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Gliridae (Mammalia: Rodentia) from the Miocene of Bełchatów in Poland

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Abstract. Remains of dormice (*Gliridae*) were collected from three levels of sediments in the brown-coal mine of Bełchatów, representing mammalian zones MN 4 to MN 9. Besides a few teeth of *Glis* sp. from Opole they constitute the first material of this rodent family from the Miocene of Poland. 19 populations belonging to 8 genera (*Glis*, *Glirudinus*, *Muscardinus*, *Myoglis*, Cf. *Heteromyoxus*, *Microdyromys*, *Glirulus* and *Bransatoglis*) were described. The composition of the dormice fauna suggests the existence of a forest environment all through the time of sedimentation in the Bełchatów basin. The fauna of glirids of Bełchatów is similar to that of western and central Europe.

Key-words: fossil mammals, rodents, *Gliridae*, Miocene, Poland.

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I. INTRODUCTION

The data we have so far on fossil dormice in Poland concern only the Pliocene and Quaternary (KOWALSKI 1963, DAOUD 1993). The unique information about their presence in the Miocene of Poland was gathered at Opole, where isolated teeth belonging to *Glis* sp. were discovered (KOWALSKI 1967).

Miocene sediments of the brown-coal mine of Bełchatów in Central Poland disclosed numerous remains of small mammals (KOWALSKI 1994, RZEBIK-KOWALSKA 1994). The oldest horizon with such remains, Bełchatów C contained a fauna of mammalian zone MN 4, the middle one, Bełchatów B, that of MN 5/6 and the upper one, Bełchatów A, of MN 9. All the three horizons contained isolated teeth of dormice (*Gliridae*).

The study of the fossil fauna of Bełchatów was supported by grant N° 6 6219 92 03 of the Polish Scientific Committee. The author is indebted to Dr Adam SZYNKIEWICZ, who provided geological data on the locality, to Miss Beata SŁOWIK, who selected most of the small mammals from the samples collected at Bełchatów and to Mr Marek KAPTURKIEWICZ who prepared the drawings. The discussions with Drs Remmert DAAMS, Burkart ENGESSER and Wenyu WU during the preparation of this paper were of great help to the author.

The specimens described in the present paper are housed in the collections of the Institute of Systematics and Evolution of Animals, Polish Academy of Sciences, Cracow. All dimensions are in millimeters.

II. SYSTEMATIC PART

Family *Gliridae* THOMAS, 1897

Subfamily *Glirinae* THOMAS, 1897

Genus *Glis* BRISSON, 1962

Glis vallesiensis AGUSTI, 1981

Bełchatów A (Fig. 1 a - j)

M a t e r i a l. 86 isolated teeth: 14 left and 8 right P_4, 5 left and 3 right M_1, 3 left and 8 right M_2, 1 left M_3, 7 left and 8 right P^4, 8 left and 5 right M^1, 3 left and 3 right M^2, 5 left and 8 right M^3 (MF/2202). The disproportionately high number of premolars may suggest that they include also deciduous teeth which could not be distinguished from the permanent ones. Probably at least 14 individuals are represented in the material.

D e s c r i p t i o n. The occlusal surfaces of lower molars are nearly flat, thouse of the upper ones slightly concave.

P_4 (MF/2202/1; Fig. 1: a) has a single root with shallow longitudinal grooves on both sides. The occlusal surface has a triangular outline with rounded corners. Besides four main ridges, they have the centrolophid and a posterior additional ridge differing in development. The anterolophid and metalophid form a loop. The posterior accessory ridge ends free or is at its labial end attached to the mesolophid. In some of the teeth it is composed of several unconnected elements. In one specimen it is absent.

M_1 (MF/2202/2; Fig 1: b) has two, antero-posteriorly flattened roots. Its occlusal surface is rectangular in outline, slightly narrower anteriorly. There are four main ridges and three lower ones, the centrolophid being about as strong as the two accessory ridges. The mesolophid is not attached to the posterolophid. The metalophid is slightly oblique, and the other ridges are perpendicular to the long axis of the tooth.

M_2 (MF/2202/3; Fig. 1: c) is very similar to M_1 but much broader. Its two roots are antero-posteriorly flattened. The anterior border of the crown is slightly wider than the posterior one. The postero-labial corner is protruding. There are four main ridges and three well-developed and isolated, lower, accessory ridges, sometimes merging with the endolophid. The mesolophid may be slightly oblique. The accessory ridges usually occupy three quarters of the width of the crown. No accessory ridges are present on the sides of the centrolophid.

M_3 (MF/2209/4; Fig. 1: d) is three-rooted. Its occlusal surface has four main ridges and three accessory ones. The centrolophid is situated in the middle of the tooth, the accessory ridges extend between the anterolophid and metalophid and between the mesolophid and posterolophid. They both reach the lingual border of the crown.

P^4 (MF/2209/5-6; Fig. 1: e, f) has one root, the longitudinal grooves on which suggest that it was formed by the coalescence of three roots. The occlusal surface is oval, broader than long. There are four main ridges, the anteroloph being well developed. The centroloph is of various length, on the average reaching the middle of the tooth. An additional ridge is always present between the metaloph and the posteroloph.

Both M^1 and M^2 have three roots each, of which one, large and flattened laterally, is situated on the lingual side, the other two, smaller, are situated labially. These two teeth are similar and sometimes difficult to distinguish one from the other. M^1 is smaller, its anterior border is convex, the posterior rectilinear, longer than the former. M^2 is usually larger and particularly broader than M^1, with its anterior border rectilinear and longer than the posterior one. The occlusal surfaces of both teeth are slightly concave.

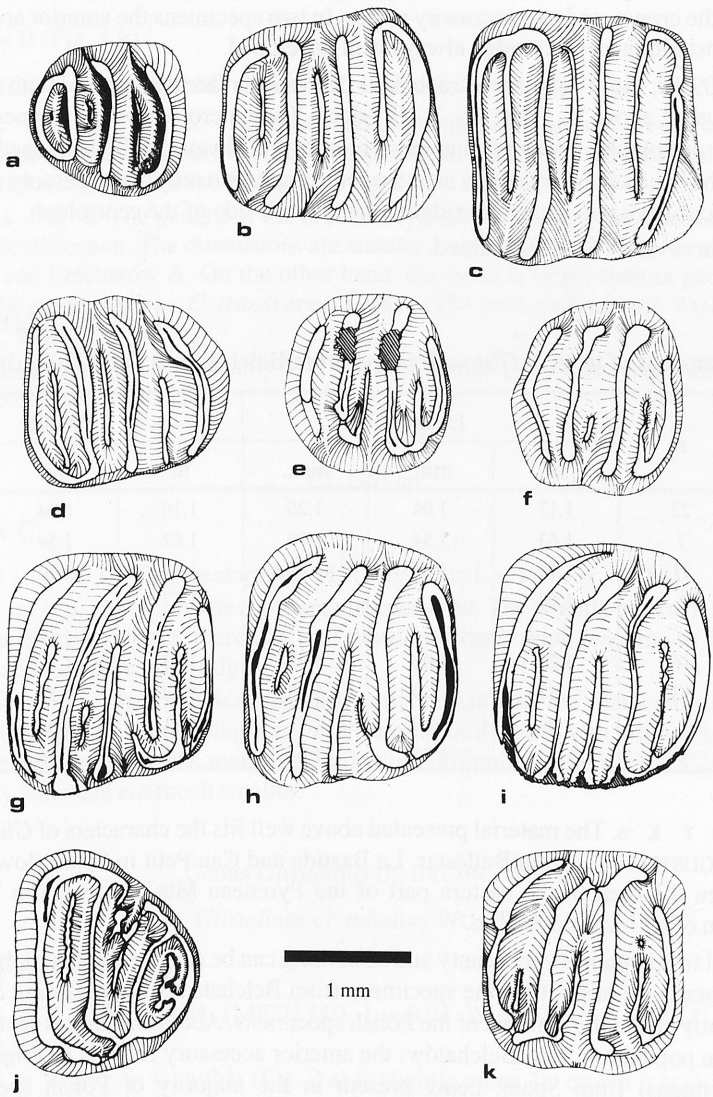

Fig. 1. a-j: *Glis vallesiensis*, Bełchatów A. a – right P_4 (MF/2202/1), b – left M_1 (MF/2202/2), c – left M_2 (MF/2202/3), d – right M_3 (MF/2202/4), e – right P^4 (MF/2202/5), f – right P^4 (MF/2202/6), g – right M^1 (MF/2202/7), h – right M^1 (MF/2202/8), i – right M^2 (MF/2202/9), j – left M^3 (MF/2202/10). k: *Glis* sp., Bełchatów B, right M^2 (MF/2207).

M^1 has four main ridges and the centroloph, which reaches to the middle or to 2/3 of the width of the crown. The centroloph is usually as high as the other main ridges and always independent of them. Only in one tooth the centroloph is much lower than the main ridges. As a rule, two accessory ridges are present: one between the anteroloph and the protoloph, the other between the mesoloph and the posteroloph. In four specimens the anterior accessory ridge is absent. In two others the third accessory ridge is situated behind the centroloph (MF/2202/7, 8; Fig. 1: g, h).

M^2 (MF/2202/9; Fig. 1: i) has four main ridges, the prominent centroloph reaching about 2/3 of the width of the crown, and two accessory ridges. In two specimens the anterior accessory ridge is absent, the posterior accessory ridge always well developed.

M^3 (MF/2209/10; Fig. 1: j) is three-rooted, its occlusal surface is trapezoid with the antero-labial corner elevated above it. There are 7 - 9 ridges. The anteroloph is not connected with the endoloph. The protoloph, metaloph and posteroloph are always well developed. From nine specimens two have no accessory ridges near the centroloph, two only one accessory ridge situated anteriorly and four have two accessory ridges, one on each side of the centroloph.

D i m e n s i o n s: see Table I.

Table I

Dimensions of teeth in *Glis vallesiensis* from Bełchatów A (MF/2202) (in mm)

Tooth	n	Length			Width		
		m	min.	max.	m	min.	max.
P_4	22	1.17	1.04	1.26	1.16	1.04	1.25
M_1	7	1.63	1.54	1.70	1.62	1.54	1.70
M_2	11	1.72	1.65	1.84	1.81	1.70	1.90
M_3	1	1.68			1.62		
P^4	16	1.20	1.01	1.31	1.33	1.21	1.43
M^1	13	1.57	1.49	1.67	1.68	1.52	1.81
M^2	5	1.64	1.60	1.71	1.81	1.67	1.91
M^3	9	1.34	1.26	1.53	1.62	1.56	1.73

R e m a r k s. The material presented above well fits the characters of *Glis vallesiensis* described by AGUSTI (1981) from Ballestar, La Bastida and Can Petit in Spain (lower and upper Vallesien of Seu d'Urgell in the eastern part of the Pyrenean Mts.). This taxon has not been recognized from other localities so far.

The material from Spain is very scanty and so nothing can be said about its variability. P_4 from Spain (2 specimens) are larger than the specimens from Bełchatów; the remaining Spanish teeth are near or slightly above the maxima of the Polish specimens. Accessory ridges seem to be better developed in the population from Bełchatów: the anterior accessory ridge is lacking in the lower molars (2 specimens) from Spain, being present in the majority of Polish specimens. The centrolophid is present in our sole specimen of M_3; it is absent in the specimen from Can Petit. These differences may point to geographical variation in *Glis* in the Late Miocene of Europe.

In the recent fauna the genus *Glis* is represented by one species only in its extensive European area of distribution. Several taxa of *Glis* have been described from the Quaternary, maybe all representing one species, *Glis sackdillingensis* (HELLER, 1930). A smaller species, *Glis minor* KOWALSKI, 1956 is known from the Early Pliocene of Poland.

Glis is rare in the Miocene of Western Europe. It is much more common in the east of Europe, where that genus, represented by *Glis guerbuezi* ÜNAY-BAYRAKTAR, 1989 first appeared in the Middle Oligocene of Turkish Thrace. This species is the smallest and oldest known member of its genus (ÜNAY-BAYRAKTAR 1989).

Glis vallesiensis is the dominant dormouse of the fauna of Bełchatów A. It is characteristic that this species is present in the Vallesian of the Pyreneen Mts., being absent from the rich contemporaneous faunas from the southern Vallès - Penedès (AGUSTI, 1981).

Glis sp.

Bełchatów B (Fig. 1 k)

M a t e r i a l. 1 right M^2 (MF/ 2207; L = 1.48, W = 1.62).

D e s c r i p t i o n. The roots of the sole specimen are not preserved. The occlusal surface is slightly concave. The crown is composed of four main ridges, the centroloph, occupying 2/3 of the occlusal surface and two accessory ridges.

R e m a r k s. The pattern of the crown is typical of *Glis*, but the material is insufficient for specific identification. The dimensions are smaller than those of *G. vallesiensis*, from both its type locality and Bełchatów A. On the other hand, the tooth is larger than in geologically older members of the genus, such as, *G. transversus* ÜNAY, 1994 or *G. gallitopouli* VAN DER MEULEN & DE BRUIJN, 1982

M^2 of *Glis* sp. from Opole (probably MN 7/8) is of similar pattern but larger than the specimen described above (KOWALSKI 1967).

Cf. *Glis* sp.

Bełchatów C

M a t e r i a l: 1 fragmentary left M^1 (MF/2211; L = 1.98, W = 1.84).

D e s c r i p t i o n. The roots are not preserved. The slightly concave crown is deeply worn. Besides the main ridges, there is a well developed centroloph reaching to 3/4 of the width of the crown and two accessory ridges.

R e m a r k s. The tooth described above fits best in with the characters of the genus *Glis* (in *Myoglis* the ridges are more oblique and in *Bransatoglis* the endoloph is more well-developed), but its fragmentary preservation makes identification difficult. All species of *Glis* known so far from the Early Miocene are much smaller.

Genus *Glirudinus* DE BRUIJN, 1966

Glirudinus cf. *minutus* WU, 1993

Bełchatów B (Fig. 2 a - b)

M a t e r i a l: Right M_1 (MF/2174/1, L = 0.91, W = 0.78) and right M^1 (MF/2174/2, L = 1.00, W = 1.05).

D e s c r i p t i o n: M_1 (Fig. 2 a) is slightly worn. Its crown is trapezoid. There are five main and six accessory ridges. Three of the accessory ridges are situated between the anterolophid and the protolophid.

M^1 (Fig. 2 b) is heavily worn. It is three-rooted, with a slightly concave crown. The anterolop extends obliquely backwards and ends free. The protoloph runs parallel to it and continues backwards as the endoloph. There are no extra ridges between the anteroloph and protoloph and between the metaloph and posteroloph. Of four extra ridges two are situated anteriorly and posteriorly to the centrolophs and two between the centrolophs.

R e m a r k s. The morphology and dimensions of the specimens from Bełchatów very well fit the species *G. minutus*. It was first described from Petersbuch 2 and Erkertshofen 2 by WU (1993). According to that author this species is very similar to *G. gracilis* (DEHM, 1950) but differs from it in smaller dimensions and better developed accessory ridges. WU (1993) is of the opinion that *G. minutus* is also present in Wintershof-West, Sansan, Erkertshofen 1 and probably also in Anwil and that it evolved in mammalian zones MN 3 to MN 8 independently of the *G. gracilis* - *G. undosus* lineage.

Glirudinus undosus MAYR, 1979

Bełchatów C (Fig. 2 c - d).

M a t e r i a l: Right M_3 (MF/2172/1; L= 0.89, W = 0.86) and right M^1 (MF/2172/2; L = 1.09, W = 1.27).

D e s c r i p t i o n. M_3 (Fig. 2 c) has one root formed by the coalescence of the anterior and posterior roots and split near its end. The crown has the shape of a triangle with rounded angles. There are five main ridges and four accessory ones.

M^1 (Fig. 2 d) has three roots. Its occlusal surface is flat. There are six well developed accessory ridges. One of them occurs between the anteroloph and protoloph, another one between the metaloph and posteroloph. The anterior centroloph is longer than the posterior and reaches the endoloph. The posterior centroloph ends free. The metaloph is slightly S-shaped.

R e m a r k s. The above mentioned characters are typical for *G. undosus*. They are: the number of roots, the high number of accessory ridges and, particularly, the presence of these last between the metaloph and posteroloph as well as the S-shaped metaloph. Another species of the same size-group, *G. modestus* (DEHM, 1950), is slightly smaller and has much worse-developed accessory ridges.

G. undosus was first described by MAYR (1979) from Erkertshofen 1 (MN 4). It was also cited from Petersbuch 2, Erkertshofen 2, Schneitheim and Forsthart in Germany (WU 1993), from Buñol

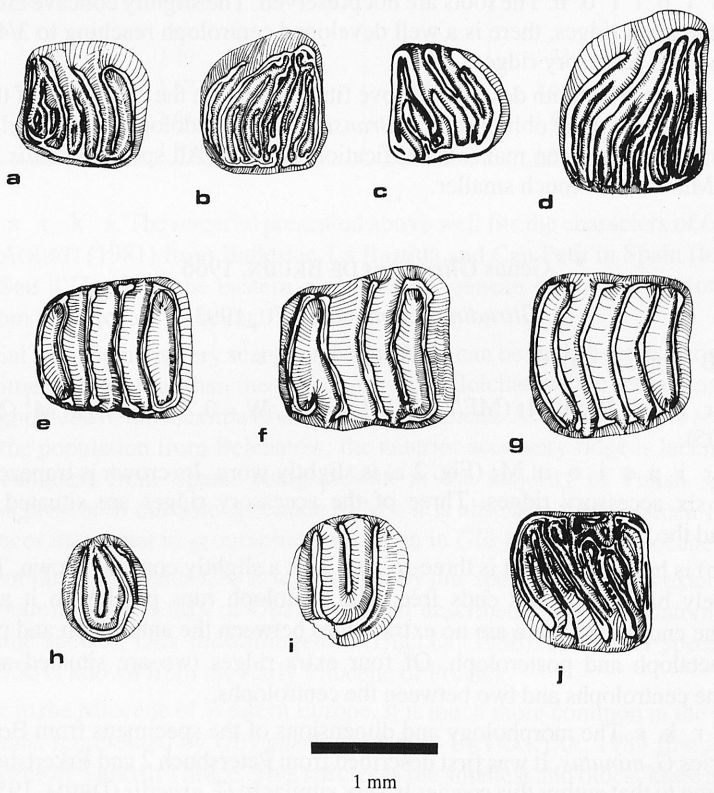

Fig. 2. a-b: *Glirudinus* cf. *minutus*, Bełchatów B. a – right M_1 (MF/2174/1), b – right M^1 (MF/2174/2). c-d: *Glirudinus undosus*, Bełchatów C. c – right M_3 (MF/2172/1), d – right M^1 (MF/2172/2). e-j: *Muscardinus hispanicus*, Bełchatów A. e – right M_1 (MF/2168/3), f – right M_1 (MF/2168/5), g – left M_2 (MF/2168/6), h – left dP^4 (NF/2168/8), i – left P^4 (MF/2168/9), j – left M^1 (MF/2168/10).

(DAAMS 1976) and Can Marti Vell in Spain (AGUSTI 1983) and from Petit Camon, Mounicot and Bézian in France (BAUDELOT & COLLIER 1982). It is represented in mammalian zones MN 3 to MN 4.

Glirudinus sp.

Bełchatów B

M a t e r i a l: Right M^1 (MF/2173; L = 1.34, W = 1.43).

D e s c r i p t i o n. The crown is flat. Besides 6 main ridges there are 6 accessory ones. The accessory ridge between the protoloph and anterior centroloph is as high as the main ridges. There is a short ridge between the anteroloph and protoloph. No accessory ridge is present between the metaloph and posteroloph.

The metaloph is straight. Both centrolophs are long, the anterior one is longer and joins the protoloph.

R e m a r k s. The tooth was collected at an early stage of work in Bełchatów. No more material of this species has been found in Bełchatów B. The specimen was studied by Prof. V. FAHLBUSCH, who identified it as "*Glirulus* sp., the group *Gl. gracilis - undosus*". The dimensions point rather to *G. undosus*, but in *G. undosus* the metaloph is S-shaped and an accessory ridge is always present between the metaloph and posteroloph.

The material is too scanty for identification to species level. The presence of this tooth is, however, a proof that two different species of *Glirudinus* were represented in the fauna of Bełchatów B.

Genus *Muscardinus* KAUP, 1829

Muscardinus hispanicus DE BRUIJN, 1966

Bełchatów A (Fig. 2 e - j)

M a t e r i a l: 10 isolated molars: 2 right, 3 left M_1, 1 right, 1 left M_2, 1 left dP^4, 1 left P^4, 1 left M^1. Also two fragments of molars (MN/2168). At least 3 individuals are represented in the material.

D e s c r i p t i o n: The occlusal surface is flat. Enamel ridges are transverse and slightly curved anteriorly in lower molars, oblique in the only upper molar present in the material.

Roots are preserved only in one M_1 (MF/2168/2). It is two-rooted, with the anterior root bifurcated near its end. The crown is slightly narrower anteriorly. Four specimens (e.g. MF/2168/3, Fig. 2 e) have six complete main ridges and no accessory ridges (morphotype 3 in DAAMS, 1985). The remaining specimen (MF/2168/5, Fig. 2 f) has five complete ridges and an incomplete one (morphotype 2).

Both M_2 have six main ridges and no accessory ones. In one specimen (MF/2168/6, Fig. 2 g) the bases of three roots are present (one posterior and two anterior ones).

dP^4 (MF/2168/8, Fig.2 h) and P^4 (MF/2168/9, Fig. 2 i) are one-rooted. They are oval and their crowns have four transverse ridges each. In P^4 the posterior ridge is low and insignificant.

The only M^1 (MF/2168/10, Fig. 2 j) is deeply worn, and its crown pattern is not well preserved. It has six oblique main ridges, a long centroloph and four low, accessory ridges.

D i m e n s i o n s: see Table II.

Table II

Dimensions of molars in *Muscardinus hispanicus* from Bechatów A (in mm)

Tooth	Length	Width
M_1, No 2168/1	1.17	0.97
M_1, No 2168/2	1.16	–
M_1, No 2168/3	1.12	1.00
M_1, No 2168/4	1.12	1.00
M_1, No 2168/5	1.29	1.16
M_2, No 2168/6	1.21	1.23
M_2, No 2168/7	1.27	1.24
dP^4, No 2168/8	0.63	0.76
P^4, No 2168/9	0.82	0.98
M^1, No 2168/10	1.06	0.99

R e m a r k s. The genus *Muscardinus* probably evolved in Europe from the genus *Glirudinus* DE BRUIJN, 1966. One of its oldest members, *Muscardinus sansaniensis* (LARTET 1851), originally described from Sansan (MN 6), has been identified in localities ranging from MN 5 (e.g. Puttenhausen; FAHLBUSCH & WU 1981) to MN 8 (Anwil; ENGESSER, 1972). WU (1993) identified in Petersbuch 2 (MN 4a) *Muscardinus* cf. *sansaniensis*. Later populations of *Muscardinus* originating from zones MN 9 to MN 16 belong to two lineages: one with small forms [*M. sansaniensis* - *M. avellanarius* (LINNAEUS, 1758)] and one with larger-sized species, leading to *M. dacicus* KORMOS, 1930. At the beginning of MN 9 two different forms of this genus are present in European faunas. The second lineage disappeared in the Pleistocene.

In both lineages the evolution of *Muscardinus* is generally towards a more flat occlusal surface of the molars, towards a reduction of accessory ridges, and towards larger dimensions and development of additional roots in cheek teeth.

The population from Bełchatów B is identical to *M. hispanicus*. This species was first described as *M. pliocaenicus hispanicus* by DE BRUIJN (1966) from Pedregueras 2C (MN 9) in Spain. In the same year HARTENBERGER (1966) established a new taxon, *M. crusafonti*, for the specimens from Can Llobateres. The latter form seems to be identical with *M. hispanicus* and according to DAAMS (1985) *M. crusafonti* is a junior synonym. I had the opportunity to compare my specimens from Bełchatów A with the holotype of *M. hispanicus* in the Institute of Paleontology in Sabadell and found them completely identical.

M. hispanicus was later cited from Montrédon (MN 10; AGUILAR 1982) and Castelnou 1 (MN 12, AGUILAR et al. 1995), both in France, and from Marktl and Hammerschmiede in Germany (MN 9; MAYR 1979). *M. crusafonti*, in addition to its type-locality Can Llobateres (MN 9; HARTENBERGER 1966), is also known from Peralejos and Masia del Barbo 2A and 2B (MN 10, VAN DE WEERD 1976), as well as from Carrilanga 1 and Pedregueras 2C (MN 9, DAAMS 1985), all in Spain. It was identified from Camanesti 2b in Romania (MN 9; FERU, RADULESCO, SAMSON 1980), and from Kastellios Hill in Greece (MN 10; DE BRUIJN & ZACHARIASSE 1979) as *M.* cf. *crusafonti*.

The size, crown-pattern and the number of roots differentiate the Bełchatów population of *M. hispanicus* from the older species *M. sansaniensis*, and from numerous species described from periods younger than MN 10.

Genus *Myoglis* BAUDELOT, 1966

Myoglis antecedens MAYR, 1979

Bełchatów C (Fig. 3 a - g)

M a t e r i a l. 9 isolated teeth: 1 right P_4, 1 right M_1, 2 damaged left M_1, 1 left M_2, 1 left M_3, 1 left P^4, 1 left M^1, 1 left M^2 (MF/2214). At least 2 individuals are represented in the material.

D e s c r i p t i o n. The crowns of cheek-teeth are low and flat. The ridges are narrow, the valleys broad.

P_4 (MF/2214/1, Fig. 3 a) has one root with longitudinal grooves on both sides and bifurcated near end. The valleys between the meta- and mesolophid and between the meso- and posterolophid are open on both sides of the tooth.

M_1 was probably two-rooted (the roots are not preserved) and its occlusal surface is subrectangular. Only one specimen is complete (MF/2214/2, Fig. 3 b). The main ridges are only slightly oblique. Between the anterolophid and the metalophid an accessory, in some case sinuous ridge is present. Another accessory ridge is present in all specimens beween the mesolophid and posterolophid, reaching to one fourth or half of the width of the tooth.

M_2 (MF/2214/5, Fig. 3 c) has a subquadrate occlusal surface with oblique ridges. The anterolophid is straight, the other ridges being undulated. The best-developed accessory ridge is situated between the anterolophid and metalophid; its labial end joins the anterolophid. In the valley between the meta- and mesolophid irregular elevations of enamel replace the accessory ridge.

M_3 (MF/2214/6, Fig. 3 d) is relatively large, and slightly narrowes posteriorly. It has two well-developed accessory ridges: one between the antero- and metalophid, the other between the meso- and posterolophid.

P^4 (MF/2214/7, Fig. 3 e) has an oval occlusal surface with 5 main ridges. The centroloph is bifurcated near the labial border of the tooth.

No trace of accessory ridges is observed.

M^1 (MF/2214/8, Fig. 3 f) has no accessory ridges. One isolated centroloph, reaching the middle of the tooth, is present. The valley between the anteroloph and metaloph is open on both sides.

M^2 (MF/2214/9, Fig. 3 g) is very similar to M^1 but with a more rectangular occlusal surface. Short accessory ridges are present at both sides of the centroloph.

D i m e n s i o n s: see Table III.

Table III

Dimensions of teeth in *Myoglis antecedens* from Bełchatów C (in mm)

Tooth	Length	Width
P_4, No 2214/1	1.16	1.04
M_1, No 2214/2	1.22	1.24
M_1, No 2214/3	1.15	1.12
M_1, No 2214/4	–	1.17
M_2, No 2214/5	1.62	1.43
M_3, No 2214/6	1.31	1.37
P^4, No 2214/7	1.09	1.27
M^1, No 2214/8	1.65	1.73
M^2, No 2214/9	1.60	1.76

R e m a r k s. Flat and low crowns of molars with ridges oblique to the longitudinal axis of the teeth are characteristic of the genus *Myoglis*, present in Europe during the Early and Middle Miocene. The oldest record of this genus is from several German localities in the region of Ulm (WERNER 1994), all representing zone MN 2.

A more modern species off the same lineage is *M. antecedens* MAYR, 1979 described from Erkertshofen 1 (MAYR 1979) and recognized also by the same author in Rubielos de Mora in Spain (originally described as *Myoglis* sp. by DE BRUIJN & MOLTZER 1974), and at Dolnice 1-3 and boring Kr 72 in the Czech Republic (ČTYROKY, FEJFAR, HOLY 1964). It was later found in Petersbuch 2 (WU 1993). All localities of this species represent zone MN 4.

In younger localities *Myoglis* is represented by *M. meini* (DE BRUIJN, 1965) described from Manchones in Spain (MN 6) and later recognized in several fossil localities reaching from Spain through France (Sansan) to Romania (e.g. Comanesti; FERU, RADULESCO, SAMSON 1980). *Myoglis larteti* BAUDELOT, 1966 described from Sansan is junior synonym of *M. meini*. The *Myoglis anecedens-meini* lineage covers MN4 - MN9.

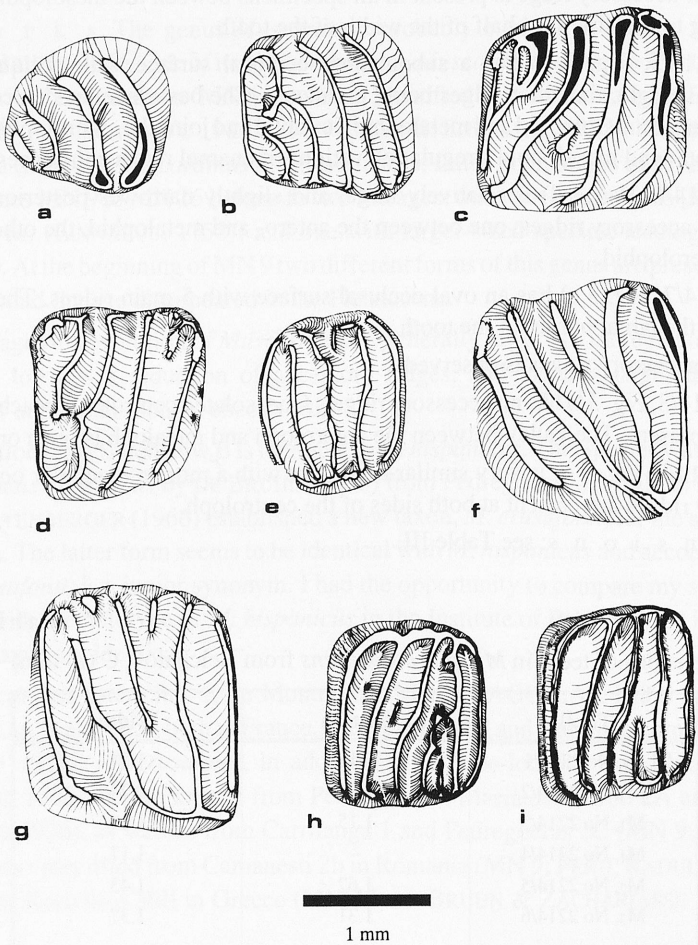

Fig. 3. a-g: *Myoglis antecedens*, Bełchatów C. a – right P_4 (MF/2214/1), b – right M_1 (MF/2214/2), c – left M_2 (MF/2214/5), d – left M_3 (MF/2214/6), e – left P^4 (MF/2214/7), f – left M^1 (MF/2214/8), g – left M^2 (MF/2214/9). h-i: Cf. *Heteromyoxus* sp., Bełchatów C. h – right M^2 (MF/2212/1), i – right M_2 (MF/2212/2).

The population from Bełchatów represents a similar level of evolution to that of *M. antecedens*. The Bełchatów specimens are of the same size or only slightly smaller than the population of *M. antecedens* from Petersbuch 2 and in pattern they resemble the molars from that locality. On the other hand, *M. larteti* is much larger and the ridges of its upper molars are more oblique.

Genus *Heteromyoxus* DEHM, 1938

Cf. *Heteromyoxus* sp.

Bełchatów C (Fig. 3 h - i)

M a t e r i a l. 2 isolated right M^2 (MF/2212/1; L = 1.20, W = 1.36 and MF/2212/2; L = 1.21, W = 1.39).

D e s c r i p t i o n. Both teeth have low, flat crowns in the form of rounded rectangles. They were probably four-rooted but the roots are not preserved. The labial borders of the teeth are slightly incised in the middle of their lengths. The ridges are narrow, the valleys very broad. The posterior part of the anteroloph extends into the endoloph and forms an uninterrupted ridge along the lingual border of the crown. The anterior centroloph reaches the endoloph. In one of the teeth (MF/ 2213/1, Fig. 3 h), the posterior centroloph is irregular, interrupted in its lingual part and connected by a longitudinal crest with the metaloph. In this tooth two short accessory ridges occurr between the anteroloph and protoloph and between the protoloph and anterior centroloph. In both teeth the accessory ridge between the metaloph and posteroloph is lacking.

R e m a r k s. From Eggingen in Germany SCHLOSSER (1884) described a new species, *Myoxus wetzleri*, with very peculiar lower molars in which transverse ridges are interconnected by short, longitudinal crests. DEHM (1938) gave this taxon a new generic name, *Heteromyoxus*. Later the same author established (DEHM 1950) a new species, *Heteromyoxus schlosseri*, with Wintershof-West as its type locality. According to him, the new species differs from *H. wetzleri* in slightly larger dimensions and details of the crown-pattern of lower molars.

The lower molars, which are particularly characteristic of the genus *Heteromyoxus*, are not represented in Bełchatów. Upper molars described above resemble in general pattern the specimens of both species of *Heteromyoxus* as illustrated by WU (1993) and WERNER (1994). They differ, however, in the lack of the accessory ridge between the metaloph and posteroloph, which is always present in both forms of *Heteromyoxus*. They are also much smaller than the teeth of the members of this genus.

Heteromyoxus is a rare form, so far known only from Germany and France. In Germany it was described from Eggingen (SCHLOSSER 1884, DEHM 1938, WERNER 1994), Bissingen (SCHALK 1957), Schaffhausen and Treuchtlingen 2 (DEHM 1978), Wintershof-West (DEHM 1950), Stubersheim 3 and Petersbuch 2 (WU 1993). Scarce remains have also been described from French localities Estrepouy and Mounicot (BAUDELOT & COLLIER 1982). All these localities belong to the mammalian zones MN 1/2 to MN 4a.

The specimens from Bełchatów do not belong to any of the described species of *Heteromyoxus*. They may represent either a new species of *Heteromyoxus*, or another, so far undescribed glirid genus. The available material is too poor for difinite identification.

Genus *Microdyromys* DE BRUIJN, 1966

Microdyromys sp.

Bełchatów A (Fig. 4 a - c)

M a t e r i a l. 3 isolated right lower teeth: P_4 (MF/2206/1; L = 0.72, W = 0.61), M_1 (MF/2206/2; L = 0.87, W = 0.77), M_2 (MF/2206/3; L = 0.88, W = 0.90). All teeth may belong to one individual.

D e s c r i p t i o n. The occlusal surface is concave. P_4 has four main ridges, a well developed centrolophid and two accessory ridges. M_1 is elongated. Its anterior accessory ridge and centrolophid are irregular; the posterior accessory ridge is well developed. M_2 is slightly damaged and has a well-developed centrolophid as well as two accessory ridges, one in the anterior, the other in the posterior part of the crown.

R e m a r k s. The 3 teeth described above have the crown-pattern of the genus *Microdyromys*. I could compare them directly with specimens of *M. complicatus* DE BRUIJN 1966 from Sansan which are, however, usually more complicated in their crown pattern. They fit rather *M. koenigswaldi* but the lack of upper molars makes their specific identification impossible. *Microdyromys* has not been so far known from younger zones than MN 8.

Microdyromys koenigswaldi DE BRUIJN, 1966

Bełchatów B (Fig. 4 d - e).

M a t e r i a l. 2 isolated molars: right M^1 (MF/2159/1; L = 0.88, W = 1.03) and left M^2 (MF/2159/2; L = 0.89, W = 1.06).

D e s c r i p t i o n: The occlusal surface of both teeth is distinctly concave. The lingual side of the crown is ornamented. All four main ridges are connected with the endoloph. The anterior centroloph is longer than the posterior, in M^1 the centrolophs are separated at the end, in M^2 nearly fused together. The accessory ridges are lower than the main ones. In M^1 besides six main ridges one insignificant additional ridge is present between the anteroloph and protoloph and another between the protoloph and anterior centroloph. There is also a cusp on the border of the tooth, between the centrolophs (Fig. 4 d). In M^2 there is only one accessory ridge between the protoloph and the anterior centroloph (Fig. 4 e).

R e m a r k s. The characteristics of the teeth are conformable to the diagnosis of the genus *Microdyromys* given by DE BRUIJN (1966). This genus, present from the Upper Oligocene to the end of the Middle Miocene of Europe has also been recognized in China (WU 1986) and in Kazakhstan (KOWALSKI, SHEVYREVA 1997). From seven species of the genus known so far *M. praemurinus* (FREUDENBERG, 1941), *M. legidensis* DAAMS, 1981 and *M. monspeliensis* AGUILAR, 1977, limited to the Oligocene and lower Miocene, are of smaller dimensions than our specimens. *M. sinuosus* (ALVAREZ SIERRA, 1986) has more or less undulating ridges and a very complicated structure of the crown. *M. sinensis* WU, 1986 is about the size of our specimens, but its anterior and posterior centrolophs are fused together at the end, whereas in our teeth they are not fused. This species is also very distant in respect of its geographic location from all the remaining members of the genus.

The specimens of Bełchatów B are very similar to two species known from the Upper Miocene of Europe: *M. complicatus* DE BRUIJN, 1966 and *M. koenisgwaldi*. Both these species occur together in many localities. According to DAAMS (1981) "most of the teeth in these associations, however, cannot be assigned to species". The teeth of *M. complicatus* have usually more well-developed additional ridges and are larger. First two upper molars of *M. koenigswaldi* have only one or two additional ridges each, just as in our specimens. I compared the M^1 from Bełchatów B with the holotype of *M. koenigswaldi* and found them being nearly identical. It seems justified to determine the scanty material from Bełchatów B as belonging to *M. koenigswaldi*.

M. koenigswaldi described by DE BRUIJN (1966) from Valdemoros 3B in Spain (MN 4) was identified from numerous Miocene localities covering mammalian zones from MN 4b to MN 7/8 (WU 1993) in Spain, France, Switzerland, Germany, and the Czech Republic (FEJFAR & ROČEK 1986). "cf. *Microdyromys koenigswaldi*" was listed from Pasalar in Anatolia (FLYNN & JACOBS 1990).

Glirulus THOMAS, 1906

Glirulus diremptus (MAYR, 1979)

Bełchatów C (Fig. 4 f -h).

M a t e r i a l: 3 isolated molars: right M_1 (MF/2215/1; L = 0.93, W = 0.87), right M_2 (MF/2215/2; L = 0.92, W = O.87), left M^2 (MF/2215/3; L = 0.85, W = 0.82).

D e s c r i p t i o n. Lower molars with two roots, upper M^2 three-rooted. Grinding surface of the crowns distinctly concave. Lower molars without continuous endolophid. The crown of M_1 is composed of four main ridges, a bifurcated centrolophid and three lower, accessory ridges (Fig. 4 f). This tooth is narrower in its anterior part. M_2 , on the contrary, is narrower posteriorly, has one strong centrolophid and three accessory ridges (Fig. 4 g).

M^2 has a continuous endoloph and ornamented lingual side of the crown. Besides four main ridges, two centrolophs and three accessory ridges are present. The anterior centroloph is longer than the posterior one, but it is not directly connected with the endoloph (Fig. 4 h).

R e m a r k s. The teeth described above have all characters of the genus *Glirulus* present in Europe from MN3 till the end of the Neogene and the oldest part of the Quaternary and which has survived in East Asia until now. In the structure of the crown and in dimensions they agree with the species *G. diremptus*.

In 1972 ENGESSER created the new genus *Paraglirulus* for *P. werenfelsi* from Anwil, similar to *Glirulus*, but characterized by lack of the continuous endolophid, which is present in the late

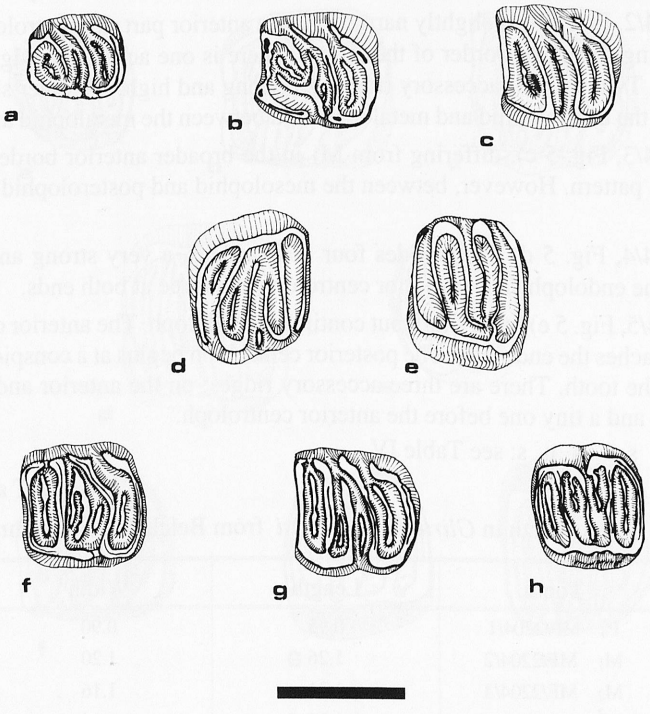

Fig. 4. a-c: *Microdyromys* sp., Bełchatów A. a – right P_4 (MF/2206/1), b – right M_1 (MF/2206/2), c – right M_2 (MF/2206/3). d-e: *Microdyromys koenigswaldi*, Bełchatów B. d – right M^1 (MF/2159/1), e – left M^2 (MF/2159/2). f-h: *Glirulus diremptus*, Bełchatów C. f – right M_1 (MF/2215/1), g – right M_2 (MF/2215/2), h – left M^2 (MF/2215/3).

Neogene and Recent *Glirulus*. MAYR (1979) first described *Paraglirulus diremptus* from Erkertshofen in Germany (MN 4). The same form was later found in Puttenhausen in Germany (MN 5; FAHLBUSCH & WU 1981) and in Aliveri (Greece, MN 4) by VAN DER MEULEN & DE BRUIJN (1982).

VAN DER MEULEN and DE BRUIJN (1982) do not recognize *Paraglirulus* as a genus different from *Glirulus*. They found high variability of the main character distinguishing *Glirulus* from *Paraglirulus*: the presence of a continuous endolophid in the former and an incomplete one in the latter. Also the number of roots in lower molars (three in *Glirulus*, two in *Paraglirulus*) is not, according to these authors, a useful character for distinguishing them as two genera. VAN DER MEULEN and DE BRUIJN (1982) therefore recognize *Glirulus* s.s. and *Paraglirulus* only as two subgenera. According to these authors the lineage of *Glirulus* contains small species, that of *Paraglirulus* larger ones. They place *G. diremptus* in the subgenus *Paraglirulus*.

Glirulus werenfelsi (ENGESSER, 1972)

Bełchatów A (Fig. 5 a - e).

M a t e r i a l. 5 isolated teeth: right P_4, left M_1, right M_2, left M^2, left M^3 (MF/2204/1-5).

D e s c r i p t i o n. In all specimens the roots are missing. The crowns are distinctly concave. There is no continuous endolophid, but the endoloph is always continuous.

P_4 (MF/2204, Fig. 5 a) is short and broad. It has four main ridges, a well-developed centrolophid, a short accessory ridge before the centrolophid and two other accessory ridges, nearly as high as the main ones. The anterolophid and metalophid are not connected labially.

M_1 (MF/2204/2, Fig. 5 b) is slightly narrower in its anterior part. Its centrolophid is very well developed reaching the labial border of the crown. There is one accessory ridge on each side of the centrolophid. Two pairs of accessory ridges (one long and high, the other short and low) are situated between the anterolophid and metalophid and between the metalophid and posterolophid.

M_2 (MF/2204/3, Fig. 5 c), differing from M_1 in the broader anterior border of the crown is similar to it in its pattern. However, between the mesolophid and posterolophid there is only one accessory ridge.

M^2 (MF/2204/4, Fig. 5 d) has, besides four main ridges, a very strong anterior centroloph connected with the endoloph. The posterior centroloph ends free at both ends.

M^3 (MF/2204/5, Fig. 5 e) has a short, but continuous endoloph. The anterior centroloph is well developed and reaches the endoloph. The posterior centroloph begins at a conspicuous cusp on the labial border of the tooth. There are three accessory ridges: on the anterior and on the posterior part of the crown and a tiny one before the anterior centroloph.

D i m e n s i o n s: see Table IV.

T a b l e IV

Dimensions of teeth in *Glirulus werenfelsi* from Bełchatów A (in mm)

Tooth		Length	Width
P_4	MF/2204/1	0.95	0.90
M_1	MF/2204/2	1.26	1.20
M_2	MF/2204/3	1.21	1.16
M^2	MF/2204/4	1.26	1.34
M^3	NF/2204/5	0.98	1.02

R e m a r k s. The small series of teeth from Bełchatów A well fits the specimens of *G. werenfelsi* from Anwil in Switzerland with which I had the opportunity to compare them directly.

The dimensions of specimens from Bełchatów A are very similar, may be slightly larger than those from Anwil and the number of accessory ridges higher. These ridges seem to be higher than in the typical series from Anwil.

Glirulus werenfelsi was first described by ENGESSER (1972) as *Paraglirulus werenfelsi* from Anwil in Switzerland (MN 7/8). It was also noted from other localities in Switzerland: Tobel-Hombrechtikon (MN 5/6), Ornberg-Dürnten (MN 6) and Grat-Kirchberg (MN 7) by BOLLIGER (1992). It was described from Schönenberg (MN 5), Kleineisenbach (MN 7/8), Giggenhausen (MN 7/8) and Marktl (MN 9), all in Germany, by MAYR (1979) as well as from another German locality, Puttenhasen (MN 5) by FAHLBUSCH and WU (1981). Finally, it was listed from Las Planas 4C (MN 5) and Valalto 2C (MN 6) in Spain by DAAMS (1989).

Bełchatów B (Fig. 5 f - h).

M a t e r i a l. 4 isolated molars: left M_1 (MF/2209/1), left M^1 (MF/2209/2), damaged left M^1 (MF/2209/3), right M^2 (MF/2209/4). At least two individuals are represented in the material.

D e s c r i p t i o n. M_1 (MF/2209/1; Fig. 5 f) has less complicated structure than the same tooth in *G. werenfelsi* from Bełchatów A. There are no accessory ridges anteriorly and posteriorly to the centrolophid and there is only one accessory ridge between the anterolophid and metalophid and between the mesolophid and posterolophid.

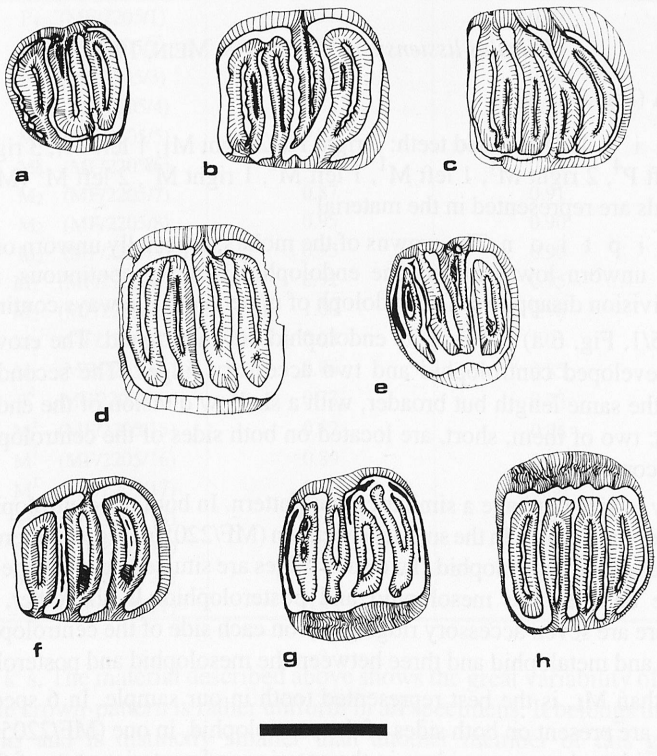

Fig. 5. *Glirulus werenfelsi*. a-e: Bełchatów A. a – right P_4 (MF/2204/1), b – left M_1 (MF/2204/2), c – right M_2 (MF/2204/3), d – left M_2 (MF/2204/4), e – left M^3 (MF/2204/4). f-h: Bełchatów B. f – left M_1 (MF/2209/1), g – left M^1 (MF/2209/2), h – right M^2 (MF/2209/4).

The upper molars have a continuous endoloph and a distinctly ornamented labial wall of the crown. Both M^1 and M^2 have four accessory ridges each and their centroloph is connected with the endoloph (Fig 5 g - h).

D i m e n s i o n s: see Table V.

Table V

Dimensions of teeth in *Glirulus werenfelsi* from Bełchatów B (in mm)

Tooth	Length	Width
M_1 MF/2209/1	1.15	1.08
M^1 MF/2209/2	1.12	1.19
M^1 MF/2209/3	1.25	1.18
M^2 MF/2209/4	1.17	1.27

R e m a r k s. The described material very well fits the species *Glirulus werenfelsi*. The crown-pattern of molars is simpler than in the population of the same species from Bełchatów A, but nearly identical with specimens from the type locality of the species, Anwil in Switzerland, with which I was able to compare them directly. It is very probable that in the case of *Glirulus werenfelsi* in Bełchatów B and A we have to do with representatives of one evolutionary lineage from two stages of their evolution, progressing towards a more complicated crown-pattern.

The distribution of *G. werenfelsi* was discussed above.

Glirulus lissiensis HUGUENEY & MEIN, 1965

Bełchatów A (Fig. 6 a - h)

M a t e r i a l. 21 isolated teeth: 3 right P_4, 2 right M_1, 1 left M_1, 3 right M_2, 3 left M_2, 1 right M_3, 1 left P^4, 2 right M^1, 1 left M^1, 1 left M^2, 1 right M^3, 2 left M^3 (MF/2205/1-21/. At least 3 individuals are represented in the material.

D e s c r i p t i o n. The crowns of the molars, especially unworn ones, are distinctly concave. In the unworn lower molars the endolophid is never continuous, in strongly worn specimena, its division disappears. The endoloph of upper teeth is always continuous

P_4 (MF/2205/1, Fig. 6 a) is worn, its endolophid not interrupted. The crown has four main ridges, a well-developed centrolophid and two accessory ridges. The second specimen of P_4 (MF/2205/2) is the same length but broader, with a shallow division of the endolophid and four accessory ridges: two of them, short, are located on both sides of the centrolophid. The third P_4 resembles the second one.

Two M_1 vary in size but have a similar crown-pattern. In both the centrolophid, ending at the base of the endolophid, is long. In the smaller specimen (MF/2205/4, Fig. 6 b) there are no accessory ridges on the sides of the centrolophid. Two such ridges are situated between the anterolophid and metalophid, one between the mesolophid and posterolophid. In the other, larger specimen (MF/2205/5) there are seven accessory ridges: one on each side of the centrolophid, two between the anterolophid and metalophid and three between the mesolophid and posterolophid.

M_2, shorter than M_1, is the best represented tooth in our sample. In 6 specimens two short accessory ridges are present on both sides of the centrolophid, in one (MF/2205/6, Fig. 6 c) there is only one such ridge. Accessory ridges in the anterior and posterior parts of the crown may be accompanied by smaller ridges varying in development.

In the unique M_3 (MF/2205/13, Fig. 6 d) the well-developed centrolophid is not accompanied by accessory ridges but in the anterior and the posterior part of the crown there are pairs of such ridges.

P^4 (MF/2205/14, Fig. 6 e) is oval. The anteroloph is free at both ends being completely unconnected with the endoloph. A narrow accessory ridge is situated in front of the centroloph. Of the two remaining accessory ridges one occurs between the anteroloph and the metaloph, and the other between the mesoloph and the posteroloph.

M^1 (MF/2205/15, Fig. 6 f) has a continuous endoloph and a well developed anterior centroloph connected with the endoloph. The posterior centroloph is shorter and free at both ends. One accessory ridge is situated anteriorly to the centrolophs, the other two are in the anterior and posterior ends of the crown. The crown-pattern of the remaining two specimens is similar.

M^2 (MF/2205/18, Fig. 6 g) is nearly unworn. Its endoloph is continuous and the lingual side of the crown sculpted. The anterior centroloph reaches the border of the endoloph but does not join it and is distinctly lower. The posterior centroloph is shorter. Of three accessory ridges one is situated before the anterior centroloph, two others in the anterior and posterior parts of the crown.

Three specimens of M^3 are quite different in their proportions, but all have a continuous endoloph, two centrolophs and three accessory ridges. The represented specimen (MF/2005/19, Fig. 6 h) is relatively unworn, two others have heavily worn crowns.

D i m e n s i o n s. See Table VI

Table VI

Dimensions of teeth in *Glirulus lissiensis* from Bełchatów A (in mm)

Tooth	Length	Width
P_4 (MF/2205/1)	0.77	0.69
P_4 (MF/2205/2)	0.77	0.74
P_4 (MF/2205/3)	0.78	0.64
M_1 (MF/2205/4)	0.82	0.73
M_1 (MF/2205/5)	0.92	0.86
M_2 (MF/2205/6)	0.78	0.84
M_2 (MF/2205/7)	0.87	0.91
M_2 (MF/2205/8)	0.95	0.90
M_2 (MF/2205/9)	0.93	0.90
M_2 (MF/2205/10)	0.92	0.95
M_2 (MF/2205/11)	1.00	0.96
M_2 (MF/2205/12)	0.98	1.01
M_3 (MF/2205/13)	0.86	0.85
P^4 (MF/2205/14)	0.73	0.73
M^1 (MF/2205/15)	0.82	0.76
M^1 (MF/2205/16)	0.89	0.88
M^1 (MF/2205/17)	0.80	0.80
M^2 (MF/2205/18)	0.92	0.98
M^3 (MF/2205/19)	0.79	0.76
M^3 (MF/2205/20)	0.70	0.90
M^3 (MF/2205/21)	0.83	0.79

R e m a r k s. The material described above shows the great variability of dimensions and proportions but the crown-pattern is rather uniform in all specimens. It belongs unquestionably to the genus *Glirulus* and is distinctly smaller than another member of this genus present in Bełchatów A, *G. werenfelsi*. Its dimensions and crown-pattern well fit two species belonging to the small-size lineage of *Glirulus*, *G. lissiensis* and *G. conjunctus* (MAYR, 1979). According to DAXNER-HÖCK and DE BRUIJN, 1981), the differences between *lissiensis* and *conjunctus* are unsufficient for specific discrimination. I therefore use the name *G. lissiensis*, which has priority.

G. lissiensis was first described by HUGUENEY and MEIN (1965) from Lissieu (MN 13) in France. It is also known (as *G.* cf. *lissiensis*) from Ambérieu (MN 13) in France (FARJANEL, MEIN 1984). In Austria this species was identified from Eichkogel (MN 11) by DAXNER-HÖCK and DE BRUIJN (1981) and from Kohfidisch (MN 11) by BACHMAYER and WILSON (1983), in the last locality as *Paraglirulus* cf. *P. lissienis*. It was noted from Suchomasty (MN 10) in the Czech Republic (FEJFAR 1990) and from Rudabánya in Hungary (KRETZOI et al. 1974).

G. conjunctus described (as *Paraglirulus conjunctus*) from Marktl (MN 9) in Germany by MAYR (1979) was also present, according to the same author, in other German localities: Adelsberg (MN 5), Eitensheim (MN 5), Schönenberg (MN 6) Kleineisenbach (MN 8), Giggenhausen (MN 8) and Hammerschmiede (MN 9). MEIN and ROMAGGI (1991) hold a different opinion about the systematic relation of *G. lissiensis* and *G. conjunctus*. In Saint-Bauzile in southern France they discovered a skeleton of *G. lissiensis* with an imprint of soft parts pointing to the existence of a patagium. This would be the first known glirid that adapted to gliding. According to their opinion, *G. conjunctus* developed in the Middle Miocene from *G. diremptus* and became extinct in MN 10. *G. lissiensis* developed at the same time from *diremptus* as an independent lineage and survived until MN 14 when it evolved into *G. pusillus* (HELLER, 1936).

Glirulus minor first described from Petersbuch 2 (MN 4) by WU (1993) is smaller and has a simpler crown-pattern than the form from Bełchatów. *G. ekremi* diagnosed from the specimens from Keseköy (MN 3) by ÜNAY (1994) is characterized by its incomplete endoloph. It is worth mentioning that this species, known from a large sample, is very variable.

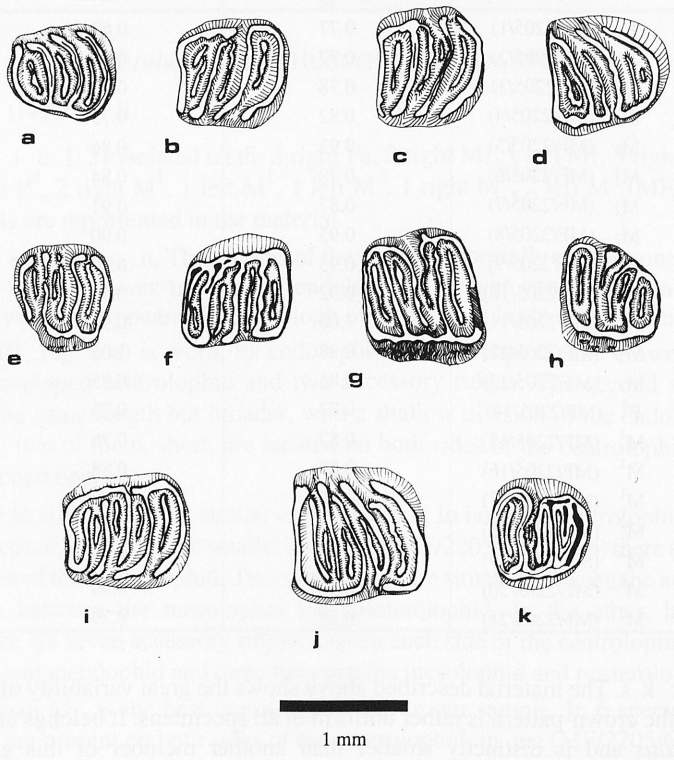

Fig. 6. *Glirulus lissiensis* . a-h: Bełchatów A. a – right P_4 (MF/2205/1), b – left M_1 (MF/2205/4), c – left M_2 (MF/2205/6), d – right M_3 (MF/2205/13), e – left P^4 (MF/2205/14), f – rigtht M^1 (MF/2205/15), g – left M^2 (MF/2205/18), h – left M^3 (MF/2205/19). i-k: Bełchatów B. i – left M_1 /MF/2210/1), j – right M^2 (MF/2210/2), k – left M^3 (MF/2210/3).

Bechatów B (Fig. 6 i - k)

M a t e r i a l. 3 isolated molars: 1 left M_1 (MF/2210/1; L = 0.92, W = 0.80), 1 right M_2 (MF/2210/2; L = 0.99, W = 0.92), 1 left M^3 (MF/2210/3; L = 0.77, W = 0.77).

D e s c r i p t i o n. Both upper molars are unworn. Their endolophids are well-developed, but interrupted, higher than other ridges. Also the pattern of the crown is similar. In M_1 (Fig. 6 i) there are four main ridges, a long centrolophid and five accessory ridges. Two of them are situated on both sides of the centrolophid, two between the anterolophid and metalophid and one between the mesolophid and posterolophid. The same ridges are present in M_2 (Fig. 6 j).

M^3 (Fig. 6 k) is heavily worn. Its endoloph is complete. Besides main ridges the crown has a long centroloph and three accessory ridges.

R e m a r k s. Three teeth described above correspond in size and crown-pattern to the teeth of the species *Glirulus lissiensis*. There are no differences between the samples from Bełchatów A and B.

Genus *Bransatoglis* HUGUENAY, 1967

Bransatoglis astaracensis (BAUDELOT, 1970)

Bełchatów A (Fig.7 a - b)

M a t e r i a l. 2 isolated molars: left M_2 (MF/2203/1; L = 1.82, W = 1.76), right M^2 (MF/2203/2; L = 1.73, W = 1.77).

D e s c r i p t i o n. M_2 (Fig. 7 a) has a distinctly concave occlusal surface. Its crown is composed of four main ridges, a well developed centrolophid and two accessory ridges, one between the anterolophid and protolophid, the other between the mesolophid and posterolophid. There are no accessory ridges on the sides of the centrolophid.

M^2 (Fig. 7 b) has three roots, its occlusal surface is distinctly concave. The crown is composed of 4 main ridges and a centroloph accompanied anteriorly and posteriorly by two well developed accessory ridges. No accessory ridge is present in the posterior part of the tooth, but there are irregular elevation of enamel in the valley between the anteroloph and protoloph. The endoloph is complete.

R e m a r k s. The teeth from Bełchatów A are very similar to the specimens of *B. astaracensis* from Anwil with which I was able to compare them directly. *B. astaracensis* was described by BAUDELOT (1970) from Sansan in France. The pattern of the crown of the specimens from Bełchatów A is the same as in the holotype and in M_2 from Sansan. The dimensions of the Bełchatów A specimens exceed those in the typical series from Sansan (MN 6), the teeth from Anwil (MN 7/8) being intermediate in size. This confirms the remark made by DAAMS (1976), who noted that the evolution in the lineage of *B. astaracensis* is expressed by growing dimensions.

B. astaracensis (BAUDELOT, 1970) was listed from Póvoa de Santarém in Portugal (ANTUNES, MEIN 1977), Buñol (DAAMS, 1976), Can Marti Vell I (AGUSTI 1983) and other localities in Spain, Sansan (BAUDELOT 1970), and several Middle Miocene localities in its neighbourhood (BAUDELOT, COLLIER 1982) in France, from Anwil (ENGESSER, 1972) and several localities of Hörnlischüttung (BOLLIGER 1992) in Switzerland. It is also known from Dolnice in the Czech Republic (FEJFAR & ROČEK 1986). It ranges from MN 4 to MN 9, surviving longer than any other species of the genus *Bransatoglis*. Bełchatów A is one of the latest occurrences of this species, and it is situated far to the north-east of its known range in Europe.

Bransatoglis cf. *infralactorensis* (BAUDELOT & COLLIER, 1982)

Bełchatów C (Fig. 7 c - f)

M a t e r i a l. 5 isolated molars: 2 right M_1, 1 right M_2, 1 right M^1, 1 right M^2. At least 3 individuals are represented in the material (both M_2 are almost unworn, all upper molars havily worn) (MF/2213/1-5).

Description. All these molars, particularly the upper ones, have distinctly concave crowns. The ridges are broad and low. In the upper molars the endoloph is continuous and their ridges are irregular in the middle part of the crown. The upper molars have three, the lower ones two roots.

M_1 (MF/2213/1-2) is slightly trapezoid, narrower in its anterior part. It has four main ridges and one centroloph, which in both specimens reaches 3/4 of the width of the crown. Anterior and posterior accessory ridges are well developed (Fig. 7 c).

M_2 (MF/2213/3, Fig. 7 d) is broader then M_1. Its anterior border is straight, the posterior one convex. The centroloph extends to the labial border of the tooth.

M^1 (MF/2213/4, Fig. 7 e) is heavily worn. Its endoloph is continuous. There are two centrolophs about the same length; they probably reached the endoloph or ended near it. The anterior and posterior accessory ridges are lacking. In the heavily worn central part of the crown there are irregular elevations of the enamel.

M^2 (MF/2213/5, Fig. 7 f), slightly damaged, is also heavily worn and its ridges can hardly be traced. Both centrolophs are of the same length, reaching the middle of the tooth. They extend,

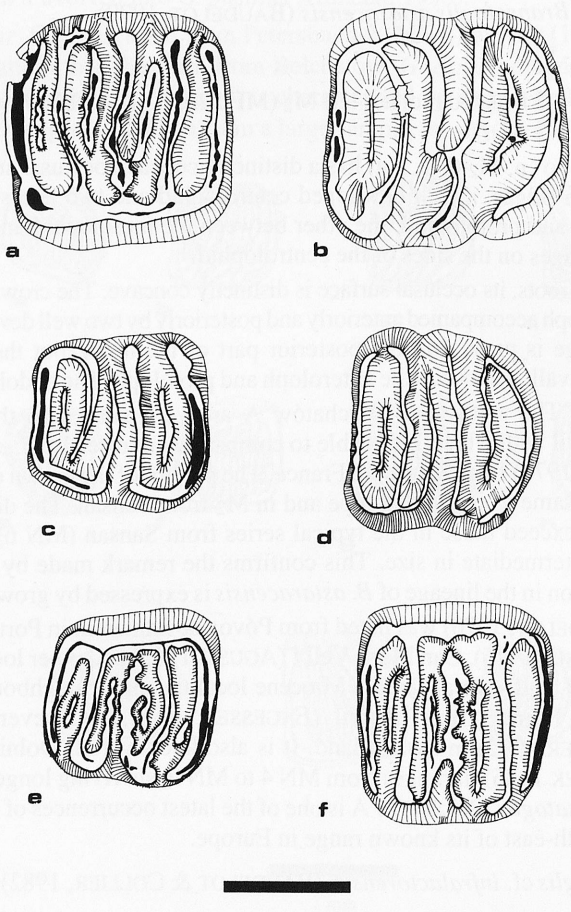

Fig. 7. a-b: *Bransatoglis astaracensis*, Bełchatów A. a – left M_2 (MF/2203/1), b – left M^2 (MF/2203/2). c-f: *Bransatoglis* cf. *infralactorensis*, Bełchatów C. c – right M_1 (MF/2213/1), d – right M_2 (MF/2213/3), e – right M^1 (MF/2213/4), f – right M^2 (MF/2213/5).

however, up to the endoloph by several irregular accessory ridges. The accessory ridges, irregular in shape are also present anteriorly and posteriorly to the centrolophs.

D i m e n s i o n s: see Table VII.

Table VII

Dimensions of molars in *Bransatoglis* cf. *infralactorensis* from Bechatów C (in mm)

Tooth	Length	Width
M_1, No 2213/1	1.34	1.30
M_1, No 2213/2	1.36	1.25
M_2, No 2213/3	1.40	1.43
M^1, No 2213/4	1.29	1.20
M^2, No 2213/5	1.37	1.53

R e m a r k s. The material described above has typical characters of the genus *Bransatoglis*: distinctly concave occlusal surface of the molars, U-shaped trigone of M^1 - M^2, low ridges and long anterior centroloph almost joining the endoloph.

The genus *Bransatoglis* was very diversified in the Oligocene and earliest Miocene. Few of its species, however, survived until higher stages of the Miocene. One of them is *B. infralactorensis* first described from Estrepuy (MN 3) and the neighbouring localities of the same age (BAUDELOT and COLLIER 1982). The description is laconic and the figures accompanying it not very precise, but no evident differences can be found between the typical series and our specimens.

WERNER (1994) described a new subspecies under the name of *"Paraglis" infralactorensis ingens* from Ulm-Westtangente (MN 2a). He listed it also from Jungingen, a locality of similar age. The differences between this subspecies and the typical one are in details which cannot be studied in our scanty material. The dimensions of the specimens from Bełchatów C lie within the range of variability of *B. i. ingens* (except for M^2), but they generally exceed the averages values of the respective dimensions in this species.

The material from Bełchatów C is too scant to allow specific identification, but in all probability it belongs to the lineage of *B. infralactorensis*.

Bransatoglis sp.

Bełchatów B (Fig. 8 a - d)

M a t e r i a l. 5 isolated molars: 2 left M_3,1 left P^4, 1 left M^1, 1 right M^2 (MF/2208/1-5). 2 individuals are represented in the material.

D e s c r i p t i o n. All the molars have concave crowns and flat, broad ridges. In the upper molars there is a distinct, continuous endoloph. All the specimens studied have heavily worn crowns.

M_3 (MF/2208/1-2, Fig. 8 a) has a long centrolophid and well developed posterior accessory ridge. The tooth has two roots.

P^4 (MF/2208/3, Fig. 8 b) has three roots, but the large lingual root and two labial ones are partly fused together. The anterior centroloph does not reach the endoloph, the posterior centroloph is lacking. There is only one accessory ridge, it is situated between the metaloph and the posteroloph.

M^1 (MF/2208/4, Fig. 8 c) has three roots. The endoloph is continuous. The tooth has four main ridges and two centrolophs. The centrolophs are fused near the lingual border of the tooth. There is only one accessory ridge anteriorly between the anterior centroloph and the protoloph.

M^2 (MF/2208/5, Fig. 8 d) is much broader than M^1, three-rooted. It has a continuous endoloph and four main ridges. Two centrolophs are of the same length, extending halfway across the tooth, but in the form of an irregular ridge reaching the endoloph.

D i m e n s i o n s: see Table VIII

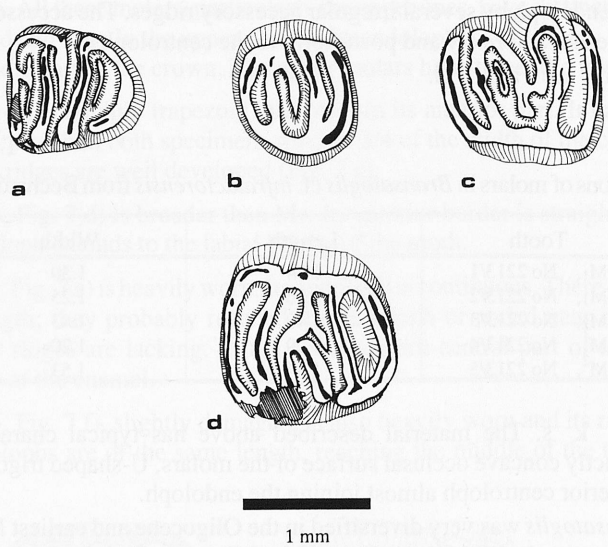

Fig. 8. *Bransatoglis* sp. Bełchatów B. a – left M_3 (MF/2208/1), b – left P_4 (MF/2208/3), c – left M^1 (MF/2208/4), d – right M^2 (MF/2208/5).

Table VIII

Dimensions of molars in *Bransatoglis* sp. from Bełchatów B (in mm)

Tooth	Length	Width
M_3, No 2208/1	1.02	0.95
M_3, No 2208/2	1.08	1.08
P^4, No 2208/3	0.95	1.02
M^1, No 2208/4	1.24	1.15
M^2, No 2208/5	1.33	1.23

R e m a r k s. The molars are slightly smaller than the specimens of *Bransatoglis* cf. *infralactorensis* from Bełchatów C. Several species of *Bransatoglis* of similar size have been described from the lower Miocene, but so far none has been recorded from younger layers. Small dimensions of the form from Bełchatów B do not permit to recognize it as ancestral to *B. astaracensis*. Because of limited material it is impossible to determine the systematic position of the series of molars described above more exactly. This situation may suggest the presence of two lineages of *Bransatoglis* in the Middle Miocene of eastern part of Europe: one with a tendency for the tooth dimensions to increase and the other with progressively diminishing size of teeth.

III. DISCUSSION

The collection of Gliridae from Bełchatów is composed exclusively of isolated teeth. 167 complete or nearly complete premolars and molars were collected, 127 of them in Bełchatów A,

18 in Bełchatów B and 22 in Bełchatów C. Only crowns of molariform teeth are preserved, while nearly all specimens lack roots.

The numbers of taxa present in each level, regardless of differences in the size of samples are similar: 6 taxa were present in level A, 7 in level B and 6 in level C. (Table IX). The diversity of glirids in different fossil localities in Europe is very variable. In Miocene localities with numerous rodent teeth the number of taxa of Gliridae is, e. g., 5 in Rudabanya (KRETZOI et al., 1974), 6 in Aliveri (VAN DER MEULEN & DE BRUIJN 1982), 10 in Stubersheim 3 (WU 1990), 11 in Anwil (ENGESSER, 1972) and 19 in Petersbuch 2 (WU 1990). These differences in the number of taxa are partly the result of taphonomic factors. The very high number (as in Petersbuch 2) probably results from a medley of taxa from layers of different ages (WU 1990).

As a result of small number of specimens, the lists of taxa of Gliridae in particular layers of Bełchatów probably are incomplete and the taxa which were rare or distributed only in biotopes lying far from the place of accumulation of the remains were missing. Nevertheless the fauna of dormice was highly diversified. Nowhere in the recent fauna more than 4 sympatric species of Gliridae have been listed.

Table IX

Minimal number of individuals (MNI) and number of upper and lower first and second molars (M1-M2) of Gliridae in particular horizons of Bełchatów

Bełchatów A

Species	MNI	M1+M2
Glis vallesiensis	14	39
Muscardinus hispanicus	3	8
Microdyromys sp.	1	2
Glirulus werenfelsi	1	3
Glirulus lissiensis	3	9
Bransatoglis astaracensis	1	2
Total	23	63

Bełchatów B

Species	MNI	M1+M2
Glis sp.	1	1
Glirudinus cf. *minutus*	1	2
Glirudinus sp.	1	1
Microdyromys koenigswaldi	1	2
Glirulus werenfelsi	2	4
Glirulus lissiensis	1	2
Bransatoglis sp.	2	2
Total	9	14

Bełchatów C

Species	MNI	M1+M2
Cf. *Glis* sp.	1	1
Glirudinus undosus	1	1
Myoglis antecedens	2	5
Cf. *Heteromyoxus* sp.	2	2
Glirulus diremptus	1	3
Bransatoglis cf. *infralactorensis*	3	5
Total	10	17

Among 18 populations of different taxa from all three layers of Bełchatów 8 genera (*Glis*, *Glirudinus*, *Muscardinus*, *Myoglis*, cf. *Heteromyoxus*, *Microdyromys*, *Glirulus* and *Bransatoglis*) and 11 species have been identified. All these taxa (with exception of specifically undetermined *Glis*) are new for the Miocene fauna of Poland.

The fauna of dormice from Bełchatów A, B and C is similar to that of western Europe. Its discovery extends the known area of distribution of its particular elements far towards the north-east. This fauna differs from that of southern Europe (the Iberian Peninsula, south-east Europe) and Anatolia in the lack of representatives of the subfamily Myomiminae, which were probably adapted to an open environment.

The Miocene fauna of glirids of western and central Europe was rather similar. However, the genus *Glis* seems to have been rare in the west and was common in eastern Europe.

The time range of particular species in Bełchatów generally agrees with the data from western Europe. *Bransatoglis infralactorensis* was known only from zones MN 2 to MN 3; it was probably present in the zone MN 4 of Bełchatów C.

Some lineages of glirids are represented by morphologically different populations in successive layers of Bełchatów, but the material is too poor for us to be sure that the existing differences result from evolutionary changes.

VAN DER MEULEN and DE BRUIJN (1982) divided all the taxa of dormice into six groups on the basis of their crown-pattern. By extrapolating from the ecology of living species of particular groups, they tried to determine the diet and biotope of each group. The species present in Bełchatów belong mainly to the "flat molar group" (*Muscardinus*, *Myoglis*, *Heteromyoxus*, *Glirudinus*) and "symmetrical molar group" (*Glis*, *Glirulus*, *Bransatoglis*). These groups contain dormice which are mainly vegetarian, arboreal and live in forests or thickets. Members of the "simple intermediate molar group" (*Microdyromys koenigswaldi*), which contains eurytopic, omnivorous taxa living mainly in forests but also in open country, were very rare.

The fauna of Gliridae therefore points to the presence of a forest environment during all the known period of sedimentation in the Bełchatów basin. That was to be expected in the light of the nature of the sediments (brown-coal) and floral remains. Fossil teeth of small mammals were probably brought to the basin by streams, by predators or by both these factors at least partly from the biotopes situated outside the basin. The lack of typical open country elements in the fossil fauna suggests that the regions outside the basin were also forested.

The paleoecological conditions were probably relatively stable during all the time of accumulation of faunal remains in Bełchatów. The cycles of vegetation changes from swamp forests to forests of dry habitats (STUCHLIK, SZYNKIEWICZ 1990) were not accompanied by very deep changes in the composition of the rodent fauna.

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