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## COMPARATIVE ANATOMY OF THE MANDIBLE IN THE MAMMAL SYSTEMATICS (MAMMALIA: INSECTIVORA, CHIROPTERA, RODENTIA) FROM ROMANIA. (I)

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Abstract. The paper presents the comparative anatomy of the mandible in 30 mammal species of the orders Insectivora, Chiroptera and Rodentia. The material is from the mammal collections of “Grigore Antipa” National Museum of Natural History (Bucharest) and most of it represents the result of the field collectings from different regions of Romania. Drawings of the mandible, with their constituent parts and the necessary explanations are presented for each species. The paper is necessary to the mammalogists, ornithologists who study the food of the birds of prey and to the paleontologists interested in the knowledge and recognition of the mammals from the fossiliferous deposits.

Résumé. On présente l’anatomie comparative de la mandibule pour 30 espèces de mammifères des ordres Insectivora, Chiroptera et Rodentia. Le matériel appartient aux collections de Muséum National d’Histoire Naturelle “Grigore Antipa” (Bucarest) et, pour la plupart, il représente les résultats des captures en régions différentes de la Roumanie. Les dessins de la mandibule, avec leurs parties composantes et des explications nécessaires, sont présentés pour chaque espèce. Le travail est nécessaire aux mammalogistes, ornithologistes qui étudient la nourriture des oiseaux de proie et aux paléontologistes intéressés à la connaissance et à l’identification des mammifères des dépôts fossilifères.

Key words: mandible, morphology, description, Mammalia, Insectivora, Chiroptera, Rodentia.

For the time being, the following studies are known: the comparative anatomy in mammals for the spine, Dornescu & Nițescu (1965), Nițescu (1966); pelvic girdle, Herăñ (1968); turbinated bones, Andreescu (1970); skeleton in small mammals, Andreescu (1971); omoplate, Țalman (1971); postcranial skeleton, Červený & Țalman (1974), Červený (1978); coxal bone in six South-American bat species, Răduleț & Murariu (2000); coxal bone in 11 bat species from Romania, Răduleț (2003). Also, measurements of the coxal bones were made by Herăñ (1967).

My study, as that one on the morphology of the coxal bone, creates the possibility of the species identification after the skeleton remains from pellets, collections or found in the ground substratum, hollows, caves, garrets, etc. As yet, the systematists based especially on the phenotypical and genetical features of the mammals for the species identification. Mandible morphology will complete the knowledge on the phenotypical features of the species and, of course, will develop the identification keys in mammals. The paper is necessary to the mammalogists, ornithologists and paleontologists.

### MATERIAL AND METHOD

The about 300 studied skulls are from the mammal collections of “Grigore Antipa” National Museum of Natural History (Bucharest). From the total of the studied skulls, only the skull of *Cricetullus migratorius* (Pallas, 1773) is from

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English translation by Mihaela Barcan Achim.

Ukraine, the rest being the result of the captures made in the field in different regions of Romania. For species as *Mus musculus* Linnaeus, 1766, *Microtus arvalis* (Pallas, 1778), *Clethrionomys glareolus* (Schreber, 1780), *Sorex araneus* Linnaeus, 1758 some tens of specimens were studied, and only one skull for each *Rhinolophus mehelyi* Matschie, 1901, *Pipistrellus savii* (Bonaparte, 1837), *Barbastella barbastellus* (Schreber, 1774). Making a comparison between the constituent parts of the mandible, morphological differences were identified according to the species, but not according to the sex. The skulls were studied with the stereomicroscope and drawings were made using camera lucida.

Pucek (1981) uses the term of *angular processus* for the formation placed on the posterior side of the mandibular rami and under *processus condyloideus* (PCON). He refers to this formation in the identification key, but only for the genus *Plecotus*.

Murariu (2004) named it *angular apophysis*.

For the name of this formation I based on the nomenclature from “Latin Nomina Anatomica” (Modern Latin Anatomical Term) – Internet, but it does not refer to such a formation, so I named myself “*non nominatus processus*” (NNP).

Abbreviations:

<i>caput mandibulae</i>	CAP M
<i>collum mandibulae</i>	COLM
<i>corpus mandibulae</i>	CORM
<i>incisura mandibulae</i>	IM
<i>linea obliqua mandibulae</i>	LOM
<i>non nominatus processus</i>	NNP
<i>processus condylaris (condyloideus)</i>	P CON
<i>processus coronoideus</i>	P COR
<i>ramus mandibulae</i>	RM

#### RESULTS AND DISCUSSIONS

I present the description of the mandible morphology in 30 mammal species of the orders Insectivora, Chiroptera and Rodentia.

##### Order Insectivora

##### Family Talpidae

*Talpa europaea* Linnaeus, 1758 (Fig. 1) in RM has a deeper concavity in the central side, almost round, with a prolongation in P CON; LOM vertical; P COR is a vertical trapezium-shaped thick blade, terminally rounded; IM in an obtuse angle; in lateral view, P CON, isosceles triangle with a rounded tip, centrally with an elongated concavity; in dorsal view, CAP M is a trapezium with a rounded surface, and the small side in the posterior part; NNP is a thick blade, oblique on RM, and the lower margin is overhung. Terminally, NNP is rounded, with its tip upwards.

##### Family Soricidae

In *Sorex araneus* Linnaeus, 1758 (Fig. 2) RM is flat; LOM vertical; P COR is a trapezoidal elongated thick blade, with a rounded tip and bevelled antero-posteriorly, and on the outer surface it has an elongated superficial depression; IM is

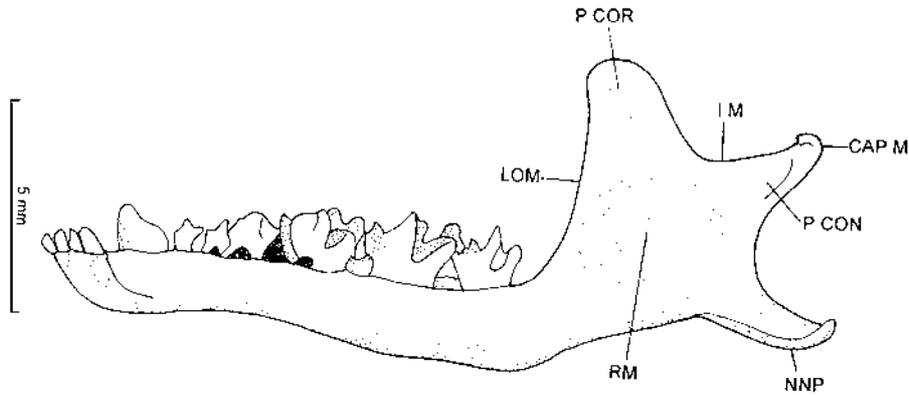


Fig 1 – External lateral view of the mandible in *Talpa europaea* Linnaeus, 1758.

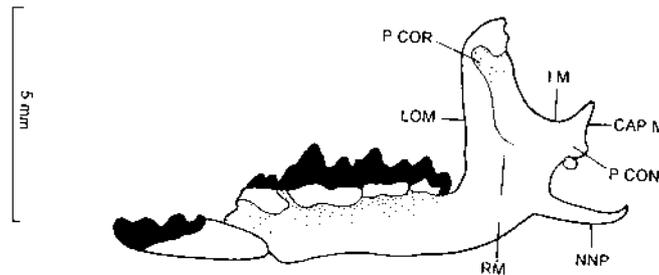


Fig. 2 – External lateral view of the mandible in *Sorex araneus* Linnaeus, 1758.

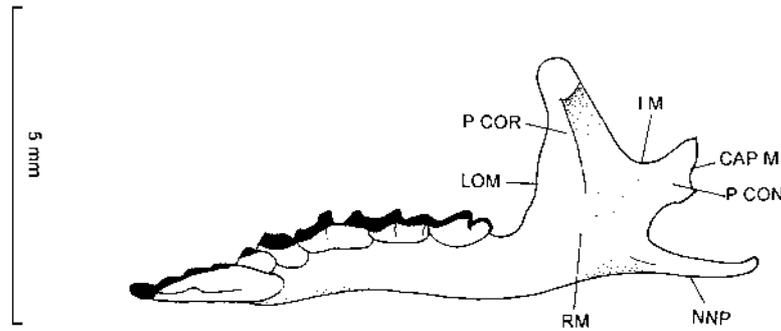


Fig. 3 – External lateral view of the mandible in *Sorex minutus* Linnaeus, 1766.

semicircular; in lateral view, P CON is bifid, lower side short, and the upper one longer, obliquely posterior directed; CAP M is L-shaped, with the short segment posterior-lowerly directed, innerwardly, and the long one vertical, flattened towards exterior; NNP as a thin spine, elongated (ca. 2.2 mm), with its tip slightly curved upwards.

In *Sorex minutus* Linnaeus, 1766 (Fig. 3) RM is flat; LOM vertical, subterminally concave; P COR is a thick trapezoidal blade, terminally rounded,

posterior side straight, along the outer surface having an elongated depression towards IM, superiorly delimited by a small prominence; IM approximately in a right angle; in outer lateral view, P CON is bifid, with the lower side short and thick, and the upper one, longer and vertical; CAP M is L-shaped, with the short segment posterior and innerly directed, and the longer one thick, ending flattened outerly; NNP is a thin elongated spine (1.9 mm), directed horizontally in comparison with RM, slightly curved innerly, and its tip slightly curved upwards.

In *Sorex alpinus* Schinz, 1837 (Fig. 4), the mandible resembles mostly with that of *Sorex araneus* Linnaeus, 1758. But, RM is flat; P COR has an elongated depression with a small elliptical prominence subterminally, on the outer surface, towards IM; P CON bifid with the upper ramus oblique upwardly and posterior, and the lower one slightly marked; CAP M is more like a right-angled triangle-shaped, with its hypotenuse innerly directed; NNP is like a spine slightly convex, with an oblique rounded tip upwards.

*Neomys fodiens* (Pennant, 1771) (Fig. 5). RM has the outer surface falt; P COR is like a thick, trapezoidal blade, with the posterior side straight, the tip rounded with a “beak” posterior directed, and on the outer surface, subterminally, has a reduced oval depression, superiorly and inferiorly delimited by a small prominence; IM approximately in a right angle; in outer lateral view, P CON is bifid, lower ramus slightly marked, and the upper one obliquely elongated upwards,

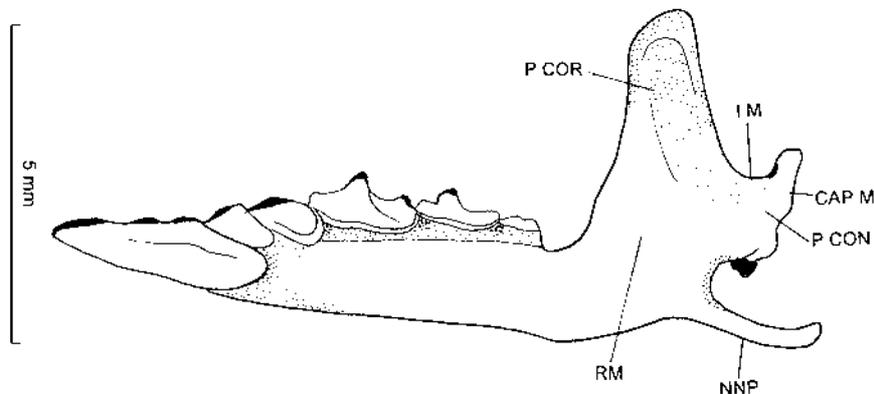


Fig. 4 - External lateral view of the mandible in *Sorex alpinus* Schinz, 1837.

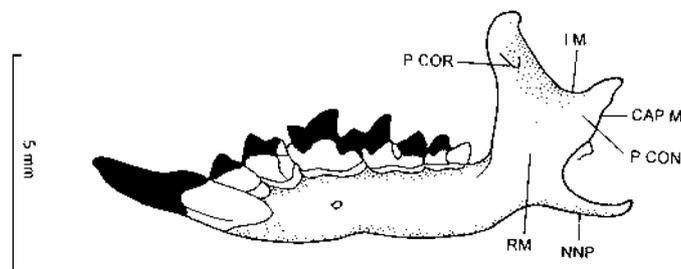


Fig. 5 – External lateral view of the mandible in *Neomys fodiens* (Pennant, 1771).

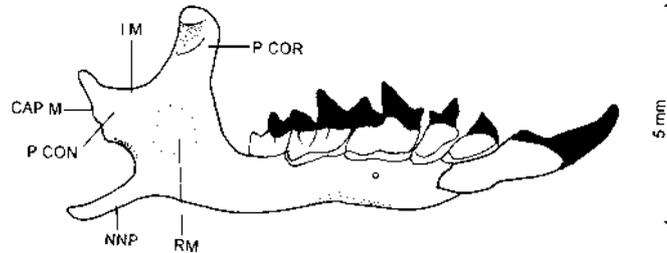


Fig. 6 – External lateral view of the mandible in *Neomys anomalus* Cabrera, 1907.

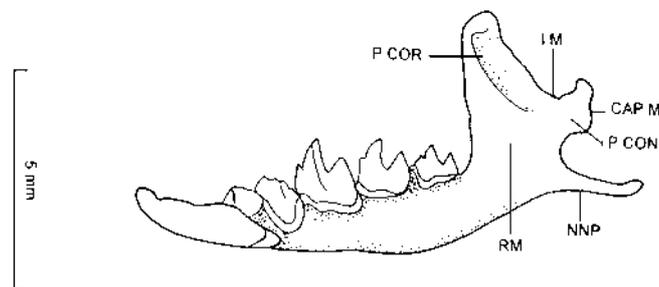


Fig. 7 – External lateral view of the mandible in *Crocidura leucodon* (Hermann, 1780).

posteriorly; CAP M is L-shaped, with its segments almost equal, the posterior one narrower, towards inner side, and the vertical one thicker, flattened towards exterior; NNP horizontal, slightly curved, terminally rounded and upwards directed.

In *Neomys anomalus* Cabrera, 1907 (Fig. 6) RM has a slight central depression area on the outer surface; P COR is like a trapezoidal thick blade, with a rounded tip, but, on the outer side, subterminally, it has a concavity superiorly and inferiorly delimited by a small prominence; IM semicircular; in outer lateral view, P CON, is bifid, lower side slightly obvious, and the upper one obliquely elongated upwards, posterior; CAP M is L-shaped, with its segments approximately equal, the upper one vertical, terminally thicker and flattened towards outer side, the lower one is oblique, transversal; NNP is like an oblique spine on RM, straight and the tip flattened upwards.

In *Crocidura leucodon* (Hermann, 1780) (Fig. 7) RM has a flat outer surface; P COR is a thick trapezoidal blade rounded in tip, but it has a superficial longitudinal ditch on the outer side towards IM, semicircular; in outer lateral view P CON is bifid, lower ramus being shorter and rounded, the upper one, vertical; CAP M is L-shaped, with its segments almost equal, the vertical one thicker and flattened terminally towards exterior, the inferior one, thinner, oblique innerly; NNP is like a thin spine, elongated (ca. 2.1 mm), horizontal, with its tip rounded and directed upwards.

In *Crocidura suaveolens* (Pallas, 1811) (Fig. 8) RM has a superficial ditch on the outer surface towards IM; P COR is a isosceles trapezium-shaped blade, terminally thicker and rounded, from which an elongated depression starts towards IM; IM is semicircular; in outer lateral view, P CON is thick, bifid, upper ramus obviously bigger, the lower one, short, wide; CAP M approximately like a right triangle with the hypotenuse innerly directed; NNP is a thin spine, oblique on RM and with its tip rounded, curved upwards.

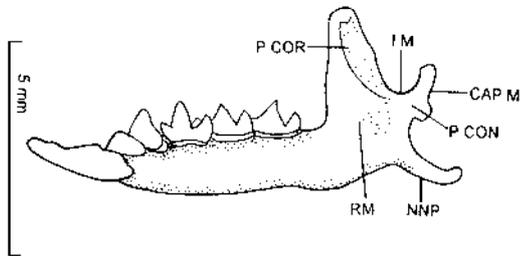


Fig. 8 – External lateral view of the mandible in *Crocidura suaveolens* (Pallas, 1811).

Order Chiroptera  
Family Rhinolophidae

Mandible of *Rhinolophus ferrumequinum* (Schreber, 1774) (Fig. 9) has RM with an elongated concavity towards P CON on the outer side; P COR is a triangular blade, thin, with a rounded tip; IM large; in lateral view P CON has a triangular aspect with a rounded turned up to exterior; in dorsal view, CAP M is like a cylindrical wand, slightly flattened, transversal towards inner side; NNP is like an elongated arm, oblique on RM and slightly towards exterior, with a rounded tip.

In *Rhinolophus hipposideros* (Bechstein, 1800) (Fig. 10) RM has an elongated concavity under P COR, IM and towards P CON; P COR is a triangular blade, with a flattened tip towards posterior side; IM wide, semicircular; in lateral view, P CON is an isosceles triangle with a rounded tip; in dorsal view, CAP M is like a transversal wand; NNP is like a blade slightly lateral oblique on RM, with a rounded tip.

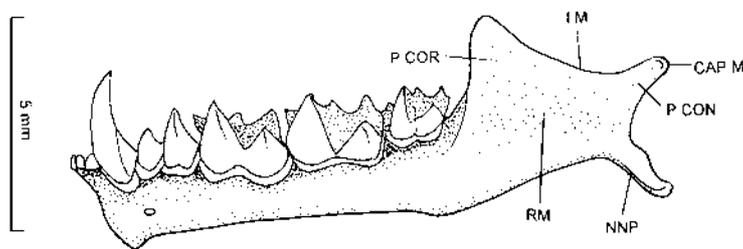


Fig. 9 – External lateral view of the mandible in *Rhinolophus ferrumequinum* (Schreber, 1774).

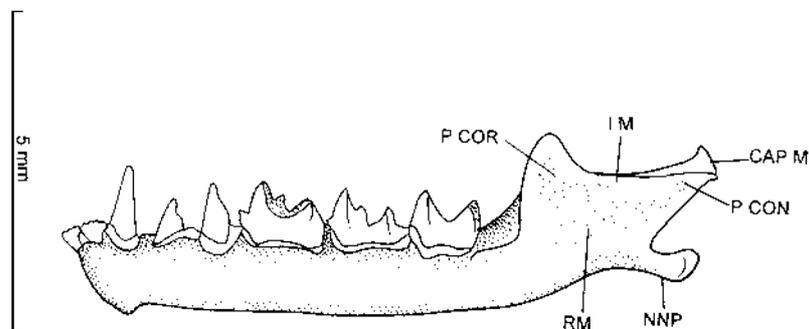


Fig. 10 – External lateral view of the mandible in *Rhinolophus hipposideros* (Bechstein, 1800).

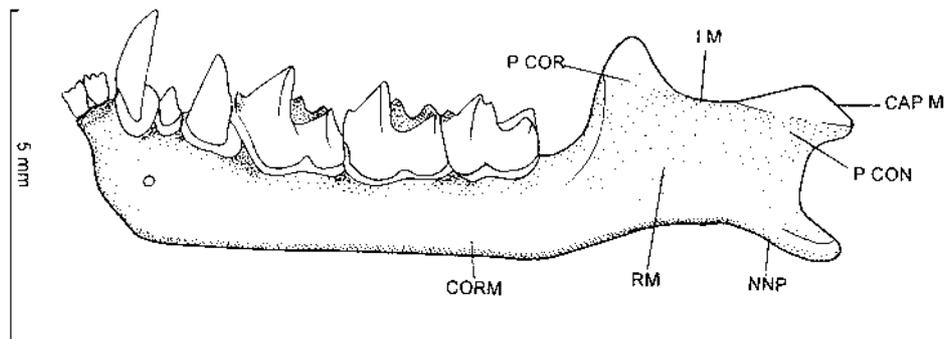


Fig. 11 – External lateral view of the mandible in *Rhinolophus mehelyi* Matschie, 1901.

In *Rhinolophus mehelyi* Matschie, 1901 (Fig. 11) inferior RM is thickened and has an elongated concavity from CORM to P CON; P COR is a vertical thin triangular blade with the tip slightly flattened towards posterior side; IM wide, semicircular; in lateral view, P CON is an isosceles triangle with a rounded tip; in dorsal view, CAP M is like a transversal wand, asymmetrical oblique towards inner side; NNP is like an elongated arm, obliquely directed to exterior, terminally bended upwards and the tip rounded.

#### Family Vespertilionidae

*Myotis myotis* (Borkhausen, 1797) (Fig. 12) has: RM with a more obvious concavity in the central part; P COR is a vertical thin triangular blade, higher than in *Myotis blythii* (Tomes, 1857), with a rounded tip; IM semicircular; in lateral view, P CON is concave, terminally rounded with turned up margins towards exterior; in dorsal view, CAP M is oval-elongated transversally, asymmetrical towards interior; NNP like a thick arm, terminally rounded and turned up upwards.

Mandible in *Myotis blythii* (Tomes, 1857) (Fig. 13) has: RM central, thin with a larger concavity towards P CON; P COR is like a thin triangular blade, with the anterior margin thickened and the tip rounded; IM semicircular slightly deep; in

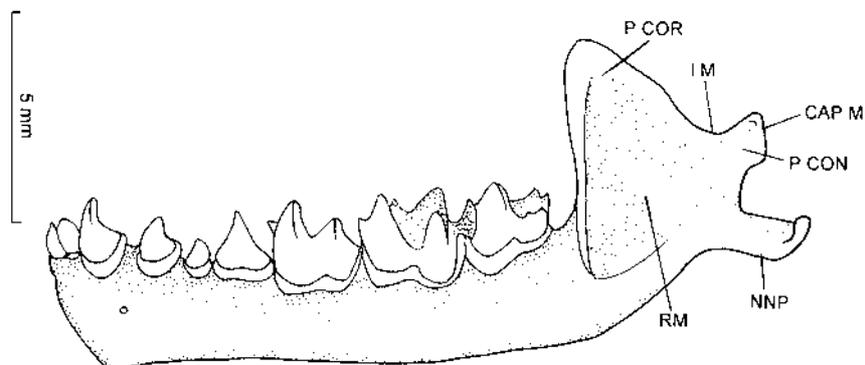


Fig. 12 - External lateral view of the mandible in *Myotis myotis* (Borkhausen, 1797).

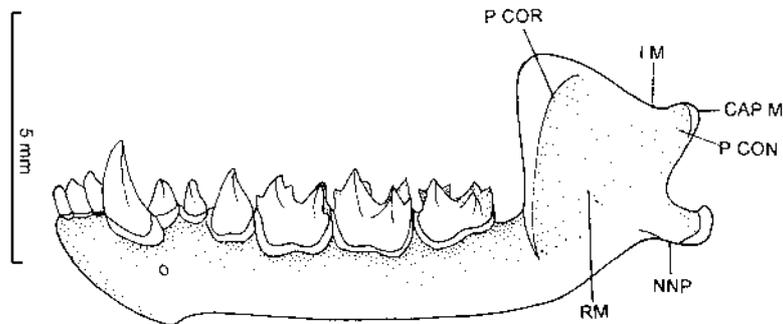


Fig. 13 – External lateral view of the mandible in *Myotis blythii* (Tomes, 1857).

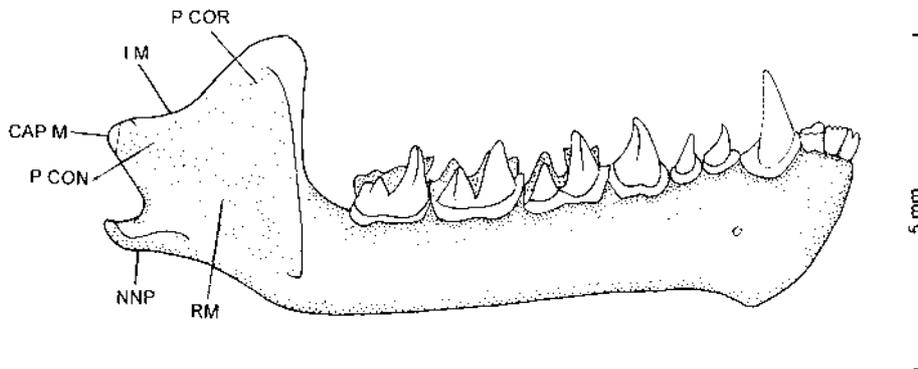


Fig. 14 – External lateral view of the mandible in *Myotis emarginatus* (E. Geoffroy, 1806).

lateral view, P CON is triangular, short, thick, concave, terminally rounded, with turned up margins towards exterior; CAP M is oval-elongated transversally and asymmetrically; NNP is like a short thick arm, in a right angle in comparison with P CON, obliquely directed towards exterior, with a rounded tip and turned up to exterior.

*Myotis emarginatus* (E. Geoffroy, 1806) (Fig. 14). RM has a deeper depression centrally, oblique towards P CON; P COR is like a thin triangular blade, slightly directed to exterior, with the tip postero-anteriorly flattened; IM widely semicircular; in lateral view, P CON is triangular with a flattened tip; CAP M ellipsoidal, transversal, slightly asymmetrical, with the inner side curved in front; NNP like a short thick arm, in a right angle in comparison with P CON, oblique towards exterior, with a rounded tip and slightly curved upwards.

*Plecotus austriacus* (Fischer, 1829) (Fig. 15). RM has a more obvious concavity towards CORM and directed to P CON; P COR is like a vertical triangular blade, slightly directed towards exterior, terminally in a sharp angle and with a rounded tip; IM widely semicircular; P CON is like an isosceles triangle with a rounded tip; in dorsal view, CAP M is ellipsoidal-elongated, transversal, asymmetrical towards interior; NNP is like an elongated arm, obliquely directed to exterior in comparison with RM and with a rounded tip.

In *Vespertilio murinus* Linnaeus, 1758 (Fig. 16) RM has an oblique concavity under P COR, IM and directed to P CON; P COR is like a triangular blade, slightly directed to exterior, with a rounded tip, inclined to the front; P CON short, rounded in tip; IM straight, horizontal; in lateral view, P CON is short, rounded in tip; in dorsal view, CAP M is ellipsoidal, reduced, transversal and symmetrical; NNP like a blade with a rounded tip.

In *Eptesicus serotinus* Schreber, 1774 (Fig. 17) mandible is strong. RM has a wide concavity, more obvious towards CORM; P COR is trapezium-like thick blade, with a rounded tip; IM superficial; P CON short, rounded in tip; in dorsal view, CAP M is transversal, ellipsoidal, with a convex surface, asymmetrical towards interior; NNP is like a short thick blade, terminally rounded.

*Nyctalus noctula* (Schreber, 1774) (Fig. 18) has a RM thin centrally, concave towards P CON; P COR is like a triangular blade, with a rounded tip and slightly anteriorly directed; IM slightly deep, oblique towards P CON; in dorsal view, CAP M is oval, convex, transversal, asymmetrical displayed; NNP is like a short thick arm, with a rounded tip, obliquely directed towards exterior.

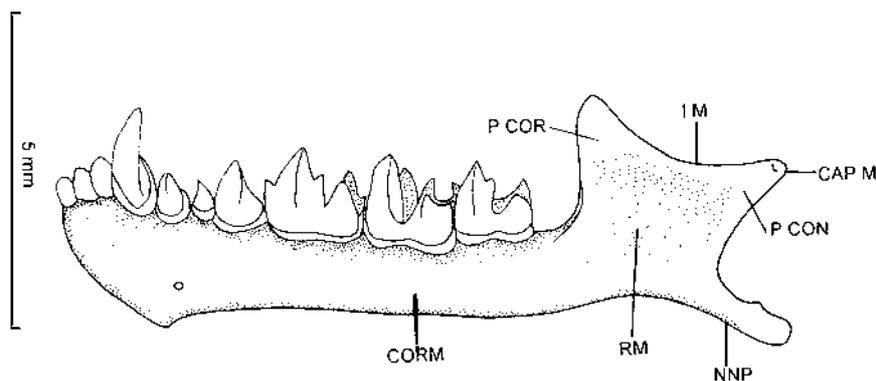


Fig. 15 – External lateral view of the mandible in *Plecotus austriacus* (Fischer, 1829).

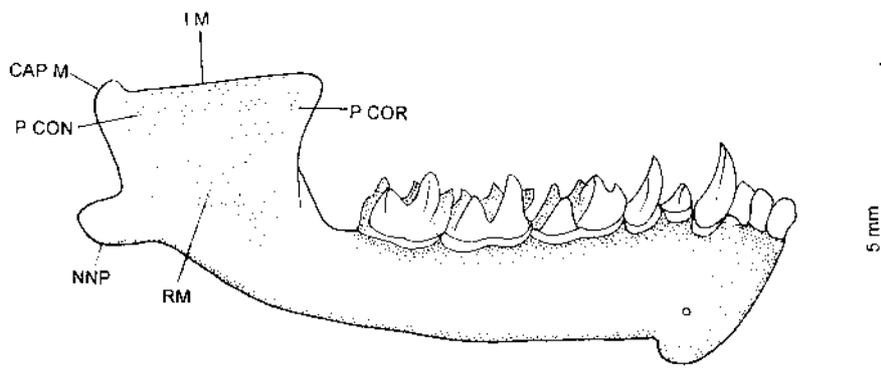


Fig. 16 – External lateral view of the mandible in *Vespertilio murinus* Linnaeus, 1758.

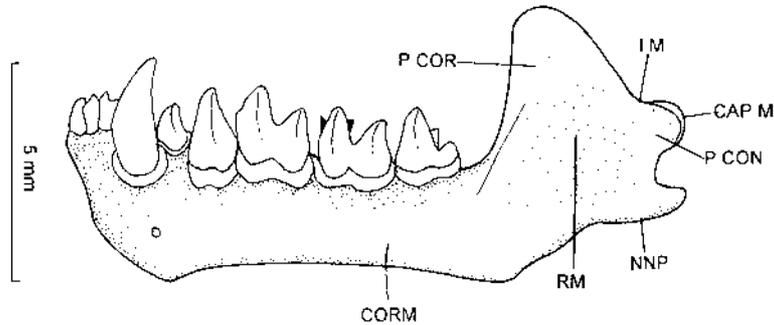


Fig. 17 – External lateral view of the mandible in *Eptesicus serotinus* Schreber, 1774.

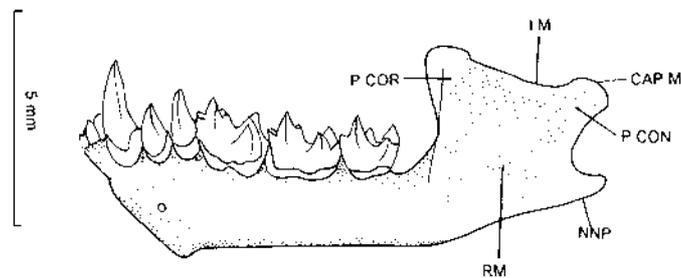


Fig. 18 – External lateral view of the mandible in *Nyctalus noctula* (Schreber, 1774).

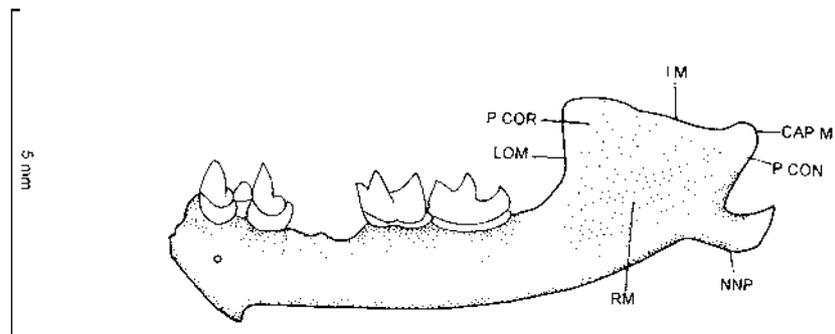


Fig. 19 – External lateral view of the mandible in *Pipistrellus savii* (Bonaparte, 1837).

*Pipistrellus savii* (Bonaparte, 1837) (Fig. 19). RM has an elongated concavity under P COR and towards P CON; P COR is like a triangular blade, terminally almost in right angle; LOM vertical, obvious; IM wide, straight, oblique towards P CON; in lateral view, P CON is triangular with a turned up tip exteriorly directed; in dorsal view, CAP M is ellipsoidal, transversal, and symmetrical; NNP is like a spine exteriorly directed, with the tip upwards.

*Barbastella barbastellus* (Schreber, 1774) (Fig. 20). RM has an elongated concavity, deeper under P COR and directed towards P CON; P COR is like a vertical triangular blade, with a pointed tip but rounded; IM is wide, semicircular,

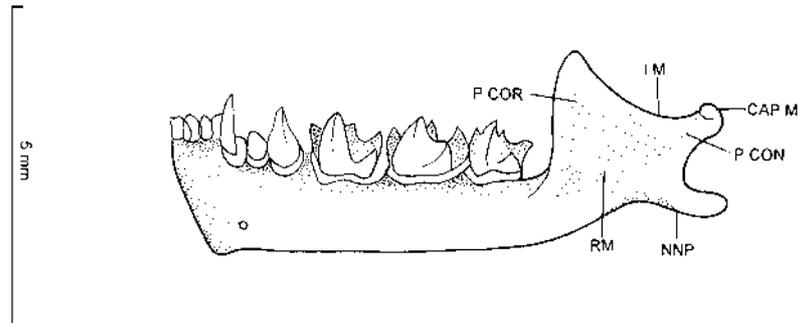


Fig. 20 – External lateral view of the mandible in *Barbastella barbastellus* (Schreber, 1774).

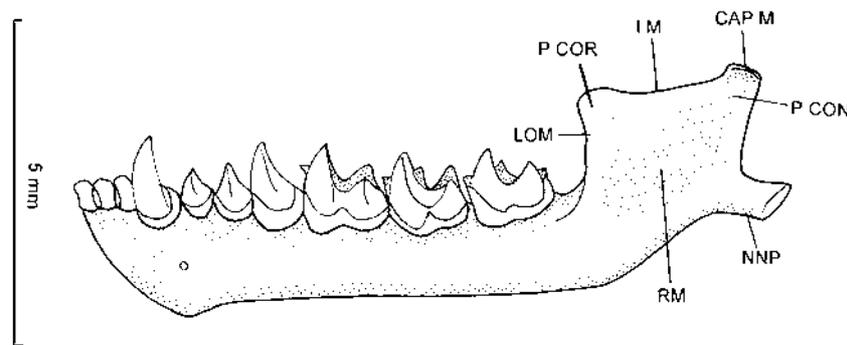


Fig. 21 – External lateral view of the mandible in *Miniopterus schreibersi* (Kuhl, 1819).

oblique towards P CON; CAP M is ellipsoidal, transversal, and slightly asymmetrical, in dorsal view; NNP is like an arm directed downwards, with a rounded tip.

*Miniopterus schreibersi* (Kuhl, 1819) (Fig. 21). In RM concavity is more obvious under IM; P COR is a thick blade exteriorly directed, terminally rounded; LOM vertical, well marked; IM wide, straight, slightly ascending to P CON; P CON is short, with a tip turned up towards exterior; in dorsal view, CAP M is ellipsoidal, asymmetrical to the interior; NNP is a thick arm, obliquely displayed on RM, with a rounded and rugged tip.

#### Order Rodentia Family Myoxidae

In *Dryomys nitedula* (Pallas, 1778) (Fig. 22) RM has a more obvious depression under IM and prolonged in P CON; P COR is like a spine curved posterior; IM oval; P CON is an elongated trapezoidal blade; CAP M, as an ovoid cap; NNP is a wide blade, terminally thickened, rugged, and the lower corner bent towards interior has an oval depression centrally, obvious with a very thin wall.

*Myoxus glis* (Linnaeus, 1766) (Fig. 23) has a flat RM, and under P COR it has a small oval prominence; P COR is like a thin spine, bent to the posterior side of the

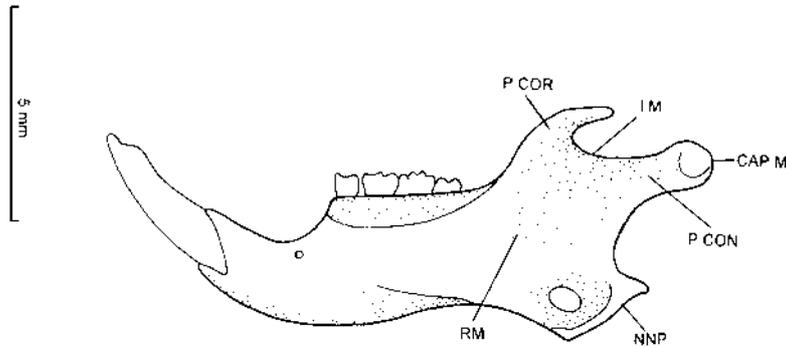


Fig. 22 – External lateral view of the mandible in *Dryomys nitedula* (Pallas, 1778).

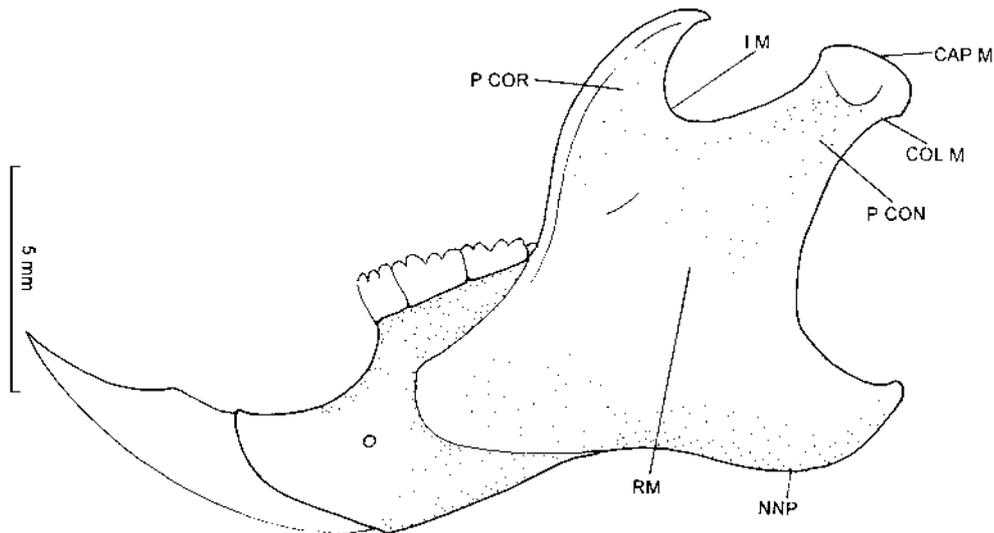


Fig. 23 – External lateral view of the mandible in *Myoxus glis* (Linnaeus, 1766).

mandible; IM ellipsoidal; P CON is like a trapezoidal blade, and centrally has an elongated depression; CAP M a rounded cap; NNP is a convex wide blade, terminally flattened to the upper side, with thick margins, the lower one being bent towards interior.

#### Family Muridae

*Cricetullus migratorius* (Pallas, 1773) (Fig. 24). Centrally RM is convex; P COR is a thin spine bent to the posterior part of the mandible, tip rounded; IM oval; P CON is like a blade with an elongated concavity towards IM; in lateral view, CAP M is like a comma, and in dorsal view as a fusiform cap along P CON and reduced only in its upper terminal part; NNP is a blade with thickened margins, bent towards interior, a rugged tip, flattened to the upper side.

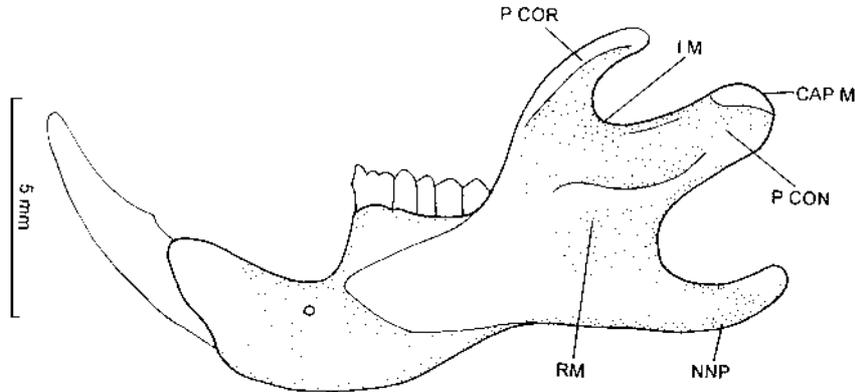


Fig. 24 – External lateral view of the mandible in *Cricetullus migratorius* (Pallas, 1773).

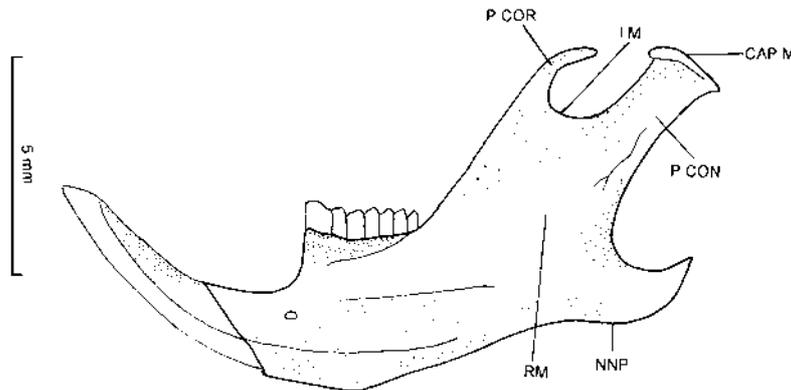


Fig. 25 – External lateral view of the mandible in *Clethrionomys glareolus* (Schreber, 1780).

In *Clethrionomys glareolus* (Schreber, 1780) (Fig. 25) RM flat, P COR as an elongated spine, bent towards P CON; IM oval; P CON is an elongated thin blade, terminally slightly convex; CAP M as a reduced cap; NNP as a widened thin spine, with the tip bent upwards.

*Microtus subterraneus* (de Selys-Longchamps, 1836) (Fig. 26) has a RM flat; P COR is a triangular blade, with a rounded tip posterior directed; IM ellipsoidal; P CON is an elongated thin blade, centrally slightly convex; CAP M a reduced cap at the upper terminal side of P CON, and in the dorsal view, oval; NNP is a widened spine, with the lower margin thickened, rugged, bent towards interior, the spine tip pointed.

*Microtus arvalis* (Pallas, 1778) (Fig. 27) with RM flat; P COR is an elongated thin spine, bent towards posterior side; IM oval; P CON is an elongated thin blade; CAP M is like a reduce cap on the terminal upper side of P CON, oval, in dorsal view; NNP is a L-shaped blade, with a conic tip, oblique upwards, and the margins thickened, the lower one being rugged.

*Chionomys nivalis* (Martins, 1842) (Fig. 28). RM has a superficial depression, continued in P CON; P COR is an elongated thin spine, bent towards posterior side; IM oval; P CON is an elongated thin blade, subterminally slightly convex, with an

oval basal depression towards IM; in lateral view, CAP M is like a reduced cap on the terminal upper side of P CON, and in the dorsal view, oval; NNP is a wide spine, with the conic tip oblique upwards, with the lower margin bent towards interior.

In *Mus musculus* Linnaeus, 1766 (Fig. 29) centrally RM has a prominence elongated towards P CON and a depression under P COR and IM; processus P COR

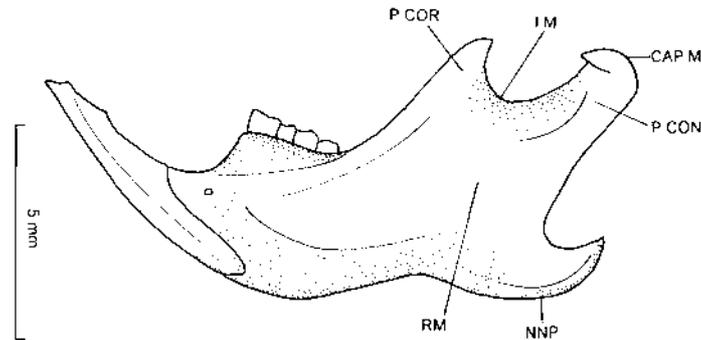


Fig. 26 – External lateral view of the mandible in *Microtus subterraneus* (de Sélys-Longchamps, 1836).

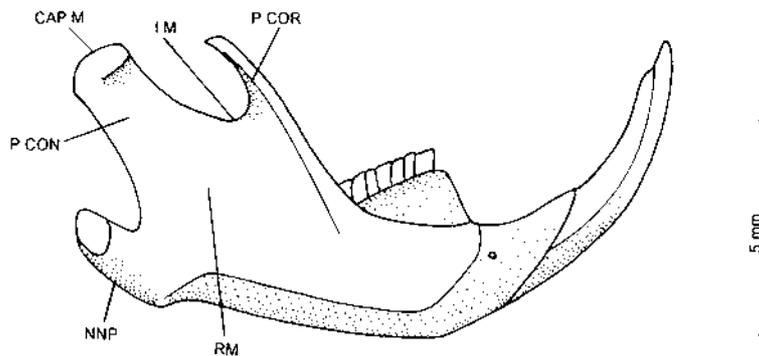


Fig. 27 – External lateral view of the mandible in *Microtus arvalis* (Pallas, 1778).

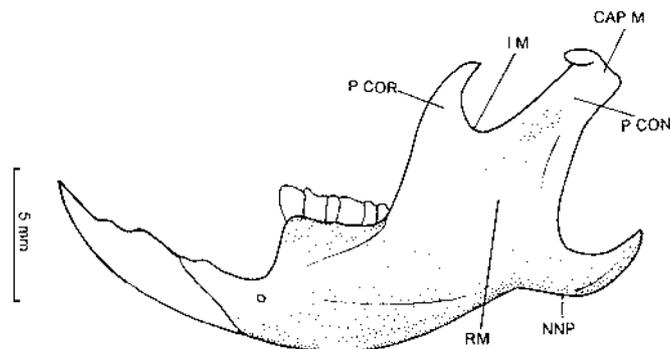


Fig. 28 – External lateral view of the mandible in *Chionomys nivalis* (Martins, 1842).

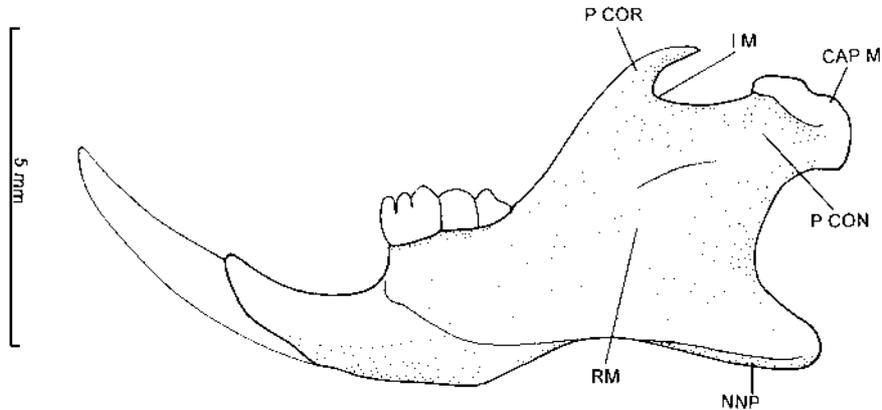


Fig. 29 – External lateral view of the mandible in *Mus musculus* Linnaeus, 1766.

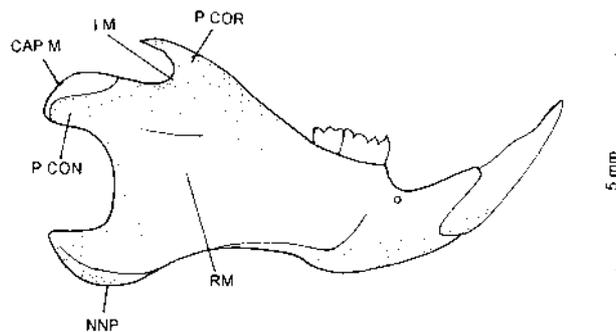


Fig. 30 – External lateral view of the mandible in *Mus spicilegus* Petenyi, 1882.

is a thin spine with a pointed tip, posterior directed; IM ellipsoidal; P CON is a trapezoidal wide thin blade; in dorsal view, CAP M is fusiform, and in lateral view is like a cap on P CON with a rounded terminal side, bent downwards; non NNP is a triangular wide blade, with a rounded tip and the inferior margin overhung.

*Mus spicilegus* Petenyi, 1882 (Fig. 30). Centrally RM has a prominence elongated towards P CON, in the upper side limited by a depression under P COR, IM and prolonged up to CAP M; P COR is a spine with a pointed tip, posterior directed; IM ellipsoidal; P CON thin trapezoidal blade; in dorsal view, CAP M fusiform, and in lateral view, as a reduced cap on the upper terminal side of P CON, and its lower side like a “beak” bent downwards; NNP a wide thin blade with the lower margin thickened, interiorly curved and a rounded tip.

#### Conclusions

The main structures (CAP M, IM, NNP, P COR, P CON, RM) are different from a species to another by size, shape, position, thickness, direction. Therefore, in general, the mandible is characteristic so it can be taken into account in the identification of the mammal species. Besides coxal bone, the mandible can help in completing the identification keys in mammals by its morphology. I think that in the

future even the herpetologists and ornithologists should take into consideration the morphology of the coxal bone and of the mandible when identifying species. This will help a lot the mammalogists, ornithologists and paleontologists.

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#### ANATOMIA COMPARATĂ A MANDIBULEI ÎN SISTEMATICA MAMIFERELOR (MAMMALIA: INSECTIVORA, CHIROPTERA, RODENTIA) DIN ROMÂNIA. (I)

#### REZUMAT

În lucrare se prezintă morfologia mandibulei de la 30 specii de mamifere (Insectivora, Chiroptera, Rodentia), în majoritate, din fauna României. Studiul a fost realizat pe baza materialului din colecțiile științifice ale Muzeului Național de Istorie Naturală "Grigore Antipa" (București). Pentru fiecare specie se prezintă desene ale mandibulei, cu părțile componente și explicațiile corespunzătoare. Structuri ca CAP M, IM, NNP, P COR, P CON, RM diferă de la o specie la alta prin mărime, formă, poziție, grosime, orientare una față de cealaltă. În viitor cunoașterea morfologiei mandibulei va completa cheile de determinare a speciilor de mamifere și va fi de un real ajutor pentru mamalogi, ornitologii care studiază hrana unor păsări răpitoare ca și paleontologilor.

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