

BULGARIAN ACADEMY OF SCIENCES
NATIONAL MUSEUM OF NATURAL HISTORY

NEOGENE-QUATERNARY BIRDS OF BULGARIA

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This presentation summarizes the most significant results of a series of scientific projects of the NMNHS-BAS realized in the last decade. Part of them - international projects (1998-2008), are listed below:

- *1998 - The Late Pliocene and Pleistocene birds of Bulgaria. Institute of Systematics and Evolution of Animals, PAS (Cracow, Poland).*
- *1999 - Identification of fossil avian material from the Balkan region. The Natural History Museum (London – NHM Bird Group Tring, U.K.).*
- *2001 - Late Miocene birds from Bulgaria. Institute of Systematics and Evolution of Animals, PAS (Cracow, Poland).*
- *2003 - Morphology and Taxonomy of birds of some Tertiary localities in Bulgaria. Royal Society. London – NHM Bird Group Tring, U.K.).*

Because of the limited time of the presentation, a considerable part of the results (on the Bulgarian Holocene bird fauna) remain uncovered.

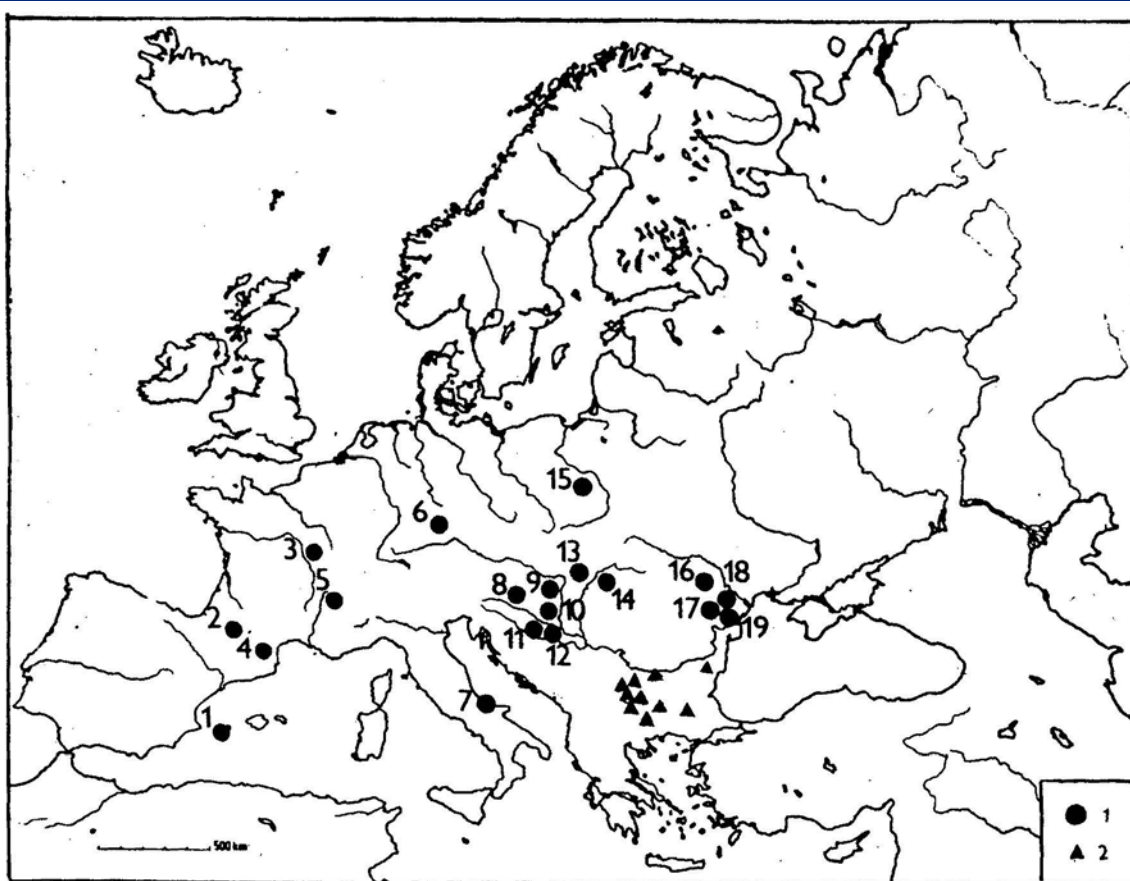
Part of the author's publications deal with fossil birds of Greece, Azerbaijan and Vietnam, while other part .

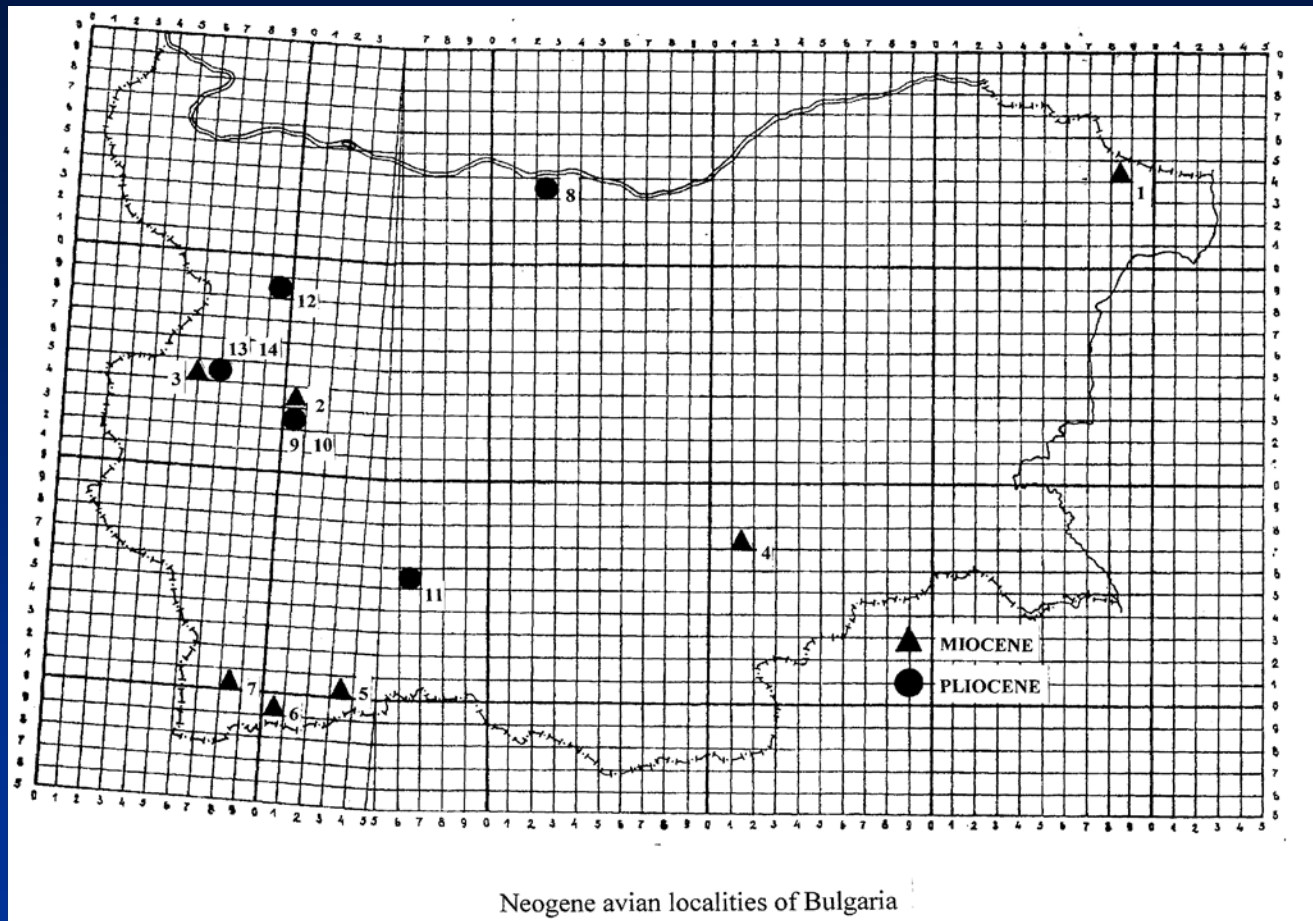


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RESEARCHES ON THE NEOGENE BIRDS IN BULGARIA

The Neogene record of Europe is relatively abundant. The Neogene avifauna and all the fossil bird fauna of Bulgaria, remained unstudied almost until present time. By the 1984 only three sites were known, 2 of them provided 2 new species, both described in collaboration of foreign paleornithologists, while the finds of the 3rd site remained unexamined. Since 1995 a series of papers describe several new avian taxa or new bird material from the Bulgarian Neogene deposits.





Bird finds from the Neogene deposits are known at present from 14 sites, Pleistocene – 20, and Holocene – 67. Seven of the Neogene sites are of Miocene age and seven - of Pliocene age. Four sites contain fossils of the Early Pliocene and 3 – of Late Pliocene. Here the full taxonomic list of the Neogene avifauna in Bulgaria is discussed. A total of 1840 bone fragments, bones and articulated skeletons of at least 316 individuals have been collected.

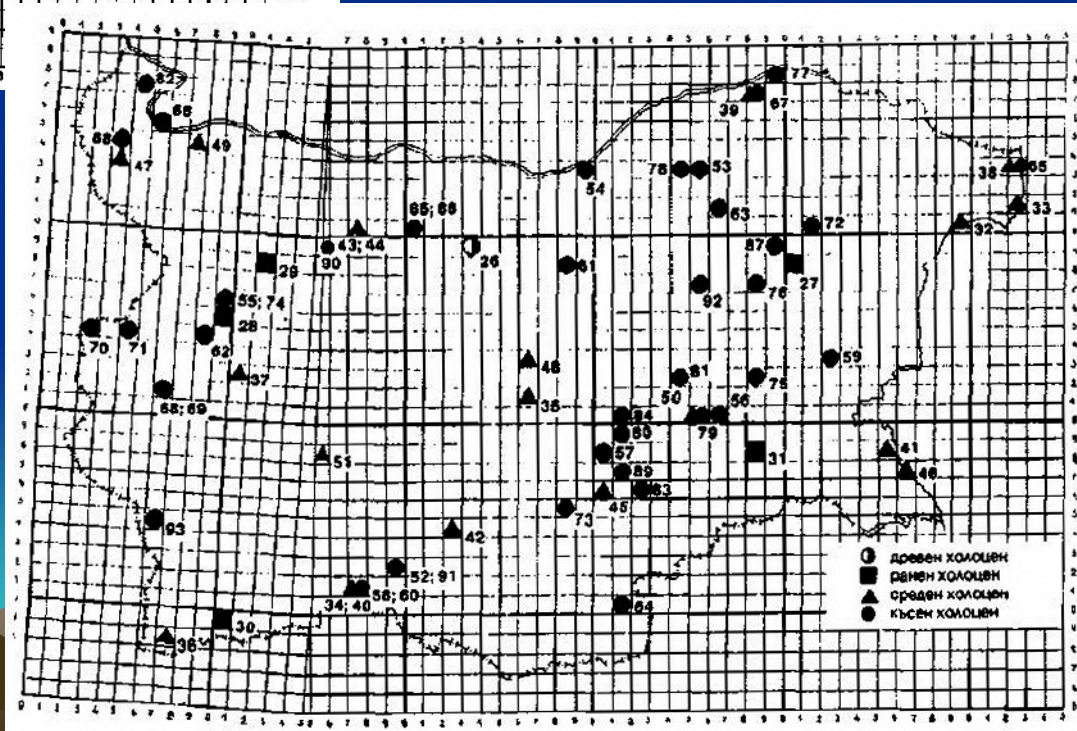
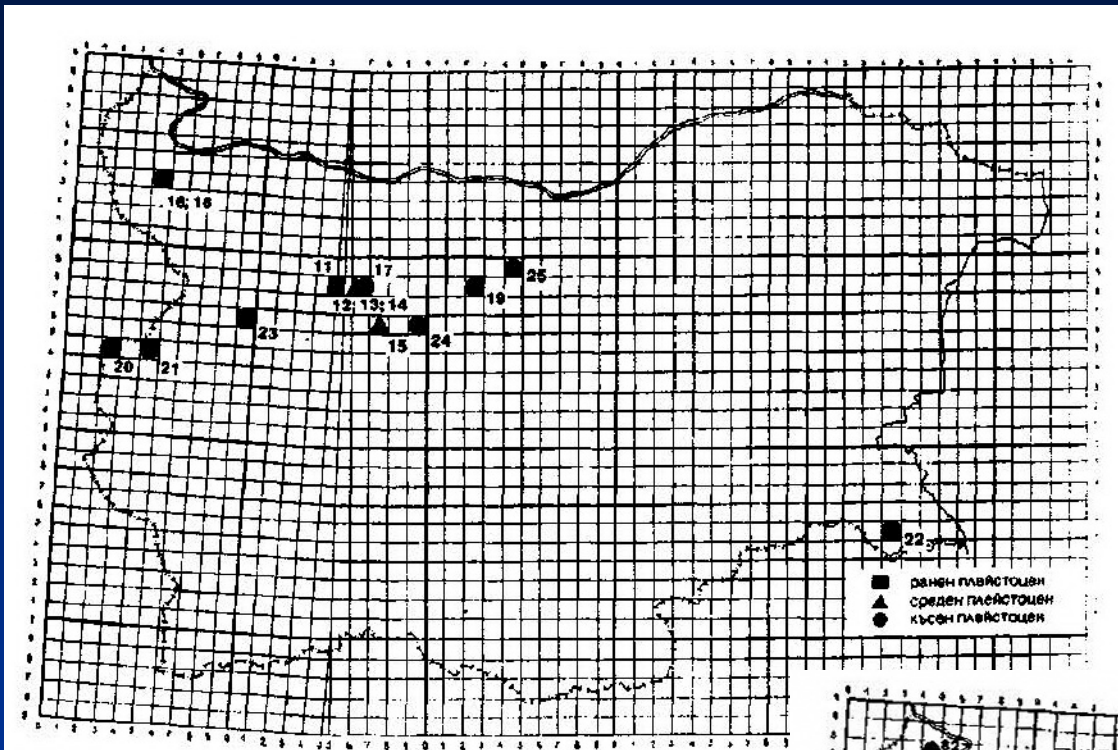


Table 1. Chronostratigraphical distribution of the Neogene avian fossils from Bulgaria

Periods	Subperiods	Sites	Number of finds	Percentage of all Neogene avian finds of Bulgaria	Number of taxa	Percentage of all Neogene avifauna of Bulgaria
	Late Pliocene	Balsha	3	0.16	1	0.83
		Slivnitsa	102	5.54	17	14.16
		Varshets	1638	89.02	78	65.00
Pliocene	Early Pliocene	Dorkovo	3	0.16	3	2.50
		Sofia - 2	1	0.05	1	0.83
		Sofia - 1	?	?	?	?
		Muselievo	14	0.76	5	4.16
		Hadzhidimovo	23	1.25	5	4.16
		Kalimantsi	1	0.05	1	0.83
		Gorna Sushitsa	1	0.05	1	0.83
Miocene	Late Miocene	Troyanovo	21	1.14	2	1.66
		Hrabarsko	24	1.30	4	3.33
		Kremikovtsi	1	0.05	1	0.83
	Middle Miocene	Kardam	8	0.43	1	0.83
	Early Miocene	-	-	-	-	-
TOTAL			1840	100,00	120	100,00





EVOLUTIONARY, PALEORNITHOGEOGRAPHICAL AND PALEOECOLOGICAL IMPLICATIONS

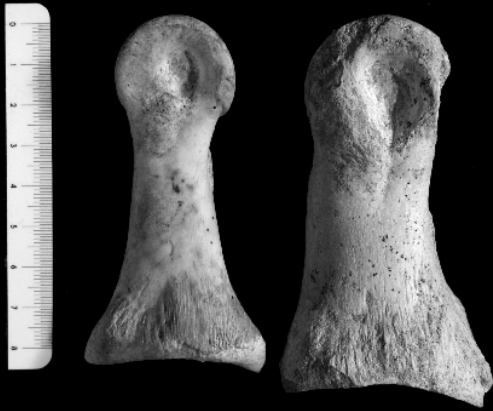
Struthioniformes Struthionidae

Struthio cf. *Struthio karatheodoris* Forsythe Major, 1888

After Mlíkovský (1996), all Tertiary records of *Struthio* in Europe “... are confined to its south-eastern parts”. *S. camelus* survived in the Ukraine and Moldova up to the beginning of the Pleistocene.

The late Miocene European ostrich finds are actually restricted to the N Peri-Pontic region, Greece and Bulgaria). The taxonomic similarity of the ostriches from Samos, Pikermi, Hadzhidimovo and Kalimantsi, and their distinctions from the contemporaneous finds of the N Peri-Pontic area supports a supposition for the existence of a land connection between the Balkan and the Asia Minor areas during the transition from the early to the middle Turolian.





Struthio cf. Struthio karatheodoris

This conclusion confirms the existence of a Balkan-Iranian zoogeographic province in the Turolian and the existence of a southern route of faunal exchange through the Balkans and Asia Minor no later than the early/middle Turolian.

The presence of ostriches in the megafauna of the ~ middle Turolian localities of Kalimantsi and Hadzhidimovo also supports the conception of the existence of open spaces in the mosaic landscape of the open woodlands/park type forest landscape in the western Pontic part of the of the Pikermian biome of the Balkan-Iranian late Miocene zoogeographic province.

Ciconiiformes

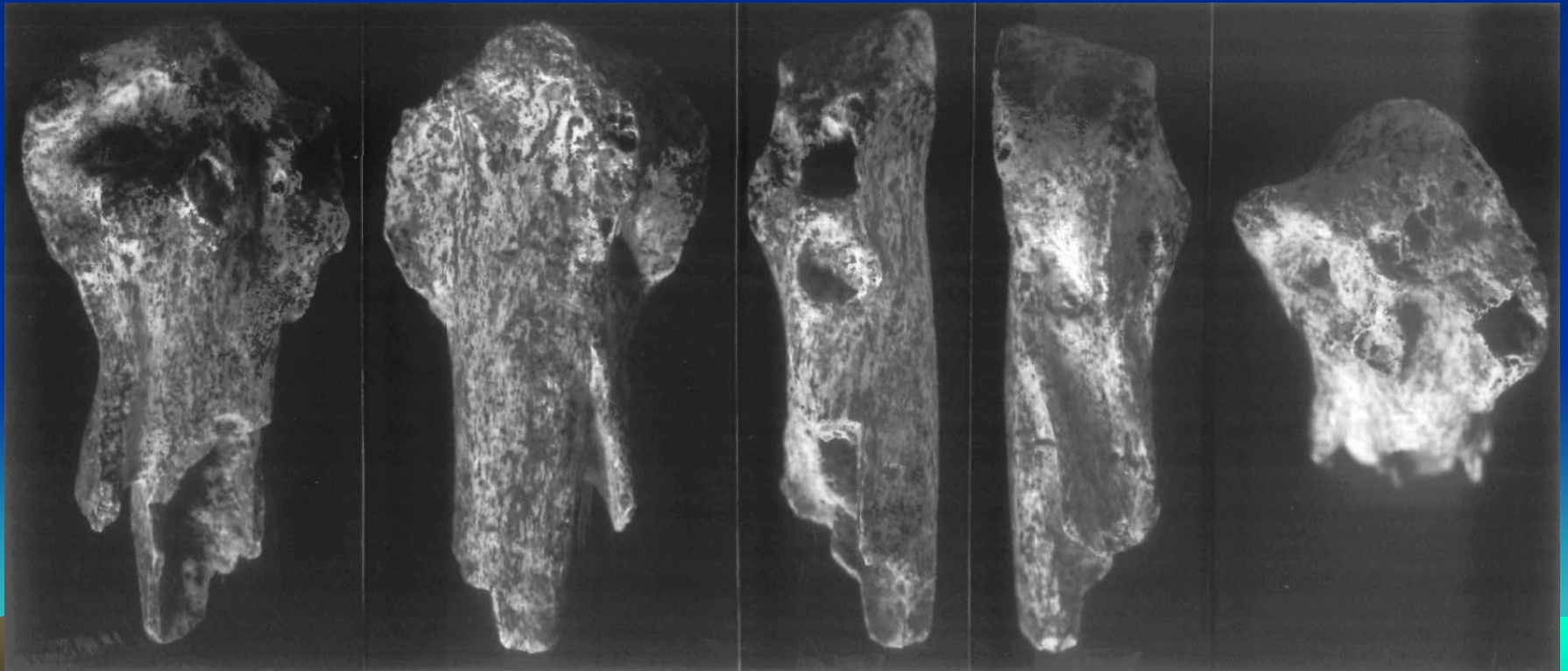
Ardeidae

Botaurinae

The find belongs to a bittern (Botaurinae) and represents a distal end of the right carpometacarpus. Morphological features suggest a form similar to *Botaurus*. It is the only Bulgarian record of Neogene bitterns. Bochenski (1997) and Mlikovsky (2002) list no fossil taxa from Europe of Botaurinae.



The finds of *Geronticus balcanicus* from Bulgaria represent the only Tertiary record of *Geronticus* on the Balkans and the Eastern Europe. They prove the existence of Bald Ibises in the Eastern Mediterranean contemporaneously with these of the Western Mediterranean, at least during the very end of the Pliocene.



The genus *Geronticus* numbers 4 taxa – 2 extant and 2 fossil. The Middle Villafranchian Balkan Bald Ibis (*Geronticus balcanicus*) was possibly a more primitive sister-taxon to the recent *G. eremita*. Paleoornithology has not firm data to consider the genus *Geronticus* to be of an African origin. Its presence in Europe is well documented since the Middle Miocene, through the final of the Upper Pliocene, Early Holocene and until recent times.





Anseriformes

Anatidae

Cygnini
Cygnus

Cygnus verae is an early Pliocene swan, differing from the recent *Cygnus* species by its well developed incisura capitis. It is the 3rd anatid, described from the Balkan region.

Anatini

Anas

The find of *Anas* cf. *clypeata* is the oldest record of that species so far. It indicates its Pre-Glacial presence on the Balkans, defining it as a Tertiary relict in the modern SE-European (and Western Palearctic) avifauna.



Balcanas

Balcanas pliocaenica was a small to medium sized duck, combining the features of *Anas* and *Aix*. Such mosaic structure of skeletal elements is known for many Tertiary, mainly Neogene, taxa. *Balcanas* coexisted with *Anas* in S (SE) Europe at least during the Late Miocene - Early Pliocene.

Accipitriformes

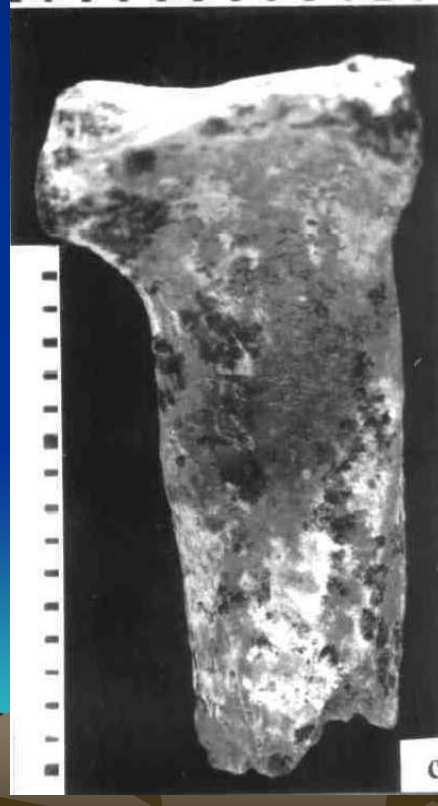
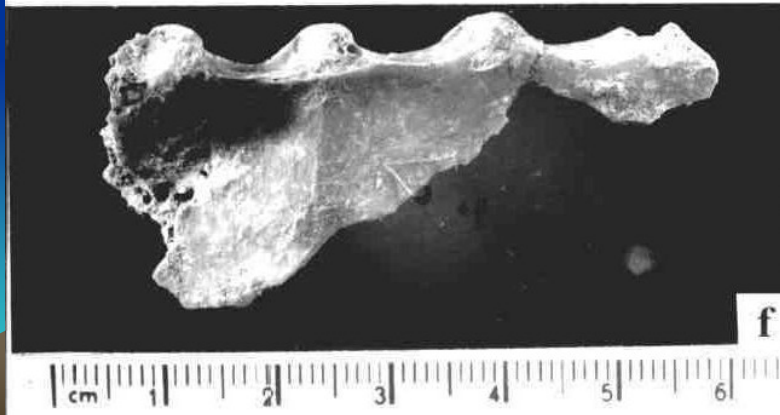
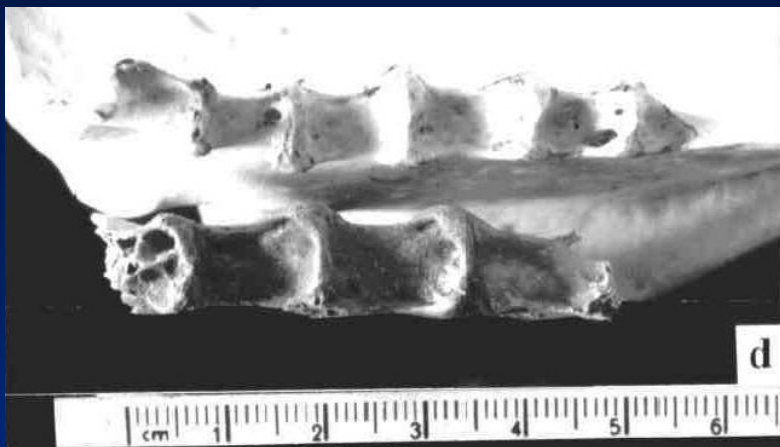
Accipitridae

Gyps

Both osteology and dimensions show that the fossil griffon (*Gyps* sp. n.) from Varshets was closer to recent *G. fulvus* than to dubious fossil *G. melitensis*.

The finds of *Gyps* sp. n. are the oldest fossil record of the genus *Gyps* from Europe. They mark its presence at least from the Late Pliocene. On the other hand, Varshets is the first Pliocene (and Tertiary at all) site of *Gyps* in the Palearctic region. In spite of the southern origin of the genus, it is clear that by the beginning of the Quaternary the genus *Gyps* was spread at least in the SE-European territories (Balkans).





Gyps sp. n



Accipiter

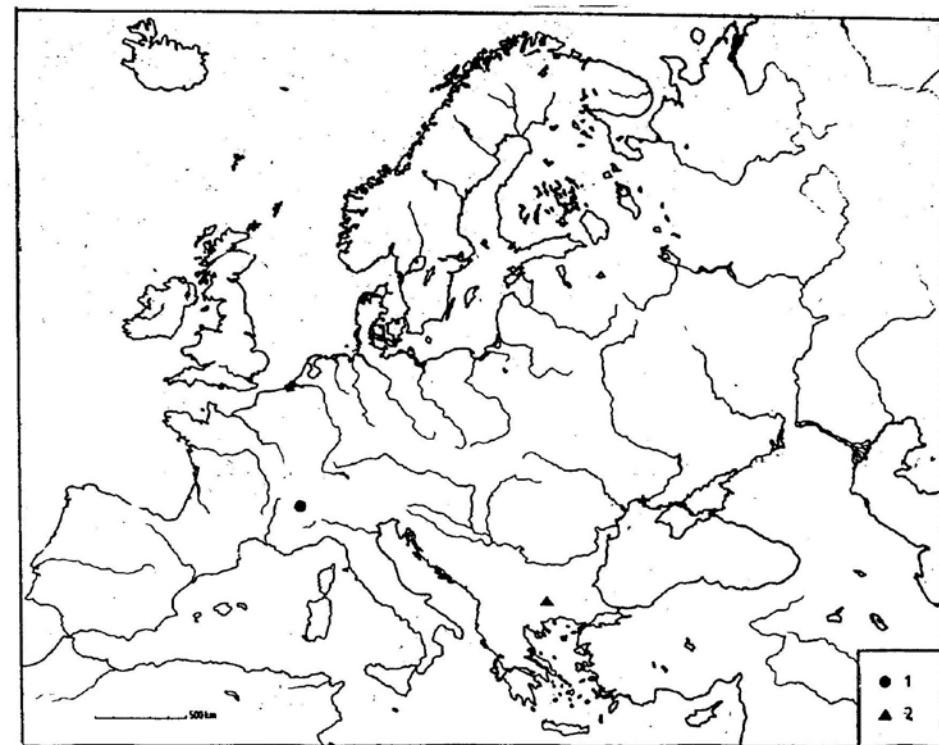
The only Tertiary records of *Accipiter* in Europe originate from Bulgaria (Muselievo and Varshets; Mlikovsky, 1996).

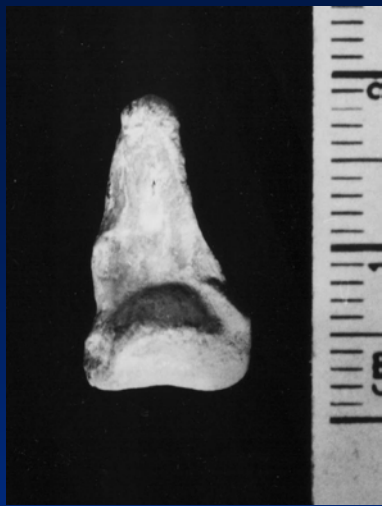
The Muselievo specimen represents a fossil hawk of the *gentilis* group, differing from *A. gentilis*.

Thus, the find of *Accipiter* sp. ex gr. *gentilis* represents the oldest record of the genus *Accipiter* and provides the second fossil taxon of that genus.

This taxon possibly lies on the same evolutionary lineage as the recent *A. gentilis* and may be considered an ancestor of the recent Holarctic Goshawk.

The find of *Buteo spassovi* from Hadzhidimovo represents the 2nd record of *Buteo* in Europe (and all the Western Palearctic). At the same time, it is the 2nd European fossil species of the genus *Buteo*. Both Miocene sites (La Grive-Saint-Alban and Hadzhidimovo) now mark the S European distribution of *Buteo* in the Miocene of Europe.





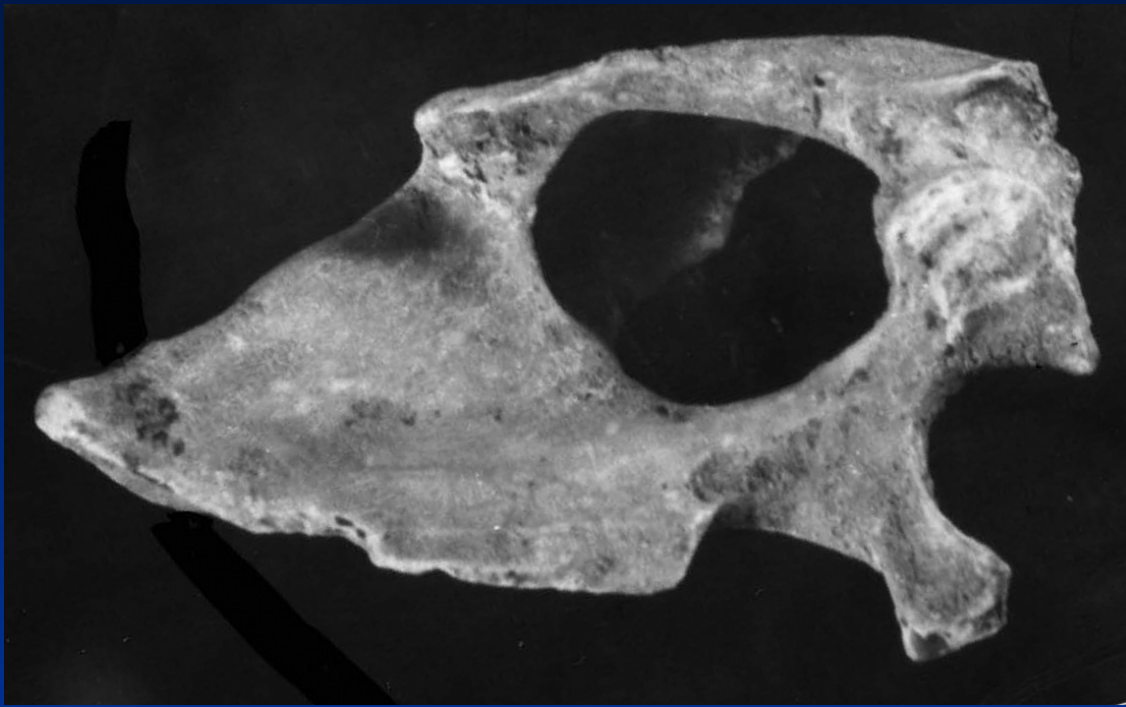
Circaetus

Similar is the situation with the records of some other accipitrid genera. The site of Varshets yielded the first fossil record of *Circaetus* in Europe, as well as in all the World.

Hieraeetus

The same site yielded the oldest fossil record of the Bonelli's Eagle (*Hieraeetus fasciatus*).





Falconiformes

Falconidae

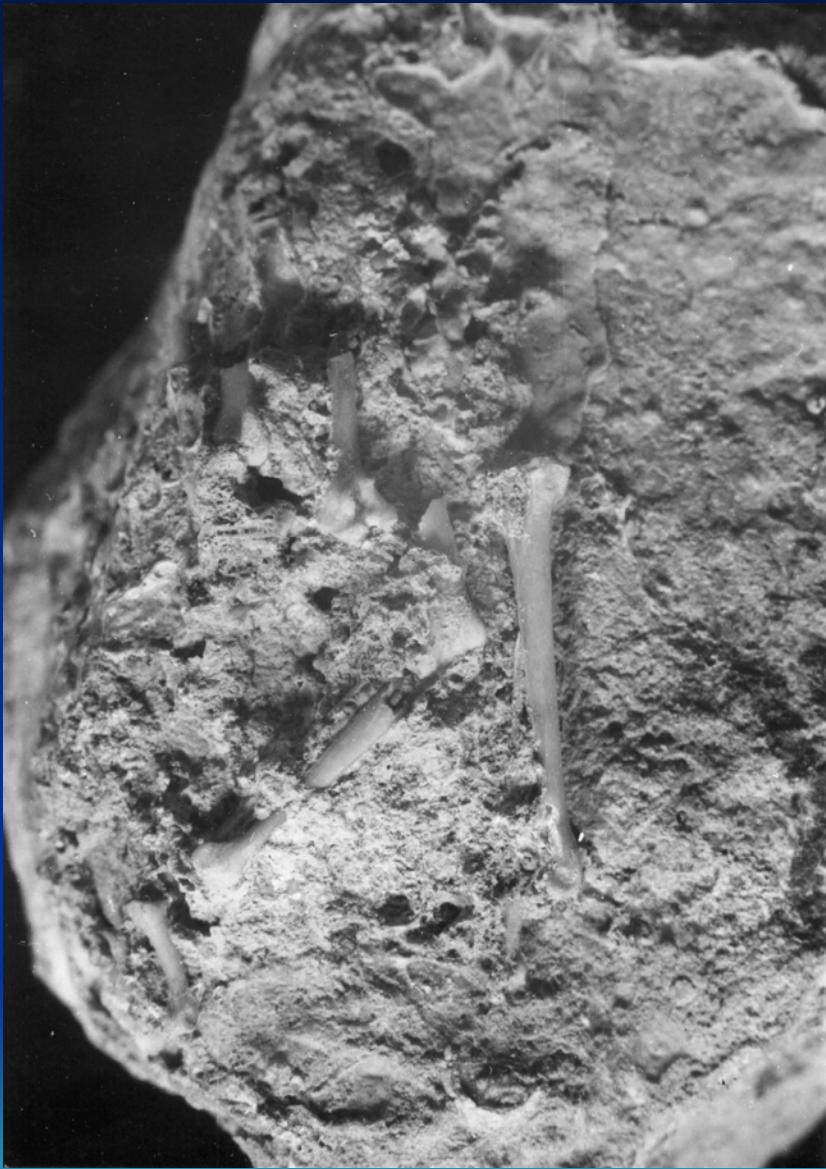
Falco

All the four sites of genus *Falco* lie in the SE Europe (Hungary, Ukraine and Bulgaria) and provide the only fossil record of falcons on the continent during the Tertiary. Obviously, by the beginning of Neogene, its representatives roamed widely the S-European territories.

The fossil species *Falco bakalovi* has been designated through a synsacral fragment. Since 1999 during the new excavations 16 new finds have been collected and referred to this falcon.

The second taxon, the falcon from Hadzhidimovo is preserved by 17 bones of an adult specimen. It is also a small falcon of the "*tinnunculus*" group, but it has relatively longer wings (humeri) and shorter legs (tinner, and possibly shorter, tarsometatarsi). Its examination started in 2003.





Galliformes

Phasianidae

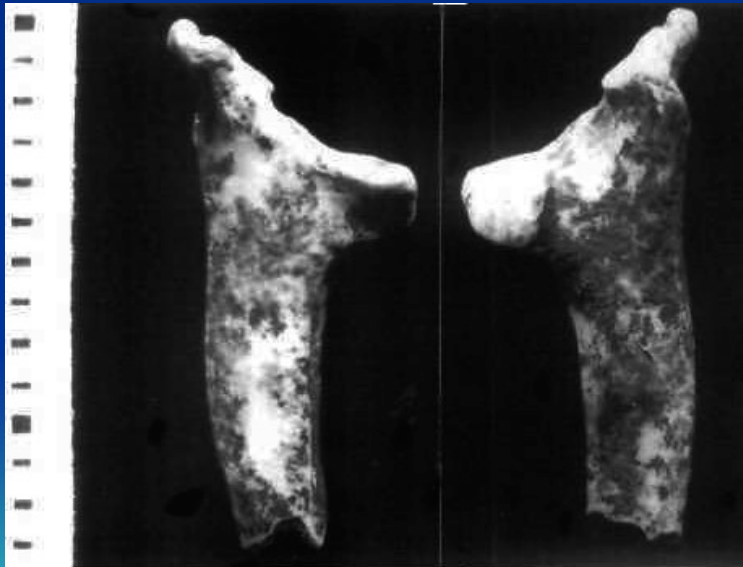
Chauvireria

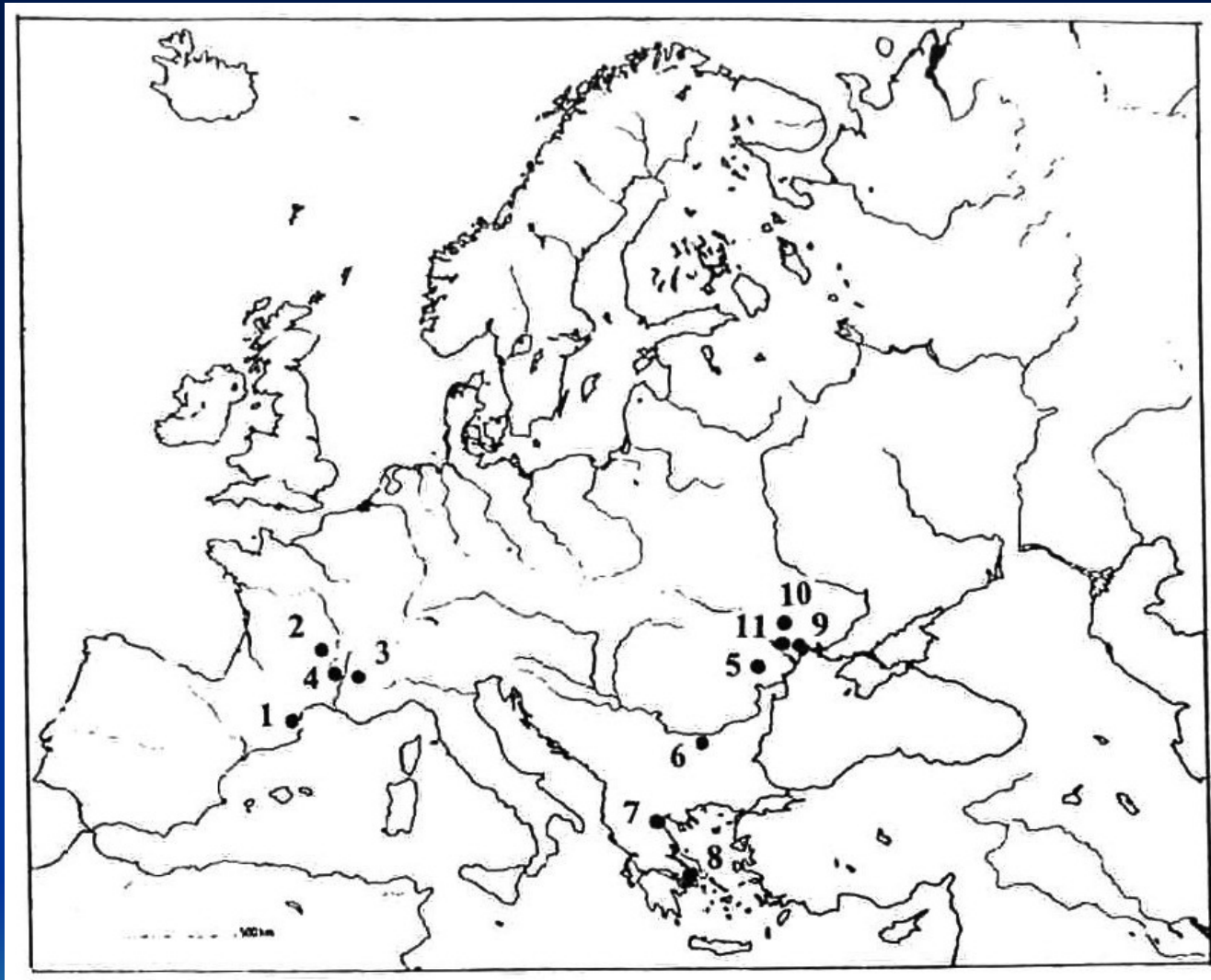
The extremely numerous remains (over 1160 bones and bone fragments from at least 52 individuals) of an unknown small phasianid of *Perdicinae* have been described as *Chauvireria balcanica*. This Villanyian galliform is closely related to the genus *Palaeocryptonyx* Deperet, 1892 from the West Europe. *Chauvireria balcanica* finds represent almost 62 percent of all the Neogene bird remnants, found in Bulgaria.



Chauvireria balcanica was of the same size as recent *Ammoperdix griseogularis* and *A. heyi*.

It is surprisingly, but a second species of the same new genus, *Chauvireria*, existed in a slightly younger site, Slivnitsa, near Sofia. It is also numerous in its site and 54 remnants were collected of 4 individuals at least. The description of that species is forthcoming.



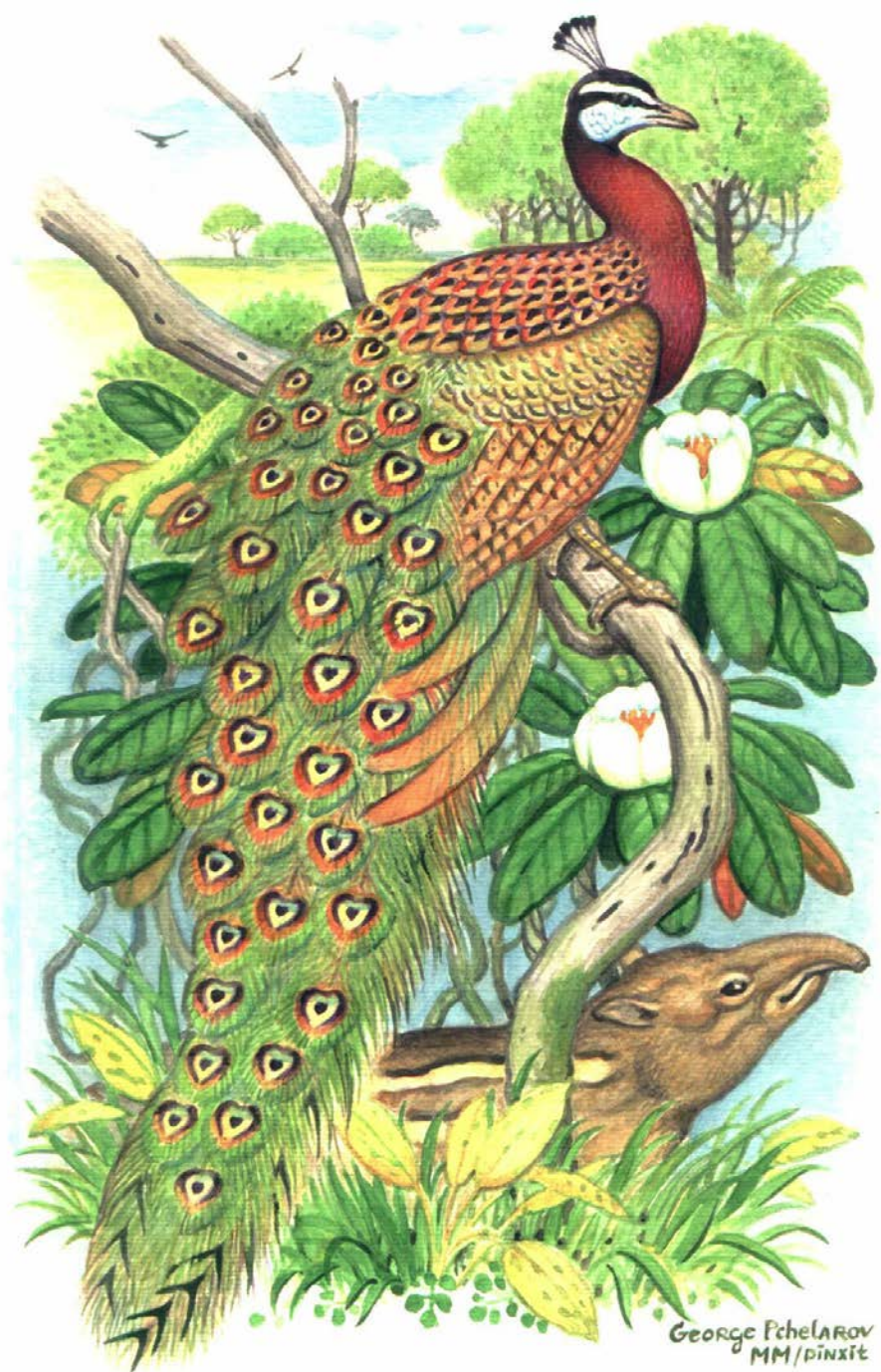


Pavo

The Bulgarian finds of peafowl suggest that *Pavo bravardi* inhabited the South-European forests, both in the West and the East of the continent, but possibly not later than the Late Miocene - Early Pliocene.

The stratigraphic range of *Pavo bravardi* is Early to Late Pliocene. It roamed the whole Southern Europe, both Western and Eastern Europe. It is likely that in SE Europe this peafowl had survived in the relatively warmer habitats until more recent time by the beginning of the Pleistocene. Muselievo is the 10th European site of *Pavo*. Recently we established the next, 11th site in the N Greece, near Thessaloniki (Megalo Emvolon). Thus, 4 of the European sites are W-European (France), and 7 – E-European (Bulgaria, Greece, Moldavia and Ukraine).

Pavo bravardi. Reconstruction of Georgi Pchelarov, 2000



George Pchelarov
MM/pinxit

Tetraonidae

Four of the nine Tetraonid species in Bulgaria are fossil: *Lagopus atavus* Jánossy, 1974, *Lagopus balcanicus*, *Tetrao partium* (Kretzoi, 1962) and *Tetrao rhodopensis*.

The relative geographical proximity and the chronostratigraphical similarity proves that in the Ruscinian two regions of the continent, the Balkans and Central Europe, were inhabited by well-distinguished representatives of the basic genera of Tetraonidae. This suggests an older origin for Tetraonidae, i. e. not Ruscinian, but possibly the end of the Late Miocene (Turolian - Pontian). Thus, the fossil record of the family does not agree with the statement of Lucchini et al. (2001) who accept a North American origin of the family and all the constituent Tetraonidae genera, “with the possible exception of *Tetrao*”. They consider that the present distribution of the tetraonids should be regarded as a result of at least three dispersal events from North America to Eurasia, involving the ancestors of *Bonasa*, *Lagopus* and *Tetrao* in the Palearctic.

We do not accept such a position, because 9 species of the total 17 and 4 genera of the total 7 are represented in the recent Palearctic tetraonid fauna.

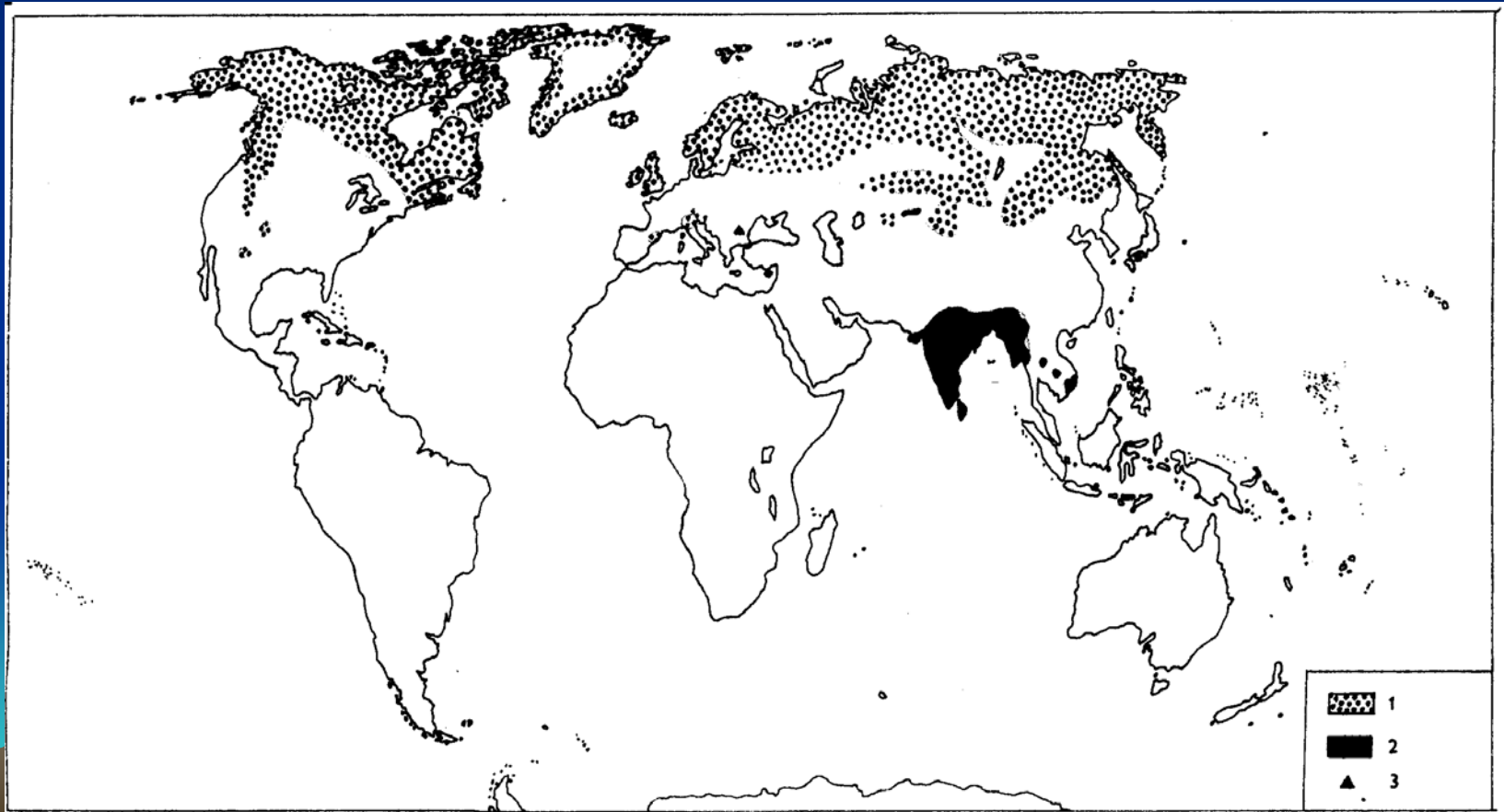


The Early Pliocene records suggest that the Palearctic (European, and even SE-Europe) is the area of the origin of the family, confirming a statement of Denes Jánossy.

It is not very likely that Tetraonidae appeared in Nearctic because no fossil evidence is known in North America besides the four (?)doubtful Miocene taxa rejected by Olson (1985). In the Western Palearctic we have a well-documented fossil record of Tetraonidae (13 taxa, 9 of them fossil) from the Ruscinian until the Early and Late Pleistocene and further up to recent times. Another reason for rejecting a North American origin for Tetraonidae is that they are considered to have differentiated morphologically from Phasianidae (Potapov, 1987; De Juana 1994). Furthermore, phasianids are only found in the Old World, and no fossil record is known of the family from the New World up to the present. This completely causes one to reject the hypothesis that Nearctic was their area of origin. Another fact : Traditionally Tetraonidae have been considered cold-loving birds. This may be true, if we consider recent species. However, the earliest fossil tetraonids do not fit such a view and data from Bulgaria reject it. *Lagopus balcanicus* and *Tetrao partium* from Varshets coexisted with the warm-loving *Apus baranensis* Jánossy, 1977, *Hieraaetus* cf. *fasciatus*, *Gyps* sp. n., and *Circaetus* sp. *Tetrao rhodopensis* also shared the surroundings of Dorkovo with a small undetermined species of *Perdicinae*, while *Lagopus atavus* in Muselievo coexisted with *Pavo bravardi*.

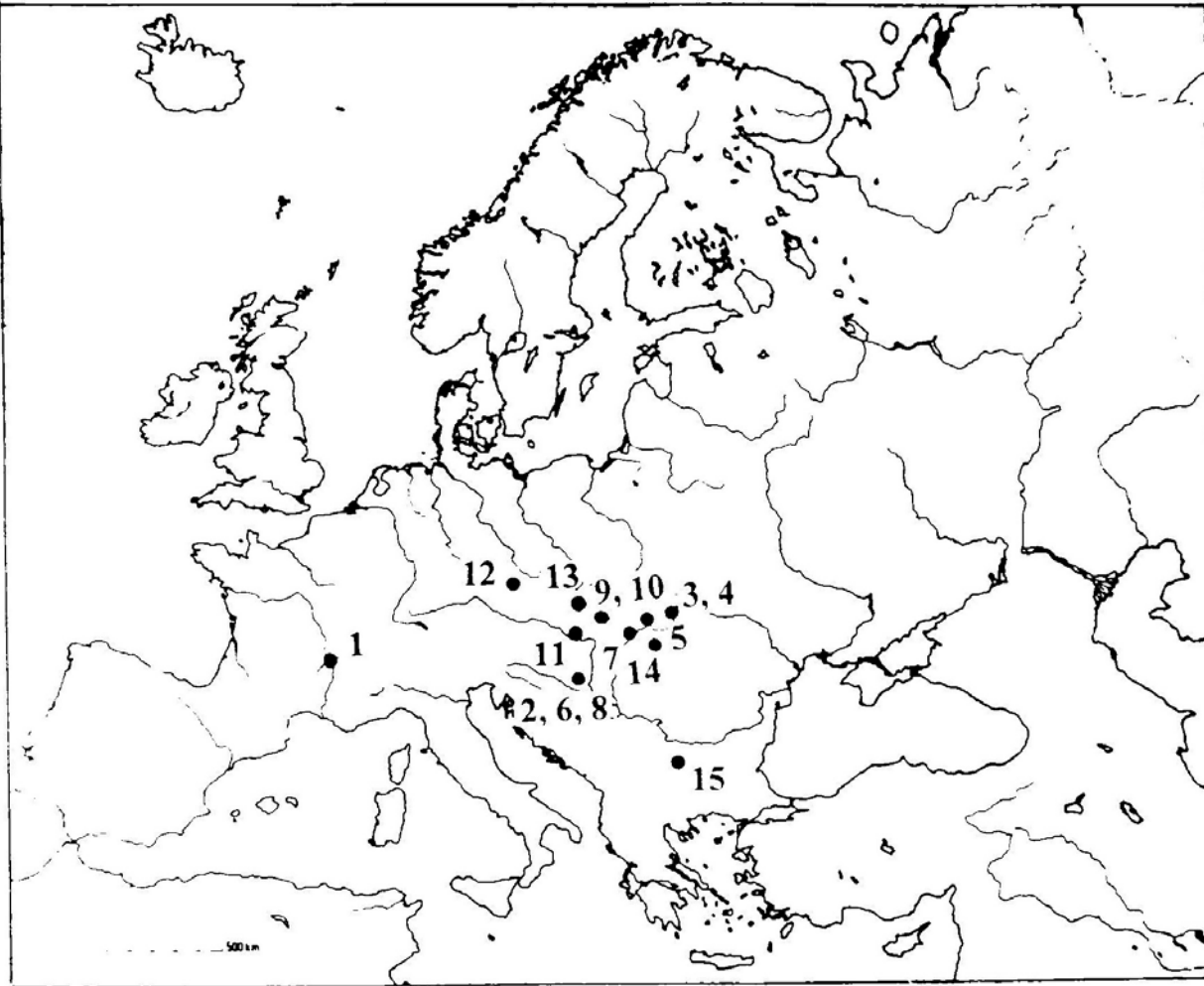


If not the all thee family, at least the genus *Lagopus*, appeared in the forested savannah or savannah-forest. The habitats for the earliest representatives of *Tetrao* may have been similar. In short, Tetraonidae probably first appeared in the Western Palearctic (most likely SE Europe - SW Asia) during the Late Miocene (Pontian), because *Lagopus* and *Tetrao* are known from the Ruscinian as two distinctive and differentiated genera. Forested savannah, savannah-steppe or parkland forest was the habitat of the first tetraonids. The earliest tetraonids were not cold-loving birds, they lived in habitats of a warmer climate than the family lives in today. Their adaptattions to colder climates and habitats with snow are a more recent phenomenon, i. e. Late Pliocene – Early Pleistocene.



Tetrao

The geographical range of *Tetrao partium* following Janossy (1976) encompasses a large territory of Europe from France to Ukraine, while stratigraphically the species was spread from the Middle Villafranchian to Mindel.



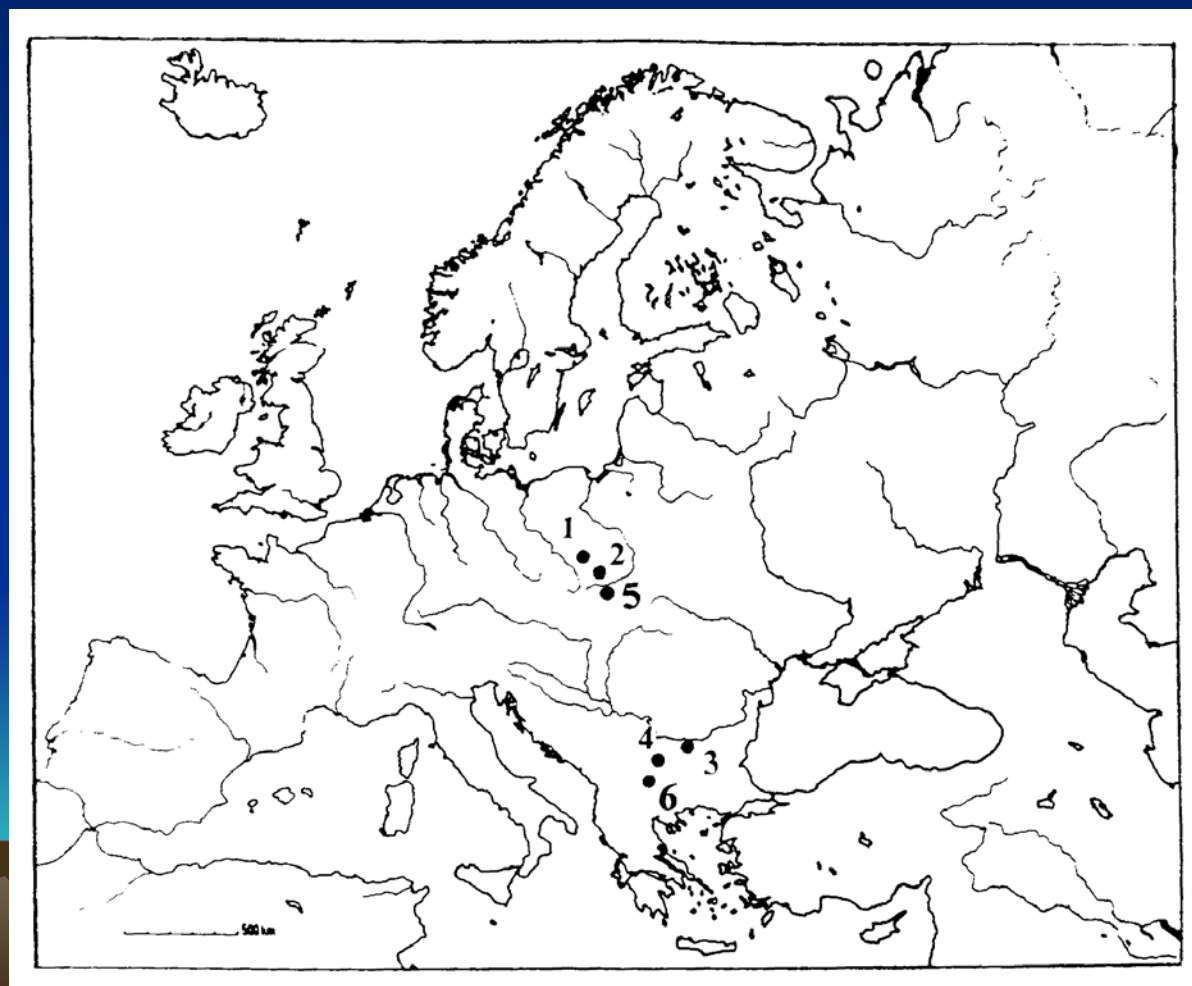
Mlikovsky (1996) lists no Tertiary sites of that species in Europe. Tyrberg (1998) defines the stratigraphic range of *T. partium* between 19 and 21 MNQ zones.

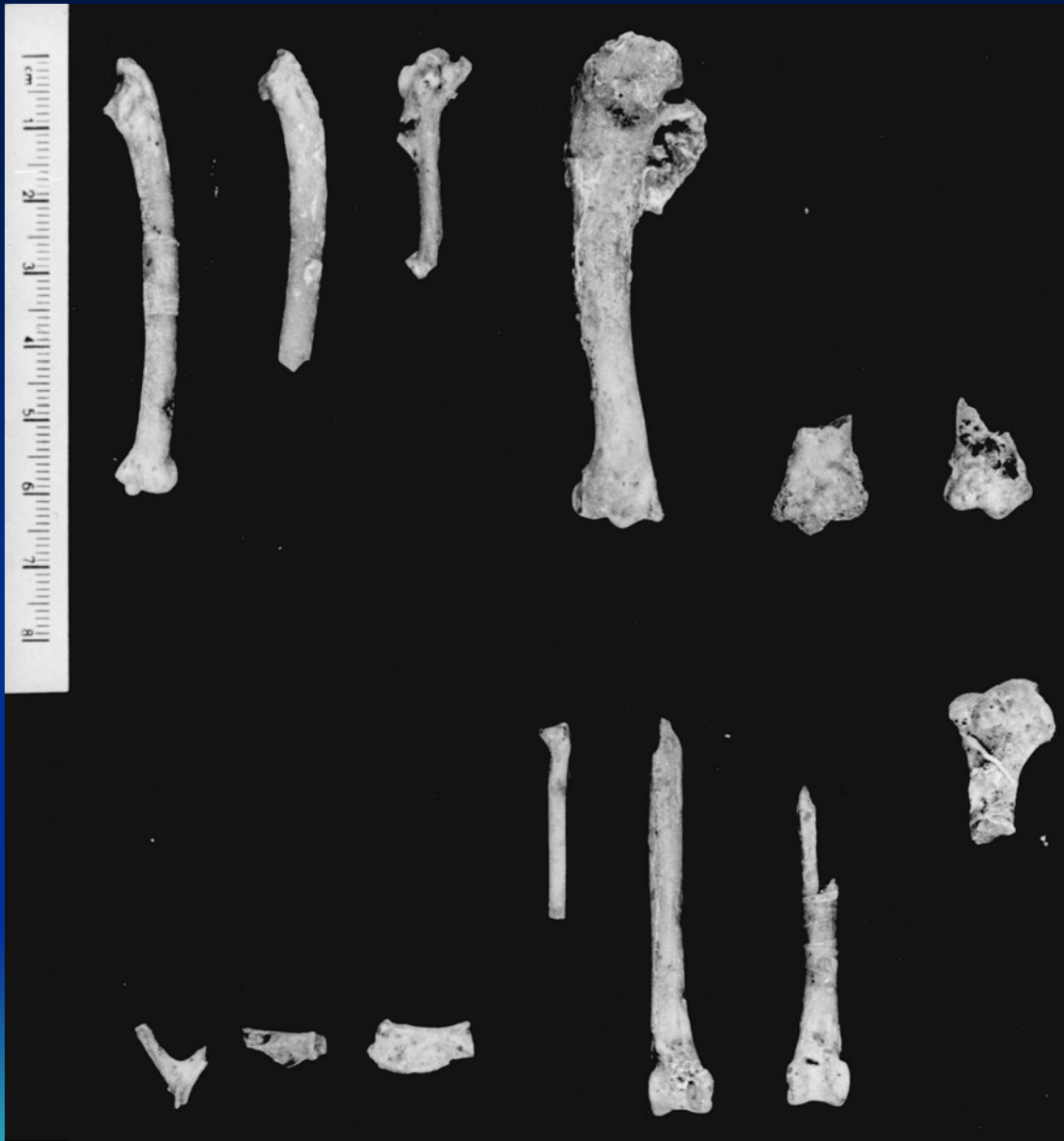
The finds of *T. partium* from Bulgaria came from Varshets. They show that at least in the Middle Villafranchian the species occurred not only in the Western and Central Europe, but also in the Eastern part of the continent. The record from Bulgaria is the earliest find on the Balkans and marks the southern limit of its range.

The find of *Tetrao rhodopensis* from Bulgarian Ruscinian of Dorkovo also confirms the splitting of the *Lagopus* and *Tetrao* lineages at least in the beginning of the Pliocene.



The find from Muselievo is among the oldest records of *Lagopus*. Moreover, the site of Muselievo marks its southernmost distribution in the Tertiary. The site is unique with the coexistence of *Lagopus* and *Pavo* in the Early Pliocene of SE Europe. It reveals an association that so far has been unknown.





The numerous Pliocene remains of *L. balcanicus* confirm the forested savannah-forest or forest-steppe origin of genus *Lagopus*. Even in the Pleistocene *Logopus* species adapted to the Boreal/mountain treeless habitats.

Gruiformes

Rallidae

Rails occur regularly in the Neogene deposits of the Northern hemisphere. The fossil taxa were spread throughout E Europe. We consider the Pliocene *Porzana* sp. n. from Bulgaria a possible ancestor of *Porzana porzana*. *Porzana* sp. n. existed in MNQ 17 zone, while the oldest finds of the closest species, *P. porzana*, originate even from the Middle Pleistocene.

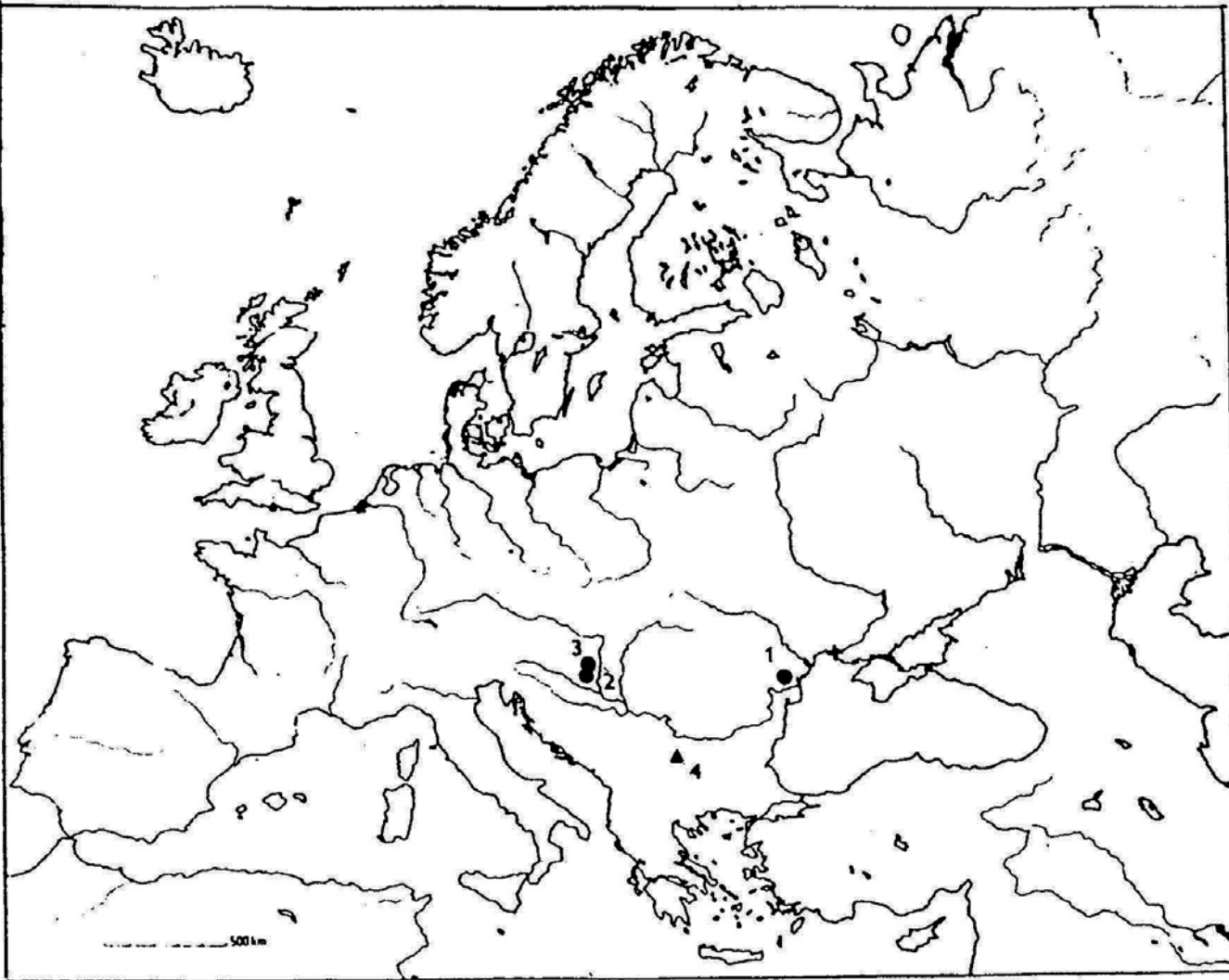




The second rallid, *Gallinula balcanica* from the Middle Villafranchian, is considered to be a direct ancestor of the recent *G. chloropus*. Finds of *Gallinula* are reported from the Early Pliocene in Hungary. No other Tertiary finds (except these of Tanzania) are reported up to now (Mlikovsky, 1996).

Otitidae

All finds of *Otis khosatzkii* originate from plain (Etulya, Polgardi), or hilly (Beremend, Varshets) regions of Central and SE Europe. These regions are specific for all recent Otitidae species.



The Khosatzkiy's bustards had probably been wide spread in the Late Pliocene throughout S and E Europe. According to the available data so far, its range encompassed the perri-Carpathian region (Hungary, Moldova, Bulgaria). On our opinion, the Khosatzki's Bustard was a species of (South-) East-European distribution. After Janossy (1991) the occurrence of *Otis khosatzkii* as the first proof of the presence of genus *Otis* in the region.

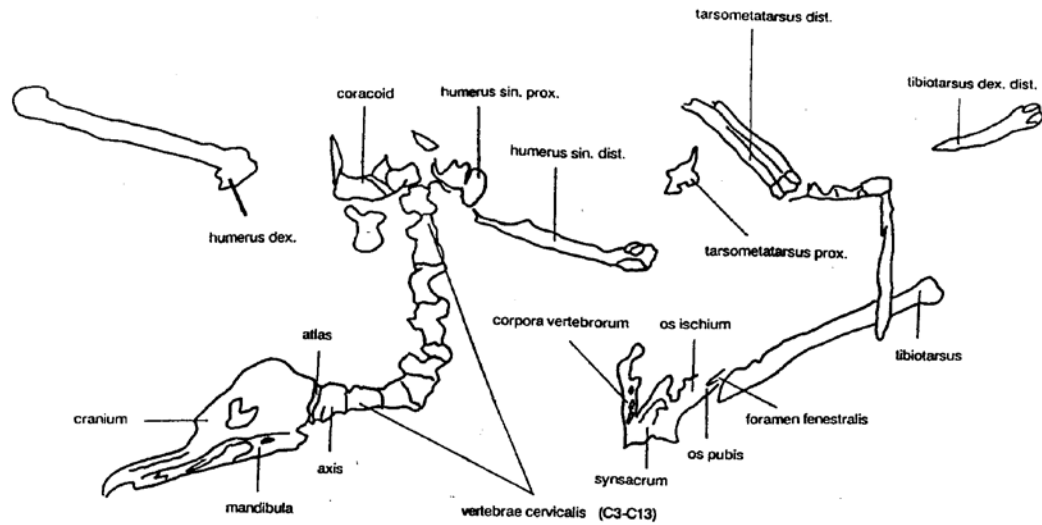




Charadriiformers

Scolopacidae

The Pliocene distal tarsometatarsus from Varshets is the earliest record of *Actitis* at all. As the larger part of the breeding range of the genus lies in the Palearctic region and the earliest finds originate from Europe, we may consider the Pliocene S-European fresh-water shore habitats as the initial grounds, where the *Actitis* evolved. It is quite possible that *A. balcanucus* was the direct ancestor of recent *A. hypoleucos*.



Laridae

The fossil record of gulls (*Larus*) in Europe is concentrated in the Vallesian deposits (MN 9-10) (Mlikovsky, 1996). Turolian sites are not very numerous. The Bulgarian find from Hrabarsko represents a skeleton, laying on its left side up. The find is included in a coal block. The specimen has intermediary size between the recent *Larus minutus* and *Larus ridibundus*.

Besides the incomplete determination (Larinae gen.), the find of the gull from Hrabarsko has important significance. The avian fauna of the site not only confirms the presence of forested savannah habitats (proved by two larks - *Melanocorypha* sp. n. and *Alaudidae* cf. *Lullula*), but also indicates the presence of large water bodies (*Phalacrocorax*, Larinae gen.).

Columbiformes

Columbidae

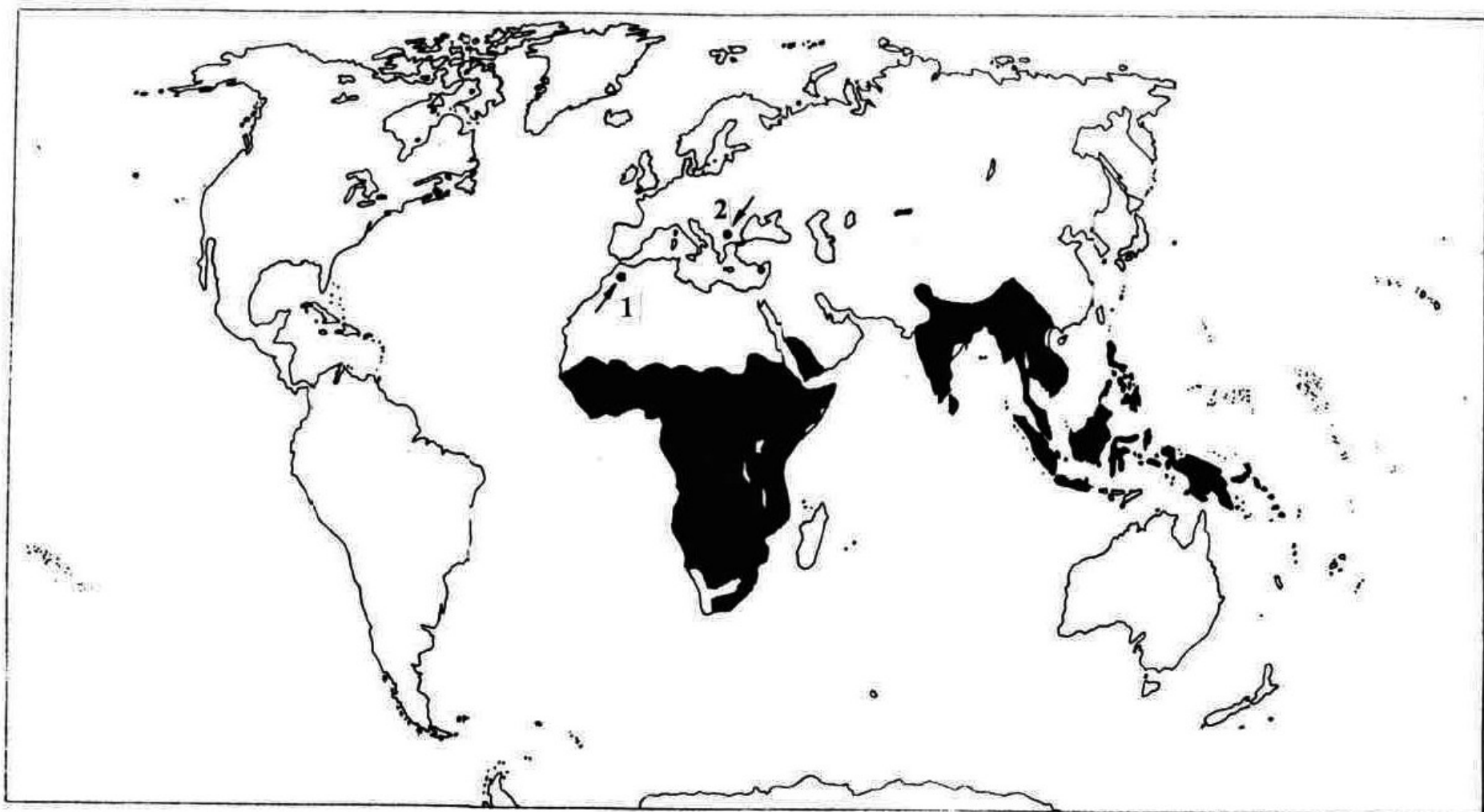
The late Pliocene finds of *Columba* sp. – 1 and *Columba* sp. – 2 came from the site of Varshets. They could not be determined further, because they originate from immature individuals, except a specimen, showing morphological differences from the recent Rock Pigeon (*Columba livia*). Three other finds from the same site belongs to *Streptopelia* sp. Mlikovsky (2002) lists no other Neogene records of that genus for Europe.

Strigiformes

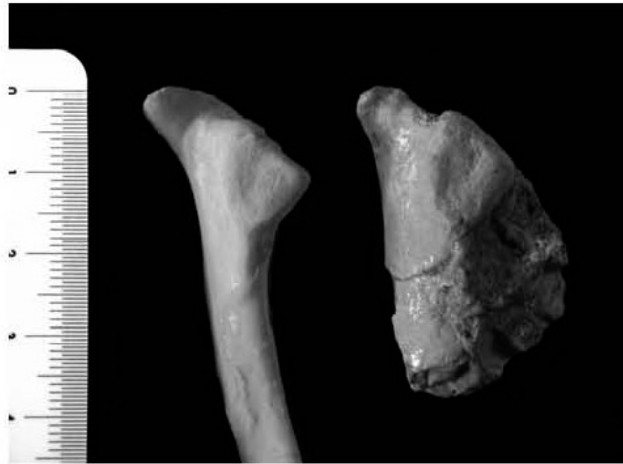
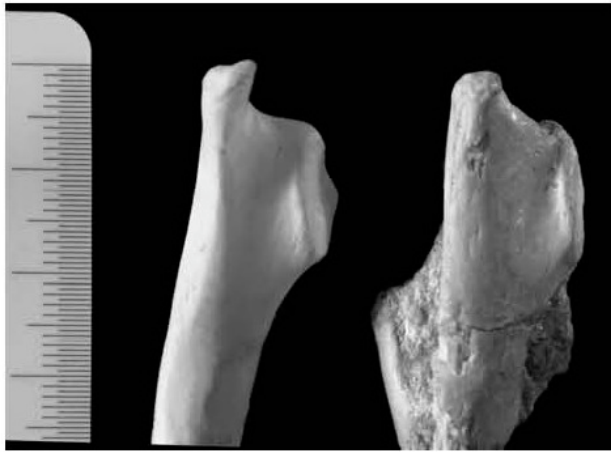
Strigidae

As woodland birds, owls are not numerous in the fossil record. Their only find (an incomplete sternum of *Athene* sp.) originates of the end of Late Pliocene from Slivnitsa. Besides its incomplete identification, after Mlikovsky (2002) it is the oldest so far European record of that genus in Europe.

Hornbills are currently distributed through the Paletropics. The Ground-hornbills (Bucorvinae) include 2 recent and 1 fossil species (Brunet, 1971; Kemp, 2001).



The fossil record of Bucerotidae is scanty and in fact only two papers contain data on the fossil history of this family. Brunet (1971) describes *Bucorvus brailoni* from the late Miocene in N Morocco. This record has been confirmed and accepted by Olson (1985), whose suggestion that "...bucerotids should be looked for in the Tertiary deposits of the modern Palearctic region" was correct, bearing in mind their recent discovery in Bulgaria.



The faunal complex suggests that *Euroceros bulgaricus* in its appearance, behaviour and ecological adaptations may have resembled the recent ground-hornbills. This is only tentatively, because of the presence of the savannah-like open grass habitats, where the ostrich is the most diagnostic species among birds.

The proportional comparison of the osteometrical dimensions shows a very good separation of the Bulgarian Ground-hornbill from its closest relatives (*Bucorvus abyssinicus* and *B. leadbeateri*).

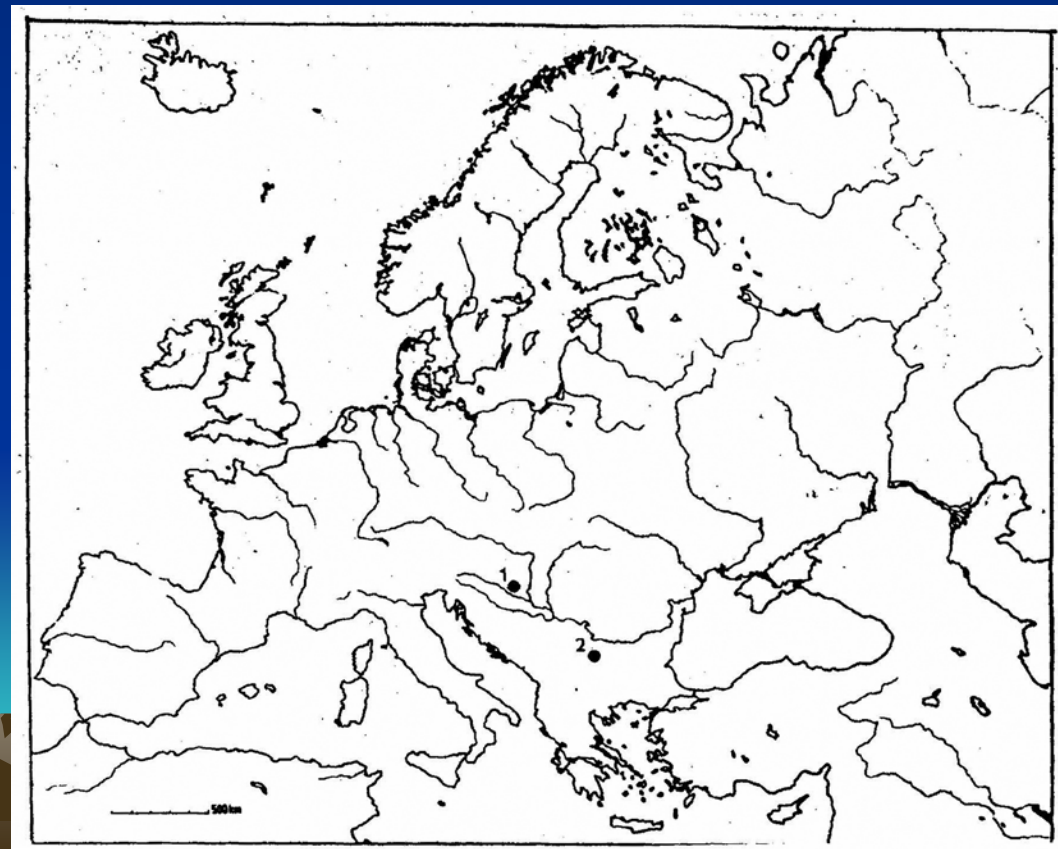
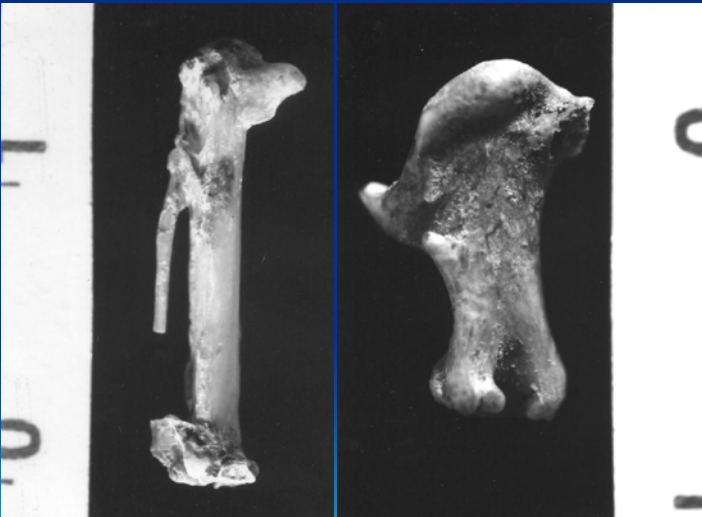
The fossils of Hadzhidimovo are the oldest known record of Bucerotidae so far. The new locality from Bulgaria suggests a formerly much wider Afro-Euroasiatic range of Bucerotidae in the Tertiary, or at least in the Miocene. This record for the first time proves the former distribution of Bucerotidae in Europe.



Apodiformes

Apodidae

The Pliocene swiftlet *Apus baranensis* Janossy, 1977, was spread at least in Central (S Hungary) and South-Eastern (W Bulgaria) Europe. The site of Varshets is the first confirmation of the species' existence up to now, after its description in 1977 from Beremend in Southern Hungary.





Passeriformes

Alaudidae

The Bulgarian Neogene record of larks is relatively abundant and 16 fossils have been collected so far. The site of Hrabarsko yielded the earliest records of the family at all, except the find listed as “Alaudidae” from the middle Miocene of France. The late Miocene specimen of Hrabarsko belongs to a new species of *Melanocorypha*.

Another new species of *Melanocorypha* of lesser size has been uncovered in the late Pliocene of Varshets. *Alauda* sp., *Galerida* sp. and *Eremophila* sp. are established in Varshets and represent the oldest European records of these genera.

Motacillidae

Both basic genera (*Anthus* and *Motacilla*) in the recent fauna of the family in the Western Palearctics, are represented in the Bulgarian Neogene record, both in the site of Varshets. These finds, together with the finds of S Hungary, are the oldest ones so far.

Regulidae

No fossil taxa of genus *Regulus* have been described so far and *Regulus bulgaricus* is the only yet known fossil kinglet.



Muscicapidae

The only record is a find of *Muscicapa* sp. from the Late Pliocene of Varshets. After Mlikovsky (2002) it is the second Cenozoic record of *Muscicapa* genus (besides a site of Mallorca) and the oldest one so far in Europe.

Turdidae

Bulgarian turdid fossil fauna came from the two Villafranchian sites, Varshets and Slivnitsa, and numbers a total of 8 taxa and 3 species at least. The records of *Turdus merula*, *T. iliacus* and *T. philomelos* are the earliest known records at all. In addition, a find of *Erithacus* sp. from Varshets is also the oldest record of that genus so far (Mlikovsky, 2002).

Paridae

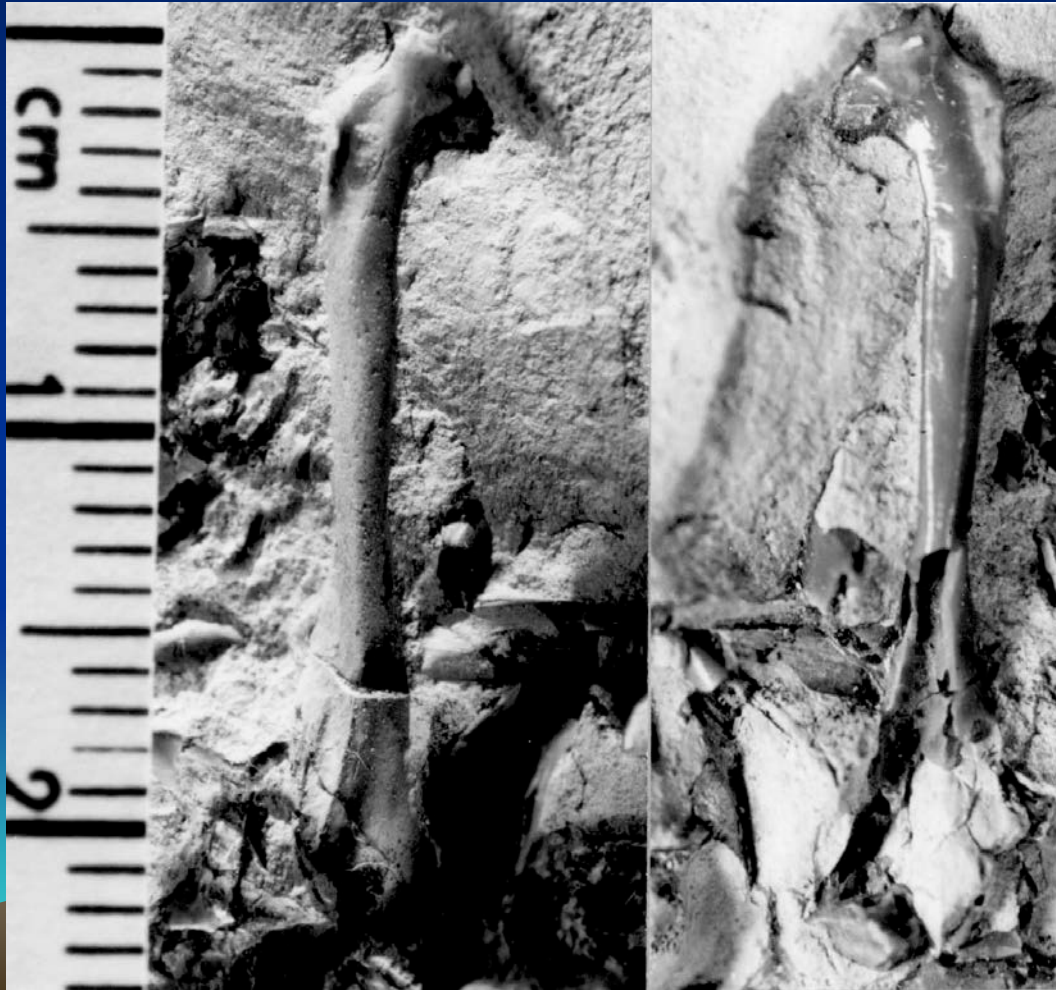
The site of Varshets also yielded the earliest record of the Paridae. Part of the finds belong to *Parus* cf. *major*, the oldest record of the Great Tit, while another smaller species (*Parus* sp.) coexisted with it.



No Tertiary records are known of the family of starlings (Mlikovsky (2002). In SE Europe, including the Balkans, also there are no data. The late Pliocene *Sturnus* sp. from Varshets differs morphologically from the modern *Sturnus vulgaris*, *St. roseus* and *St. pagodarum*, and most probably represent a new species. Another species of Sturnidae is the oldest record of the family, originating from the middle Miocene (MN 5-8) of the site of Kardam.



The specimen show higher similarity both to *Sturnus*, *Speo* and *Lamprotornis* from Sturnidae. It lies within the measurements range of *Sturnus* spp., but it could not be firmly referred to any of the compared recent genera of Sturnidae. Thus, even its incomplete identification so far, the specimen of Kardam marks the presence of the Sturnidae family even in the middle Miocene of SE Europe.



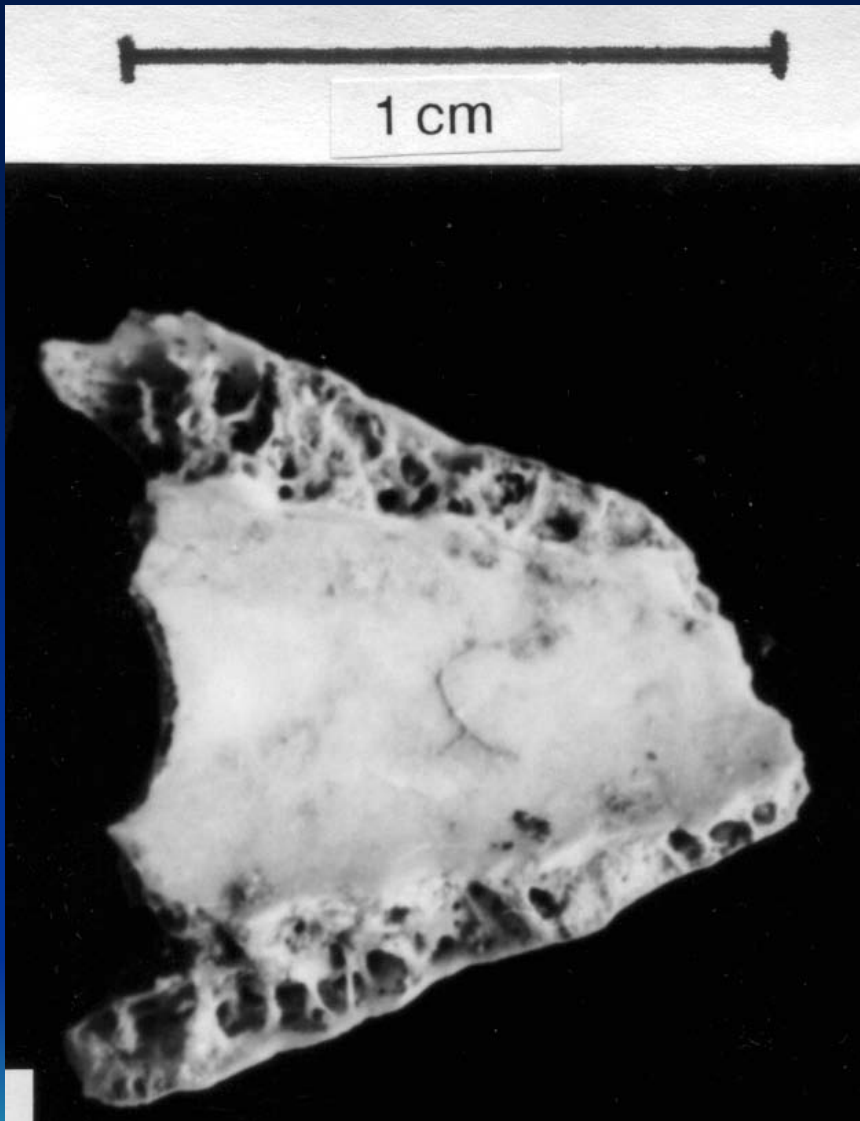




Corvidae

The richest corvid Neogene faunas in Europe is discovered so far in two late Pliocene sites of Bulgaria – Varshets and Slivnitsa, where 5 genera and 5 taxa were distinguished. The records of *Nucifraga* sp., *Pica* sp., *Pyrrhocorax pyrrhocorax*, and *Corvus* cf. *monedula* from Varshets are the earliest records of these taxa. The record of *P. graculus* is the 2nd one after that of Hungary (Mlikovsky, 2002).

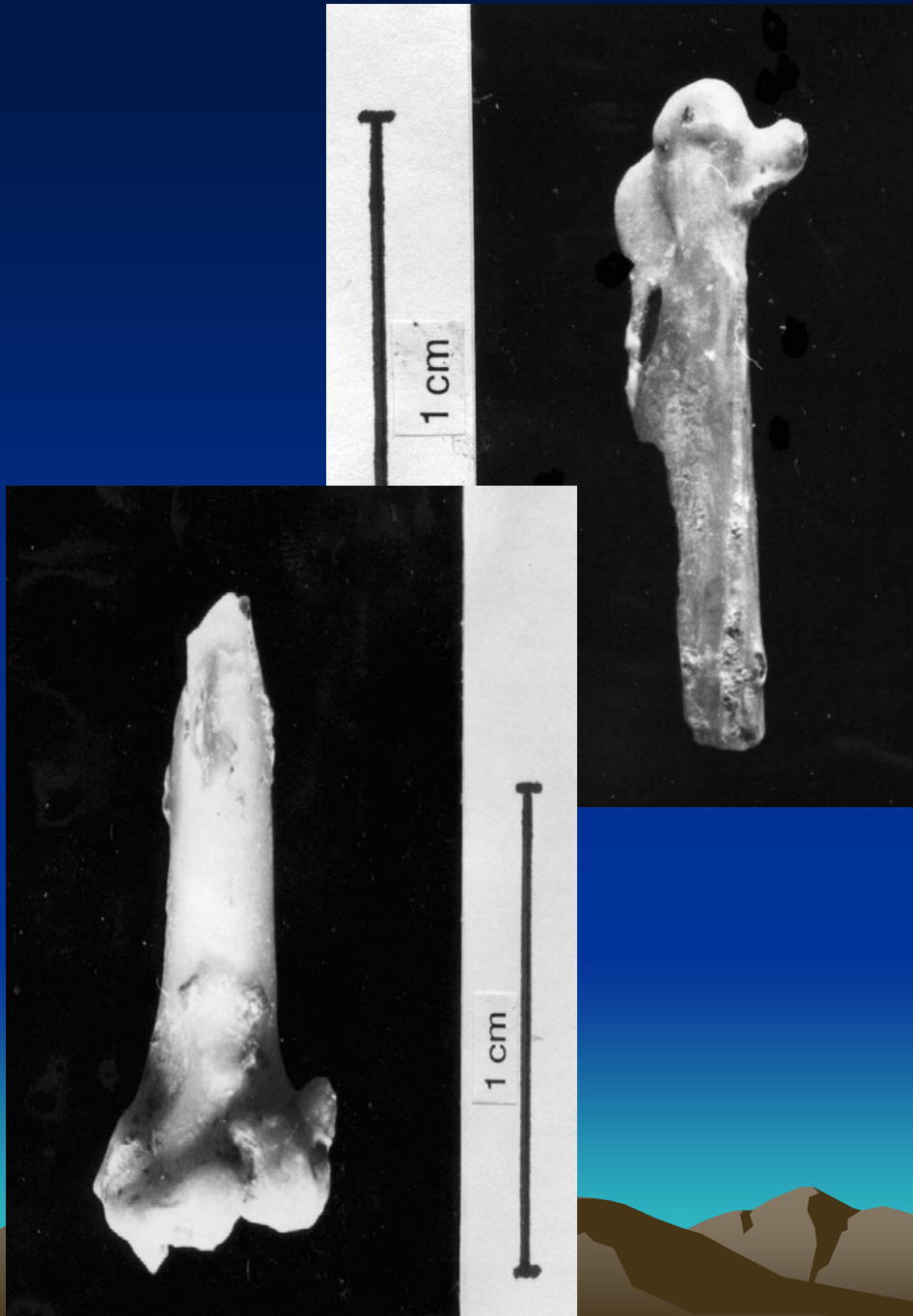
Such a corvid fauna is an example of the s.c. “mixed” faunas, as all taxa are specific to the openland/ rocky areas, except *Nucifraga*, which is a typical woodland form.



Fringillidae

Four genera (*Carduelis*, *Loxia*, *Fringilla* and *Coccothraustes*) were established in the Bulgarian late Pliocene deposits. They also are the oldest record in the European Neogene except that of *Fringilla* sp. from Spain. The only known prehistoric species of extant genera of the World fringillid fauna came namely from the Bulgarian Neogene.

The late Pliocene finds from Varshets and Slivnitsa provide the earliest record of the *Coccothraustes* up till now. *Coccothraustes balcanicus* is considered as the Late Pliocene direct ancestor of recent Hawfinches (*C. coccothraustes*) in W Palaearctic.



A taxonomical identity of *C. balcanicus* and *C. simeonovi*, cannot be excluded until additional homologous remains are collected. In any case, the late Pliocene finds from Varshets and Slivnitsa provide the earliest record of the genus *Coccothraustes*. Both species mark the distribution of a forested landscape in the vicinities of the sites during the Villaniyan.

The Middle Villafranchian crossbill *Loxia patevi* inhabited the light mixed open broadleaf forests of park type. At present *Loxia* is an indicator for a forest habitat. This record is the 2nd one in Europe, after a Miocene record from France.

The numerous finds of *Carduelis* cf. *carduelis* and *Carduelis* sp. from Varshets are the earliest known record of the European Goldfinch. Its pre-glacial occurrence determines it as a Tertiary relics in Europe. The same could be stated for the finds of *Fringilla coelebs*.

Emberizidae

Eight finds of *Emberiza* sp. from the Middle Vilafranchian of Varshets and Slivnitsa mark the distribution of buntings in the pre-glacial time throughout the SE Europe. After Mlikovsky (2002) they are still the earliest fossil record of that numerous genus on the continent.



ECOLOGICAL FAUNAL COMPLEXES AND THE “MIXED” AVIFAUNAS

Eliminating temporal (chronostratigraphical) distribution, four major avifaunal complexes could be divided – aquatic, woodland, openland (and rocky/stone areas) and shrubland (incl. broken woodland) of the Bulgarian Neogene avifaunas.

Neogene record of the aquatic avian complex of Bulgaria (6 orders, 8 families):

Pelecaniformes: *Phalacrocorax serdicensis*;
Ciconiiformes: *Geronticus balcanicus* and Botaurinae gen.;
Anseriformes: *Anser thraceiensis*, *Balcanas pliocaenica*, *Cygnus verae*, *Anas* cf. *clypeata* and Anatinae gen.;
Gruiformes: *Gallinula balcanica*, *Porzana* sp. n.;
Charadriiformes: *Actitis balcanica* Boev, 1998, Larinae gen. indet. and Charadriiformes fam.
Passeriformes: *Motacilla* sp.



Neogene record of the woodland avian complex of Bulgaria (5 orders and 12 families):

Accipitriformes: *Accipiter* sp. ex gr. *gentilis*, *Accipiter* sp., *Aquila* sp. ex gr. *clanga*, *Buteo* *spassovi*, *Buteo* sp.,

Galliformes: *Tetrao rhodopensis*, *Tetrao* aff. *partium*, *Pavo bravardi*,

Strigiformes: *Athene* sp.,

Columbiformes: *Streptopelia* sp.,

Passeriformes: *Lullula* sp. *Parus* sp. ex gr. *major*, *Parus* sp., *Regulus bulgaricus*, *Muscicapa* sp., *Fringilla* cf. *coelebs*, *Coccothraustes simeonovi*, *Coccothraustes balcanicus*, *Loxia patevi*,

Turdus cf. *merula*, *Turdus* cf. *iliacus*, *Turdus* cf. *philomelos*, *Turdus* sp., *Erithacus* sp.,

Nucifraga sp., *Pica* sp. n., *Corvus* aff. *praecorax*



**Neogene record of the openland (incl. rocky/stone areas) avian complex of Bulgaria
(7 orders and 9 families):**

Struthioniformes: *Struthio* cf. *Struthio karatheodoris*
Accipitriformes: *Gyps* sp. n.,
Galliformes: *Chauvireria balcanica*, *Chauvireria* sp. n., cf. *Perdix* sp., *Lagopus balcanicus*,
Lagopus aff. *atavus*, *Lagopus* sp.,
Gruiformes: *Otis* cf. *khosatzkii*, Otididae gen.
Coraciiformes: *Euroceros bulgaricus*
Apodiformes: *Apus baranensis*,
Passeriformes: *Melanocorypha* sp. n., *Alauda* sp., *Eremophila* sp. n., *Pyrrhocorax* cf. *graculus*,
Pyrrhocorax c *pyrrhocorax*, *Corvus* cf. *monedula*

**Neogene record of the shrubland (incl. broken woodland) avian complex of Bulgaria
(2 orders and 2 families):**

Accipitriformes: *Circaetus* cf. *gallicus*, *Circaetus* sp., *Hieraaetus* cf. *fasciatus*, *Hieraaetus* sp.,
Falconiformes: *Falco bakalovi*, *Falco* sp. ex gr. *tinnunculus*, *Falco* sp. ex gr. *cherrug*, *Falco* sp.



Besides this provisional dividing, the Bulgarian Neogene bird fauna shows varied composition, not only in taxonomic, but also in the ecological (habitat) aspect. Pliocene “mixed” faunas have been already mentioned. They were best represented at the end of Pliocene during the Villafranchian.

In Hadzhidimovo *Struthio* and Bucorvini (*Euroceros*), coexisted with *Aquila* sp. ex. gr. *clanga* in the late Miocene.

In Muselievo *Pavo* coexisted with *Lagopus* in the Early Pliocene.

In Varshets coexisted a series of taxon-pairs: *Otis* and *Tetrao*, *Lullula* and *Melanocorypha*, *Parus* cf. *major* and *Eremophila*, *Regulus* and *Pyrrhocorax*, *Loxia* and *Galerida*, etc. in the late Pliocene.

In Slivnitsa *Coccothraustes* and *Pyrrhocorax*, *Lullula* and *Falco* sp. ex gr. *tinnunculus* coexisted in the late Pliocene.



AFRO-TROPICAL AND AFRO-INDO-MALAYAN ELEMENTS IN THE NEOGENE AVIFAUNA OF BULGARIA AND THEIR PALEOZOOGEOGRAPHICAL IMPLEMENTATIONS

The peafowl, ostriches and ground-hornbills are the only three avian taxa of recent Afro-tropical/Afro-tropical – Indo-Malayan distribution, established in the Bulgarian Neogene record. They are also excellent examples of taxa from sites, located between the present day disjunct parts of the groups' ranges:

- (1) The sites of *Pavo bravardi* lie between the ranges of *Afropavo congensis* (tropics of Africa) and the *Pavo muticus* and *Pavo cristatus* (S and SE Asia – Hindustan and Indochina);
- (2) The site of *Euroceros bulgaricus* lie between the present day ranges of Bucerotidae in Africa (south of Sahara) and that of S and SE Asia (Hindustan and Indochina);
- (3) The sites of *Struthio cf. karatheodoris* lie between the present day range of struthionids (*Struthio camelus* in Africa (south of Sahara) and its subrecent range in Arabian Peninsula and its former Holocene range in the Central Asia and China, where it possibly survived up to 10th century A.D.

The Bravard's peafowl, was the last resident (non-migratory) avian species of the s. c. “tropical” complex of Europe.



The finds of the ground-hornbills confirm the former range-continuity throughout Europe, possibly, at least until the end of the late Miocene. They suggest that within the Bucorvini in the Turolian - Meotian at least two lineages (these of *Bucorvus* and *Euroceros*) existed. On the other hand, they also confirm the former presence of the savannah-like biomes in the S Bulgaria. This is supported also by the finds of *Struthio* in the same site and a neighbouring locality of the same age. Their records (of *Struthio* cf. *Struthio karatheodoris*) in two sites (very close to the Greek border) seriously contribute to the hypothesis of the very fast elevation of the surrounding mountains. At present the landscape of this region is highly mountainous and the fossils of the ground-hornbills and ostriches confirms the very rapid and intensive elevation of the relief. Now both sites lie ca. 80 km away from the highest peak of the Balkan Peninsula, the Mount Musala (2925 m a. s. l.) in the Rila Mountain. In the late Miocene ca. 9 mya the regions in the vicinities of the localities were similar to the present day African plains with open clear grass savannah with scattered trees and shrubs.



THE VALUE OF THE BULGARIAN NEOGENE AVIFAUNA TO THE KNOWLEDGE OF THE WORLD NEOGENE AVIFAUNAS

From the ca. 1500 fossil bird species, 17 (1.1 %; all of them Neogene) were described from Bulgaria. The following parameters characterize the significance of the researches of the Bulgarian Neogene bird fauna:

Number of new species, described from Bulgaria – 17:

Pelecaniformes

Phalacrocorax serdicensis Burchak-Abramovich & Nikolov, 1982

Ciconiiformes

Geronticus balcanicus Boev, 1998

Anseiformes

Anser thraceiensis Burchak-Abramovich & Nikolov, 1982

Balcanas pliocaenica Boev, 1998

Cygnus verae Boev, 2000

Accipitriformes

Buteo spassovi Boev, 1998

Falconiformes

Falco bakalovi Boev, 1998

Coraciiformes

Euroceros bulgaricus Boev, 2007



Galliformes

Tetrao rhodopensis Boev, 1998

Lagopus balcanicus Boev, 1995

Chauvireria balcanica Boev, 1997

Gruiformes

Gallinula balcanica Boev, 1999

Charadiiformes

Actitis balcanica Boev, 1998

Passeriformes

Regulus bulgaricus Boev, 1999

Loxia patevi Boev, 1999

Coccothraustes simeonovi Boev, 1998

Coccothraustes balcanicus Boev, 1998

Number of new genera, described from Bulgaria – 3:

Balcanas Boev, 1998 (of Anatini – Anseiformes)

Chauvireria Boev, 1997 (of Perdicinae – Galliformes)

Euroceros Boev, 2007 (of Bucorvini – Coraciiformes)



Number of taxa of the Neogene avifauna of Bulgaria:

orders – 13
families – 24
genera – (incl. “cf.” and “aff.” categories) - 48
species (incl. “cf.” and “aff.” categories) – 30

Number of fossil taxa, described from other regions of the World, established in the Bulgarian Neogene record - 7:

Struthio cf. *Struthio karatheodori*
Lagopus aff. *atavus*
Tetrao aff. *partium*
Pavo bravardi
Otis aff. *khosatzkii*
Apus baranensis
Corvus aff. *praecorax*



RESEARCHES ON THE PLEISTOCENE BIRDS OF BULGARIA

As a country of southern geographical situation in Europe, Bulgaria has a great significance for the elucidation of the building of ranges and the former range fluctuations of the recent bird species in Europe. The Pleistocene avifaunas of Bulgaria are still insufficiently known. In contrast to some countries of Central and Western Europe, the Pleistocene bird faunas of Bulgaria remained completely unstudied until the early 1980-ies. During the last two decades the author has published a series of studies. Most of the data came from cave deposits or rock fissures. Our data on Pleistocene avifaunas concerns 18 caves. Here we summarize all data on the Pleistocene bird faunas of Bulgaria, based on 5770 avian bone fossils (Boev, 1999, 2001). The complete taxonomic list includes at least 160 recognized species.



THE BALKAN PENINSULA AS A REFUGIUM OF THE ARBOREAL AND TERMOPHYLIC AVIFAUNA

It is believed that during the last glaciation (ca. 70 000 B.P.) the three Mediterranean peninsulas (Pyrenees, Apennines and Balkans) played a key role in the survival of the wood avifaunistical complex. Blondel (1982) summarizes that the glacial events did not cause extinctions, or speciations in the Mediterranean region in the Pleistocene. On the contrary, because of the extraordinary topographic, edaphic and climatic heterogenerosity and the high diversity derived from it, a process of intensive speciation in the Pyrenees, Apennines and Balkans occurred during the Pleistocene, but this speciation concerns only a very limited part of the arboreal avifauna of the region (Blondel, 1984; 1985; 1987). The southern parts of the Balkan Peninsula, as well as the other two larger peninsulas of Europe sheltered suitable refugia for the heat-loving fauna in the colder stages during the Middle and the Late Pleistocene. As it is known, the glacial events on the Balkans were considerably poorer, especially in the southern parts of the peninsula. The main part of the populations of *Turdus* spp., *Sitta* spp., *Picus* spp., *Picoides* spp., *Certhia* spp., *Prunella* spp., *Alectoris* spp., *Garrulus glandarius*, *Hieraeetus fasciatus*, *Falco eleonora*, etc. have survived namely in these regions (Blondel, 1985). The representatives of most of these genera have been established in the Pleistocene deposits in Bulgaria also. They were usually found in several localities. Thus, for the first time the fossil record of Bulgaria has confirmed the regularities, mentioned above.



According to Blondel (1984; 1987) the evolution of *Alectoris*, *Sitta*, *Sylvia* and *Monticola* of the Palearctic fauna occurred predominantly in the Mediterranean. The Balkans and the West Asia Minor form the second (after the Pyrenees-Appennines) center of speciation in warblers of the genus *Sylvia* during the Pleistocene. At present this eastern center is inhabited by 11 species. Blondel calls it “eastern center of endemism and dispersion of the “*melanocephala*” group. *Sylvia communis* has been established in Devetashkata Cave, while the remains of *S. cf. atricapilla* occurred in the Cherdzenitsa Cave – 1. These finds mark the genus’s distribution during the middle and late Pleistocene in Bulgaria.

As Blondel (1987) summarizes, the oldest record of *Alectoris*, *Sitta* and *Sylvia* comes from the Mediterranean and dates back to the Middle to Late Pleistocene. Here the record of the Late Pliocene *Sitta* sp. n. from W Bulgaria, the oldest record of this genus in the world, deserves special attention.



The fossil record of Bulgaria shows that in the Pleistocene at least 50 recent avian genera were spread: *Accipiter*, *Falco*, *Buteo*, *Aquila*, *Aegypius*, *Circus*, *Falco*, *Alectoris*, *Perdix*, *Coturnix*, *Phasianus*, *Lagopus*, *Tetrao* (incl. *Lyrurus*), *Crex*, *Porzana*, *Rallus*, *Gallinula*, *Otis*, *Columba*, *Streptopelia*, *Otus*, *Bubo*, *Nyctea*, *Strix*, *Apus*, *Dendrocopus*, *Lullula*, *Alauda*, *Riparia*, *Ptyonoprogne*, *Anthus*, *Lanius*, *Oenanthe*, *Turdus*, *Monticola*, *Erithacus*, *Cettia*, *Sitta*, *Bombycilla*, *Fringilla*, *Loxia*, *Carduelis*, *Pyrrhula*, *Passer*, *Sturnus*, *Garrulus*, *Pica*, *Nucifraga*, *Pyrrhocorax*, *Corvus*, etc. Most of them could be unquestionably referred to the group of the dendrophylous, or arboreal birds. A smaller part (*Alectoris*, *Apus*, *Riparia*, etc.) are obligatory termophylous, chiefly petrophylous elements.

The representatives of the arboreal avifauna have been localized in the glacials south of the Balkan Range, where besides coniferous, there were vast deciduous forests in the southern parts. It is believed that in Bulgaria the most important were the broad-leaved forests in the SE parts of the country (Strandza and Sakar mountains). These regions as a whole, are determined by Moreau (1954) as refugia for the survival of Honey Buzzard, Tawny Owl, Middle Spotted Woodpecker, Green Woodpecker, Golden Oriole, Nuthatch, Icterine Warbler, Blackcap, Whitethroat, Wood Warbler, Red-breasted Flycatcher, Hawfinch, etc. Tetraonids are determined as a specific element of the Pleistocene avifaunas of Europe by Mourer-Chauviré (1993). This regularity is present in the Pleistocene localities in the Balkans too. All the five tetraonids spread in Europe were widely spread during the Pleistocene in Bulgaria too.

The following bird species of the termophylic fauna have been established in Bulgaria: Honey Buzzard, Swift, Alpine Swift, Nightjar, Bee-eater, Sand Martin, Northern Wheatear, (entomophagous), Quail, Corncrake, Baillon's Crake, Turtle Dove, (phytophagous), Short-toed Eagle (herpetophagous), etc.

All of them are now represented in Bulgaria and the Balkans by their breeding populations. result of the Holocene migration of the faunal complexes.



SEASONAL MIGRANTS IN THE PLEISTOCENE LOCALITIES

Now it is well known that most of the modern species of birds appeared in the Late Pliocene and the Pleistocene. Many relict routes of migrations have survived until the present. Hence, the seasonal migrations of birds are a paleogeographic heritage.

On the other hand, migrations as an adaptation of birds to evade the unfavorable environmental conditions are very dynamic and “plastic”. For the bird fauna of the neighboring Romania for example, Drugescu (1987) states that its genesis is due to the migration of the elements of the Mediterranean, Caucasian, Syrian, Indian and Mongolian refugia after the end of Pleistocene.

Our data for Bulgaria, at least for S Bulgaria, do not support this hypothesis. The Early Holocene faunal changes were actually the last considerable events, which led to the modern state of the recent Balkan avifauna. But it should be evaluated in reference to the faunal complexes of the terrestrial vertebrate fauna that had been formed earlier, i. e. in the Pleistocene. As a whole, the avifauna of Bulgaria had almost a modern definite character.



Most of the S-European bird populations made trans-Mediterranean migrations to N Africa or SW Asia. The water birds, however, were not forced to leave their shelters in the S-European limits along the coasts of the Tyrrhenian, Adriatic, Aegean, Black, Asov and Caspian seas, where they had suitable wintering grounds. We have established the occurrence of some aquatic species of a more “northern” for the region distribution in the Early to Late Holocene too. Some of the localities of the S Black Sea Coast and of N Bulgaria: *Oxyura leucocephala*, *Aythya nyroca*, *A. ferina*, *A. fuligula*, and *Phalacrocorax aristotelis*. Most of them are now only winter visitors of the country.

Some migrants that now visit the country only in the winter season have been established by their numerous fossil (and subfossil) remains: *Gavia arctica*, *G. immer*, *G. stellata*, *Anser fabalis*, *A. albifrons*, *A. erythropus*, *Anas penelope*, *A. crecca*, *Bucephala clangula*, *Melanitta nigra*, *Buteo lagopus*, *Circus cyaneus*, *Cygnus olor*, *Tringa nebularia*, *Tr. glareola*, etc. During the Middle and Late Pleistocene they were visiting the country, but we do not know their status of sojourn. Their breeding range now lie further N of the territory of Bulgaria.



BOREAL ELEMENTS IN THE PLEISTOCENE AVIFAUNAS

Now for the first time the whole “boreo-mountain”, “glacial”, “alpine”, “Pleistocene” avifaunistical complex, characteristic for the glacial stages of the Pleistocene in the Temperate Zone of Europe, has been established in Bulgaria too. At present the arcto-alpine fauna has a very limited distribution in Bulgaria.

Our data show that the avian boreal complex numbers at least 15 woodland, steppe and hydrophilous species. These species are: Willow Grouse, Ptarmigan, Snowy Owl, Short-eared Owl, Pygmy Owl, Tengmalm's Owl, Great Grey Owl (identified as *Strix* aff. *nebulosa*), Rough-legged Buzzard, Whimbrel or Slender-billed Curlew (*Numenius phaeopus/tenuirostris*), Red-breasted Goose, Goldeneye, Common Scotter, Shore Lark, Chough and Alpine Chough. This list completes the information available so far from the remaining Balkan countries.

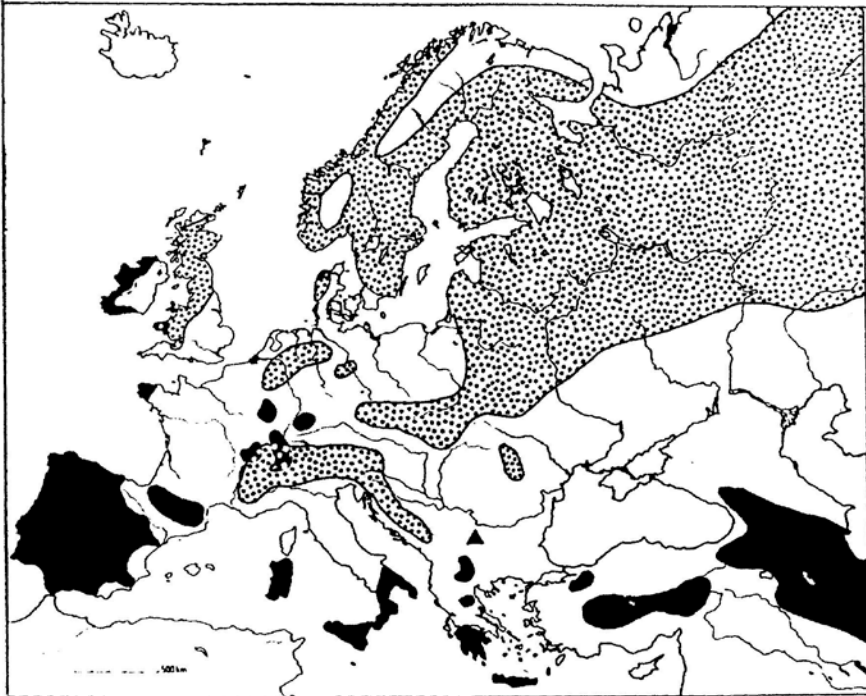
The boreal avifauna is best established in the Late Pleistocene deposits of the Devetashkata Cave. Some specific faunal elements have been established also in other caves. The presence of the snowy owl for example has been proved in the Kozarnika Cave in the Western Stara Planina Mountain. All these records also confirm for the first time in Bulgaria the southward extension of the ranges of boreal elements during the cold phases of the Pleistocene.



“MIXED” AVIFAUNAS IN THE PLEISTOCENE

Because of the high diversity of the relief and the mosaic character of the landscape, in the neighboring parts of a territory birds so different in type such as the thermophilic “Mediterranean” *Sylvia atricapilla*, and the cold-loving “boreal” *Aegolius funereus* occurred together. The occurrence of *S. atricapilla* during the Early Pleistocene in the Cherdzenitsa Cave was proven, while *S. communis* was spread in the vicinity of the Devetashkata Cave in the Late Pleistocene. In addition, a find of *Sylvia* sp. has been established in the Razhishkata Cave dating back to the Late Pleistocene too.

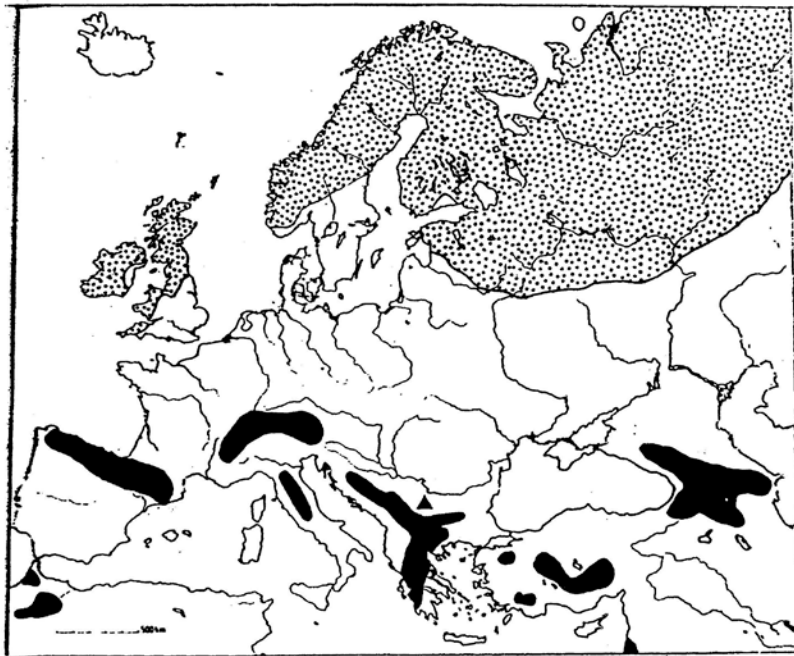
S. atricapilla coexisted in the Early Pleistocene with *Dendrocopos minor* and *Pyrrhula pyrrhula*, while in the Late Pleistocene *S. communis* coexisted with *Tetrao tetrix*, *Lagopus lagopus*, *Tetrastes bonasia*, *Glaucidium passerinum* and *Aegolius funereus*. Such “mixed” avifaunas were discovered in the Pleistocene for different parts of the Palearctic: Transcaucasia, Western Mediterranean, etc. Similar are the associations of “*Nyctea scandiaca* - *Pyrrhocorax graculus*” from the Kozarnika Cave in W Bulgaria (Late Pleistocene).



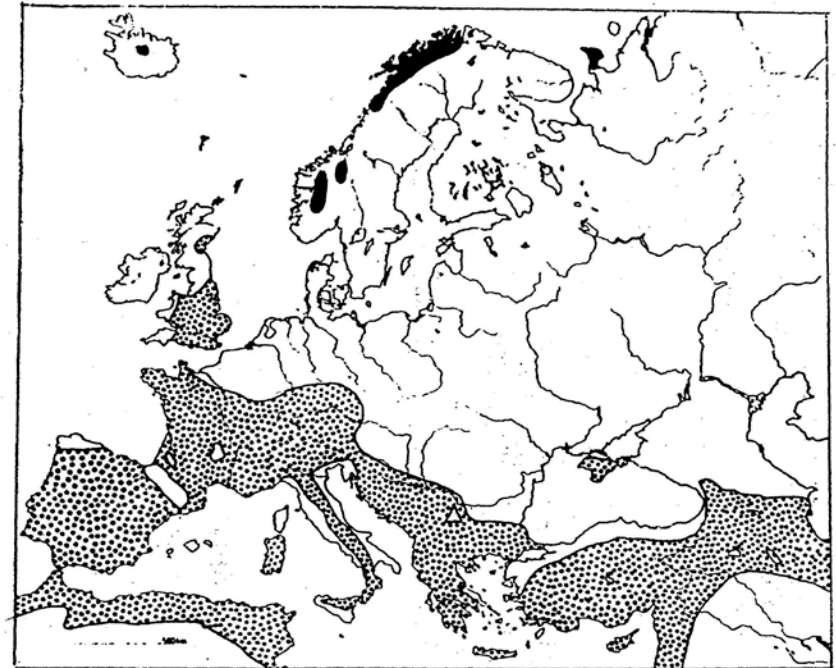
Coexistence of *Tetrao tetrix* and *Pyrrhocorax pyrrhocorax* (Kozarnika Cave) in the late Pleistocene.

“Mixed” Pleistocene faunas are known also from Middle Europe. Barbato et al. (1992) report on common occurrence of *Alectoris graeca* and *Nyctea scandiaca* and of *Pyrrhocorax graculus* and *Perdix perdix*. This overlapping of the ranges of the “northern” and “southern” forms is one of the most specific features of the Pleistocene avifaunas of Europe. *P. graculus* and *L. lagopus* also coexisted during the Late Pleistocene in Bulgaria.

Almost all the rest of the records of the snowy owl and rock partridges are among the best examples of the “mixed” avifaunas. This association is also established in Bulgaria (the Kozarnika Cave and the Devetashkata Cave). A similar example from the Kozarnika Cave is the coexistence of the Willow Grouse and the Red-rumped Martin.



Present day range of *Lagopus lagopus* (dotted) and *Pyrrhocorax graculus* (black) in Europe (after Jonsson, 1994) and the location of the Kozarnika Cave (triangle), where both species coexisted in the Late Pleistocene.



Present day range of genus *Nyctea* (black) and genus *Alectoris* (dotted) in Europe (after Jonsson, 1994) and the location of the Kozarnika Cave (triangle), where species of both genera coexisted in the Late Pleistocene.

The association (*Melanocorypha* sp. - *Pyrrhocorax pyrrhocorax*/ *P. graculus*) have been established for the first time in Bulgaria in the Razhishkata Cave. Other examples of the “mixed” avifaunas are also known from Bulgaria. Bocheński (1982) reports on remains of *Lagopus mutus* and *Alectoris graeca* in the Bacho Kiro Cave that have coexisted. Our data proved that in the surroundings of the Temnata Doupka Cave ca. 28 900 B. C. some Mediterranean (*A. monachus* and *Al. graeca*) and some boreo-mountain (*N. caryocatactes*) species also coexisted. In the Kozarnika Cave the Chough coexisted with the Willow Grouse

There are also a number of other examples from Bulgaria. According to Blondel (1985) this combination of birds of different biotas could be explained by the uniqueness of the physico-geographical characteristics of the N Mediterranean being a kaleidoscope of landscapes.

Thus, during all phases of the Pleistocene, due to the topographic diversification of the region, various species of the humid (i. e. mesophilous) forests, as well as the inhabitants of the drier xerophitic cold steppes coexisted in the mosaic landscapes of the Mediterranean. As a whole, the “mixed” avifaunas in Europe had survived until ca. 50 000 B.P., when the distribution of birds acquired its modern aspect.



CONCLUSIONS - NEOGENE

1. Bulgarian Neogene fauna consist in 120 taxa (26 families and 13 orders) at least.
2. The greater majority of the avian record (80.0 percent) comes from the Late Pliocene, where 96 taxa at least were established.
3. Early Pliocene record is much poorer and consists in 7.5% and 9 taxa. All the Miocene record is represented by 12.5 % and 15 taxa.
4. The chronostratigraphical distribution of the families is as follows: Middle Miocene - 1, Late Miocene - 9, Early Pliocene - 6, and Late Pliocene - 22.
5. Twenty-four taxa are represented by the earliest European record in the Neogene deposits of Bulgaria and marks their appearance on the continent. Even more, in most cases, they are the only known so far fossil record in Europe, or all over the World.
6. Varshets is the richest Neogene site in Bulgaria and the richest one of the Late Pliocene (Villanyian) of Europe, containing fossils of at least 78 avian taxa.



CONCLUSIONS - PLEISTOCENE

1. The avian Pleistocene record of Bulgaria includes 160 species of 13 orders - 40,0 % of the recent country's bird fauna. Most of the material originates from Wurmian (Late Wurmian) deposits, making 2/3 of the Pleistocene sites.
2. The Pleistocene avifauna of Bulgaria contained 8 species that disappeared from the recent country's fauna: *Lagopus mutus*, *Lagopus lagopus*, *Tetrao tetrix*, *Phasianus colchicus* (native subspecies *colchicus* form), *Glaucidium passerinum*, *Nyctea scandiaca*, *Strix* aff. *nebulosa* and *Pyrrhocorax pyrrhocorax*.
3. The Late Pleistocene avifaunas included fossil taxa – one fossil species (*Perdix palaeoperdix*) and one fossil subspecies (*Pyrrhocorax graculus vetus*).
4. The Early Pleistocene avifaunas of Bulgaria are known from 4 localities with 26 taxa of 5 orders. The most numerous are the Passeriformes. One species (the Chough) has disappeared. The Cherdzenitsa Cave is the 4th Early Pleistocene locality of that species in the Palearctic (Tyrberg, 1998). The records of the Lesser Spotted Woodpecker, Red-rumped Swallow, Sand Martin, Rock Thrush and the House Sparrow are the oldest ones, while the finds of the Woodlark are the 2nd known from the Early Pleistocene in the Palearctic.



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Thank you for attention!

