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SHAPE VARIABILITY IN THE SKULL OF LONG-TAILED CHINCHILLA (*CHINCHILLA LANIGER*, MOLINA 1782) PART 2. RELATIVE GROWTH RATE OF SOME SKULL REGIONS

ZMIENNOŚĆ KSZTAŁTU CZASZKI SZYNSZYLI MAŁEJ (*CHINCHILLA LANIGER*, MOLINA 1782) CZĘŚĆ 2. WZGLĘDNA SZYBKOŚĆ WZROSTU WYBRANYCH OBSZARÓW CZASZKI

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Streszczenie. Celem pracy było przedstawienie względnej szybkości wzrostu poszczególnych obszarów czaszki i żuchwy szynszyli małej (*Chinchilla laniger*) oraz uchwycenie zmian morfometrycznych w różnych okresach rozwoju tych zwierząt. Badania przeprowadzono na 299 czaszkach samców i samic szynszyli małej, które podzielono wg wieku. Do pierwszej grupy zakwalifikowano czaszki osobników najmłodszych – w wieku 1–30 dni życia (n = 29), do drugiej grupy – dziewięć czaszek osobników w wieku od 31 do 58 dni. Grupa trzecia obejmowała szkielety głowy zwierząt w wieku od 258 do 360 dni (n = 135), czwarta grupa – w wieku 366–399 dni (n = 72), piąta grupa – w wieku od 400 do 507 dni (n = 54). Wartości empiryczne 26 cech metrycznych czaszki i żuchwy zlogarytmowano; po uwzględnieniu okresu rozwoju morfologicznego oszacowano wartości względnej szybkości wzrostu poszczególnych obszarów szkieletu głowy szynszyli małej. Ponadto oszacowano wartości współczynników korelacji Pearsona dla badanych cech. Wyniki przedstawiono w sześciu tabelach.

Key words: age, craniometry, long-tailed chinchilla, sex, skull.
Słowa kluczowe: czaszka, kraniometria, wiek, płeć, szynszyla mała.

INTRODUCTION

An important source of knowledge that helps learn and understand many biological phenomena is morphometric data. They are being used in studies on the phylogeny of organisms (Rae 1998), evolutionary changes (Kobryń 1984, Liberman 1998), and past and modern population history and structure (Gawlikowski 1989, Gonzalez-Jose et al. 2001) but also on sexual dimorphism o (Vincent et al. 2004), condition and growth (Green 2001, Stępień and Gawlikowski 1998), or inheritance or asymmetry of traits in populations living under different ecological conditions (Willmore 2005, Baranowski and Wojtas 2011).

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Previous studies on the morphometry of long-tailed chinchilla skulls have concerned a comparison of the metric traits of specimens from modern farming of these rodents with historic skulls being collected at the Natural History Museum in London. A significant effect of both breeding and natural environmental factors on the size of respective neurocranium and viscerocranium segments has been observed in these animals (Baranowski et al. 2013a, b). The aim of this study is to present the relative growth rate of respective cranial and mandibular regions in long-tailed chinchilla and to observe morphometric changes in different stages of development of these animals.

MATERIAL AND METHODS

Research material includes 299 long-tailed chinchilla skulls, the description of which has been presented in previous papers (Baranowski et al. 2013a, b). In order to perform studies aiming at estimation of relative growth rate for cranial and mandibular parameters in farm chinchillas, the Schmalhausen-Brodie method (Nikitiuk 1972) was used, consisting in logarithmisation of the empirical values of cranial and mandibular metric traits, taking into account the stage of morphological development:

$$C = \log V2 - \log V1 / 0.4343 \times t$$

where:

C – relative growth rate of a trait,

V1 and V2 – bone dimensions in subsequent stages of life,

t – time interval between measurements (in days),

0.4343 – constant.

The data analysis was conducted based on dates of birth and death (i.e. slaughter or casualty) of an animal. The material was divided into five age groups. The first group included the youngest specimens, at the age of 1–30 days of life (n = 29; 12 males and 17 females), the second group 9 skulls (5 males and 4 females) aged 31 to 58 days. The third group included the skulls of animals in the age range of 258 to 360 days (n = 135; 78 males and 57 females), the fourth group those aged 366–399 days (n = 72; 60 males and 12 females), and the fifth group those of 400 to 507 days of age (n = 54; 44 males and 10 females). All animals, the skulls of which were subject to biometrical analysis, had been kept under equal maintenance and feeding conditions. The empirical data obtained and the values of Pearson's simple correlation coefficients were statistically processed using Statistica v.9 PL computer software package.

RESULTS AND DISCUSSION

The skull grows in three directions: length-wise, width-wise and height-wise, until viscerocranial and neurocranial sutures become completely ossified. The viscerocranium develops in connection with the anterior alimentary tract, and the type of food being consumed cannot but have an effect on the formation of its respective segments (Baranowski et al. 2013a, b). The formation, development and differentiation direction of osseous tissue cells are affected by physical and chemical micro-environmental factors, such as pressure, mechanical forces, osteogenesis inductors and other growth-stimulating factors. The dynamics of that process depends on age. Tables 1–3 present the relative growth rate of some long-tailed chinchilla skull traits. These animals represent an interesting model, consisting in the fact that they do not reach full maturity before month 17 of life (Leal and França 2009), even in the situation when they are born larger and grow longer (Lammers et. al 2001).

In the first age stage of relative growth rate evaluation, this parameter was found to be positive for all traits being examined. The fact that larger number of traits with higher relative growth rate includes the crania and mandibles of females in noteworthy. A trait with the highest relative growth rate was the greatest breadth of cranium (*Zygion-Zygion*) and the breadth of the occipital bone (*Otion-Otion*) in males (Tabela 2). In animals of that sex, the neurocranium grew relatively faster between *Akrokranion* and *Supraorbitale* and *Eurion* and *Eurion*,too, but the breadth of the occipital condyles, the height of cranium, the area of the occipital triangle and the area of the *Foramen magnum*, and the cranial capacity had higher values in females (Table 2). The highest relative growth rate in the first age stage in both sexes was characteristic of the nasals (*Nasion-Prosthion*). Different relative growth rate in this age stage was characteristic of the traits of the skull base (Table 3), where the palatine bone (*Praemolare-Palatinoorale*) and the palatal breadth, constituting the whole palatal segment, as well as the neurocranium base in males grew faster. The relative growth rate of the segment *Palatinoorale-Prosthion* in both sexes was similar.

The relative growth rate of chinchilla mandible is almost similar to that of their palate. In the first age stage, higher relative growth rate was characteristic of males (Table 4), while females dominated males only in the growth rate of *Diastema*.

In the next age stage, the relative growth rate of most cranium length traits decreased similarly in both sexes, with the relative growth rate of neurocranium length (A-Sp) in females (0.00223) being higher than in males (0.00192). The relative growth rates of the greatest breadth of cranium (Zyg-Zyg) and the breadth of the occipital bone (Ot-Ot) in males was many times higher than those in females (Table 2), in which these two traits in the third age stage being analysed did not show any increase. In that time, all traits of the mandible in both sexes were characterised by equally high relative growth rate, the values of which were still higher in males.

From the third age stage, a halt was observed in the relative growth rate of such traits as the length of the nasals (*Nasion-Prosthion*) in males, the length of viscerocranium (*Supraorbitale-Prosthion*) in females, the neurocranium breadth (*Eurion-Eurion*), the greatest breadth of cranium (*Zygion-Zygion*) and the breadth of the occipital bone (*Otion-Otion*) in females and all traits associated with it, i.e. the height of cranium, the area of the occipital triangle and the area of the *Foramen magnum*, and the cranial capacity. Among the traits being characteristic of the skull base in the third age stage being analysed, negative relative growth rate values were recorded for the following traits: *Basion-Praemolare*, *Praemolare-Palatinoorale* and the palatal breadth in males, whereas positive values for the *Basion-Prosthion* trait. By contrast, positive values for these traits in the fourth age may suggest a continuation of the growth of the skull base in that sex (Table 3).

Table 1. Relative growth rate of some long-tailed chinchilla skull length traits
Tabela 1. Względna szybkość wzrostu wybranych cech długości czaszki szynszyli małej

Age group sequence Sekwencja grup wiekowych	*Akrokranion-Prosthion*	*Akrokranion-Supraorbitale*	*Supraorbitale-Prosthion*	*Nasion-Prosthion*	*Akrokranion-Nasion*
			Males – Samce		
1–2	0.01508 (4)	0.01547 (3)	0.01482 (5)	0.02151 (2)	0.06326 (1)
2–3	0.00264 (3)	0.00192 (5)	0.00300 (2)	0.00341 (1)	0.00230 (4)
3–4	0.00025	0.00066	0.00006	–0.00005	0.00024
4–5	–0.00016	–0.00017	–0.00017	–0.00076	0.00005
			Females – Samice		
1–2	0.01501 (3)	0.01472 (4)	0.01628 (2)	0.01672 (1)	0.01628 (2)
2–3	0.00221 (3)	0.00223 (2)	0.00219 (4)	0.00300 (1)	0.00151 (5)
3–4	–0.00015	0.00003	–0.00023	–0.00095	0.00028
4–5	0.00037	0.00034	0.00667	0.00255	–0.00073

Explanations: numbers in parentheses mean the order of trait relative growth rate in an age stage.
Objaśnienia: cyfry w nawiasach oznaczają kolejność względnej szybkości wzrostu cechy w okresie.

Table 2. Relative growth rate of some long-tailed chinchilla skull breadth and hight traits and nuchal plate area
Tabela 2. Względna szybkość wzrostu wybranych cech szerokości, wysokości i pola powierzchni tarczy karkowej czaszki szynszyli małej

Age group sequence Sekwencja grup wiekowych	*Eurion-Eurion*	*Zygion-Zygion*	*Otion-Otion*	Breadth of occipital condyles Szerokość kłykci potylicznych	Height of the cranium 1 Wysokość czaszki 1	Height of the cranium 2 Wysokość czaszki 2	Aera of the occipital triangle Pole powierzchni trójkąta potylicznego	Area of the foramen magnum Pole powierzchni otworu wielkiego	Cranial capacity 2 Pojemność czaszki 2
Males – Samce									
1–2	0.01144 (6)	0.36816 (2)	0.40085 (1)	0.00934 (9)	0.01051 (8)	0.01054 (7)	0.02200 (4)	0.01393 (5)	0.03333 (3)
2–3	0.00082 (9)	0.06358 (1)	0.06106 (2)	0.00094 (8)	0.00186 (6)	0.00173 (7)	0.00415 (4)	0.00226 (5)	0.00485 (3)
3–4	–0.00051	0.01022	0.00116	0.00052	0.00005	–0.00005	0.00019	–0.0094	–0.00032
4–5	0.00006	–0.01460	–0.00136	0.00195	–0.00047	0.00038	0.00029	0.00222	0.00048
Females – Samice									
1–2	0.00815 (9)	0.01319 (5)	0.01767 (4)	0.01123 (8)	0.01139 (7)	0.01247 (6)	0.02469 (2)	0.02395 (3)	0.03690 (1)
2–3	0.00068 (8)	0.00194 (3)	0.00127 (6)	0.00057 (9)	0.00155 (4)	0.00141 (5)	0.00279 (2)	0.00089 (7)	0.00360 (1)
3–4	–0.00045	–0.00044	–0.00044	0.00087	–0.00098	–0.00017	–0.00062	–0.00053	–0.00035
4–5	–0.00036	0.00004	–0.00064	–0.00125	0.00049	0.00042	0.00079	–0.00141	–0.00067

Explanations: as in Table 1.
Objaśnienia: jak w tab. 1.

Table 3. Relative growth rate of some long-tailed chinchilla skull base traits
Tabela 3. Względna szybkość wzrostu wybranych cech podstawy czaszki szynszyli małej

Age group sequence Sekwencja grup wiekowych	*Basion–Prosthion*	*Basion–Praemolare*	*Praemolare–Palatinoorale*	*Palatinoorale–Prosthion*	Palatal breadth Szerokość podniebienia
Males – Samce					
1–2	0.01593 (4)	0.01643 (2)	0.01620 (3)	0.01850 (1)	0.01498 (5)
2–3	0.00296 (4)	0.00325 (2)	0.00321 (3)	0.00327 (1)	0.00151 (5)
3–4	0.00027	–0.00006	–0.00033	0.00033	–0.00040
4–5	0.00055	–0.00046	0.00070	0.00029	0.00205
Females – Samice					
1–2	0.01418 (4)	0.01423 (3)	0.01579 (2)	0.01803 (1)	0.01326 (5)
2–3	0.00260 (2)	0.00230 (4)	0.00294 (1)	0.00248 (3)	0.00117 (5)
3–4	–0.00044	–0.00078	–0.00022	0.00008	–0.00102
4–5	0.00079	0.00143	–0.00003	0.00050	–0.00286

Explanations: as in Table 1.
Objaśnienia: jak w tab. 1.

Table 4. Relative growth rate of some long-tailed chinchilla mandible traits
Tabela 4. Względna szybkość wzrostu wybranych cech żuchwy szynszyli małej

Age group sequence Sekwencja grup wiekowych	Height of the mandible in front of M3 Wysokość gałęzi żuchwy na granicy M2/M3	Height of vertical ramus from Gov to the condylar process Wysokość gałęzi żuchwy od punktu *Gov* do wyrostka kłykciowego	Length of the mandible from Goc to the oral border of P1 Długość żuchwy od punktu Goc do doustnej granicy P1	Diastema	Breadth of the vertical ramus from Goc to the aboral border of M3 Szerokość gałęzi żuchwy od punktu Goc do pozaustnej granicy M3	Height of the mandible from Gov to the coronoid process Wysokość żuchwy od punktu Gov do wyrostka dziobiastego	Length of the mandible from the angular process to the aboral border of P1 Długość żuchwy od wyrostka kątowego do pozaustnej granicy P1
				Males – Samce			
1–2	0.02305 (4)	0.02651 (1)	0.02036 (6)	0.01321 (7)	0.02462 (2)	0.02389 (3)	0.02300 (5)
2–3	0.00262 (7)	0.00335 (1)	0.00299 (5)	0.00279 (6)	0.00304 (4)	0.00307 (3)	0.00316 (3)
3–4	–0.00025	–0.00014	0.00012	0.00043	0.00037	0.00014	–0.00015
4–5	–0.00089	–0.00089	0.00022	–0.00065	0.00163	–0.00092	0.00012
				Females – Samice			
1–2	0.02034 (3)	0.02330 (4)	0.02008 (6)	0.01789 (7)	0.02133 (2)	0.02374 (1)	0.02015 (5)
2–3	0.00193 (7)	0.00289 (1)	0.00238 (5)	0.00211 (6)	0.02790 (2)	0.00242 (4)	0.00259 (3)
3–4	–0.00031	–0.00186	–0.00115	0.00088	0.00013	–0.00089	–0.00069
4–5	0.00111	0.00385	0.00178	–0.00218	–0.00121	0.00196	0.0185

Explanations: as in Table 1.
Objaśnienia: jak w tab. 1.

Table 5. List of chinchilla cranial and mandibular metric traits for estimation of simple correlation coefficients allowed for in the analysis of relative growth rate (continued in Tables 6–9)
Tabela 5. Zestawienie cech metrycznych czaszki i żuchwy szynszyli w celu oszacowania współczynników korelacji prostej uwzględnionych w analizie względnej szybkości wzrostu (cd. stanowią tabele 6–9)

Trait group Grupa cech		Trait correlation – Skorelowanie cech
1	A-P x	Eu-Eu. Zyg-Zyg. Ot-Ot. Breadth of the occipital condyles. Height of the cranium 1. Height of the cranium 2. Area of the occipital triangle. Area of the foramen magnum. Cranial capacity 2. Length of the mandible from the angular process to P1 Eu-Eu. Zyg-Zyg. Ot-Ot. Szerokość kłykci potylicznych. Wysokość czaszki 1. Wysokość czaszki 2. Pole powierzchni trójkąta potylicznego. Pole powierzchni otworu wielkiego. Pojemność czaszki 2. Długość żuchwy od wyrostka kątowego do P1
2	Zyg-Zyg x	Ot-Ot. Breadth of the occipital condyles. Area of the occipital triangle. Area of the foramen magnum. Cranial capacity 2 Ot-Ot. Szerokość kłykci potylicznych. Pole powierzchni trójkąta potylicznego. Pole powierzchni otworu wielkiego. Pojemność czaszki 2
3	Ot-Ot x	Breadth of the occipital condyles. Height of the cranium 1. Height of the cranium 2. Area of the occipital triangle. Pole Area of the foramen magnum. Cranial capacity 2 Szerokość kłykci potylicznych. Wysokość czaszki 1. Wysokość czaszki 2. Pole powierzchni trójkąta potylicznego. Pole powierzchni otworu wielkiego. Pojemność czaszki 2
	Area of the occipital triangle x Pole powierzchni trójkąta potylicznego x	Area of the foramen magnum. Cranial capacity 2 Pole powierzchni otworu wielkiego. Pojemność czaszki 2
	Area of the foramen magnum x Pole powierzchni otworu wielkiego x	Cranial capacity 2 Pojemność czaszki 2
4	B-P x	B-Pm. Pm-Po. Po-P. Palatal breadth B-Pm, Pm-Po, Po-P. Szerokość podniebienia
	Height of the mandible in front of M3 x Wysokość żuchwy przed M3 x	Height of the mandible from Gov to the condylar process. Length of the mandible from Goc to P1. Diastema. Breadth of the vertical ramus from Goc to M3. Length of the mandible from the angular process to P1 Wysokość gałęzi żuchwy od Gov do wyrostka kłykciowego żuchwy. Długość żuchwy od Goc do P1. Diastema. Szerokość gałęzi żuchwy od Goc do M3. Długość żuchwy od wyrostka kątowego żuchwy do P1

Table 6. List of the number of correlated traits in respective age stages of the chinchilla growth allowing for sex (in parenthese. the number of correlation coefficients significant at P ≤ 0.05) for the 1st group of traits
Tabela 6. Zestawienie liczby cech skorelowanych w poszczególnych okresach wzrostu szynszyli, z uwzględnieniem płci (w nawiasach podano liczbę współczynników istotnych przy P ≤ 0,05), dla 1 grupy cech

Intervals of Pearson's simple correlation coefficients Przedział wartości współczynników korelacji prostej Pearsona	Chinchilla age (in days) – Wiek szynszyli (w dniach)				
	1–30	31—58	258–360	366–399	400–507
Males – Samce					
<0.19	2	1	2	3	2
0.20–0.39	3	0	3 (3)	4 (1)	4 (1)
0.40–0.59	1	0	5 (5)	2 (2)	4 (4)
0.60–0.79	2 (1)	1	0	1 (1)	0
0.80–0.99	1 (1)	8 (3)	0	0	0
% significant – istotne	22%	30%	80%	40%	50%
Females – Samice					
<0.19	0	0	0	4	5
0.20–0.39	1	1	3 (1)	4	2
0.40–0.59	1	0	3 (3)	0	2
0.60–0.79	0	3	4 (4)	2	1 (1)
0.80–0.99	8 (8)	6 (1)	0	0	0
% significant – istotne	80%	10%	80%	0%	10%

Table 7. List of the number of correlated traits in respective age stages of the chinchilla growth allowing for sex (in parenthese. the number of correlation coefficients significant at P ≤ 0.05) for the 2nd group of traits
Tabela 7. Zestawienie liczby cech skorelowanych w poszczególnych okresach wzrostu szynszyli, z uwzględnieniem płci (w nawiasach liczba współczynników istotnych przy P ≤ 0,05), dla 2 grupy cech

Intervals of Pearson's simple correlation coefficients Przedział wartości współczynników korelacji prostej Pearsona	Chinchilla age (in days) – Wiek szynszyli (w dniach)				
	1–30	31–58	258–360	366–399	400–507
Males – Samce					
<0.19	–	1	2	3	3
0.20–0.39	–	0	2 (2)	1 (1)	0
0.40–0.59	–	0	1 (1)	1 (1)	2 (2)
0.60–0.79	–	1	0	0	0
0.80–0.99	–	3 (1)	0	0	0
% significant – istotne	–	20%	60%	40%	40%
Females – Samice					
<0.19	0	0	1	2	2
0.20–0.39	1	0	2	2	1
0.40–0.59	1	2	1 (1)	1 (1)	2
0.60–0.79	0	1	1 (1)	0	0
0.80–0.99	3 (3)	2	0	0	0
% significant – istotne	60%	0%	40%	20%	0%

Table 8. List of the number of correlated traits in respective age stages of the chinchilla growth allowing for sex (in parenthese. the number of correlation coefficients significant at P ≤ 0.05) for the 3rd group of traits
Tabela 8. Zestawienie liczby cech skorelowanych w poszczególnych okresach wzrostu szynszyli, z uwzględnieniem płci (w nawiasach liczba współczynników istotnych przy P ≤ 0,05), dla 3 grupy cech

Intervals of Pearson's simple correlation coefficients Przedział wartości współczynników korelacji prostej Pearsona	Chinchilla age (in days) – Wiek szynszyli (w dniach)				
	1–30	31–58	258–360	366–399	400–507
Males – Samce					
<0.19	3	3	3	6	5
0.20–0.39	3	1	3 (3)	3 (1)	2
0.40–0.59	2	1	3 (3)	0	2 (2)
0.60–0.79	1 (1)	2	0	0	0
0.80–0.99	0	2 (1)	0	0	0
% significant – istotne	11%	11%	66%	11%	22%
Females – Samice					
<0.19	0	1	1	4	4
0.20–0.39	1	2	5 (3)	2	3
0.40–0.59	4 (3)	1	1 (1)	1	2
0.60–0.79	2 (2)	0	2 (2)	2	0
0.80–0.99	2 (2)	5	0	0	0
% significant – istotne	77%	0%	66%	0%	0%

Table 9. List of the number of correlated traits in respective age stages of the chinchilla growth allowing for sex (in parenthese. the number of correlation coefficients significant at P ≤ 0.05) for the 4th group of traits
Tabela 9. Zestawienie liczby cech skorelowanych w poszczególnych okresach wzrostu szynszyli, z uwzględnieniem płci (w nawiasach liczba współczynników istotnych przy P ≤ 0,05), dla 4 grupy cech

Intervals of Pearson's simple correlation coefficients Przedział wartości współczynników korelacji prostej Pearsona	Chinchilla age (in days) – Wiek szynszyli (w dniach)				
	1–30	31–58	258–360	366–399	400–507
Males – Samce					
<0.19	1	1	3	1	3
0.20–0.39	1	0	4 (3)	5 (5)	2 (2)
0.40–0.59	5	1	0	1 (1)	3 (3)
0.60–0.79	2 (2)	1	2 (2)	2 (2)	1 (1)
0.80–0.99	0	6 (3)	0	0	0
% significant – istotne	22%	33%	55%	88%	66%
Females – Samice					
<0.19	0	0	2	3	1
0.20–0.39	0	1	4 (4)	0	2
0.40–0.59	0	0	2 (2)	3	2
0.60–0.79	0	0	1 (1)	1 (1)	2
0.80–0.99	9 (9)	8 (4)	0	2 (2)	2 (2)
% significant – istotne	100%	44%	77%	33%	22%

In the third age stage, five of seven mandibular traits in females had negative relative growth rate values, whereas in the next fourth age stage they were again positive and higher than in males (Table 4). Special attention should be drawn to the *Diastema* and the breadth of the vertical mandibular ramus from Goc to the aboral border of the alveolus of M_3, the relative growth rate values of which were positive in the third age stage. In the fourth age stage, they were negative, whereas other values were positive and even higher, as in the case of the height of the vertical mandibular ramus from Gov to the condylar process, when compared to the second age stage. High positive relative growth rate values in the last age stage may indicate revitalisation of the growth of that part of the skull in females.

Developmental changes in the skull may be also traced by the analysis of Pearson's simple correlation coefficients between linear parameters (Table 5). The number of simple correlation coefficients in respective intervals, every 0.2 in separate age groups, is presented in Tables 6–9. It was observed that the number of traits being statistically significantly correlated within the area of the dorsal surface and nuchal plate of the cranium increased in both sexes to about one year of age (age groups 258–360 days / 366-399 days) but this number in females dominated that in males, whereas the number of traits being significantly correlated on the skull base and the mandible in next age stages was higher, with a similar pattern – in higher number of females.

CONCLUSIONS

In literature, the role of sexual dimorphism in the development of animal body size, including their skulls, has been raised many times. It has been demonstrated quite clearly that combining male and female skulls during comparison of populations leads to a loss of much valuable biological information (Rösing 1984). There are many findings referring to the cranial skeleton in different animal species indicating the effect of sexual dimorphism on the development of skull size or the emergence of sex-typical traits (Gittleman et al. 1997, Lynch et al. 1997, Kauhala et al. 1998, Günay and Altinkök 2000). As a general rule, the skulls of males, as individuals being somatically larger, are characterised by more strongly developed muscle and fascia attachments, as well as the areas of attachments of these muscles are adequately larger in males than in females (Mystkowska 1966, Scott 1957, The and Trouth 1976, Trouth et al. 1977). However, the studies describing age-related morphological variability of cranial regions are scarce (Gębczyńska 1964, Krasińska et al. 2008), while in view of the phenomenon of small, reversed sexual dimorphism observed in chinchillas, being rare in mammals (Spotorno et al. 2004), the study being carried out provide interesting data indicating differences in the growth of respective skull elements in the progressive phase of growth of that rodent species.

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Abstract. The aim of this study was to present the relative growth rate of respective cranial and mandibular regions in the long-tailed chinchilla (*Chinchilla laniger*) and to observe morphometric changes in different stages of development of these animals. The study was conducted on 299 skulls of male and female long-tailed chinchillas which were divided by age groups. The first group included the youngest specimens, at the age of 1–30 days of life (n = 29), the second group 9 skulls aged 31 to 58 days. The third group included the skulls of animals in the age range of 258 to 360 days (n = 135), the fourth group those aged 366-399 days (n = 72), and the fifth group those of 400 to 507 days of age (n = 54). The empirical values of 26 cranial and mandibular metric traits were logarithmised and, after taking into account the stage of morphological development, the values of relative growth rate for respective chinchilla skull regions were estimated. Moreover, the values of Pearson's simple correlation coefficients for the traits being examined. The findings are presented in six tables.

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