It is distributed also in Morocco, Algeria, Egypt, and Lebanon[6]. The separation between its distribution in Lebanon and its presence in the Nile Delta of Egypt is unexpected and has taken zoologists to believe that this weasel was introduced into Egypt[6].

Dayan and Tchernov[7] documented that during a cooler phase of the region in the Pleistocene, *M. nivalis* is one of the little species that shifted southwards into Egypt through the Mediterranean coast. Today *M. nivalis* remains a glacial relict in Egypt; the high productivity of the Nile Delta and *M. nivalis* commensalism may allow it to resist climate change in the region. The size variation is very significant in *M. nivalis*. Large-sized weasels are found in the Levant southwest and reaching the maximum size forms in Egypt[8].

Several previous studies considered the Egyptian weasel as a subspecies of *M. nivalis*. Whereas, the Egyptian weasel differs morphometrically and concerning sexual dimorphism of size from all the other taxa of *M. nivalis*. Van Zyll de Jong[2] used skull morphometric analysis of *M. nivalis* then he deduced that the large Egyptian weasel is a separate species as *M. subpalmata*, Hemprich and Ehrenberg 1833. Reig[9] followed the opinion of van Zyll de Jong[2] and considered the Egyptian weasel as a separate species.

Abramov and Baryshnikov[10] assume the following logic scheme of the origin and modification of different forms of *M. nivalis*. Large long-tailed weasels of North-Western Africa, southern Spain, islands of the Mediterranean, and Greece, with a coloration of *nivalis*-type, are probably most close to the original state for the species *M. nivalis*. Large weasels were in the past probably more widely spread in Europe and also penetrated Asia Minor and Central Asia. To judge by fossil remains from Palestine in the cold epochs of the Late Pleistocene *M. nivalis* could have reached the Levant and Egypt[7].

Rodrigues *et al.*[11] present the first determination of the genetic and taxonomic status of the Egyptian weasel when comparing the cytochrome b gene and control region sequences from the western Palearctic. In the present study, we investigated and analyzed the morphological measurements and presented a detailed description of the Egyptian weasel collected from four different governorates in Egypt.

MATERIAL AND METHODS

Weasels collection

A total of 41 male specimens of the Egyptian weasel were collected from four different governorates of the lower Nile Valley and Delta in Egypt (Table 1) by an animal catcher from October 2020 to July 2021. Different localities near residential houses were selected at each of Alexandria, Giza, Beni Suif, and Sharquiya Governorates for trapping (Table 1 and Figure 1). Captured live animals were taken to the laboratory for examination and processing. The skin and skull of these animals were prepared and deposited at Al-Azhar University Zoological Collection (AUZC), Faculty of Science, Al-Azhar University, Cairo, Egypt. The study design and protocol followed the guidelines of the Ethical Committee of Desert Research Center for animal use, El Matareya, Cairo, Egypt (approval number: ACUC-APPD-APPRD-DRC-18).

External measurements

The following external measurements of the studied weasels were taken using standard millimeter ruler. These external measurements were: head and body length (HBL), tail length (TL), ear length (EL), and hind foot length (HFL), in addition to body mass (BM) in grams.

Cranial and dental measurements

Twenty three cranial and dental measurements were taken using 0-150 mm digital caliper. Figure "2" showed a graphic

Table 1: The four studied regions, coordinates, and number of specimens of the Egyptian weasel collected during this study.

Region	Latitude	Longitude	No. of specimens
Abo Rawash, Giza	30°02'47.1"N	31°05'55.1"E	10
Kafr Abo Hatab, Sharquiya	30°41'30.6"N	31°35'33.6"E	10
Ameria, Alexandria	31°00'25.5"N	29°48'03.8"E	11
Dalas, Beni Suif	29°11'11.7"N	31°08'09.5"E	10
Total			41

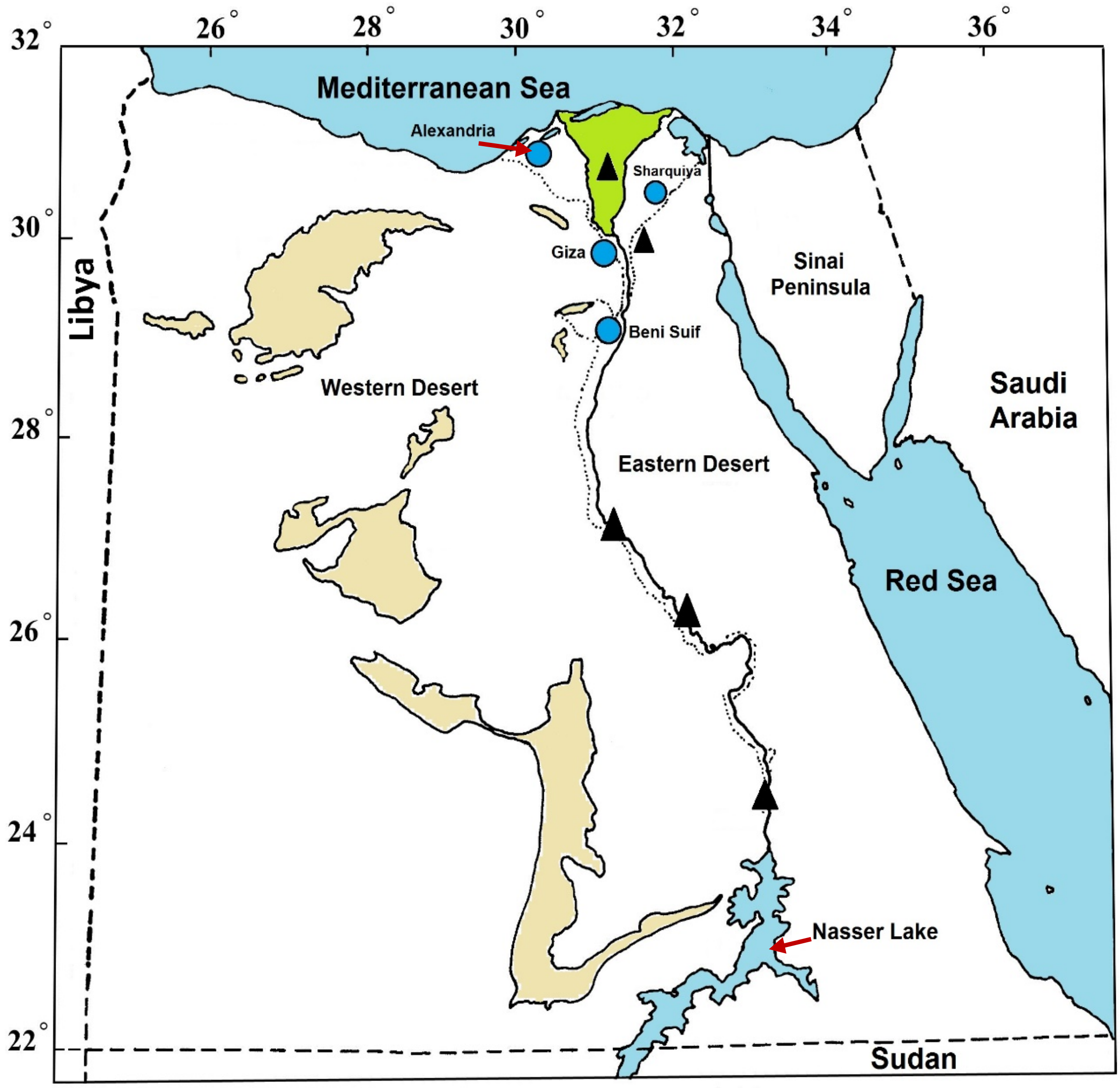

Figure 1: Egyptian map showing the collecting weasel localities; blue dots = the current study and the black triangles = the previous studies.

definition of measurements in the Egyptian weasel skull. Table "2" listed the definition of these 23 cranial and dental measurements.

Statistical Analysis

The statistical analysis and dendrogram were performed using Statistical Package

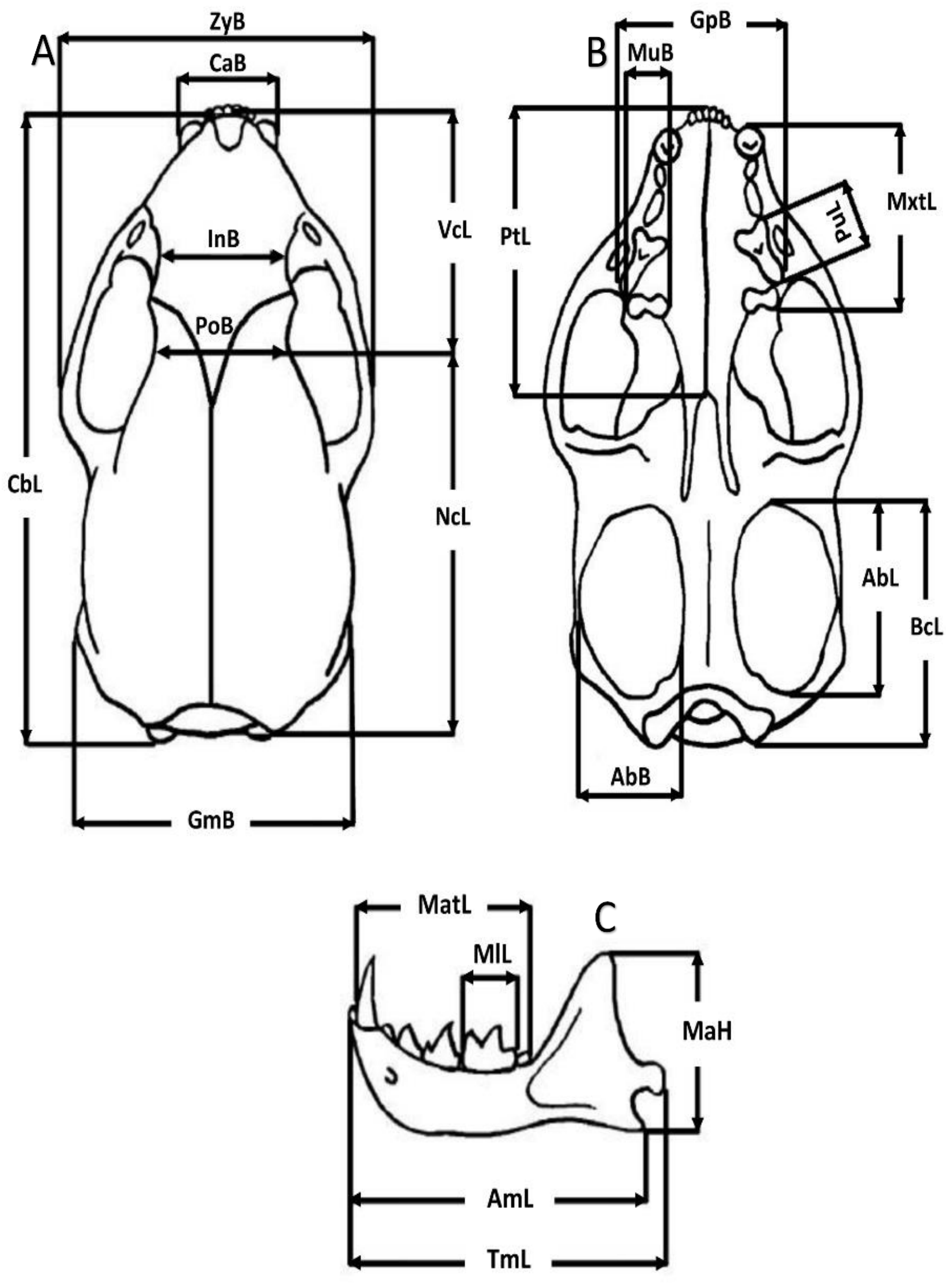

Figure 2: Cranial and dental measurements of the Egyptian weasel used in this study. (A) Dorsal view, (B) ventral view, and (C) the lower jaw.

Software System, version 20 (SPSS Inc., Chicago, Illinois) according to Levesque[12]. One-way ANOVA test and Pearson's co-efficient correlation analysis were applied to test the reliability and correlation of the study characters among the four studied regions. The *P*-value < 0.05 is considered significant.

Table 2: Definition of cranial and dental measurements of the Egyptian weasel used in this study.

Symbol	Measurement Definition
Cranial measurement	
CbL	Condylobasal length: taken ventrally from an occipital condyle to the anterior extremity of a premaxilla
NcL	Neurocranium length: taken dorsally from an occipital condyle to the post orbital constriction
VcL	Viscerocranium length: taken dorsally from the post orbital constriction to the anterior extremity of a premaxilla
PtL	Palatal length: taken ventrally from the tip of a palatine to the anterior extremity of the skull
BcL	Greatest length between oral border of the auditory bulla and aboral border of the occipital condyles
AbL	Greatest diameter of the auditory bulla
AbB	Least diameter of the auditory bulla
ZyB	Zygomatic breadth: the greatest breadth of the skull across the zygomatic arches, regardless of where this point is situated along the length of the arches taken ventrally or dorsally
GmB	Greatest mastoid breadth: taken dorsally from a mastoid process to the other one
PoB	Least breadth of the supraorbital processes
InB	Least breadth between the orbits
GpB	Greatest palatal breadth: taken ventrally from the end of the upper jaws internally
PdT	Palatal depth behind tooth row: taken laterally from the end of an upper jaw to the equivalent point at the roof of the skull. Not shown in Figure "2"
HbC	Height of brain case: taken at the posterior roots of the zygomatic arches. Not shown in Figure "2"
TmL	Total length of the mandible: taken from the tip point of a lower jaw to the condyloid process
AmL	Angular process length of the mandible: taken from the tip point of a lower jaw to the angular process
MaH	Mandible height the vertical ramus: taken from the angular to coronoid processes
Dental measurement	
MuB	Upper molar M^1 breadth
PuL	Upper carnassial teeth length
MxtL	Maxillary tooth row length: taken ventrally from the front of the upper canine to the back of the crown of the last upper molar
CaB	Breadth at the canine alveoli: taken ventrally at the maximum width of the alveoli of the two canines
MatL	Mandibular tooth row length: taken from the front of the lower canine to the back of the crown of the last lower molar
MIL	Length of lower carnassial teeth M_1

RESULTS AND DISCUSSION

A comparison of the Egyptian weasel populations collected from four different regions based on 28 absolute morphometric, 4 external in addition to body mass, and 23 cranial and dental characters (Table 3) and 23 ratios (Table 4) was undertaken. Except for MuB/MxtL ratio, which only showed a significant difference (Table 4), all of the remaining absolute measurements and their ratios showed no significant difference between the four studied regions (Tables 3 and 4). The common weasel, *M. nivalis*, Linnaeus, 1766 was first described in Sweden. There is no general approval of the common weasel taxonomy, due to the question of the number of weasel subspecies and species in Africa, Europe, and Asia[10]. The larger-sized weasel (previously called *M. nivalis subpalmata*) presents in Egypt and attains maximum sizes more than *M. nivalis*. Van Zyll de Jong[2] previously observed this difference in the Egyptian weasel size. After using the UPGMA dendrogram, Abramov and Baryshnikov[10] reported that the small-size weasels are presented in one cluster, the average-size weasels in another cluster, and all large sizes comprise the third cluster. The Egyptian weasel is separated from its other members and also placed in the third cluster.

Table 3: Absolute morphological, cranial, and dental measurements for the Egyptian weasel collected from the four studied areas. All measurements are in mm unless otherwise stated.

Absolute character	The studied regions			
	Alexandria	Giza	Beni Suif	Sharquiya
External measurements				
BM (g)	317.75±124.83 (204.46-451.58) 11	328.64±132.39 (193.61-472.21) 10	332.69±55.76 (251.52-378.80) 10	314.20±137.12 (172.30-482.34) 10
HBL	261.67±18.93 (240.0-275.0) 11	245.0±19.71 (220.0-264.0) 10	256.0±18.22 (231.0-273.0) 10	265.60±29.82 (232.0-302.0) 10
TL	111.67±12.91 (90.0-125.0) 11	97.0±3.46 (94.0-102.0) 10	106.50±12.26 (94.0-118.0) 10	97.60±13.16 (84.0-116.0) 10
HFL	46.0±4.58 (41.0-50.0) 11	41.50±5.80 (36.0-47.0) 10	47.0±6.27 (39.0-52.0) 10	37.20±8.81 (28.0-46.0) 10
EL	16.33±0.58 (16.0-17.0) 11	11.75±2.99 (8.0-15.0) 10	17.0±2.16 (14.0-19.0) 10	16.80±2.77 (13.0-20.0) 10
Cranial measurements				
CbL	48.70±3.36 (44.84-50.98) 11	45.86±3.11 (42.33-49.77) 10	50.03±2.80 (46.10-52.69) 10	47.16±4.25 (41.91-51.09) 10
NcL	28.09±2.48 (25.23-29.54) 11	27.11±2.39 (23.92-29.69) 10	28.23±1.77 (26.0-30.23) 10	27.30±2.26 (24.14-29.23) 10
VcL	20.61±0.93 (19.61-21.44) 11	18.76±1.20 (17.27-20.08) 10	21.80±1.14 (20.10-22.46) 10	19.86±2.06 (17.58-21.86) 10
PtL	20.94±1.38 (19.42-22.10) 11	19.43±1.82 (17.64-21.87) 10	21.22±1.35 (19.24-22.20) 10	20.20±2.51 (17.35-23.14) 10
BcL	19.0±1.13 (17.69-19.68) 11	18.01±0.87 (17.24-19.14) 10	19.26±1.14 (18.19-20.41) 10	18.27±1.83 (15.98-19.92) 10
AbL	14.72±0.77 (13.85-15.32) 11	14.13±1.05 (13.03-15.37) 10	15.03±0.77 (13.94-15.64) 10	14.30±1.32 (12.79-15.84) 10
AbB	9.63±0.81 (8.71-10.25) 11	9.11±0.67 (8.49-9.90) 10	9.72±0.67 (8.93-10.57) 10	9.18±0.89 (8.02-9.99) 10
ZyB	28.23±1.26 (26.81-29.24) 11	27.09±3.14 (24.29-30.28) 10	28.21±2.22 (25.08-29.88) 10	26.63±3.23 (22.68-29.86) 10

Table 3 Continuous

Absolute character	The studied regions			
	Alexandria	Giza	Beni Suif	Sharquiya
GmB	25.01±2.07 (22.62-26.37) 11	23.42±1.94 (21.54-26.00) 10	25.21±1.27 (23.59-26.68) 10	23.69±2.32 (20.55-25.68) 10
PoB	8.41±0.42 (7.94-8.74) 11	8.71±0.67 (8.09-9.60) 10	8.30±0.57 (7.45-8.64) 10	8.55±0.73 (7.44-9.39) 10
InB	10.79±0.87 (9.91-11.64) 11	10.50±1.01 (9.30-11.71) 10	10.83±0.94 (9.57-11.60) 10	10.21±1.35 (8.53-11.67) 10
GpB	15.20±0.61 (14.50-15.62) 11	14.63±1.01 (13.39-15.59) 10	15.86±1.06 (14.42-16.71) 10	14.61±1.31 (12.93-16.24) 10
PdT	11.75±0.43 (11.49-12.25) 11	15.80±1.33 (14.52-17.16) 10	11.92±1.25 (10.45-13.44) 10	10.98±1.12 (9.60-12.10) 10
HbC	16.38±0.47 (15.84-16.66) 11	12.36±1.65 (10.91-13.81) 10	16.44±1.09 (14.97-17.43) 10	16.0±1.39 (14.49-17.39) 10
TmL	25.28±2.04 (23.27-27.34) 11	23.59±2.04 (21.16-25.70) 10	26.33±1.71 (23.91-27.87) 10	24.65±3.57 (20.52-28.35) 10
AmL	24.82±1.93 (22.60-26.13) 11	23.34±2.10 (21.02-25.47) 10	25.59±1.99 (22.67-27.12) 10	23.87±3.01 (19.86-26.83) 10
MaH	13.04±0.67 (12.26-13.46) 11	12.36±1.65 (10.91-13.81) 10	13.46±1.47 (11.33-14.66) 10	12.89±2.07 (10.14-14.85) 10
Dental measurements				
MuB	3.48±0.07 (3.42-3.56) 11	3.72±0.26 (3.52-4.09) 10	3.80±0.18 (3.58-4.01) 10	3.76±0.25 (3.50-4.02) 10
PuL	4.60±0.03 (4.56-4.62) 11	4.35±0.31 (4.12-4.80) 10	4.89±0.26 (4.54-5.18) 10	4.63±0.37 (4.10-4.98) 10
MxtL	13.03±0.48 (12.54-13.50) 11	11.83±0.71 (11.04-12.59) 10	13.55±0.72 (12.51-14.17) 10	12.60±1.11 (11.30-13.79) 10
CaB	11.19±0.42 (10.71-11.45) 11	10.47±1.18 (9.30-11.73) 10	11.51±1.04 (10.05-12.50) 10	10.55±1.55 (8.51-12.01) 10
MatL	15.32±0.94 (14.32-16.19) 11	14.18±0.85 (13.0-14.84) 10	14.67±2.14 (11.83-16.74) 10	14.92±0.77 (13.88-15.56) 10
MlL	4.66±0.28 (4.34-4.86) 11	4.59±0.42 (4.18-5.06) 10	4.88±0.41 (4.37-5.37) 10	4.73±0.62 (4.05-5.63) 10

The data presented as mean ± standard deviation, (range), and number of specimens.

In Egypt, the Egyptian weasel is a small carnivore mustelid with limited distribution to the lower Nile Valley and Nile Delta[6]. It was previously known as the common weasel *M. nivalis*[13] and traditionally considered a subspecies of *M. nivalis* as *M. n. subpalmata*[6,14]. Depending on cranial measurements analysis, van Zyll de Jong[2] noted the specific status of the Egyptian weasel. He believed that an additional argument in favor of the specific separation of the Egyptian weasel is the sexual dimorphism in skull size, which is distinct from other subspecies of the common weasel, *M. nivalis*. Abramov and Baryshnikov[10] reported that the cranial measurements of the Egyptian weasel differ essentially from that of *M. nivalis*. The detachment of the Egyptian weasel from the ancestral form may happen at an earlier phase of evolution than the *M. nivalis* division into major groups. Rodrigues *et al.*[11] reported the first genetic determination of the taxonomic status of the Egyptian weasel by comparing mitochondrial DNA sequences to those of the common weasel *M. nivalis* from the western Palearctic.

Table 4: Ratios of morphological and cranial measurements for the Egyptian weasel specimens from the four studied areas.

Ratio	The studied regions			
	Alexandria	Giza	Beni Suif	Sharquiya
TL/HBL	0.425±0.045 (0.375-0.463) 11	0.398±0.030 (0.366-0.436) 10	0.415±0.025 (0.384-0.438) 10	0.368±0.036 (0.337-0.430) 10
TL/HFL	2.416±0.193 (2.195-2.553) 11	2.366±0.281 (2.087-2.667) 10	2.272±0.099 (2.178-2.410) 10	2.693±0.402 (2.087-3.107) 10
PtL/CbL	0.430±0.005 (0.424-0.434) 11	0.423±0.011 (0.414-0.439) 10	0.424±0.008 (0.417-0.436) 10	0.427±0.019 (0.401-0.453) 10
MxtL/CbL	0.268±0.010 (0.259-0.280) 11	0.258±0.011 (0.264-0.270) 10	0.271±0.002 (0.269-0.273) 10	0.267±0.003 (0.264-0.270) 10
AbL/CbL	0.302±0.006 (0.298-0.309) 11	0.308±0.005 (0.301-0.314) 10	0.301±0.005 (0.294-0.307) 10	0.303±0.008 (0.291-0.315) 10
ZyB/CbL	0.508±0.015 (0.570-0.598) 11	0.590±0.038 (0.545-0.631) 10	0.563±0.017 (0.544-0.586) 10	0.563±0.019 (0.541-0.584) 10
GmB/CbL	0.513±0.008 (0.504-0.518) 11	0.510±0.010 (0.498-0.522) 10	0.504±0.008 (0.493-0.512) 10	0.502±0.007 (0.490-0.508) 10
PoB/CbL	0.173±0.005 (0.168-0.177) 11	0.191±0.020 (0.167-0.208) 10	0.166±0.015 (0.148-0.185) 10	0.182±0.016 (0.166-0.207) 10
InB/CbL	0.222±0.007 (0.215-0.228) 11	0.229±0.021 (0.207-0.252) 10	0.216±0.009 (0.208-0.227) 10	0.216±0.011 (0.204-0.232) 10
GpB/CbL	0.313±0.010 (0.304-0.323) 11	0.319±0.017 (0.298-0.336) 10	0.317±0.006 (0.312-0.326) 10	0.310±0.007 (0.299-0.318) 10
CaB/CbL	0.230±0.008 (0.224-0.239) 11	0.228±0.015 (0.207-0.241) 10	0.230±0.013 (0.218-0.245) 10	0.223±0.014 (0.203-0.239) 10
TmL/CbL	0.519±0.017 (0.502-0.536) 11	0.514±0.015 (0.500-0.533) 10	0.526±0.005 (0.519-0.530) 10	0.521±0.030 (0.490-0.555) 10
HbC/CbL	0.337±0.014 (0.326-0.353) 11	0.344±0.016 (0.323-0.360) 10	0.328±0.005 (0.324-0.334) 10	0.339±0.006 (0.334-0.347) 10
GpB/PtL	0.727±0.024 (0.700-0.747) 11	0.755±0.046 (0.713-0.807) 10	0.748±0.024 (0.716-0.773) 10	0.726±0.039 (0.686-0.787) 10
CaB/PtL	0.535±0.017 (0.517-0.551) 11	0.539±0.030 (0.500-0.572) 10	0.542±0.028 (0.522-0.582) 10	0.542±0.029 (0.475-0.547) 10
PuL/MxtL	0.353±0.015 (0.338-0.368) 11	0.368±0.014 (0.353-0.381) 10	0.361±0.013 (0.344-0.376) 10	0.367±0.011 (0.358-0.383) 10
MuB/MxtL*	0.268±0.013 (0.253-0.277) 11	0.314±0.011 (0.301-0.325) 10	0.280±0.005 (0.275-0.286) 10	0.299±0.009 (0.288-0.310) 10
AbL/BcL	0.775±0.012 (0.761-0.783) 11	0.784±0.022 (0.756-0.803) 10	0.781±0.026 (0.766-0.82) 10	0.783±0.016 (0.762-0.800) 10
AbB/AbL	0.654±0.028 (0.629-0.684) 11	0.645±0.014 (0.627-0.662) 10	0.646±0.027 (0.616-0.683) 10	0.642±0.020 (0.615-0.661) 10
PoB/ZyB	0.298±0.007 (0.292-0.305) 11	0.324±0.036 (0.275-0.362) 10	0.296±0.031 (0.264-0.339) 10	0.323±0.036 (0.285-0.382) 10
HbC/GmB	0.657±0.038 (0.631-0.700) 11	0.675±0.025 (0.649-0.704) 10	0.652±0.019 (0.635-0.678) 10	0.676±0.019 (0.661-0.708) 10
MlL/TmL	0.185±0.009 (0.175-0.193) 11	0.196±0.026 (0.167-0.228) 10	0.185±0.009 (0.178-0.199) 10	0.192±0.013 (0.176-0.208) 10
MaH/TmL	0.517±0.021 (0.492-0.531) 11	0.523±0.032 (0.482-0.556) 10	0.510±0.031 (0.474-0.543) 10	0.522±0.029 (0.475-0.552) 10

The data presented as mean ± standard deviation, (range), and number of specimens (*****$P<0.05$: significant difference between these four studied regions).

The Egyptian weasel is accepted as a species separate from *M. nivalis* by many studies[2,9,10,15-19]. Previously, the Egyptian weasel was restricted to the lower Nile Valley of Egypt, between Beni Suif in the south and the Nile Delta to Alexandria in the north[19]. Basuony *et al*.[20] reported the area of occupancy is 84 km² and the extent of occurrence is 16,470 km² depending on 23 records from four localities. The Egyptian weasel sightings and trapping from buildings of Aswan city (D. Hoek and I. Haitham pers. comm. 2014). We recorded a dead specimen of the Egyptian weasel in Assiut city. After asking the dwellers about their knowledge and sightings of the Egyptian weasel, they confirmed its presence in Assuit, Sohag, Qena, and Luxor Governorates. Hence, the Egyptian weasel, *M. subpalmata*, is distributed in Nile Delta, Nile Valley, and Upper Egypt. Basuony *et al*. [20] and Leach *et al*.[21] recognized the Egyptian weasel to be amongst the fewest mammalian species endemic to Egypt.

In the current study, the dorsum of the Egyptian weasel specimens collected from the Alexandria region was cacao brown. Venter is brown with a narrow white strip down to cream white. The demarcation between the side and venter is straight or irregular. The throat is whitish. Rostrum is short-square. The tail tip is slightly darker than the rest of the tail and the body to black. Toes are whitish. The hair of the palm is sometimes whitish, while sole is brown. Claw is dark red, while pads are red. The dorsum of the Egyptian weasel specimens collected from Giza region was brown to pale brown. Venter is white tinged and sometimes pale yellow to rust-red. The demarcation between the side and venter is straight or irregular. The throat is whitish with small brown patches. Rostrum is also short-square. The tail tip is slightly darker than the rest of the tail and the body to black. Toes are also whitish. The hair of the palm is sometimes whitish, while sole is brown. The claw is dark at the base and white at the tip, pads are red. The dorsum of the Egyptian weasel specimens collected from Beni Suif region was cacao brown. Venter is whitish. The demarcation between the side and venter is straight or irregular. The throat is whitish with small brown patches. No brown patches were observed in one specimen only. Rostrum is short-square, as usual. The tail tip is slightly darker than the rest of the tail and body. Toes are whitish. The hair of the palm is sometimes whitish, while sole is brown. Claw is brownish red and pads are whitish to reddish. The dorsum of the Egyptian weasel specimens collected from Sharquiya region was pale or cacao brown to brown. Venter is whitish to pale brown. The demarcation between the side and venter is straight or irregular. The throat is whitish with small brown patches. A whitish-orange throat was observed in one specimen only. Rostrum is short-square. The tail tip is slightly darker than the rest of the tail and the body to black. Toes are whitish. The hair of the palm is sometimes whitish and sole is brown. Claw is brownish red to black at base and pads are reddish. More of these results agreed with that reported by Osborn and Helmy[6]. Osborn and Helmy[6] mentioned that the Egyptian weasel as *M. n. subpalmata* is brown above and the venter is whitish. Its body is a slender with notable shortage of tail and legs. The rostrum is short and the skull is broad and flattened.

Flower[22] documented that the Egyptian weasel is completely commensal. It is nocturnal, but several individuals have been seen during the day. It coexists with the human in houses and public buildings; a few of it may present at agricultural fields and canal banks of Nile Valley and Delta. Hoogstraal[23] reported that the Egyptian weasel is not preferred the public places, such as theatres, restaurants, and clubs. Weasels may kill rats and mice in houses; the contents of their stomach have red ants, cockroaches, tenebrionid beetles, small birds, fish, and fish bait. In the current study, no significant difference between the four studied regions was recorded for all absolute characters. In most of the absolute characters used in this study, the specimens of the Egyptian weasels collected from Beni Suif region were recorded as larger than others and the weasels collected from Sharquiya region were recorded the smaller ones. It may be referred to their larger BM, where the weasels collected from Beni Suif region recorded the heavier 332.69±55.76 g average BM and that collected from Sharquiya region recorded the lighter 314.20±137.12 g BM (Table 3). The average HBL of adult Egyptian weasels collected from Alexandria was 261.67±18.93 mm, Giza (245.0± 19.71 mm), Beni Suif (256.0±18.22 mm), and Sharquiya (265.0±29.82 mm), as shown in Table "3". The average TL of adult Egyptian weasels collected from Alexandria was 111.67±12.91 mm, Giza (97.0± 3.46 mm), Beni Suif (106.50±12.26 mm), and Sharquiya (97.60±13.16 mm) (Table 3). The average HFL of adult Egyptian weasels collected from Alexandria was 46.0±4.58 mm, Giza (41.5±5.80 mm), Beni Suif (47.0±6.27 mm), and Sharquiya (37.20±8.81 mm) (Table 3). The average EL of adult Egyptian weasels collected from Alexandria was 16.33±0.58 mm, Giza (11.75±2.99 mm), Beni Suif (17.0± 2.16 mm), and Sharquiya (16.80±2.77 mm) (Table 3). The average condylobasal length (CbL) of adult Egyptian weasels collected from Alexandria was 48.70±3.36 mm, Giza (45.86±3.11 mm), Beni Suif (50.03± 2.80 mm) and Sharquiya (47.16±4.25 mm), as shown in Table "3". These results were in agreement with that reported by Osborn and Helmy[6].

The current study revealed that the skulls of the Egyptian weasel from all studied areas were elongated, shallow, and the lambdoidal ridges prominent, and not exceeding the posterior of the upper lip of the foramen magnum. The postorbital process is relatively small. Postorbital constriction is narrower than the rostrum. Tympanic and mastoid bullae are moderately inflated. Mastoid process prominent. Paroccipital fused to tympanic bulla. Zygomatic arch not strongly curved upward. The coronoid process tip of the lower jaw is an angular shape. In the current study, the distal end of the baculum is slightly elevated, but the terminal hook is weakly developed. The dorsal side is a weak concave. The lower side is broad with a deep urethral groove, which continues in the proximal end of the bone as a hook-like warp. The urethral groove divides the baculum anteriorly into two lobes, of which the left lobe is larger (Figure 3). Abramov and Baryshnikov[10] stated also that in Mustelidae the baculum morphology plays an essential role in its systematics. In *M. nivalis*, this small bone has a straight shaft triangular in cross-section. In addition, Taki-El-Deen[24] mentioned that the Egyptian weasel’s skull is distinguished by long cranial and short facial regions. The short facial region and the presence of cranial sagittal crest give power to pitting action during the animal's feeding.

In the current study, the minimum average of CbL was recorded for weasels collected from Giza region (45.86±3.11 mm) and the maximum one for Beni Suif region (50.03±2.80 mm) (Table 3). The minimum average of zygomatic breadth (ZyB) was recorded for specimens collected from Sharquiya region (26.63±3.23 mm) and the maximum one for the Alexandria region (28.23±1.26 mm) and Beni Suif region (28.21±2.22 mm) (Table 3). The minimum average height of brain case (HbC) was recorded for specimens collected from Giza region at 12.36±1.65 mm and the maximum one was recorded for Beni Suif region at 16.44±1.09 mm (Table 3). The minimum average of mandibular tooth row length (matL) was recorded for weasels collected from Giza region at 14.18±0.85 mm and the maximum one for the Alexandria region at 15.32±0.94 mm. The minimum average of maxillary tooth row length (MxtL) was recorded for specimens collected from Giza region at 11.83±0.71 mm and the maximum one for Beni Suif region at 13.55±0.72 mm (Table 3). The minimum average of the total length of the mandible (TmL) was recorded for specimens collected from Giza region at 23.59±2.04 mm and the maximum one was

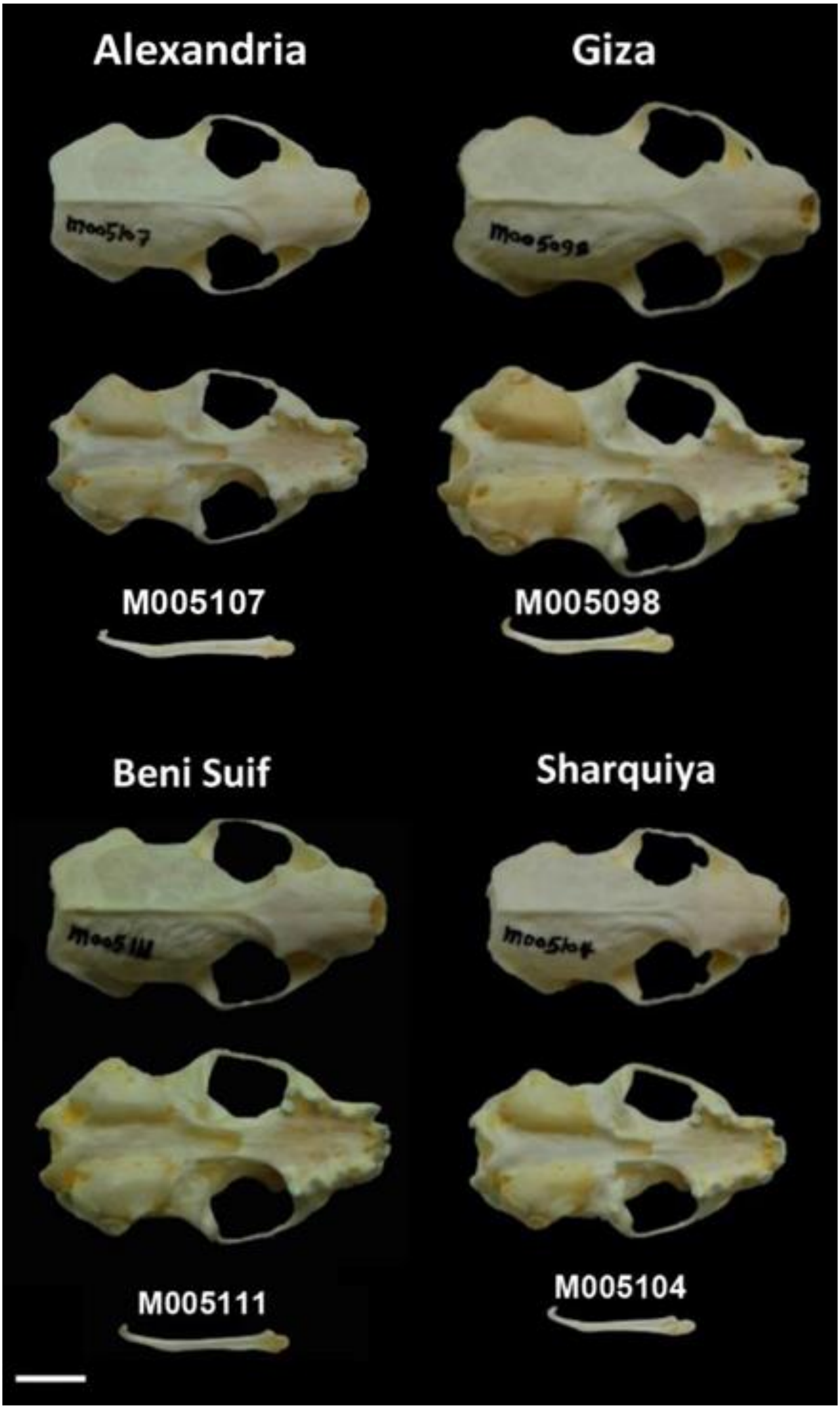

Figure 3: Dorsal and ventral views of skulls and bacula of the Egyptian weasel from the four studied regions (scale = 10 mm).

recorded for Beni Suif region at 26.33± 1.71 mm (Table 3). Referring to the mentioned measurements the skull of the weasels collected from Beni Suif region was the longest, the broadest, and the deepest.

The current study was conducted with 28 morphological characters. Five external, 17 cranial, and 6 dental measurements. The results showed 3 of 5 external characters were recorded as maximum values for Beni Suif region weasels, which were BM, HFL, and EL. The Giza region weasels recorded 3 from 5 external characters recorded as minimum values, which were HBL, TL, and EL (Table 3). Fifteen of 17 cranial measurements were recorded as maximum values for Beni Suif region weasel. The Giza region weasels recorded 12 from 17 external measurements recorded as minimum values (Table 3). The dental measurements result showed that 5 from 6 dental measurements were recorded as maximum values for Beni Suif region weasel, which were MuB, PuL, MxtL, CaB, and MiL. Five of 6 dental measurements were recorded as minimum values for Giza region weasel, which were PuL, MxtL, CaB, MatL, and MiL.

When comparing the 23 morphological character ratios used in this study, the Egyptian weasels collected from Giza region recorded 13 larger and 3 smaller ratios. The weasels collected from Beni Suif region recorded 4 larger and 9 smaller ratios. The weasels collected from the Alexandria region recorded 5 larger and 6 smaller ratios. The weasels collected from Sharquiya region recorded 3 larger and 7 smaller ratios (Table 4). The MuB/MxtL ratio only showed a significant difference between the four studied regions with the minimum value recorded for the Alexandria region 0.268±0.013 and the maximum one for Giza region 0.314±0.011 (Table 4).

The mammalian body size is recognized as a fundamental parameter when studying variation between species. The body size of mammals also may be connected to the fecundity differences and subsistence within populations among individuals. Myers and Master[25] documented that the fecundity and post weaning survival of an organism is linked to its maternal body size and the subsistence ability under harsh conditions depends on its body size. In the current study, most cranial characters were highly positively correlated with each other at about 0.9. Also, the dental characters are highly correlated with one another and are highly correlated with cranial characters (Figures 4 and 5), which are also highly correlated with one another (Figure 4). Dayan *et al.*[26] reported that although dental traits are highly correlated with one another, they are not highly correlated with cranial traits, which are also highly correlated with one another.

Some of the previous studies have demonstrated no correlation within the same species between dental characters and skull or body size[27,28]. Wolpoff[29] reported that any changes in dental measurements probably have a passive correlated response to body size changes, or that they perhaps result from a genetic disconnect between body size and tooth. Dayan *et al.*[30-32] suggested that morphological patterns in mammalian skull size may be a passive correlated response to natural selection operating on tooth size.

Figure "6" is a dendrogram showing dissimilarity between the Egyptian weasels collected from the four studied regions of the western (Alexandria) and eastern (Sharquiya) and southern (Giza) of the Nile Delta and lower Nile Valley (Beni Suif) of Egypt. The dendrogram showed that the Egyptian weasels collected from the Beni Suif region (the lower Nile Valley) stand on 28 morphological and 23 selected ratio characters that were somewhat different from those of the Alexandria, Giza, and Sharquiya regions. The similarity index between the Egyptian weasels collected from Alexandria and Sharquiya regions is very high. This cluster (Alexandria and Sharquiya) was close somewhat to the Giza cluster. It seems that the Egyptian weasel inhabited the Nile Delta for a long period before the Nile Valley and it consequently spread rapidly

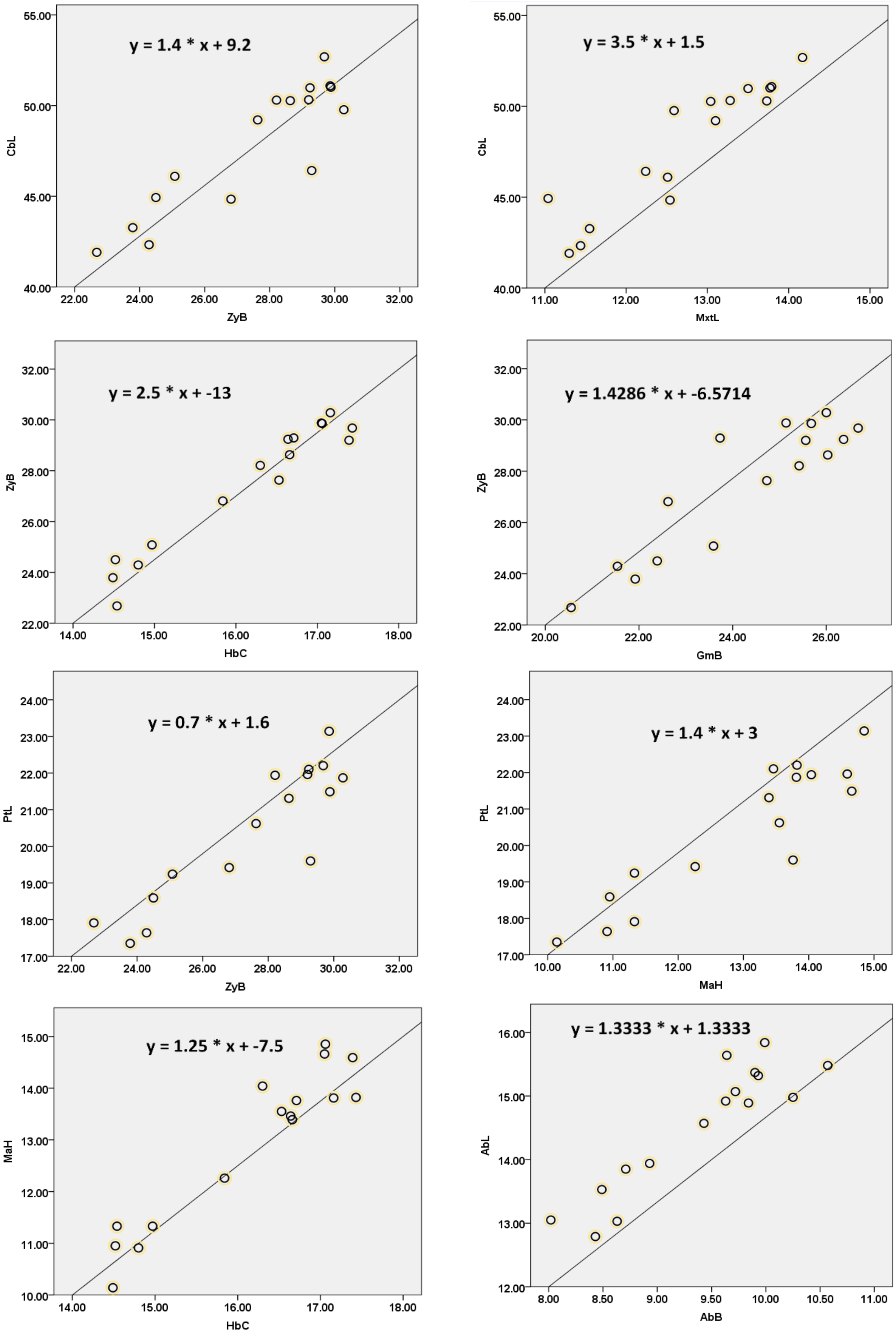

Figure 4: Correlation between cranial characters of the Egyptian weasel specimens from the four studied regions.

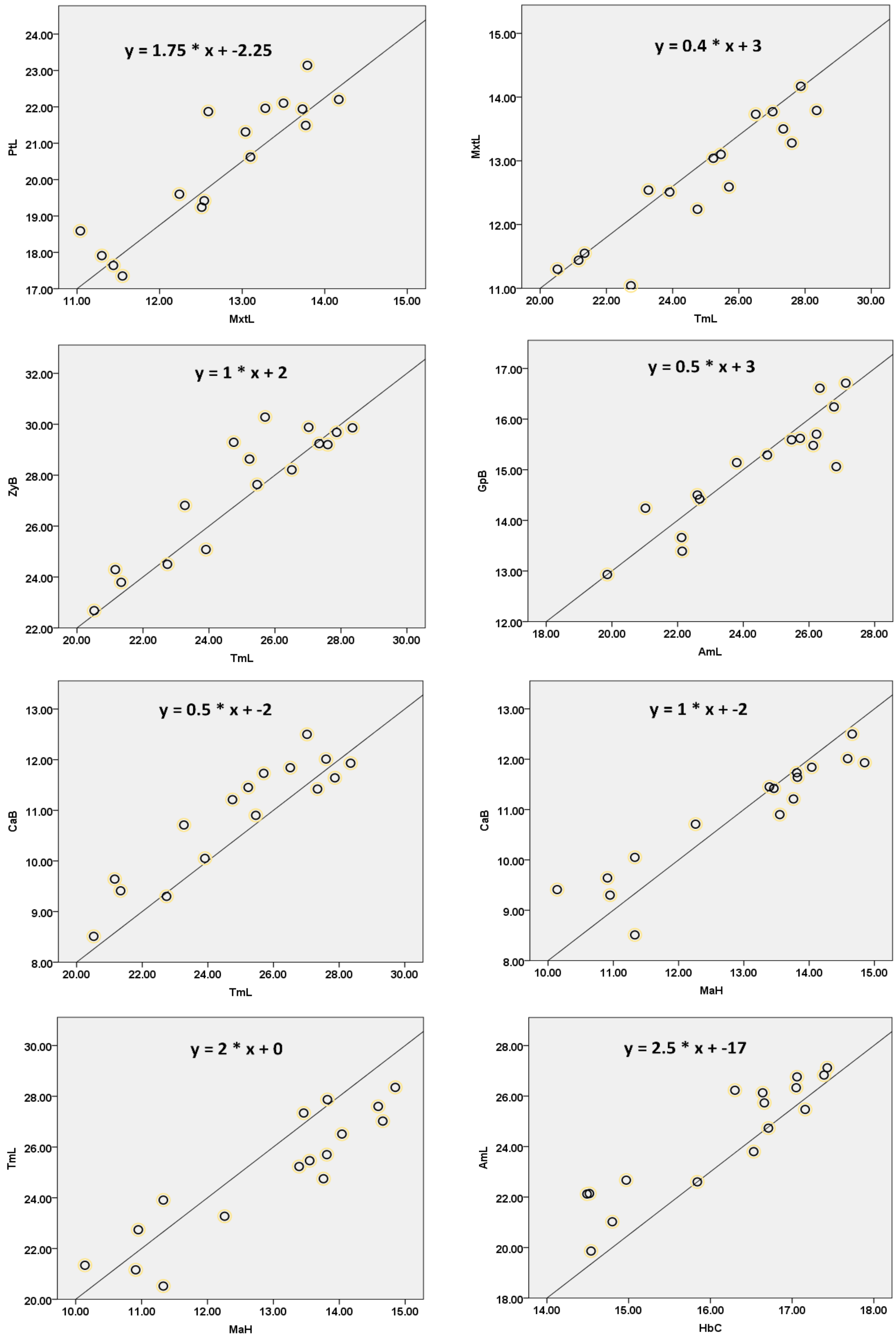

Figure 5: Correlation between dental characters of the Egyptian weasel specimens from the four studied regions.

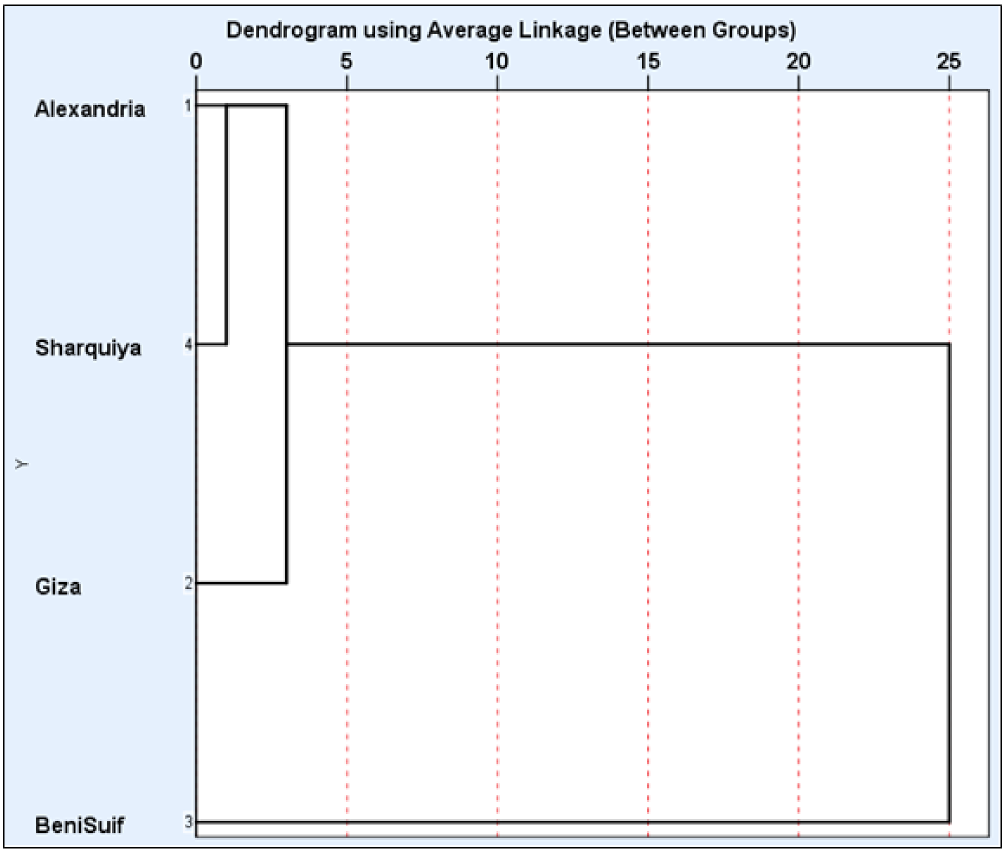

Figure 6: Dendrogram showing dissimilarity between the Egyptian weasels collected from the four studied regions.

through Nile Delta synchronously from east to west and from north to south. It is expected that the weasel specimens collected from the Alexandria region are very similar to those collected from the Sharquiya region and also closely related to those collected from the Giza region. This is due to the great similarity between the environments of those geographically connected regions, as they are within the Nile Delta limits.

In conclusion, the Egyptian weasel, *M. subpalmata*, is endemic to Egypt and found in houses and buildings of the Nile Delta, Nile Valley, and Upper Egypt. With a comparison of the morphological measurements of the Egyptian weasels collected from the four studied regions, we noted no significant difference between them. The dental measurements were highly correlated with each other and highly correlated with the cranial characters, which are also highly correlated with one another. The Egyptian weasels collected from Beni Suif region are somewhat different from those of the Alexandria, Giza, and Sharquiya regions.

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CONFLICT OF INTEREST

The authors declare that there is no conflict of interests regarding the publication of this article.

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الخصائص المورفولوجية للذكور البالغة للعرسة "*Mustela subpalmata*, Hemprich & Ehrenberg, 1833" من مناطق مختلفة في مصر

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إن معظم الخصائص التي توضح التباين بين العشائر أو الأنواع هي تلك التي ترتبط ارتباطًا مباشرًا بالقياسات المورفولوجية. وقد تناولت العديد من الدراسات القياسات المورفولوجية لجماجم الثدييات، ولكن القليل منها تعامل مع القياسات المورفولوجية المختلفة للجماجم والأسنان بشكل مفصل. تم تجميع واحد وأربعين عينة من الذكور البالغة للعرسة المصرية من أربع مناطق مختلفة في مصر هي: الإسكندرية والجيزة وبني سويف والشرقية. تم إجراء 28 قياسًا مورفولوجيًا مطلقًا (كتلة الجسم + 4 قياسات خارجية + 23 قياسًا للجمجمة والأسنان) و 23 نسبة مورفولوجية مُختارة. ولم تظهر جميع هذه القياسات فروقًا ذات دلالة إحصائية بين المناطق الأربع، فيما عدا فقط النسبة المورفولوجية "MuB/MxtL" التي أظهرت فرقًا معنويًا بين هذه المناطق الأربع. كما تم تحليل الوصف الخارجي ولون الإهاب للعرسة المصرية بشكل مفصل. وأظهرت قياسات الأسنان ارتباطًا وثيقًا ببعضها البعض ومرتبطًا ارتباطًا كبيرًا بقياسات الجماجم التي ترتبط أيضًا ارتباطًا وثيقًا ببعضها البعض. وبناءً على نتائج 28 قياسًا مورفولوجيًا مطلقًا و 23 نسبة مورفولوجية مختارة، وجد أن عينات العرسة المصرية التي تم تجميعها من منطقة بني سويف تختلف عن تلك الموجودة في مناطق الإسكندرية والجيزة والشرقية، وأن مؤشر التشابه بين العِرس المصرية التي تم جمعها من منطقتي الإسكندرية والشرقية متقارب للغاية، والتجمع الخطي للعرس المصرية من كل من الإسكندرية والشرقية متشابه إلى حد ما مع التجمع الخطي للعرس المصرية في الجيزة.