A STUDY OF BATS**

II. The Palatal Ridges of the Bat

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Introductory

The palatal ridges (*Plicae palatinae transversae*), though various in the number and type, can be found in most of the mammals; it is readily understood that they will perform the helpful functions of catching, crushing and grinding food in the oral cavity. They are also likely to play an important part for the new-born to hold the teats of their mother animals (Schultz, 1958). The very ridge is not a mere crumpled mucous membrane, but has its core of a peculiar connective tissue like what to be found in the fetuses (Niijima, 1953).

As for the palatal ridges of order Chiroptera, a brief report on some ten species of suborder Microchiroptera from the eastern parts of Europe and northern Asia is available (Ognev, 1962). The author, for once, would like to collect together into a paper the results of his observations of the palatal ridges in the 15 species and 1 subspecies of Chiroptera.

Before taking up the main subject, the author takes the liberty to express his heartfelt thanks and debts to Dr. Teruaki Uchida of Kyushu University (Institute of Zoology, Faculty of Agriculture), who not only lent him the precious specimens and gave him many useful advices and who was kind enough to have taken the trouble of revising the present copy. The author is also deeply grateful to Mr. Takayuki Môri, student of Shinshu University (Biology, Faculty of Education) for his helpful colaboration in the observations of the materials. The author is also indebted to Mr. Kimito Uchikawa of Shinshu University (Institute of Public Hygiene, School of Medicine) for his willing cooperation in the collection of the specimens.

Material and Method

The species examined, the number of the individuals observed and the

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locations of collection.

Suborder Megachiroptera

Family Pteropidae

1. *Pteropus* sp., 1

location unknown

Suborder Microchiroptera

Superfamily Emballonuroidea

Family Emballonuridae

2. *Emballonura semicaudata sulcata*, 1

Ponape Is., Micronesia

Superfamily Rhinolophoidea

Family Rhinolophidae

3. *Rhinolophus ferrumequinum nippon*, 10

Nagano City, Japan

4. *R. cornutus cornutus*, 12, fetuses 2

Nagano City, Japan

Family Hipposideridae

5. *Hipposideros armiger turpis*, 1

Ishigaki Is., Ryukyu

6. *H. a. terasensis*, 1

Formosa, China

Superfamily Phyllostomatoidea

Family Phyllostomatidae

7. *Carollia perspicillata perspicillata*, 1

Brasil

Superfamily Vespertilionoidea

Family Vespertilionidae

Subfamily Vespertilioninae

8. *Myotis nattereri bombinus*, 1

Konagi Pond, Kunitomi-cho, Miyazaki Pref., Japan

9. *M. macrodactylus*, 8 ; fetuses, 4

Nagano City, Japan

10. *M. formosus* subsp., 1

location unknown

11. *Nyctalus lasiopterus aviator*, 1 ; fetuses, 2

Okaya City, Nagano Pref., Japan

12. *Pipistrellus abramus abramus*, 12 ; fetus 1

Matsumoto City, Japan

13. *Vespertilio namiyei namiyei*, 1

Ozukue Is., Fukuoka City, Japan

14. *Plecotus auritus sacrimontis*, 3
Minowa V., Kami-ina-gun, Nagano Pref., Japan

Subfamily Miniopterinae

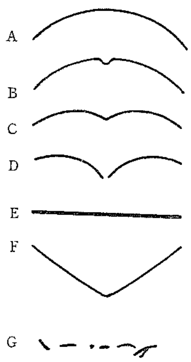
15. *Miniopterus schreibersi fuliginosus*, 7 ; fetus 1
Nagano City, Japan

Subfamily Murininae

16. *Murina leucogaster hilgendorfi*, 3
Misato V., Minami-azumi-gun, Nagano Pref., Japan
Ônami Pond, Kirishima, Kagoshima Pref., Japan

The palates of the specimens kept in alcohol were observed under the 25x-anatomical microscope, the number, type and location of the palatal ridges were put on record.

To begin with, for convenience of ready description, the palatal ridges had beforehand been classified into the following 7 types (Fig. 1).



A : arch
B : Arch with median notch
C : Double arch
D : Separated double arch
E : Straight
F : Fold in form of obtuse with tip directed occipitally
G : Fragment

Fig. 1 Classification of the types of palatal ridges.

As a standard set the palatal ridge curving forward from the line connecting the molars on both sides (Type A) which is still found retained in opposums or tupaias in its primitive qualification and shape, and Types B~F will be looked upon as varieties of Type A, and Type G as a palatal ridge in a striking degenerating tendency.

Results

With each of the adopted species, the number, type and location of the palatal ridges will be depicted in the following.

(1) *Pteropus* sp. (Table 1, Plate A)

Ridges are 12. 1st ridge rising at the bottom of canines, in gentle arch, swelling in the middle (Type A).

Table 1 *Pteropus* sp.: Number, location and type of palatal ridges

Number of Ridges	Number of Individuals	No. of Ridges	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
12	1	Location	C	P^2	P^2	P^3	$P^3 \sim M^1$	M^1	M^2	from M^2 backward near to fauces				
		Type of Ridges	A	A	A	A	D	D	D	D	D	D	D	D

1st premolars extremely small, remarkably degenerated, with no ridges in this part. 2nd ridge, taking its rise from the bottom of 2nd premolars (Type A); 3rd ridge also rising, almost in parallel, from the same place (Type A).

4th ridge rising at the bottom of 3rd premolars and arching (Type A). 5th ridge rising between 3rd premolars and 1st molars, 6th ridge at the bottom of 1st molars, 7th ridge at the bottom of 2nd molars; all these three in pair of crescents (Type D), remarkably bowing backward in the middle. 3rd molars lacking, degenerating tendency of molars is notable.

8th~12th ridges lie distributed within the range from the back of 2nd molars near to fauces, all of Type D; the further ones gradually less curving.

With this species, it is notable that the hard palate is remarkably extending backwards nearly up to the fauces, with the ridges distributed over the whole range. It has incomparably more ridges than those to bo mentioned below. *Pteropus* is generally frugivorous.

(2) *Emballonura semicaudate sulcata* (Table 2, Plate B)

Ridges are 5. 1st ridge rising at the bottom of canines, in double arch (Type C). 2nd ridge rising at the bottom of 1st premolars, in double arch (Type C), with weaker curvature than 1st ridge.

3rd ridge rising at the bottom of 1st molars, in a pair of crescents (Type D). 4th ridge rising between 1st and 2nd molars and 5th ridge at the bottom of 2nd molars, are roughly parallel (both of Type D).

About 3rd molars no ridges are found.

Table 2 *Emballonura semicaudata sulcata*: Number, location and type of the palatal ridges

Number of Ridges	Number of Individuals	No. of Ridges	I	II	III	IV	V
5	1	Location	C	P^1	M^1	$M^1 \sim M^2$	M^2
		Type of Ridges	C	C	D	D	D

(3) *Rhinolophus ferrumequinum nippon* (Table 3, Plate C)

Of the 10 individuals observed, 9 had 6 ridges and only 1 had 7; feasible to say that this species generally have 6 ridges. *R. f. ferrumequinum*, subspecies from USSR is reported to have 7 ridges but rarely 6 (Ognev, 1962). The frequency of the appearance of both types possibly variant with subspecies.

1st ridge takes rise from the bottom of canines, in a pair of crescents separated in the middle (Type D). The ridge is broad. 2nd ridge rising between canines and 2nd premolars (where to lie 1st premolars, but in this case only vestigial outside of the line of tooth series), similar in shape and size with 1st ridge. 3rd ridge rising at the bottom of 2nd premolars, in a pair of crescents separated in the middle (Type D), where curving backwards more remarkably, and narrower than 1st and 2nd ridges. 4th ridge rising at the bottom of 1st molars, more closely resembles 3rd ridge, either in shape or size. 5th ridge rising between 1st and 2nd molars, in a pair of cresents (Type D), gentler in its curve, much narrower than 4th ridge.

6th ridge rising at the bottom of 2nd molar, gentle in curve and levelling. 7 individuals showed it separated in the middle (Type D), 3 showed connecting (Type C). In the shape of this ridge individual variation is most notable. It is the least in its thickness and height.

Table 3 Genus *Rhinolophus* : Number, location and type of palatal ridges

	Number of Ridges	Number of Individuals	No. of Ridges	I	II	III	IV	V	VI	VII	VIII
R. ferrumequinum nippon	6	9	Location	C	C～P^2	P^2	M^1	M^1～M^2	M^2	/	/
			Type of Ridges	D	D	D	D	D	D	/	/
	7	1	Location	C	C～P^2	P^2	M^1	M^1～M^2	M^2	M^2	/
			Type of Ridges	D	D	D	D	D	G	D	/
R. cornutus cornutus	7	8	Location	C	P^2	M^1	M^1～M^2	M^2	M^2	M^2	/
			Type of Ridges	C	C	D	D	D	G	D	/
	8	4	Location	C	P^2	M^1	M^1～M^2	M^1～M^2	M^2	M^2	M^2
			Type of Ridges	C	C	D	D	G	G	G	D
	7	2 (fetuses)	Type of Ridges	B	C	C	C	D	G	A	/

In the 1 individual with 7 ridges, a linear thin ridge is found in pairs on both sides, between 5th and 6th ridges in ordinary cases of the others (Type G), but no different characteristics were found in the other points.

In all the individuals ridges gradually enlarged forwards, which seems to prove that degeneration possibly is tending from the occipital side. That the individuals with 6 ridges are no others than those lacking in the 6th of those with 7 ridges, is reasonably judged from its location. It is also notable that in all the individuals no ridges were found about 3rd molars.

The number, lacation and type of the ridges of *Rhinolophus ferrumequinum* will be arranged as listed in Table 3. The 6th ridge in the individuals with 6 ridges and the 7th in those with 7 ridges, having reduced to be quite simple in shape and size, show a marked tendency to degeneration.

(4) *Rhinolophus cornutus cornutus* (Table 3, Plate D)

Of the 12 individuals observed, 8 had 7 ridges and 4 had 8 ridges. The 2 instances of fetus had 7 ridges. From this it will reasonably be concluded that generally *R. cornutus cornutus* has 7 palatal ridges. Belonging to the same genus with the above *R. ferrumequinum nippon*, this species has one more palatal ridge. *R. hipposideros hipposideros* from USSR which seems akin to *R. cornutus cornutus* has 8 ridges, the 8th of which is reported to be extremely thin (Ognev, 1962).

In the first place, those with 7 ridges will be discussed. 1st ridge rising at the bottom of canines, in double arch, curving forward (Type C). In some individuals, however, the ridges show in a pair of crescents separated in the middle; of the 12 individuals observed, 7 belonging to Type C, 5 to Type D; the former type of individuals are found a little more.

2nd ridge, rising at the bottom of 2nd premolar, Type C in all the individuals. In this species, 1st premolars are pretty bigger, and in the line of tooth series, with no ridges about them. It is characteristic, therefore, with this species that 1st and 2nd ridges are conspicuously apart with each other. 3rd ridge rising at the bottom of 1st molars, in a pair of crescents separated in the middle (Type D), gentle in curving, thinner than 1st and 2nd ridges. 4th ridge rising between 1st and 2nd molars, of Type D like 3rd ridge. 5th ridge rising at the bottom of 2nd molars, also of Type D. 6th ridge got in between 5th and 7th ridges, irregular in shape either straight or crescent, not in contact with 2nd molars (Type G). The last 7th ridge rising at the bottom of 2nd molars, runs almost level and linear, often separated in the middle (Type D).

In the 4 individuals with 8 ridges, same is the status of 1st ~ 4th ridges with the above case. 5th ridge which is found a little forward than the case of the individuals with 7 ridges, lies fragmentary between 1st and 2nd molars. Both 6th and 7th ridges found at 2nd molars, without touching it, fragmentary in linear- or crescent shape. The last 8th ridge is of Type D, similar with the 7th ridge of the individuals with 7 ridges. It is quite feasible to say, therefore, that with the 5th ridge eliminated from the ridges of the individuals with 8 ridges, the pattern would come to the same with that of those with 7 ridges. Thus it is a peculiar characteristic with this species that, as observed in both cases, 4th and the following ridges all have some connections with 2nd molars, so their intervals have been much shortened.

As for the fetuses, it is interesting to notify that both instances have 7 ridges and show the aspect of the ridges, as present in Table 3, more akin to the standard than those of the adults.

In this species also, the ridges coming thicker and higher towards the front, become gradually enlarged from the 6 ridge forwards and reducing occipitally. This is convincingly proving a notable tendency to degeneration and presenting a precursory aspect to those of the individuals with 6 ridges.

(5) *Hipposideros armiger turpis* (Table 4, Plate E)

Ridges are 6. 1st ridge rising between canines and 1st premolars, in a pair of crescents (Type D), thicker than the other ridges. 2nd ridge rising at the bottom of 1st premolars, arch in shape, curving backward a little in the middle (Type B). 3rd and 4th ridges both rising at the bottom of 1st molars. running almost level, both of Type B.

5th ridge rising between 1st and 2nd molars, with neither ends reaching the inside of molar series, a little double arch in shape, slightly thick. 6th ridge rising at the bottom of 2nd molars, folded in form of obtuse, tip directed occipitally (Type F). No ridges were found about 3rd molars.

(6) *Hipposideros armiger terasensis* (Table 4, Plate F)

This is of a larger type, different from the above species in the subspecies.

Ridges are 6, as many and as similar in shape as the above species.

1st ridge rising at the bottom of 1st premolars, almost arch in shape and notably thick (Type A). 2nd ridge rising at the bottom of 1st molars, arching (Type A).

Table 4 *Hipposideros armiger turpis*, *H. a. terasensis* and *Carollia perspicillata perspicillata* : Number, location and type of palatal ridges

	Number of Ridges	Number of Individuals	No. of Ridges	I	II	III	IV	V	VI	VII
Hipposideros armiger turpis	6	1	Location	C～P^1	P^1	M^1	M^1	M^1～M^2	M^2	/
			Type of Ridges	D	B	B	B	C	F	/
H. a. terasensis	6	1	Location	P^1	M^1	M^1	M^1～M^2	M^1～M^2	M^2	/
			Type of Ridges	A	A	B	C	C	F	/
Carollia perspicillata perspicillata	7	1	Location	C～P^1	P^1～P^2	P^2～M^1	M^1	M^1	M^2	M^2
			Type of Ridges	C	C	D	D	D	D	F

3rd ridge rising at the bottom of 1st molars, arch in shape with median notch (Type B). 4th ridge is sandwitched between 3rd and 5th ridges, with both ends slightly lacking, shows double arch curving more than 3rd ridge (Type C). 5th ridge rising between 1st and 2nd molars, in double arch, remarkably curving backward in the middle (Type C).

6th ridge rising at the bottom of 2nd molars, remarkably thick, folded in form of obtuse with tip directed occipitally (Type F).

As was the case with the above *H. armiger turpis*, this species also has only one pair of premolars and no ridges about 3rd molars.

(7) *Carollia perspicillata perspicillata* (Table 4, Plate G)

Ridges are 7. 1st ridge rising between canines and 1st premolars, in double arch (Type C). 2nd ridge rising between 1st and 2nd premolars, similar in shape with 1st ridge (Type C). 3rd ridge rising between 2nd premolars and 1st molars, in a pair of crescents (Type D).

4th and 5th ridges rising close together at the bottom of 1st molars, roughly parallel, both of Type D.

6th ridge rising at the bottom of 2nd molars, in a pair of crescents (Type D). 7th ridge, jutting notably occipitally, in acute angle (Type F).

This species with a tendency in its teeth to frugivorous feeding habit is reported to be successfully bred with figs and bananas (Dalquest, 1953).

(8) *Myotis nattereri bombinus* (Table 5, Fig. 2A)

Ridges are 7. However, as the observation was made in only 1 individual, the number of ridges might be concluded with possible variation. It is reported that another subspecies from USSR, *M. n. nattereri* has the same number of ridges (Ognev, 1962).

1st ridge takes rise from the bottom of 1st premolars, lying a little more occipitally than in genus *Rhinolophus*. This shows Type B, bowing backward with median notch. 2nd ridge rising at the bottom of 3rd premolars, shows a standard arch in shape (Type A). 2nd premolars have no connection with ridges. 3rd ridge rising at the bottom of 1st molars, pretty similar in shape with 1st ridge (Type B). 4th ridge rising at the bottom of 2nd molars, in double arch (Type C). 5th ridge rising at the bottom of 2nd molars, in a pair of crescents, weak in its curving (Type D). 6th ridge rising at the bottom of 3rd molars, similar in shape with 5th ridge (Type D).

7th ridge folded in form of obtuse with tip directed occipitally (Type F). It's base-line to be produced to 3rd molars, but not actually touching it.

Another subspecies, *M. n. nattereri* from USSR, is reported to have palatal ridges similar to this subspecies (Ognev, 1962).

It is notable that in genus *Rhinolophus*, the ridges are found only in the front range of the line connecting 2nd molars on both sides, but in this species, even in the back of the 3rd molars line.

(9) *Myotis macrodactylus* (Table 5, Plate H)

Ridges are 8, in 8 adults or 4 fetuses either. In genus *Myotis* ridges are generally 7, but *M. dasycneme major* (Fig. 2 D) from USSR reported to have 8 (Ognev, 1962) and *M. formosus* subsp. has 9.

1st ridge, linear in shape, connecting 2nd incisors, of Type E, is found incomparably in the front; pretty broad. 2nd ridge found on the line connecting canines, similar in shape with 1st ridge, but larger (Type E).

3rd ridge rising at the bottom of 3rd premolars, in double arch (Type C). 1st and 2nd premolars are small, with no ridges about.

Table 5 Genus *Myotis* : Number, location and type of palatal ridges

	Number of Ridges	Number of Individuals	No. of Ridges	I	II	III	IV	V	VI	VII	VIII	IX
M. nattereri bombinus	7	1	Location	P^1	P^3	M^1	M^2	M^2	M^3	M^3	/	/
			Type of Ridges	B	A	B	C	D	D	F	/	/
M. macrodctylus	8	8	Location	I^2	C	P^3	M^1	M^2	M^2 ~ M^3	M^3	M^3	/
			Type of Ridges	E	E	C	C	D	D	D	F	/
	8	4 (fetuses)	Type of Ridges	E	E	B	C	D	C	C	F	/
M. formosus subsp.	9	1	Location	I^2 ~ C	C ~ P^1	P^2	P^3	M^1	M^1 ~ M^2	M^2	M^2 ~ M^3	M^3
			Type of Ridges	E	A	A	C	C	D	D	D	F

4th ridge rising at the bottom of 1st molars, in double arch (Type C), stronger in its curving than 3rd ridge.

5th ridge rising at the bottom of 2nd molars, in a pair of crescents separated in the middle (Type D), weaker in its curving than 4th ridge. 6th ridge rising between 2nd and 3rd molars, of Type D same as 5th ridge but much weaker in its curving. 7th ridge rising at the bottom of 3rd molars, similar in shape with 6th ridge.

8th ridge folded in form of obtuse with its tip directed occipitally (Type F); the base line to be produced up to 3rd molars, but not actually touching. This ridge is similar in shape with that of *M. nattereri bombinus*.

The height of the ridges is the greatest in 3rd ridge, and gradually reducing in front and back ones.

In fetuses, the ridges, further akin to the standard than those in adults, suggest that Type F might possibly be a variation of Type D.

(10) *Myotis formosus* subsp. (Table 5, Plate I)

Ridges are 9. 1st ridge rising between 2nd incisors and canines, straight and rather thick (Type E). As is the case with the above *Myotis macrodactylus*, ridges are rising comparatively more in front of the palate.

2nd ridge rising between canines and 1st premolars and 3rd ridge rising at the bottom of 2nd premolars, both arching (Type A).

4th and 5th ridges rising at the bottom of 3rd premolars and 1st molars severally, both in double arch (Type C). 6th ridge rising between 1st and 2nd molars, 7th ridge at the bottom of 2nd molars, both in a pair of crescents (Type D).

8th ridge rising between 2nd and 3rd molars, of type D and thick. 9th ridge rising at the bottom of 3rd molar, of type F but thin. This species has more ridges than any other species of genus *Myotis*, and it is interest that this species is reported to feed occasionally the fruit of *Euphoria Longana* (family Sapindaceae) (Imaizumi, 1960)

(11) *Nyctalus lasiopterus aviator* (Table 6, Fig. 2B)

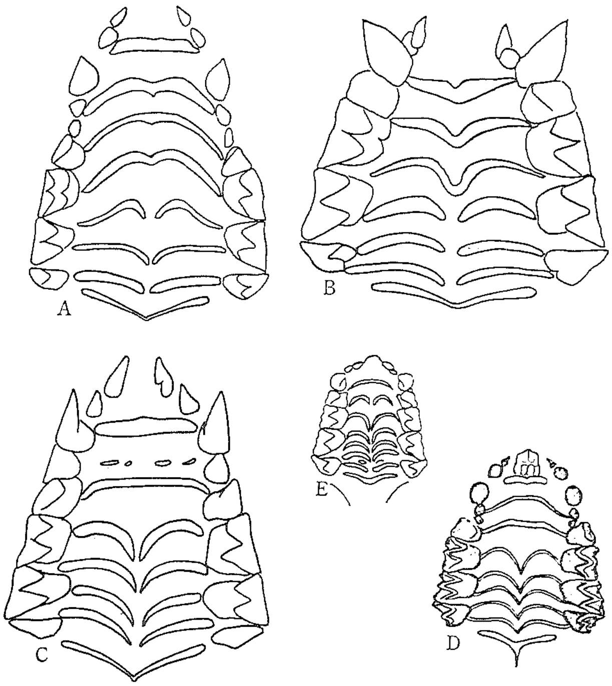


Fig. 2 Sketches of palatal ridges of some bats.

A : *Myotis nattereri bombinus*

B : *Nyctalus lasiopterus aviator*

C : *Plecotus auritus sacrimontis*

D : *Myotis dasycneme major* (from Ognev, 1962)

E : *Vespertilio namiyei anderssoni* (from Wallin, 1962)

Only 1 adult was adopted, whose ridges were 7. In the 2 fetuses ridges were also 7. In either of the same genus *N. noctula noctula* and *N. leisleri* from USSR, ridges are also reported to be 7 (Ognev, 1962).

1st ridge rising at the bottom of canines, double arch in shape, curving a bit in the middle (Type B), but as a whole weak in its curving.

1st premolars extremely small, scarcely observable, lie inside the line of tooth series. 2nd premolars rather large, and 2nd ridge rising between 2nd premolars and 1st molars, double arch in shape (Type C).

3rd ridge rising between 1st and 2nd molars, in double arch separated in the middle (Type D), pretty similar with 2nd ridge, found further occipitally together with 2nd ridge than in the other species.

4th ridge rising at the bottom of 2nd molars, in a pair of crescents separated in the middle (Type D). 5th ridge rising at the bottom of 3rd molars, of Type D just as 4th ridge. 6th ridge rising together with 5th ridge at the bottom of 3rd molars, similarly of Type D.

7th ridge, the ends to be produced up to 3rd molars on both sides, but actually not touching them. It shows Type F, suggesting a possible variation of Type D.

Generally, in fetuses the shape of ridges in comparatively akin to the standard, and the same goes with this species.

(12) *Pipistrellus abramus abramus* (Table 6, Plate K)

In all the 12 adults and 1 fetus observed, ridges are 7. It is reported as to the same genus that *P. kuhlii* has 8 ridges and *P. nathusii* and *P. pipistrellus pipistrellus* have 7 (Ognev, 1962).

1st ridge rising at the bottom of canines, straight, thick (Type E) ; an elevation is also found in gums.

2nd ridge rising at the bottom of 2nd premolars, double arch in shape (Type C), also thick and obvious.

3rd ridge rising at the bottom of 1st molars, in double arch (Type C), extremely weak in elevation, obscurer than 7th ridge.

4th ridge rising at the bottom of 2nd molars, in a pair of crescents (Type D), more obvious than 3rd ridge ; 5th ridge rising between 2nd molars and 3rd molars, similar in shape with 4th ridge (Type D), but more obvious.

6th ridge rising at the bottom of 3rd molars, similar in shape with 5th ridge (Type D). Its elevation is the most striking but those of 1st and 2nd ridges. 7th ridge runs backward, almost in an oblique line, both ends not touching 3rd molars either ; possibly a variation of Type D, a transit shape between type D and F.

It is peculiar with this species that the elevation of ridge in the middle of palate is remarkably poor.

Table 6 *Nyctalus lasiopterus aviator*, *Pipistrellus abramus abramus*, *Vespertilio namiyei namiyei* and *Plecotus auritus* : Number, location and of type palatal ridges

	Number of Ridges	Number of Individuals	No. of Ridges	I	II	III	IV	V	VI	VII	VIII
Nyctalus lasiopterus aviator	7	1	Location	C	$P^2 \wr M^1$	$M^1 \wr M^2$	M^2	M^3	M^3	M^3	/
			Type of Ridges	B	C	D	D	D	D	F	/
	7	2 (fetuses)	Type of Ridges	B	C	D	D	D	C	D	/
Pipistrells abramus abramus	7	12	Location	C	P^2	M^1	M^2	$M^2 \wr M^3$	M^3	M^3	/
			Type of Ridges	E	C	C	D	D	D	D	/
	7	1 (fetus)	Type of Ridges	E	C	C	C	D	D	D	/
Vespertilio namiyei namiyei	8	1	Location	C	$P^1 \wr M^1$	M^1	M^2	M^2	$M^2 \wr M^3$	M^3	M^3
			Type of Ridges	B	C	D	D	D	D	D	F
Plecotus auritus sacrimontis	8	3	Location	C	P^1	P^2	M^1	$M^1 \wr M^2$	M^2	$M^2 \wr M^3$	M^3
			Type of Ridges	E	G	E	D	D	D	D	F

(13) *Vespertilio namiyei namiyei* (Table 6, Plate J)

Ridges are 8. Some indidivuals of another subspecies, *V. n. anderssoni* to be collected in Inner Mongolia and about, is reported to have 9 ridges, with a vestige of another ridge of Type (Wallin, 1962) (Fig. 2 E).

1st ridge rising at the bottom of canines, in arch, curving a bit with median notch (Type B).

2nd ridge rising between 1st premolars and 1st molars, in double arch (Type C). Some individuals are reported to show the ridge in a double arch separated in the middle (Type D) (Wallin, 1962). 3rd ridge rising at the bottom of 1st molars; 4th and 5th ridges at the bottom of 2nd molars; 6th ridge between 2nd and 3rd molars; 7th ridge at the bottom of 3rd molars; all of Type D. The curving shows gradually reducing occipitally in the further ridges.

8th ridge in flat V shape, both ends to be produced to 3rd molars but not actually touching them.

The above individuals of *V. namiyei anderssoni* (Fig. 2 E) with 9 ridges are reported to have a fragmented ridge (Type G) between 6th and 7th ridges (Wallin, 1962). In other points, however, the palatal ridges of both subspecies are quite alike.

By the way, a same genus *V. murinus murinus* from USSR is reported to have 7 ridges, less than those of *V. namiyei* (Ognev, 1962).

(14) *Plecotus auritus sacrimontis* (Table 6, Fig. 2 C)

In either of the 3 adults observed, ridges numbered 8.

1st ridge rising at the bottom of canines, straight (Type E) ; 2nd ridge lies along the line connecting 1st premolars on both sides, only in an irregular series of 2～4 fragmented elevations, possibly on its way of degenration into disappearance (Type G). 3rd ridge rising at the bottom of 2nd premolars, straight (Type E), similar with 1st ridge.

4th ridge rising at the bottom of 1st molars, in a pair of crescents separated in the middle (Type D). 5th ridge rising between 1st and 2nd molars, almost same in shape with 4th ridges. 6th ridge rising at the bottom of 2nd molars, almost same in shape with 4th and 5th ridges. 7th ridge rising between 2nd and 3rd molars, also of Type D. 8th ridge, of Type F, both ends of which neither touching 3rd molars.

As for 4th～8th ridges, the further ones show the more retarded in their development.

(15) *Miniopterus schreibersi fuliginosus* (Table 7, Plate L)

All the 7 adults and 1 fetus observed, ridges numbered 8. Another subspecies *M. s. shreibersi* of the same species from USSR is reported to have also 8 ridges (Ognev, 1962).

1st ridge rising at the bottom of canines, runs almost straight (Type E), and thick. 2nd ridge rising at the bottom of 1st premolars, similar in shape with 1st ridge (Type E) but bigger. 3rd ridge rising at the bottom of 2nd premolars, almost straight, its front edge curving backward a little in the middle (Type E), narrower and poorer in elevation than 2nd ridge.

4th ridge rising at the bottom of 1st molar ; in some individuals found between 1st and 2nd molars, in a pair of crescents (Type D). 5th ridge rising at the bottom of 2nd molars, in a pair of crescents, more notable in its backwards curving than 4th ridge (Type D).

6th ridge rising between 2nd and 3rd molars, in a pair of crescents (Type D). 7th ridge rising at the bottom of 3rd molar, quite similar in shape with 6th ridge (Type D).

8th ridge, of Type F, its root not touching 3rd molars. This ridge is also similar with the 8th ridge of *Myotis macrodactylus*, the 7th ridge of *Nyctalus lasiopterus*, and with the 8th ridge of *Plecotus auritus sacrimontis*.

In the fetus, most ridges show in double arch (Type C), keep an aspect more akin to the standard than in adults.

(16) *Murina leucogaster hilgendorfi* (Table 7, Plate M)

Only 3 individuals were observed. They all have 9 ridges, the most in all the species of Microchiroptera. *M. ognevi* from USSR is reported to have 8

Table 7 *Miniopterus schreibersi fuliginosus* and *Murina leucogaster hilgendorfi* : Number, location and type of palatal ridges

	Number of Ridges	Number of Individuals	No. of Ridges	I	II	III	IV	V	VI	VII	VIII	IX
Miniopterus schreibersi fuliginosus	8	7	Location	C	P^1	P^2	M^1	M^2	$M^2 \sim M^3$	M^3	M^3	/
			Type of Ridges	E	E	E	D	D	D	D	F	/
	8	1 (fetus)	Type of Ridges	B	C	C	C	C	C	C	F	/
Murina leucogaster hilgendorfi	9	3	Location	I^2	C	P^1	P^2	M^1	$M^1 \sim M^2$	M^2	M^3	M^3
			Type of Ridges	A	A	A	C	D	D	D	D	F

ridges, but *M. ussuriensis* to have 9, as many as the present species (Ognev, 1962).

1st ridge rising at the bottom of 2nd incisors, in shape of a so-called arch rather akin to a straight line (Type A). In the observations only *Myotis macrodactylus* and the present species were found to have a ridge in the front range of canines. 2nd ridge rising at the bottom of canines, almost similar in shape with 1st ridge (Type A).

3rd ridge rising at the bottom of 1st premolars, almost similar in shape with 1st and 2nd ridges (Type A). The ridges becoming gradually thicker from 1st to 3rd. It is peculiar with the present species that 1st premolars show a remarkable developmental status.

4th ridge rising at the bottom of 2nd premolar, in double arch of gentler curve (Type C). The elevation of this ridge is poorer than in the others.

5th ridge rising at the bottom of 1st molars, in a pair of crescents, broader in width (Type D). 6th ridge taking rise from the bottoms of 1st and 2nd molars, similar in shape with 5th ridge (Type D), but conspicuous in its development. 7th ridge rising at the bottom of 2nd molar, similar in shape with 6th ridge (Type D). 8th ridge rising at the bottom of 3rd molar, of Type D, gentle in curving.

9th ridge, of Type F, similar in shape with 8th ridge of *Myotis macrodactylus*. It is peculiar with this species similar in *Pipistrellus abramus abramus* that the elevation of ridges in the middle palate is remarkably poor.

Discussion

In the above, briefly described the number, location and type of the palatal ridges in each species observed and reported. Now the differences between species shall be inquired into to find out possible significances there.

First of all, the number of the ridges from the book by Ognev (1962) and the author's observations will be arranged as present in Table 8. The number

Table 8 The number of the palatal ridges and the dental formulae upon the data by Ognev (1962), Wallin (1962)** and the present author*

	Number of Ridges	Dental Formulae
Suborder Megachiroptera		
Family Pteropidae		
1. *Pteropus* sp.*	12	$^2/_2$, $^1/_1$, $^3/_3$, $^2/_3$=34
Suborder Microchiroptera		
Superfamily Emballonuroidea		
Family Emballonuridae		
2. *Emballonura semicaudata sulcata**	5	$^2/_3$, $^1/_1$, $^2/_2$, $^3/_3$=34
Superfamily Rhinolophoidea		
Family Rhinolophidae		
3. *Rhinolophus ferrumequinum ferrumequinum*	7 or 6	
3′. *R. f. nippon**	6 or 7	$^1/_2$, $^1/_1$, $^2/_3$, $^3/_3$=32
4. *R. hipposideros hipposideros*	8	
5. *R. cornutus cornutus**	7 or 8	
Family Hipposideridae		
6. *Hipposideros armiger turpis**	6	$^1/_2$, $^1/_1$, $^1/_2$, $^3/_3$=28
6′. *H. a. terasensis**	6	
Superfamily Phyllostomatoidea		
Family Phyllostomatidae		
7. *Carollia perspicillata perspicillata**	7	$^2/_2$, $^1/_1$, $^2/_3$, $^3/_3$=34
Superfamily Vespertilionoidea		
Family Vespertilionidae		
Subfamily Vespertilioninae		
8. *Myotis nattereri nattereri*	7	
8′. *M. n. bombinus**	7	
9. *M. emarginatus emarginatus*	7	
10. *M. mystacinus brandtii*	7	
11. *M. macrodactylus**	8	$^2/_3$, $^1/_1$, $^3/_3$, $^3/_3$=38
12. *M. formosus* subsp.*	9	
13. *M. dasycneme major*	8	
14. *M. capaccinii*	7	
15. *M. daubentonii daubentonii*	7	
16. *Pipistrellus kuhlii*	8	
17. *P. nathusii*	7	
18. *Pipistrellus pipistrellus*	7	$^2/_3$, $^1/_1$, $^2/_2$, $^3/_3$=34
19. *P. abramus abramus**	8	
20. *Nyctalus noctula noctura*	7	
21. *N. leisleri*	7	$^2/_3$, $^1/_1$, $^2/_2$, $^3/_3$=34
22. *N. lasiopterus aviator**	7	

23. *Eptesicus serotinus serotinus*	7	$^{2}/_{3}$, $^{1}/_{1}$, $^{1}/_{2}$, $^{3}/_{3}=32$
24. *Amblyotus nilssonii*	7	$^{2}/_{3}$, $^{1}/_{1}$, $^{1}/_{2}$, $^{3}/_{3}=32$
25. *Vespertilio murinus murinus*	7	
26. *V. namiyei namiyei**	8	$^{2}/_{3}$, $^{1}/_{1}$, $^{1}/_{2}$, $^{3}/_{3}=32$
26′. *V. n. anderssoni***	8 or 9	
27. *Barbastella barbastella*	7	
28. *B. caspia*	7	$^{2}/_{3}$, $^{1}/_{1}$, $^{2}/_{2}$, $^{3}/_{3}=34$
29. *Plecotus auritus sacrimontis**	8	$^{2}/_{3}$, $^{1}/_{1}$, $^{2}/_{3}$, $^{3}/_{3}=36$
Subfamily Miniopterinae		
30. *Miniopterus schreibersii schreibersii*	8	
30′. *M. s. fulginosus**	8	$^{2}/_{3}$, $^{1}/_{1}$, $^{2}/_{3}$, $^{3}/_{3}=36$
Subfamily Murininae		
31. *Murina ognevi*	8	
32. *M. ussuriensis*	9	$^{2}/_{3}$, $^{1}/_{1}$, $^{2}/_{2}$, $^{3}/_{3}=34$
33. *M. leucogaster hilgendorfi**	9	
Family Molossidae		
34. *Nyctinomus insignis*	7	$^{1}/_{3}$, $^{1}/_{1}$, $^{2}/_{2}$, $^{3}/_{3}=32$

of palatal ridges is 7 with 17 species and 1 subspecies of the 34 species and 5 subspecies listed in the table.

Those with less ridges are *Emballonura semicaudata sulcata* of family Emballonuridae, with 5 ridges, *Hipposideros armiger turpis* and *H. a. terasensis* of family Hipposideridae with 6 ridges. Those which show a tendency to keep less ridges than 7 are *Rhinolophus ferrumequinum ferrumequinum* and *R. f. nippon* of family Rhinolophidae with 6 or 7 ridges.

Of those with more ridges, those with 7 or 8 ridges are 1 *Rhinolophus cornutus* of family Rhinolophidae, those with 8 ridges are 8 species and 1 subspecies of family Vespertilionidae, those with 9 ridges are only 3 species, *Myotis formosus* subsp. of subfamily Vespertilioninae, *Murina ussuriensis* and *M. leucogaster hilgendorfi* of subfamily Murininae, those with 8 or 9 ridges is *Vespertilio namiyei anderssoni*. *Pteropus* sp., the only species of suborder Megachiroptera of all the bats examined in the present research, has 12 ridges, incomparably many.

The opposum which still keeps the most original aspect of ridges of all the marsupials, and the tupaia which is regarded the common ancestry of the insectivores and the primates, have 7 ridges. The prosimians, a primitive primates, are reported to have 7 ridges (Schultz, 1958). From this the standard number of the ridges of the mammals will possibly be estimated to be 7. Most of suborder Microchiroptera still retain the standard number of ridges. But some of Microchiroptera show a tendency to decrease in the number of ridges; as do family Emballonuridae, family Rhinolophidae except *Rhinolophus hipposideros hipposideros* and *R. cornutus cornutus*, and family Hipposideridae, the latter two families belonging to superfamily Rhinolophoidea. A tendency of the increase in ridges is notable, especially in *Myotis formosus* subsp., and *Vespertilio namiyei anderssoni* of subfamily Vespertilioninae, and *Murina ussuriensis* and *M. leucogaster hilgendorfi* of subfamily Murininae.

On the other hand, remarkably lots of ridges are found in *Pteropus* sp. of Megachiroptera.

Moreover, the tendency to the increase in the number from 7 to 8, is independently found in each genus of subfamily Vespertilioninae. In Table 8, dental formulae are also shown, but it is feasible to say that no direct relation would possibly be between the number of teeth and that of palatal ridges.

The increase and decrease from the standard number of ridges take place independently in each of all the main groups of the primates (Schultz, 1958).

Next, the locations where the 1st and the last ridges come out will be arranged according to the data from the present study as present in Table 9 (Ognev mentions nothing about this point in his work).

The most of the cases is that the palatal ridges come out within the range from canines to the 3rd molars, which was the case with 5 species. The range is the most limited with *Hipposideros armiger terasensis* in which ridges are found in the range between the 1st premolars to the 2nd molars. It is followed by *Hipposideros armiger turpis* and *Carollia perspicillata perspicillata* in which the range is limited from the middle between canines and the 1st premolars to the 2nd molars. In 2 species of *Rhinolophus* and *Emballonura semicaudata sulcata*, ridges appear within the range between canines and the 2nd molars. These are the species whose ranges of ridges are much reduced.

Next, the species which has the widest range of ridges is *Pteropus*, whose range covers from the line connecting the canines to the fauces.

Myotis macrodactylus, Myotis formosus and *Murina leucogaster hilgendorfi* show a pretty wide range, if not so wide as that of *Pteropus*, covering from the 2nd incisors to the 3rd molars.

The degeneration into disappearance of the palatal ridges in considered to start generally in the further ones (Schultz, 1958; Lysell, 1955); in the prosmians of the primates, the ranges of ridges covers the whole hard palate, while the ape lacks in the furthest ridges and in man the ridges are limited within the range up to the 2nd premolars (Schultz, 1958).

Accordingly, it is notable that a degenerating tendency of the ridges is feasible in those superfamilies of Emballonuroidea, Rhinolophoidea and Phyllostomatoidea which show less numbers and less kinds of ridges, about

Table 9 Comparison of the number, location and type of the palatal ridges

	Number of Ridges	Location of Formost Ridge	Location of Hindmost Ridge	Number of the Kinds of Ridges	Degeneration Index of Ridges
Suborder Megachiroptera					
Family Pteropidae					
1. *Pteropus* sp.	12	C	near to fauces	2	48
Suborder Microchiroptera					
Superfamily Emballonuroidea					
Family Emballonuridae					
2. *Emballonura semicaudata sulcata*	5	C	M^2	2	17
Superfamily Rhinolophoidea					
Family Rhinolophidae					
3. *Rhinolophus ferrumequinum nippon*	6	C	M^2	1	18
4. *R. cornutus cornutus*	7	C	M^2	3	21
Family Hipposideridae					
5. *Hipposideros armiger turpis*	6	$C \sim P^1$	M^2	4	24
5′. *H. a. terasensis*	6	P^1	M^2	4	27
Superfamily Phyllostomatoidea					
Family Phyllostomatidae					
6. *Carollia perspicillata perspicillata*	7	$C \sim P^1$	M^2	3	22
Superfamily Vespertilionoidea					
Family Vespertilionidae					
Subfamily Vespertilioninae					
7. *Myotis nattereri bombinus*	7	P^1	M^3	5	28
8. *M. macrodactylus*	8	I^2	M^3	4	33
9. *M. formosus* subsp.	9	$I^2 \sim C$	M^3	5	38
10. *Nyctalus lasiopterus aviator*	7	C	M^3	4	25
11. *Pipistrellus abramus abramus*	7	C	M^3	3	26
12. *Vespertilio namiyei namiyei*	8	C	M^3	4	26
13. *Plecotus auritus sacrimontis*	8	C	M^3	4	29
Subfamily Miniopterinae					
14. *Miniopterus schreibersi fuliginosus*	8	C	M^3	3	35
Subfamily Murininae					
15. *Murina leucogaster hilgendorfi*	9	I^2	M^3	4	36

which to be mentioned below.

Next, let us see how many of the classified 7 types each species shows in its ridges. As present in Table 9, *Rhinolophus ferrumequinum nippon*, *Emballonura semicaudata sulcata* and *Pteropus* sp. have few and same types, while

Myotis nattereri bombinus and *Myotis formosus* have comparably more types of ridges.

In marsupials and insectivores, the ridges run in a way as if connecting the molars on both sides, which is considered to be the most non-specialized status (Schultz, 1958). These have the ridges which show a shape of arch curving forward. Take this type of ridges to be the most standard ones, and the 7 types of ridges, as seen in Chiroptera, will be considered to have branched from the standard type A in such an order as this.

$$E \longleftarrow A \longrightarrow B \longrightarrow C \longrightarrow D \longrightarrow F \cdots\rightarrow G$$

The E type of ridges, seen in *Myotis macrodactylus* and *Miniopterus schreibersi fuliginosus* are big ones which come out in the front of the palate. While types of C, D and F are the ridges mostly coming out in the occipital side of the palate, generally poorer in their elevation. Type G of ridges are those which have so badly degenerated into mere vestiges. Therefore, replace the letters with figures as G:1, F:2, D:3, C:4, B:5, A:6, E:7, and the total sum of the figures for a species will give its degenerating status quantitatively. In other words, the larger is the sum with a species the higher is the development of its ridges, while a smaller sum shows the stronger tendency to degeneration of the ridges. Name the total sum the degeneration index, and the representative degeneration indices for the species will be given as present in Table 9. In *Emballonura semicaudata sulcata* and *Rhinolophus ferrumequinum nippon* the degeneration indices are especially small, while in *Myotis formosus*, *Miniopterus schreibersi fuliginosus*, *Murina leucogaster hilgendorfi* and *Pteropus* sp., they are larger.

The palatal ridges show a greater developmental status in the herbivorous species; in wild boars (Plate N), deer, horses and cows, they are lots and cover almost whole the hard palate —— horses 16 ~ 18, cows 15 ~ 20, goats 12±, sheep 14±, pigs 20 ~ 22 (Masui, 1953), wild boars 22 are reported. While the insectivorous and carnivorous species have comparatively less ridges, whose elevation of the ridges is also poorer (Yamada et al., 1965). For instance, the ridges are tupaia 7 (Schultz, 1958), *Mogera* 8 ~ 9, *Urotrichus* 8 ~ 9 (Miyao & Môri, unpublished), dog 9 (Masui, 1953). Moreover, man who has won a higher omnivorous feeding habit, shows the palatal ridges degenerated into only 3 ~ 4 (Lysell, 1955; Schultz, 1958; Yamazaki, 1962).

Thus it is notable that there seems to be a close relationship between the devolopmental status of palatal ridges and the feeding habit; the relations between the development of the ridges and the possible specialization into herbivorous feeding habit, between the degeneration of the ridges and the inevitable acquisition of omnivorous feeding habit. Even with the primates these relations are ready to be noticed (from the data by Schultz, 1958).

As for the bats examined in the present study, the ridges of all the bats except *Pteropus* sp. show a small range of variation and the relation of the status of ridges to the feeding habit cannot be fully explained.

The species of suborder Megachiroptera are generally frugivorous, with their cheek teeth developed wonderfully to suit the frugivorous habit, lost most characteristics of the original pattern of the insectivore; the cusps of the crown smooth and motar in shape (Allen, 1939; Uchida, 1964), increased in the number of the ridges, palatal bones remarkably extended, the range of the distribution of the ridges much widened. It is feasible to say that *Pteropus* sp., once insectivorous, have changed into frugivorous and the increase in the palatal ridges possibly went with the change.

Most species belonging to suborder Microchiroptera are considered to be insectivorous, but some of them, as mentioned in the above, show a degenerating tendency in their palatal ridges and some a developing tendency.

The Microchiroptera adopted in the present study may be classified into the following 3 groups, by the range, kind and number of the palatal ridges.

I. Species of a strong degenerating tendency
1. *Emballonura semicaudata sulcata*
2. *Rhinolophus ferrumequinum nippon*
3. *R. cornutus cornutus*
4. *Hipposideros armiger turpis*
5. *H. a. terasensis*
6. *Carollia perspicillata perspicillata*

II. Intermediate species
1. *Myotis nattereri bombinus*
2. *Nyctalus lasiopterus aviator*
3. *Pipistrellus abramus abramus*
4. *Vespertilio namiyei namiyei*

III. Species of developing tendency
1. *Myotis macrodactylus*
2. *M. formosus* subsp.
3. *Miniopterus schreibersi fuliginosus*
4. *Murina leucogaster hilgendorfi*

Those belonging to Group I are comparatively inferior taxonomic groups; only 3 superfamilies, Emballonuroidea, Rhinolophoidea and Phyllostomatoidea. *Carollia perspicillata perspicillata* shows an explicit tendency to a frugivore, and its teeth show characteristics akin to those of *Pteropus* sp. Some of genus *Hipposideros* are reported to feed some fruit (Allen, 1939). *Rhinolophus* and

Emballonuroidea are said insectivorous, but no detailed data as to the kind of their food are available. It is possible to say, however, that the decrease in the ridges should imply a tendency to the omnivorous habit, feeding, besides insects, pollen, honey and fruit, and that in case of the insectivorous the ridges might have some relation with their habit of feeding comparatively bigger insects on the earth. This point is expected to be explained in a concrete way through the researches in their feeding habit and the comparison between skeletal structure and teeth.

Those belonging to Group II are limited to Vespertilioninae.

Those belonging to Group III are 2 species of genus *Myotis* of Vespertilioninae, and the species Miniopterinae and Murininae.

Although *Myotis formosus* are reported to feed the fruit of *Euphoria Longana* (Imaizumi, 1960), those belonging to Group II and III are all supposed to be insectivorous, and the relations between the developmnetal status of the ridges and the possible influential factors are expected to be explained in future; in that case, their flight potency to be counted upon in the relation to the structure of the shoulder joints and the developmental status of canines might be required to be studies.

The ancestry who might have been arboreal —— the primitive insectivores —— possibly had won the volant habit in pursuit of their food and then gradually adapted themselves to the free flight which let them successfully win enough food. In this process of development, there might have happened the diversion to frugivorous habit feeding on pollen, honey and fruit (Megachiroptera, Phyllostomatoidea), and thus such possible devolopment of habitude into insectivorous or carnivorous habit as of Family Phyllostomidae (Böker, 1937).

It is feasible to consider that the development or degeneration of the palatal ridges which play a supplemental function in the catch and crush of the food is in a close relationship with the diversion in the feeding habit. With so few numbers and species to be examined and so few concrete data for the explanation of the feeding habit, it was difficult fully to illustrate their relations. In the present report, therefore, suffice it to detail the results from the observations of the palatal ridges of the species of bats and point out a possible significance of the difference in the developmental status of the palatal ridges between the species.

Summary

With 15 species and 1 subspecies of bats that were available for the present study, observations of their palatal ridges were made (Fig. 2, Plate). The number, type and location of the ridges of each species are depicted in Table 1~Table 7. And for the comparative study of the ridges between species, the number, location and kind of the ridges are shown in Table 9.

In *Pteropus* sp. of suborder Megachiroptera, the ridges number 12, incomparably many of all, with a larger range of distribution. It is feasible to conclude that this status of the ridges has been caused for the adaptability to the frugivorous feeding habit.

In the species of suborder Microchiroptera, the ridges number 5~9, the range of the distribution is variable by the species. By the number, range of distribution and kind of the ridges, the species of suborder Microchiroptera might reasonably be classified into the following three groups.

I. Species with a strong tendency to degeneration
1. *Emballonura semicaudata sulcata*
2. *Rhinolophus ferrumequinum nippon*
3. *R. cornutus cornutus*
4. *Hipposideros armiger turpis*
5. *H. a. terasensis*
6. *Carollia perspicillata perspicillata*

II. Intermediate species
1. *Myotis nattereri bombinus*
2. *Nyctalus lasiopterus aviator*
3. *Pipistrellus abramus abramus*
4. *Vespertilio namiyei namiyei*
5. *Plecotus auritus sacromontis*

III. Species with a developing tendency
1. *Myotis macrodactylus*
2. *M. formosus* subsp.
3. *Miniopterus schreibersi fuliginosus*
4. *Murina leucogaster hilgendorfi*

The relation between the significance of such classification and the feeding habit is expected to be made clear in the future —— some species of Group I show a tendency to the omnivorous feeding habit ——, and in the present report, suffice it to say that an obvious difference between the species is noticed in the developmental status of the palatal ridges.

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APPENDIX

TABLES :

Of the signs for the locations, $I^{1\sim3}$ stand for 1st ～ 3rd incisors, C for canine, $P^{1\sim3}$ for 1st～3rd premolars, $M^{1\sim3}$ for 1st～3rd molars.

As for the types of palatal ridges, confer Fig. 1.

Explanation of Plate

Palatal radges of bats and a wild boar.

A : *Pteropus* sp.

B : *Emballonura semicaudata sulcata*

C : *Rhinolophus ferrumequinum nippon*

D : *R. cornutus cornutus*

E : *Hipposideros armiger turpis*

F : *H. a. terasensis*

G : *Carollia perspicillata perspicillata*

H : *Myotis macrodactylus*

I : *M. Formosus* subsp.

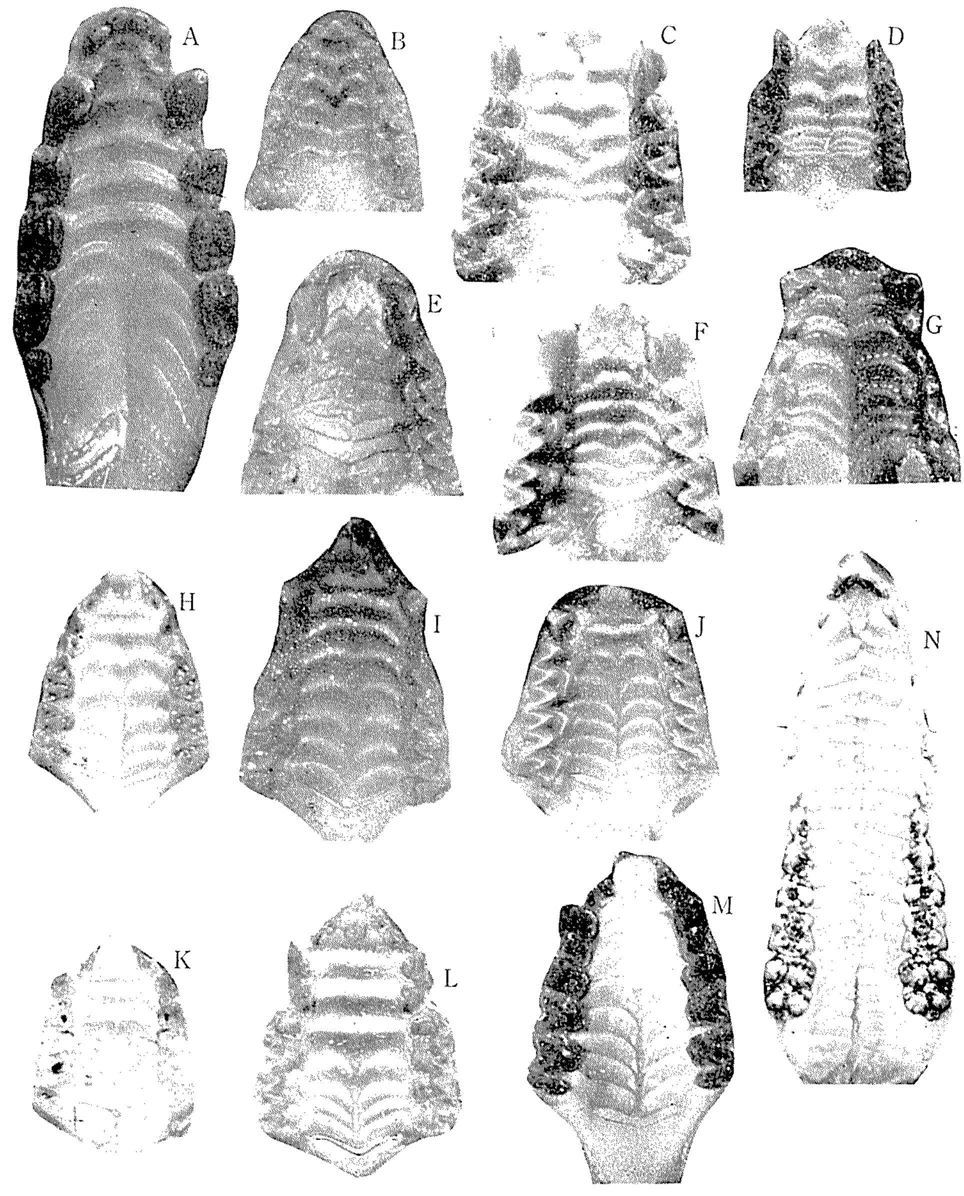
J : *Vespertilio namiyei namiyei*

K : *Pipistrellus abramus abramus*

L : *Miniopterus schreibersi fuliginosus*

M : *Murina leucogaster hilgendorfi*

N : Japanese wild boar, *Sus scrofa leucomystax*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