

A Catalogue of Non-Metrical Variations in Skull Bones of *Vipera lebetina* (Reptilia, Viperidae)

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Abstract.— This paper presents a description, codes, and figures of 16 variations of non-metrical characters of 122 skull bones of *Vipera (Macrovipera) lebetina* inhabiting Central Asia and the Caucasus. Statistical characteristics of the number of teeth on the pterigoideum and dental bones for several populations of the three subspecies of the levantine viper are provided.

Key words: Reptilia, Ophidia, Viperidae, *Vipera lebetina obtusa*, *V. l. turanica*, *V. l. cernovi*, Uzbekistan, Turkmenistan, Caucasus, osteology, skull bones.

Introduction

Currently, the use of non-metrical variation in cranial structures for the identification of differences and the determination of whether an individual belongs to some populational group, subspecies or larger taxon, is widely used in zoological studies (Berri, 1975; Yaletsky, 1978; Shubin and Sedokova, 1982; Larina and Eremina, 1988; Zerova and Chikin, 1992). While working on a catalogue of non-metrical variations of the cranial traits of *Vipera lebetina* L., 1758, I attempted to identify the range of variability, systematize the data, and unify techniques for distinguishing, describing, and coding traits and their variations.

Material and Methods

An osteological collection in the Institute of Zoology of the Uzbek Academy of Sciences as well as some skulls from Moscow State University were the basis for this work. A total of 268 skulls of the Levantine viper of different ages and sexes from various localities in both Central Asia and Azerbaijan were used. These populations are attributed by modern taxonomists to the following subspecies:

1. *Vipera (Macrovipera) lebetina obtusa* Dwigubsky, 1832, 35 specimens;
2. *V. (M.) l. turanica* Chernov, 1940, 175 specimens;
3. *V. (M.) l. cernovi* Chikin and Szczerbak, 1992, 58 specimens.

The ordinal numbers of the subspecies correspond to those in the fourth column of Tables 1 and 2 of this catalogue and in the first column of Tables 3 and 4.

Variations of the characters were revealed and illustrated while comparing the bones using the binocular MBI-9 at different magnifications and with a

magnifier. The characters are arranged in groups to be presented in the tables: the characters of the bony elements in Table 1 as foramenal characters in Table 2. Table 3 provides statistical characteristics, calculated using standard techniques (Lakin, 1990), of the numbers of the teeth in the pterigoideum and dental bones separately for males and females, and their total; the total number of teeth is given in Table 4. The populations of *V. (M.) l. turanica*—one from the eastern and western parts of the Nuratau Ridges (EN, WN) and Turkestan (T), the Malguzar Ridge (M), and Gobduntau (G)—are characterized in Tables 3 and 4.

Names of bones and bony elements are given as described by Gurtovoy et al. (1978), Groombridge (1980), Mbrkevitch and Tatarko (1983), and Szyndlar (1984). The names of the characters are coded by the letter symbols (initial letters of their Latin names).

Results

The following non-metrical variations are described in this catalogue: (Table 1) variability in the shape of most cranial bones, (Table 2) foramenal characters, (Table 3) the number of teeth (and whether a subspecies shows variations in this or that trait), and (Table 4) some schematic drawings (Figs. 1–16), illustrating the variations described.

Some of the variations may be considered as insignificant anomalies (rare phenes), which characterize only individual populations of a subspecies. However, the variations are common, i.e., found in each of the subspecies, and are “normal” for a species, though their occurrence is different in each populational group. Naturally-occurring heterogeneity of bilateral structures is not reflected in the catalogue except the characters *Mcp* and *Fpa* on the parietal bone. These

combinations, assessed by means of the values of fluctuating asymmetry and observed even on a single (nonpaired) bone, are independent characteristics of stable development and its description is not supposed here.

It is noteworthy that separate variations (Mpa, Mep), expanding the range of variability, can be in fact considered as the age characteristics and it is this case that necessitates a study on transformations of the characters in ontogeny.

This catalogue cannot be considered comprehensive and should be treated as a scheme, which, when used by researchers, will enable them to amplify it in the following:

- (1) description of variability of the other bones;
- (2) incorporation of new traits and variations;
- (3) identification of known traits and variations to individuals in various populational and taxonomic groupings, both living and fossil.

Discussion

This publication of the Catalogue is a slightly extended variant of my previous work (Chikin, 1993), which, due to its limited distribution, is inaccessible to most scientists. I will be grateful to my readers for their remarks and glad to have followers.

Acknowledgments

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Appendix I

Figures 1-16

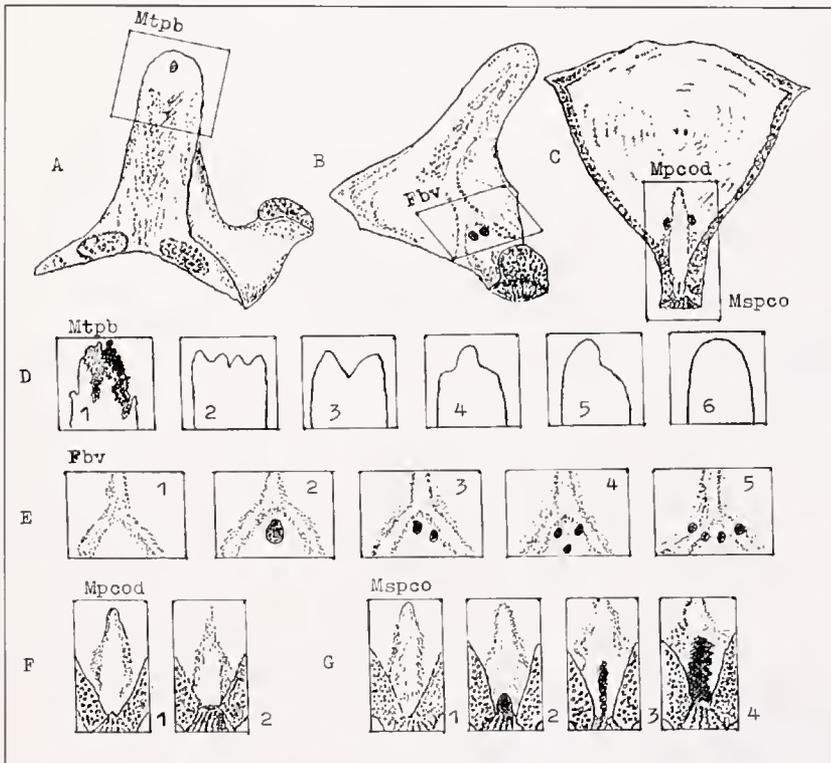


Figure 1. Basioccipital bone. A, B and C are the location of the characters; the numbers of variations correspond to those in Tables 1 and 2.

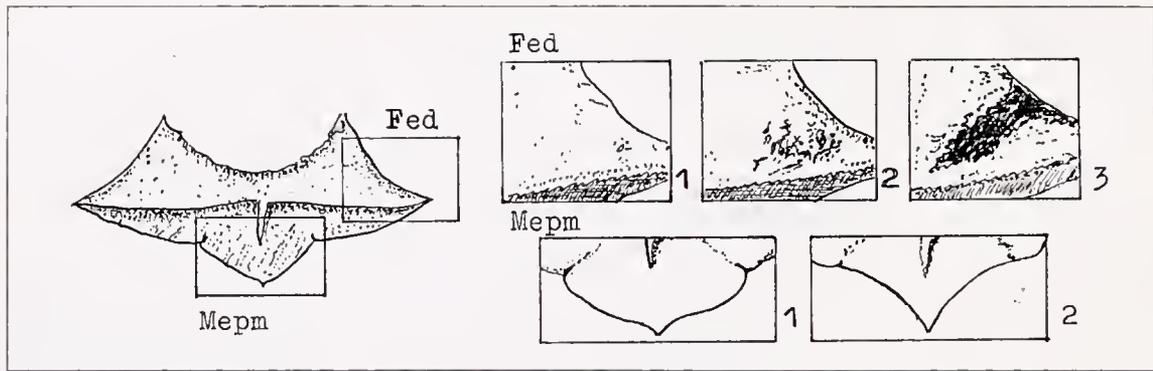


Figure 2. Supraoccipital bone (dorsal view). Location of the characters and their variations.

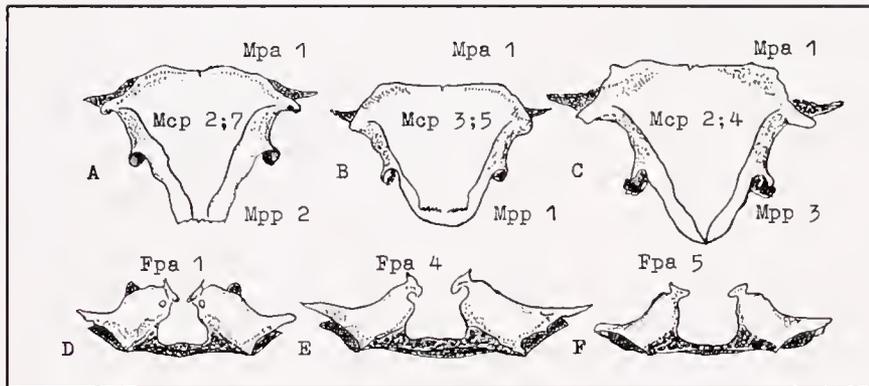


Figure 3. Parietal bone. A, B, and C are the variations of the form of the parietal crest and posterior margin. D, E, and F are the foramina and notches or the anterior edge of the descending part of the bone.

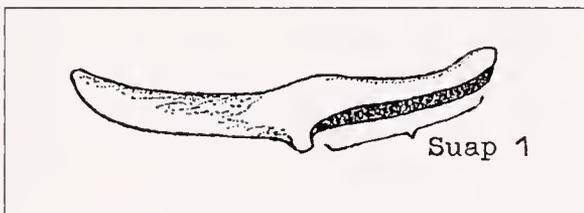


Figure 4. Postfrontal bone, showing the surface that joins with the parietal bone.

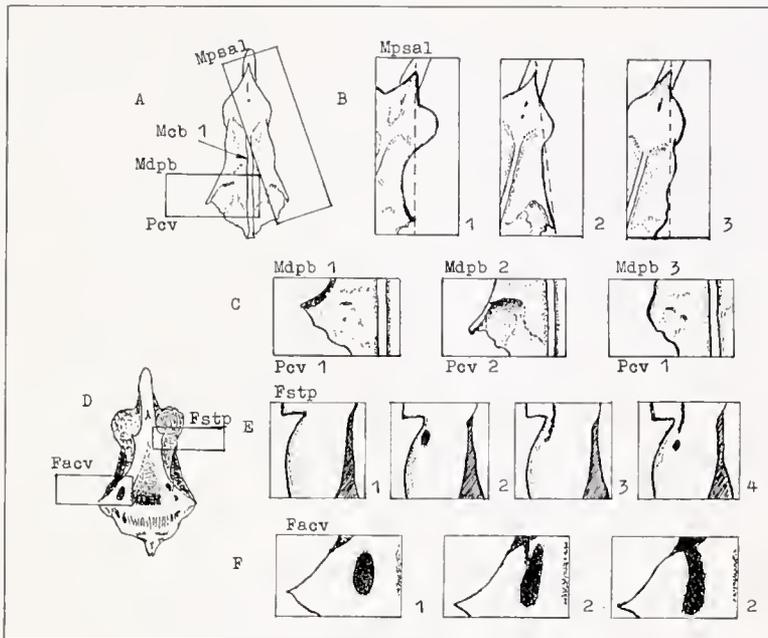


Figure 5. Basiparasphenoid bone. Location of the characters: A - inferior; D - superior views; B, C, E, F - variations.

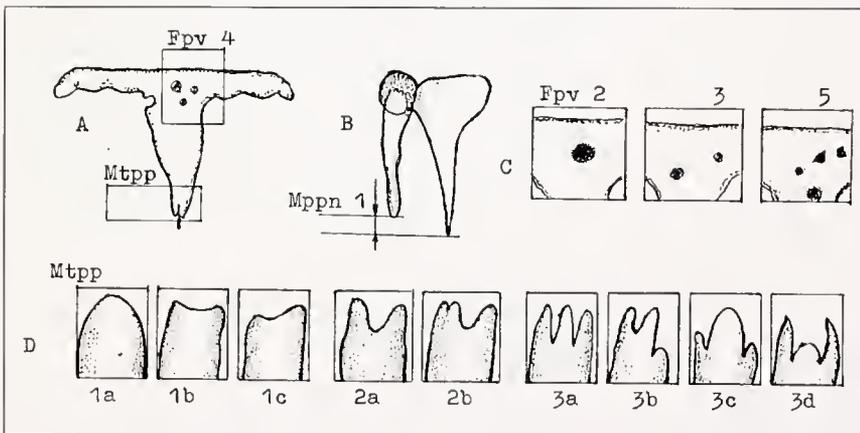


Figure 6. Premaxillary bone: A - inferior, B - lateral views. Location of the characters and (C, D) variations observed.

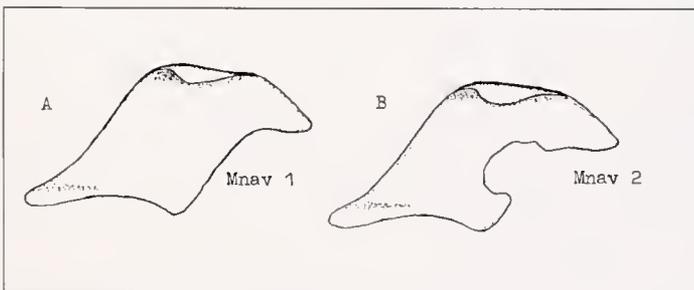


Figure 7. Nasal bone. Variations in the form of the anterior edge.

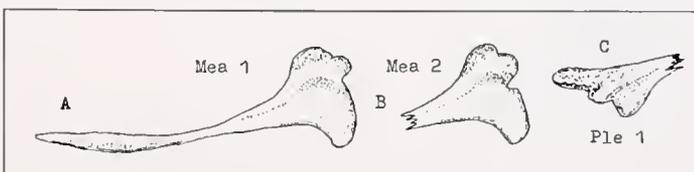


Figure 8. Variations of the anterior margin of the ectopterygoid (A, B); C- external lateral prominence.

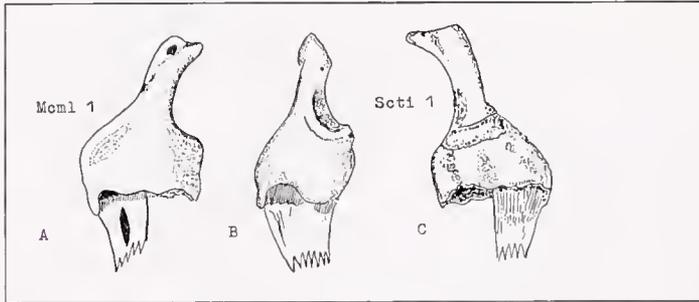


Figure 9. Maxillary bone. A - anterior, B - lateral, C - dorsal views.

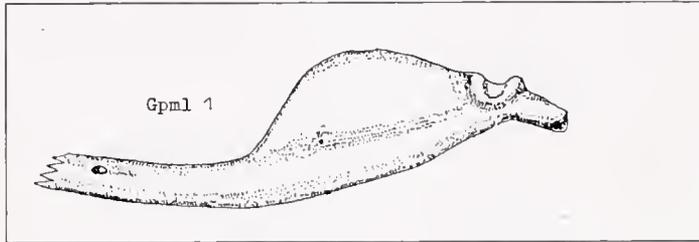


Figure 10. Articular bone. a Proximal part from the external lateral view.

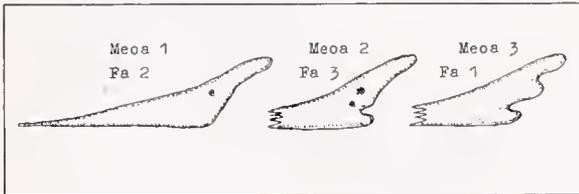


Figure 11. Angular bone. Variations in the form of the anterior margin and foramina.

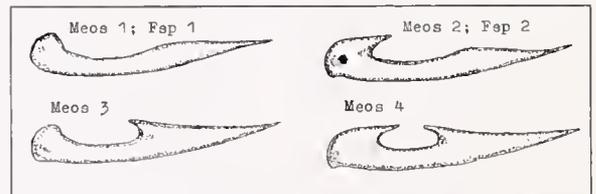


Figure 12. Splenial bone. Variations of the notch or the dorsal part and of the openings.

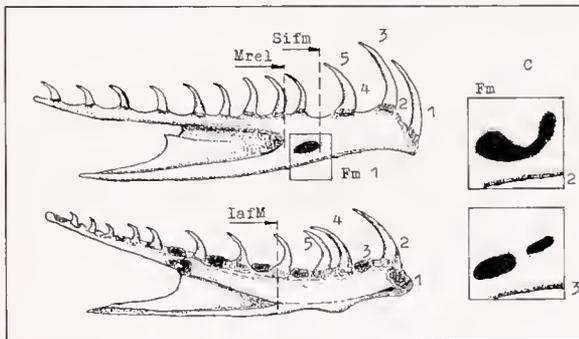


Figure 13. Dental bone. A - external lateral side; the position of the notch margin of the articular bone and mental foramen. B - the internal lateral side, where Meckel's groove begins to expand. C - variations in the form of the mental foramen. 1 - 5 - numbers of the teeth.

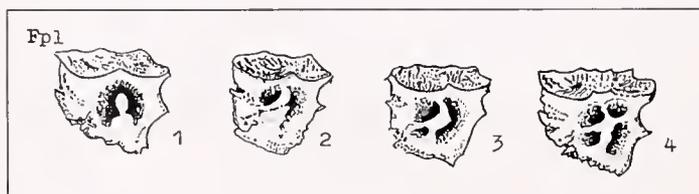


Figure 14. Prooticum (left bone). Variations of the foramina at the external lateral side.

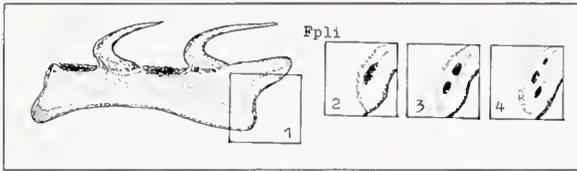


Figure 15. Palatal bone. Variations of the foramina at the dorsal part of the internal lateral surface.

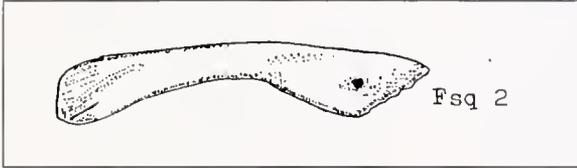


Figure 16. Squamosum bone. A variant with the foramen.

Appendix II

Tables 1-4

TABLE 1. Form of the skull bones in the Levantine Viper.

Character	Description of variations	Code	Sub-species
The main occipital bone—basioccipitale (Fig. 1)			
<i>Margo terminationis processus basioccipitalis</i> (Mtpb)	Coral-shaped	Mtpb 1	2
	Saw-shaped	Mtpb 2	2; 3
	V-shaped	Mtpb 3	1; 2; 3
	Projection in the middle	Mtpb 4	1; 2; 3
	Truncated	Mtpb 5	1; 2; 3
	Roundish	Mtpb 6	1; 2
<i>Margo prominentiae condyli occitcondilaris, pars dorsalis</i> (Mpcod)	Margin of prominence sharply extending above the bone	Mpcod 1	1; 2
	Margin of prominence gently extending above the bone	Mpcod 2	1; 2; 3
<i>Margo sinus prominentiae condili occitcondilaris</i> (Mspco)	Groove absent	Mspco 1	1; 2; 3
	Groove chink shaped	Mspco 2	1; 2
	Groove oval	Mspco 3	1
	Groove irregular	Mspco 4	2; 3
Supraoccipital bone—exoccipitale (Fig. 2)			
<i>Facies exoccipitalis, pars dorsalis</i> (Fed)	Surface is smooth or slightly wavy	Fed 1	1; 3
	Surface with hollows	Fed 2	1

(Continued)

Character	Description of variations	Code	Sub-species
	Surface with deep grooves	Fed 3	2
<i>Margo exoccipitalis posterior, pars medialis</i> (Mepm)	Margin salient	Mepm 1	2
	Margin concave	Mepm 2	3
	Margin straight	Mepm 3	1
Parietal bone—parietale (Fig. 3)			
<i>Margo parietalis anterior</i> (Mpa)	Margin straight	Mpa 1	1; 2; 3
	Margin slightly concave	Mpa 2	2 (juv)
<i>Margo crista parietalis</i> (Mcp)	Crest absent	Mcp 1	2 (juv)
	Crest reaches the posterior margin of the bone	Mcp 2	1; 3
	Crest does not reach the posterior margin of the bone	Mcp 3	2
	Left and right parts of the crest join at acute angles	Mcp 4	3
	Parts of the crest join at right angles	Mcp 5	2
	Parts of the crest do not join	Mcp 6	1
<i>Margo parietalis posterior</i> (Mpp)	Margin roundish	Mpp 1	1; 2
	Margin right-angled	Mpp 2	1; 2; 3
	Margin obtuse-angled	Mpp 3	1; 3
Postfrontal bone—postfrontale (Fig. 4)			
<i>Sutura articuli ossis postfrontale</i> (Suap)	Suture starts at the projection in midpart	Suap 1	1; 2; 3
Basiparasphenoid bone—basiparasphenoid (Fig. 5)			
<i>Margo cristae basiparasphenoidis</i> (Mcb)	Crest long with rounded top	Mcb 1	1; 2; 3
<i>Margo processus suborbitalis et areae lateralis</i> (Mpsal)	Suborbital appendix is big, in the form of a semicircle projecting beyond the line and the margin of the lateral surface passes near the line in the form of a concave arc	Mpsal 1	1
	Suborbital appendix is small, projecting beyond the line in the form of a small sector of a circle or obtuse angle, and the margin of the lateral line parallel with the line or on it	Mpsal 2	1; 2
	Suborbital appendix small, parasphenoid and suborbital appendices project beyond the line, as well as most of the lateral line	Mpsal 3	3

(Continued)

Character	Description of variations	Code	Sub-species
<i>Margo et directio processus basipterigoidis</i> (Mdpb)	Appendix sharp and directed upward and to the side	Mdpb 1	1; 2
	Appendix sharp and directed downward, forming outer margin of deep groove	Mdpb 2	1; 2
	Appendix obtuse (not manifested), the groove is shallow or absent	Mdpb 3	2; 3
<i>Pecten canalis vidianus</i> (Pcv)	Crest absent	Pcv 1	1; 2; 3
	Crest present	Pcv 2	1; 2; 3
Premaxillary bone—premaxilla (Fig. 6)			
<i>Margo terminationis processus palatinus</i> (Mtpb)	One-bladed: (a) rounded	Mtpb 1a	1; 3
	(b) flat	Mtpb 1b	1; 2; 3
	(c) truncated	Mtpb 1c	1; 3
	Two-bladed: (a) V-shaped	Mtpb 2a	1; 2; 3
	(b) V-shaped with a hollow	Mtpb 2b	1; 2
	Three-bladed: (a) equal trident	Mtpb 3a	2
	(b) one of the last teeth is smaller than the others	Mtpb 3b	2
	(c) the last teeth are smaller than the middle tooth	Mtpb 3c	2
	(d) the last teeth are bigger than the middle tooth	Mtpb 3d	2
	<i>Maginitudo processus palatinus et processus nasalis</i> (Mppn)	Palatal process is smaller than the nasal	Mppn 1
Nasal bone—nasale (Fig. 7)			
	Edge straight	Mnav 1	1; 2; 3
<i>Margo nasalis anterior, pars verticalis</i> (Mnav)	Edge with notch	Mnav 2	1
Ectopterygoid bone—ectopterygoid (Fig. 8)			
<i>Margo ectopterygoidis anterior</i> (Mea)	Margin with projection	Mea 1	1; 2
	Margin with projection and groove	Mea 2	1; 2; 3
<i>Prominentia lateralis exterior</i> (Ple)	Downward-turning projection	Ple 1	1; 2; 3
Maxillary bone—maxillare (Fig. 9)			
<i>Margo corpus maxillare, pars lateralis</i> (Mcml)	Bone expanded with large shoulder-shaped projection	Mcml 1	1; 2; 3

(Continued)

Character	Description of variations	Code	Sub-species
<i>Sinus et crista transversus dorm salts, pars interior</i> (Scti)	Opening rectangular; crest well developed	Scti 1	1; 2; 3
Articular bone—articulare (Fig. 10)			
<i>Gradus evolutionis processes medialis et processus lateralis</i> (Gpml)	The medial process is significantly larger; the lateral process is small and smooth	Gpml 1	1; 2; 3
Angular bone—angulare (Fig. 11)			
<i>Margo exiguus ossis angulares</i> (Meoa)	Margin even (no projection observed)	Meoa 1	2; 3
	Margin with process below	Meoa 2	1; 2; 3
	Margin with processes below and in the middle	Meoa 3	1; 3
Splenic bone—spleniale (Fig. 12)			
<i>Margo emarginaturae ossis spleniale</i> (Meos)	Notch not restricted by the projections	Meos 1	1; 2; 3
	Notch posteriorly restricted by the projection	Meos 2	2; 3
	Notch anteriorly restricted by the projections	Meos 3	1; 2
	Notch both anteriorly and posteriorly restricted by the projections	Meos 4	1; 2; 3
Dental bone—dentale (Fig. 13)			
<i>Magnitudo relativa emarginaturae ossis articulare, pars lateralis exterior</i> (Mrel)	Margin of notch reaches 7th tooth	Mrel 1	2
	Margin reaches 8th tooth	Mrel 2	1; 2; 3
	Margin reaches 9th tooth	Mrel 3	1; 2; 3
	Margin reaches 10th tooth	Mrel 4	1; 2; 3
	Margin reaches 11th tooth	Mrel 5	1; 2; 3
	Margin reaches 12th tooth	Mrel 6	1; 3
<i>Initialio apertionis fissurae Meckelii</i> (lafM)	Fissure opens under 7th tooth	lafM 1	1; 2
	Fissure opens under 8th tooth	lafM 2	1; 2; 3
	Fissure opens under 9th tooth	lafM 3	1; 2; 3

TABLE 2. Foramenal traits of the skull bones in Levantine Viper.

Character	Description of variations	Code	Sub-species
The main occipital bone-basioccipitale (Fig. 1)			
<i>Foramen ossis basioccipitale, pars ventrale</i> (Fbv)	Foramen not present	Fbv 1	2; 3
	One foramen	Fbv 2	1; 2; 3
	Two foramina	Fbv 3	1; 2
	Three foramina	Fbv 4	1
	Four foramina	Fbv 5	1
Prooticum bone-prooticum (Fig. 14)			
<i>Foramen ossis prooticum, pars lateralis</i> (Fpl)	One foramen	Fpl 1	1
	Two foramina	Fpl 2	1; 2; 3
	Three foramina	Fpl 3	1; 2; 3
	Four foramina	Fpl 4	2
Parietal bone-parietale (Fig. 3)			
<i>Foramens et emarginaturas ossis parietale, pars anterior</i> (Fpa)	Two completely closed foramina	Fpa 1	2
	One of the foramina is not closed	Fpa 2	2
	Two open foramina, rupture in the wall smaller than the diameter of the foramen	Fpa 3	2; 3
	Two open foramina, rupture in the wall larger than or equal to the diameter of the foramen	Fpa 4	3
	Of equal size on both sides	Fpa 5	1
Basiparasphenoid bone-basiparasphenoid (Fig. 5)			
<i>Foramen et sulcus processes trabecularis</i> (Fspt)	Both foramen and sulcus missing	Fspt 1	1; 2; 3
	Foramen present	Fspt 2	2
	Sulcus present	Fspt 3	1; 2; 3
	Both a groove and sulcus present	Fspt 4	1
<i>Foramen anterior canalis vidianis</i> (Facv)	One fossa	Facv 1	1; 2
	External edge of foramen not closed (partition has sulcus, canal)	Facv 2	1; 3
Premaxillary bone-premaxilla (Fig. 6)			

(Continued)

Character	Description of variations	Code	Sub-species
<i>Foramen ossis premaxilla, pars ventralis</i> (Fpv)	Foramen not present	Fpv 1	2
	One foramen	Fpv 2	1; 2; 3
	Two foramina	Fpv 3	1; 2; 3
	Three foramina	Fpv 4	1; 2; 3
	Four foramina	Fpv 5	1
Palatine bone-palatinum (Fig. 15)			
<i>Foramen ossis palatinum, pars lateralis interior</i> (Fpli)	Foramen not present	Fpli 1	1; 2
	One foramen	Fpli 2	1; 2; 3
	Two foramina	Fpli 3	1; 2; 3
	Three foramina	Fpli 4	1; 2; 3
Squamosse bone squamosum (Fig. 16)			
<i>Foramen squamosum</i> (Fsq)	No foramen	Fsq 1	1;2;3
	One foramen	Fsq 2	2;3
Angular bone-angularare (Fig. 11)			
<i>Foramen angulare</i> (Fa)	No foramen	Fa 1	1;2;3
	One foramen	Fa 2	2
	Two foramina	Fa 3	2
Splenal bone spleniale (Fig. 12)			
<i>Foramen spleniale</i> (Fsp)	No foramen	Fsp 1	1;2;3
	One foramen	Fsp 2	2
Dental bone-dentale (Fig.13)			
<i>Foramen mentale</i> (date, form)(Fm)	One foramen, oval	Fm 1	1;2;3
	One half-moon-shaped foramen	Fm 2	2
	Two oval foramina	Fm 3	2;3
<i>Situs foramen mentale</i> (Sifm)	One foramen under 5th tooth	Sifm 1	1
	One foramen under 6th tooth	Sifm 2	1;2;3
	One foramen under 7th tooth	Sifm 3	1;2;3
	One foramen under 8th tooth	Sifm 4	3
	Two foramina under 4th and 7th teeth	Sifm 5	2
	Two under 5th and 6th teeth	Sifm 6	2
	Two under 5th and 7th teeth	Sifm 7	2

(Continued)

Character	Description of variations	Code	Sub-species
	Two under 6th and 7th teeth	Sifm 8	2
	Two under 6th and 8th teeth	Sifm 9	2
	Two under 7th and 8th teeth	Sifm 10	2;3

TABLE 3. Statistical characteristics of tooth number on the pterigoideum and dental bones of the levantine viper

Sub-species	Sex	Pterigoideum bone indices				Dental bone indices			
		n	Range	$\bar{x} \pm Sx$	CV	n	Range	$\bar{x} \pm Sx$	CV
1	♂	16	11-15	13.2±0.33	10.1	16	15-19	16.4±0.23	5.7
	♀	40	11-16	13.4±0.16	7.6	40	14-19	16.3±0.22	8.5
	Σ	56	11-16	13.3±0.15	8.4	56	14-19	16.3±0.17	7.8
2 WN	♂	59	12-15	13.7±0.10	5.5	59	16-21	18.2±0.14	5.9
	♀	43	12-15	13.9±0.12	5.7	42	17-21	18.0±0.16	5.6
	Σ	102	12-15	13.8±0.08	5.6	101	18-21	18.1±0.10	5.8
2 EN	♂	30	12-17	13.8±0.18	7.1	29	16-20	17.7±0.17	5.1
	♀	14	12-15	13.7±0.21	5.8	14	16-20	17.4±0.28	6.0
	Σ	46*	12-17	13.8±0.13	6.8	45*	16-20	17.6±0.15	5.5
2 M	♂	21	12-17	14.1±0.27	8.8	21	16-23	18.9±0.34	8.2
	♀	8	12-14	13.4±0.25	5.2	8	17-19	17.9±0.21	3.4
	Σ	29	12-17	13.9±0.22	8.4	29	16-23	18.6±0.26	7.7
2 G	♂	16	11-15	13.4±0.25	7.4	16	17-19	17.7±0.15	3.3
	♀	2	14	—	—	2	18	—	—
	Σ	20*	11-15	13.4±0.24	8.0	19*	16-19	17.6±0.15	3.8
2 T	♂	44	12-16	13.8±0.13	6.2	42	17-20	18.2±0.14	5.1
	♀	23	12-16	13.8±0.23	7.9	24	16-23	17.9±0.28	7.7
	Σ	79*	12-16	13.9±0.10	6.7	77*	16-23	18.1±0.12	6.0
3	♂	40	12-17	14.3±0.16	7.0	38	17-20	18.3±0.14	4.8
	♀	34	13-16	14.7±0.15	6.1	29	17-20	18.3±0.13	3.9
	Σ	94*	12-17	14.4±0.10	6.9	83*	17-20	18.3±0.09	4.6

* - The bones of the snakes of unknown sex were added; \bar{x} - mean; Sx - Standard error; CV - coefficient of variation

TABLE 4. Total tooth number on the skull in the Levantine Viper.

Bone	Subspecies:	1	2, EN	2, WN	2, M	2, G	2, T	3
Maxilare (left+right)		1+1	1+1	1+1	1+1	1+1	1+1	1+1
Palatinum (left+right)		4+4	4+4	4+4	4+4	4+4	4+4	4+4
Pterygoideum (x*2)		26.6	27.6	27.6	27.8	26.8	27.8	28.8
Upper jaw segment		36.6	37.6	37.6	37.8	36.8	37.8	38.8
Dentale (x*2)		32.6	36.2	35.2	37.2	35.2	36.2	36.6
Total teeth		69.2	73.8	72.8	75.0	72.0	74.0	75.4

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