Vladislav Vergilov, Nikolay Tzankov
Giant pelobatid fossil larva from the middle Miocene of Bulgaria
Giant pelobatid fossil larva from the middle Miocene of Bulgaria

Vladislav Vergilov*, †Nikolay Tzankov

(*) [Corresponding author] Vertebrates Department, National Museum of Natural History, Bulgarian Academy of Sciences, 1 Tsar Osivoboditel Blvd, 1000 Sofia, Bulgaria, vladislav8807@gmail.com ✉; https://orcid.org/0000-0002-7464-2263

Abstract: So far, in Bulgaria several fossils of extinct anuran species have been found, but all seem doubtful. Only two pelobatid remains have been found from the Balkans and the regions – younger species (Late Pleistocene) of the genus Pelobates from Serbia and Miocene Pelobates sp. from Turkey. The fossil in the current study represents a larva of the genus Eopelobates, the first discovery of this genus not only for Bulgaria but for the Balkans as well. This pelobatid larva is gigantic, more than 200 mm in total length. The fossil is found in a diatomitian complex from the middle Miocene.

Keywords: development, extinct, Eopelobates, frontoparietal complex, gigantism, skeleton

Introduction

Previously reported fossil anurans from Bulgaria have been discovered from the bituminous argillites (shales) near Brezhanhi Village, in the south-western part of the country (Stefanov, 1951). The earliest reported taxon was *Rana temporaria fossilis* Stefanov, 1951, which name later was stated by Martín et al. (2012) as nomenclatually unavailable. From the same locality (Oligocene sediments of the Pirin Mine, in the Brezhanhi Graben), Gaudant & Vatsev (2012) reported several skeletons of adult anurans, as well as four tadpoles attributed to *Palaeobatrachus cf. grandipes* (Giebel, 1851). They also stated that the previously reported taxa (erroneously given by the authors as *Rana temporaria temporaria* Linnaeus, 1758) belonged to the genus *Palaeobatrachus* Tschudi, 1859, but did not provide any arguments about this. The specimen reported by Stefanov (1951) was not included in our study due to the fact that it was not available and virtually lost (personal communication with NT); it was only briefly discussed. Considering the data presented in the original paper (Stefanov, 1951; Fig. 1 and Fig. 2) and pending on the general habitus, including the pointed snout, the divided frontoparietal, elongated ilia and urostyle, shape of the sacral vertebra with posteriorly declined diapophyses, femur and tibiofibula ratio, the specimen clearly showed its affiliation to the ranid frogs. A more precise taxonomic conclusion would be possible only if the material becomes available.

Previously, pelobatid fossils from the Balkans were reported only from Anatolian Turkey (larva; Rückert-Ülkümen et al., 2002) and Serbia (scapula from an adult specimen; Đurić, 2016). Fossilised species of *Eopelobates* from the region have not been reported to this day.

Material and methods

Locality: The material in this study was found in March–April 2014 near Satovcha Graben region, Western Rhodope Mts, SW Bulgaria, with coordinates N41.631295°, E24.016411° (Fig. 1). In some of its sediments, the richest local paleoflora in Bulgaria was found (Bozukov & Ivanova, 2015). Bozukov (2002) determined the age of the formation as middle Miocene (for more information on the locality see Nel et al., 2016). The composition of the sediment, that contains the fossil of the anuran larva, determines the origin from a diatomitian complex from that epoch. The site corresponds to a large, deep, eutrophic freshwater palaeolake, which also corresponds to the established diatomitian flora (Bozukov, 2002; Bozukov & Ivanova, 2015).
This is the first vertebrate fossil found in any of the sediments of the studied locality.

Material: The studied material presents a fossilised skeleton (cranial bones and vertebrae) of a large pelobatid larva, surrounded by fossil leaves (Fig. 3). The fossil is assigned to the collection of the National Museum of Natural History at the Bulgarian Academy of Sciences, Sofia with catalogue number FR 33.

The developmental stages of anuran larvae were defined by Nieuwkoop & Faber (1956). They provided information about the skeletal formation, whereas the table proposed by Gosner (1960) was mainly focused on external morphological traits. Trueb & Hanken (1992) provided a comparison between the two mentioned tables. For the current study, both schemes were used, but we mostly followed Gosner’s stages.

The fossil was photographed with a stereomicroscope STEMI2000-c equipped with a Canon EOS-1300d DSLR camera. The coordinates of the species records were projected on a map with the LAEA Europe projection (ETRS89-extended) and the WGS 84 geographic coordinate system using QGIS 3.16.0 software.

Fig. 1. Locality of the fossil anuran remain near Satovcha Village, SW Bulgaria (A); highly compressed diatomic clays of the locality (B).
Results

Description and identification

The fossil consists of several bones, such as parasphenoid, paired frontoparietal bones, posterior median element (behind the parasphenoid), paired prooticum, eight (first five presacral distinguishable) vertebrae and part of the sacrum (Fig. 2). The total length of the fossil is approximately 50 mm. The parasphenoid is 24 mm long and the frontoparietals are approximately 19 mm and 18.5 mm long. The frontoparietal is represented by two halves, which later, along with the posterior median element (Fig. 2), will form the frontoparietal complex during metamorphosis. This tripartite composition is characteristic for the larval *Pelobates* Wagler, 1830 and *Eopelobates* Parker, 1929 (Roček and Wuttke, 2010; Roček et al., 2014). Based on the presence of unpaired (unique trait for *Pelobates* and *Eopelobates*) ossified pars medialis of the parasphenoid, at least stage 40 could be assigned to the described larva (after Gosner, 1960). However, direct comparison of the larval development of some skeletal characters between fossil (Maus & Wuttke, 2004; Roček, 2013) and present pelobatids (Talavera, 1990) should be treated cautiously. A rounded process on the posterior margin of the parasphenoid occurs in all species of Pelobatidae (Roček and Wuttke, 2010). In ventral aspect, the presence of a not well developed, but still present keel on the parasphenoid bone (Fig. 2), is an evidence that this specimen belongs to the genus *Eopelobates*; a keel is present also in *Pelobates cf. decheni* Troschel, 1861, but is much more prominent (see Roček and Wuttke, 2010). The general morphology of the parasphenoid bone of our fossil is similar to *Eopelobates bayeri* Špínar, 1952 (see Špínar, 1972; Roček, 2013), a species described from the Hrabák mine near Most and Nástup and the Merkur mines near Kadaň, the Czech Republic (early Miocene). *Eopelobates bayeri* is also the pelobatid with the vastest range in Europe during the Miocene.

Fig. 2. The fossil of *Eopelobates cf. bayeri* giant larva from Satovcha Vill., Bulgaria (catalogue number FR 33) (right) and its bone description scheme (left). Fr – frontals; Para – parasphenoid; PME – posterior median element; Pro – prooticum; Ex – exoccipitals; Ver – vertebrae; Sacr – sacrum.
cene, according to the fossil record. Some differences from *E. bayeri* can be detected as well. The cultriform process of the parasphenoid is wider and leaf-like, more similar to *Eopelobates anthracinus* Parker, 1929 (see Špinar, 1972). Although the caudal end of the parasphenoid bears two protuberances with a slight depression between them, as in *E. bayeri* (Špinar, 1972), in the Satovcha fossil the caudal end is wider. For this reason, the assignment of the current fossil tadpole remains questionable, until adult specimens are discovered. The tadpole could represent an undescribed species of *Eopelobates*. For the purpose of this study, we identify the current fossil larva as *Eopelobates* *cf.* *bayeri*.

The external structure of the bones of the fossil is very well preserved (Fig. 2). Several vertebrae of the vertebral column are present, the centra of the vertebrae are not fully ossified (Fig. 2). Only the first five presacral vertebrae are clearly distinguishable, the rest are more or less tentatively separated from each other. Most probably there are eight presacral vertebrae. A part of the sacrum is also present, after the eighth vertebra. Roček and Wuttke (2010) summarised that in premetamorphic pelobatid larvae eight presacral vertebrae are present. The authors note that V2, V3 and V4 are provided with perpendicular stout transverse processes, completed with cartilage at their ends. At that stage, the neural arches are not yet fused in the midline and the centra are incomplete. These statements correspond more or less to the vertebrae of the Bulgarian larva.

**Systematics**

Anura Fischer, 1813  
Superfamily Pelobatoidea Bonaparte, 1850  
Family Pelobatidae Bonaparte, 1850  
Genus †Eopelobates Parker, 1929  
Species †*Eopelobates* *cf.* *bayeri* Špinar, 1952

**Remarks**

During the larval development in *Pelobates fuscus* (Laurenti, 1768), the ossification begins with the frontoparietals (Luther, 1914; Roček, 1980) or parasphenoid in stage 31. However, according to the observations of Smirnov (1992), the paired frontoparietal appears in stage 33 and later, in stage 36, new ossifications (posterior median element, exoccipital and prootic) appear. The subsequent changes could not be observed as no other elements were preserved in the studied specimen, such as supratemporal on the dorsal roof of the otic capsule (stage 39), septomaxilla, premaxilla and nasal (stages 41–42) (Smirnov, 1992). In *Pelobates syriacus* Boettger, 1889, frontoparietals are also among the first bones to appear in the ontogeny and at least in stage 39 these ossifications are already present (Smirnov, 1992). In *Pelobates cultripes* (Cuvier, 1829), the stages follow a similar pattern (Maglia, 2003), but some species-specific peculiarities are observed. Pars medialis appears in stage 41. In this species, the neural arches of the first seven vertebrae begin to ossify in stage 31, those of vertebrae I–X begin to ossify in stage 35 and most of the neural arches of the presacral vertebrae I–VIII connect dorsally via a cartilaginous bridge. The ossification of the hypochord and vertebral centra begin in stage 39. The development of the current fossil corresponds to stage 42 (see Fig. 3 in Maglia, 2003), since the vertebral centra of the first vertebrae (I–V) were not fully ossified (Fig. 2). The incompletely ossified centra correspond to the Gosner’s stages between 35 and 42 [after Banbury & Maglia, 2006 for *Spea multiplicata* (Cope, 1863)].

**Discussion**

Based on the available data, most probably the genus *Pelobates* originates from North America (Roček & Rage 2000). Roček et al. (2014) summarised the oldest records (in geological aspect) of Pelobatidae in Europe (all from the earliest Eocene; MP 7): at Dormaal, Belgium (Duffaud, 2000); at Le Quesnoy (formerly called Creil) and Rians, both in France (Nel et al., 1999; Duffaud, 2000; Rage & Roček, 2003); and at Silveirinha, Portugal (Antunes & Russell 1981; Rage & Augé 2003). Pelobatids are also reported from the MP 10 Prémontré sands. All fossil records are fragmentary bones and because of the fragmentary status, it is not possible to identify them clearly. However, at least some of these specimens probably belong to the genus *Eopelobates* (Roček et al., 2014). *Pelobates decheni* Troschel, 1861 is known from the latest Oligocene (MP 30) of Rott, Germany (Böhme et al., 1982). Two species have been described from the middle Miocene: *Pelobates sanchizi* Venczel, 2004 (MN 6, Hungary; Venczel 2004; MN 4, the Czech Republic; see Ivanov, 2008) and *Pelobates fahlbuschi* Böhme, 2010 (MN 5, Sandelzhausen; Böhme, 2010). *Lutettiobatrachus gracilis* Wuttke in Sanchiz, 1998 from the middle Eocene, (lower Geiseltalium) Grube
Messel near Darmstadt, Hessen, Germany can be assigned to the family Pelobatidae based on the structure of the frontoparietal bone (Wuttke, 2012a), although it can be a member of a new, undescribed family (see Roček, 2013). The genus Eopelobates was distributed in North America, Europe and Asia from the Late Cretaceous (Borsuk-Białynicka, 1978) to the Pliocene (Roček et al., 2014). The type species of the genus is Eopelobates anthracinus from the late Oligocene (MP 30) of Rott, Germany (Koenigswald et al. 1992). Six species are assigned to this genus: E. anthracinus (late Oligocene), E. bayeri (early Oligocene–middle Miocene; holotype skeleton from the late Oligocene, NMP Pb 412, described by Špinar (1952, 1972); E. hinschei (Kuhn, 1941) (lower Geiseltalian section “Oberes Hauptmittel”, MP 13, middle Eocene holotype skeleton, GMH 1312), and E. wagneri (Weitzel, 1938) from the Messel Formation (MP 11, middle Eocene holotype, HLMD-Me 1286; Wuttke, 2012b) (all four species from Europe), and E. grandis Zweifel, 1956 (Chadron Formation, Ahern Member; latest Eocene or Chadronian NALMA; South Dakota, USA; Zweifel, 1956) and E. deani Roček, Wuttke, Gardner & Bhullar, 2014 (middle Eocene; BHM-123 (original number BHI-123); Roček et al., 2014) (from North America). The two species E. wagneri and E. hinschei are very similar morphologically and share the same geographic and stratigraphic distribution (middle Eocene, Germany). Without a detailed study, they should/could be considered as valid species for the moment (Roček et al., 2014).

Eopelobates bayeri is the pelobatid species with the vastest range in Europe and is found in Belgium (Smith, 2003), the Czech Republic (Špinar, 1952, 1972), Slovakia (Hodrová, 1981, 1988), Bulgaria (this study) and Russia (Syromyatnikova, 2017). Besides Bulgaria (present study), tadpoles of Eopelobates from Europe are found also in the Czech Republic (Bechlejovice; Bellon et al. 1998; Špinar, 1972).

The approximate maximal length of the tadpoles of Eopelobates was about 100 mm (Fig. 1j in Roček et al., 2014). A well-preserved giant fossil pelobatid larva (163 mm, stage 41) from the late Miocene was described by Bustillo et al. (2017). The authors stated that this gigantic larva of Pelobates was preserved in a diatomite, which was associated with shore vegetation. Data presented in Rückert-Ülkümen et al. (2002) from the Miocene of Turkey give maximal snout-vent length of 44 mm, vs. caudal length of 33 mm (not the same specimen) for larvae of Pelobates sp. Under controlled laboratory conditions, metamorphosis is usually completed within 2–2.5 months after hatching in P. fuscus, but some individuals do not metamorphose at all within two years (between 5 and 25 months), being between stages 34 and 43 and having snout-vent length of 28.5 mm (21–34 mm, n = 23) (Smirnov, 1992). For P. syriacus, tadpoles (n = 4) with snout-vent length of 42 mm in Gosner’s stage 39 were reported by the same author. Thus, retention of the larval development in P. fuscus in the laboratory may be attained under natural conditions in P. syriacus (Smirnov, 1992). Even in recent species of Pelobates, gigantic tadpoles occur exceptionally and the maximal reported length greatly overpass the commonly attained, e.g. based on a large sampling (n = 209), the largest reported tadpole by Siderovska et al. (2001) (stages 34 to 45) was respectively 110.8 mm for P. fuscus (stage 39–40) and 104 mm for P. syriacus (stage 41). Respectively, the maximal reported lengths for both species were 185 mm and 145 mm (Kuzmin, 2012). For P. fuscus, Nöllert (1990) has summarised larval lengths from several localities and gives length from 105 mm to 220 mm. The same author explained that larvae of Pelobates fuscus insubricus Cornalia, 1873 can reach maximal length of 140–150 mm. Another exceptional length of 200 mm was reported in Grillitsch et al. (1983) for three-years old, multiple overwintering larvae. The largest ever cited length was 226 mm (Hirschfeld, 1970). Present day larval gigantism has been reported only in few anuran taxa, e.g. Pelophylax spp. (Borkin et al., 1984; Covaciuc-Marcov et al., 2003; Milto, 2009). Hirschfeld et al. (1970) reported a giant larva (226 mm) of Lithobates pipiens (Schreber, 1782) (as Rana pipiens), but grown in laboratory conditions. The giant larvae of Xenopus laevis Daudin, 1802 lacked thyroid glands and the thyroid hormone that stimulates tail resorption and metamorphosis (Rot-Nikcevic & Wassersug, 2003). That is why our fossil (with length of more than 200 mm with the tail; Fig. 3) falls into the concept of giant anuran larvae, with length similar to giant larvae of P. fuscus described by Grillitsch et al. (1983). This is one of the largest amphibian larvae ever found.

Environmental conditions could influence and facilitate the prolonged larval development as in the case of Pelophylax ridibundus (Pallas, 1771) that inhabit thermal waters where it has been reported to surpass the reported maximal dimensions (Covaciuc-Marcov et al., 2003). The largest tadpole of Pseudis paradoxa (Linnaeus, 1758) ever reported has a length of 220.5
mm (Emerson, 1988), coming from a region with little seasonal variation in temperature and day length, with expressed equatorial climate. There are three environmental conditions that make possible for tadpoles to grow large: long-lasting large ponds, warm and wet climate, and the formation of soil rich in clay during the rainy season (creating shelters) (Roček et al., 2006; Fabrezi et al., 2009). These authors describe the favourable conditions for giant tadpoles of the extinct *Palaeobatrachus* and the recent species of *Pseudis* Wagler, 1830.

The climate during the middle Miocene was comparable to the present day in the tropic regions. The analyses of the diatomaceous flora reveal that during that epoch, Satovcha area was a large and deep, eutrophic freshwater paleolake, surrounded by mountain slopes, where the paleorivers were depositing coenobiotic flora. The richness of the flora suggests humid and warm-temperate to subtropical climate (mean annual temperatures above 15–16°C and rainfalls over 1000 mm). The mixed mesophytic forest of the area was close to the mixed semi-evergreen forests of South-East Asia. That rich flora (containing many different insects along with the frog of *Eopelobates* from this study) was discovered in diatomic clays that had been strongly compressed during the diagenesis (see Nel et al., 2016). Similar to our study, the giant fossil pelobatid larva from Tresjuncos, Spain (Bustillo et al., 2017) was also found in a diatomic clay layer. The authors stated that the location, where the larva was found, was a marshy border of shallow, littoral environment. Apparently, the environmental conditions and the habitat

---

Fig. 3. Reconstruction of the size and shape of *Eopelobates* cf. *bayeri* giant larva from Satovcha Vill., Bulgaria (catalogue number FR 33). Scale = 5 cm.
Giant pelobatid fossil larva from the middle Miocene of Bulgaria

Historical data from Tresjuncos, Spain during the late Miocene were very similar with the environmental conditions of Satovcha Vill., Bulgaria during the middle Miocene. The coexisting ecological complexes (warm and wet climate, large freshwater wetland and rich diatomite clay) correspond to the conditions that would have been suitable for tadpole gigantism, as described by Roček et al. (2006) and Fabrezí et al. (2009). The thermophilic elements, survived from the Paleogene, are one of the characteristics of the Satovcha paleoflora that confirms the refugium role of that area for some European Paleogene relicts (Bozukov, 2002; Bozukov & Ivanova, 2015; Simov et al., 2021a, b; Nel et al., 2016).

Both *Eopelobates* and *Pelobates* co-occurred in Europe throughout the Oligocene (Roček, 2013), but have been rarely found at the same localities (Fig. 4). The presence of *Eopelobates* together with *Pelobates* has been reported from the late Oligocene (Rott; Böhme et al., 1982) and early/middle Miocene (Sandelzhausen; Böhme, 2010) of Germany, Pliocene of Poland (Weże 1 and Rębielice Królewskie 1; Młynarski, 1977; Młynarski, 1984; Sanchiz and Młynarski, 1979), Slovakia (Ivanovce; Hodrová, 1981) and Ukraine (Dolinskoe; Ratnikov, 2002).

The genus *Eopelobates* became extinct during the middle/late Miocene (Rage & Roček, 2003; Syromyatnikova, 2017). Some authors (Sanchiz & Mlynarski, 1979; Hodrová, 1981; K.A. Tatarinov in Chkhikvadze, 1981, 1984; Sanchiz, 1998), however, reported representatives from the Pliocene of Poland, Hungary, Slovakia and Ukraine, but most of the material from these localities are postcranial bones or just fragments of cranial bones, all features that are not reliable basis for distinguishing between these two genera which are very similar in many skeletal aspects. That is why it is highly doubtful that *Eopelobates* survived until the Pliocene (Rage & Roček, 2003; Roček, 2013). In addi-

Fig. 4. Review of the fossil pelobatid records of Europe (see Appendix I). The Bulgarian record is from the present study.
tion, the Miocene was the epoch when *Eopelobates* began to be replaced by species of *Pelobates*, even *P. fuscus* (Roček, 2013).

**Acknowledgments**

We are grateful to Michail Simov and Dr Nikolay Simov (Sofia, Bulgaria) for the information about Satovcha locality and the photo of the locality; to Ilya Acosta (Sofia, Bulgaria) for the help with the figures editing and the valuable suggestions during the manuscript preparation. We appreciate very much the valuable comments and recommendations by Dr Andrea Villa (Barcelona, Spain) on the manuscript.

**References**

Antunes M.T., Russell D.E. 1981 Le gisement de Silveirinha (Bas Mondego, Portugal): La plus ancienne faune de vertébrés éocènes connue en Europe. CRAcad Sci Paris II 293: 1099–1102.

Banbury B., Maglia A.M. 2006 Skeletal Development of the Mexican Spadefoot, *Spea multiplicata* (Anura: Pelobatidae). Journal of Morphology 267: 803–821.

Bellon H., Bůžek C., Gaudant J., Kvaček Z., Walther H. 1998 The České Středohoří magmatic complex in Northern Bohemia 40K-40Ar ages for volcanism and biostratigraphy of the Cenozoic freshwater formations. Newsletters on Stratigraphy 36: 77–103.

Blain H.-A. 2009 Contribution de la paléoherpétofaune (Amphibia et Squamata) à la connaissance de l’évolution du climat et du paysage du Pliocène supérieur au Pléistocène moyen d’Espagne. Travaux del Museo de Geologia de Barcelona 16: 39–170.

Blain H.-A., Bailon S., Agustí J. 2007 Anurans and squamate reptiles from the latest early Pleistocene of Almenara-Casablanca-3 (Castellón, East of Spain). Systematic, climatic and environmental considerations. Geodiversitas 29 (2): 269–295.

Blain H.-A., Delfino M., Berto C., Arzarello M. 2016 First record of *Pelobates syriacus* (Anura, Amphibia) in the early Pleistocene of Italy. Palaeobiodiversity and Palaeoenvironments 96 (1): 111–124. https://doi.org/10.1007/s12549-015-0220-1

Blin H., López-García J., Cuenca-Bescós G. 2011 A very diverse amphibian and reptile assemblage from the late Middle Pleistocene of the Sierra de Atapuerca (Simia del Elefante, Burgos, Northwestern Spain). Geobios 44: 157–172. https://doi.org/10.1016/j.geobios.2010.08.003

Böhme M. 2008 Ectothermic vertebrates (Teleostei, Allocaudata, Urodela, Anura, Testudines, Choristodera, Crocodylia, Squamata) from the Upper Oligocene of Oberleichtersbach (Northern Bavaria, Germany). Courier Forschungsinstitut Senckenberg 260: 161–183.

Böhme M. 2010 Ectothermic vertebrates (Actinopterygii, Allocaudata, Urodela, Anura, Crocodylia, Squamata) from the Miocene of Sandelzhausen (Germany, Bavaria) and their implications for environment reconstruction and palaeoclimate. Paläontologische Zeitschrift 84: 3–41. https://doi.org/10.1007/s12542-010-0050-4

Böhme W., Roček Z., Špinar Z.V. 1982 On *Pelobates decheni* Troschel, 1861, and *Zaphrissa eurypelis* Cope, 1866 (Amphibia: Salientia: Pelobatidae) from the early Miocene of Rott near Bonn, West Germany. Journal of Vertebrate Paleontology 2 (1): 1–7.

Borkin L.J., Berger L., Günther R. 1984 Giant tadpoles of water frogs within *Rana esculenta* complex. Zool. Poloniae 29 (1–2): 103–127.

Borsuk-Bialynicka M. 1978 *Eopelobates leptoculatus* sp. n. The first Upper Cretaceous pelobatid frog from Asia. Paleontologia Polonica 38: 57–63.

Bozukov V. 2002 Miocene macroflora of the Satovcha Graben (Western Rhodopes). III. Comparative analysis of the Satovcha paleoflora with benchmark European macrofloras. Geological age of the paleoflora. Phytologia Balcanica 8 (2): 165–180.

Bozukov V., Ivanova R. 2015 New taxonomic data on the paleoflora from the Satovcha Graben (Southwestern Bulgaria). Comptes rendus de l’Académie Bulgare des Sciences 68 (5): 623–630.

Bustillo M.A., Díaz-Molina M., López-Garcia M.J., Delclòs X., Peláez-Campomanes P., Peñalver E., Rodríguez-Talavera R., Sanchiz B. 2017 Geology and paleontology of Tresjuncos (Cuenca, Spain), a new diatomaceous deposit with Konservat-Lager-
Giant pelobatid fossil larva from the middle Miocene of Bulgaria

Historia naturalis bulgarica 43 (2021)
Cliff, Hampshire – a preliminary report. Tertiary Research 4: 149–154.

Mito K. 2009 A giant tadpole record of Rana esculenta in Northwestern Russia. Russian Journal of Herpetology 16 (2): 143–145.

Młynarski M. 1977 New notes on the amphibian and reptilian fauna of the Polish Pliocene and Pleistocene. Acta Zoologica Cracoviensia 22: 13–36.

Młynarski M. 1984 Notes on the amphibian and reptilian fauna of the Polish Miocene. Acta Zoologica Cracoviensia 27: 127–148.

Nel A., de Plöeg G., Dejax J., Dutheil D., de Frasceschi D., Gheerbrant E., Godinot M., Hervet S., Menier J.-J., Augé M., Bignot G., Cavagnetto C., Duffaud S., Gaudant J., Hu, Jossang A., de Lapparent, de Broin F., Pozzi J.-P., Paicheler J.-C., Beuchet F., Rage J.-C. 1999 Un gisement sparnacien exceptionnel à plantes, arthropodes et vertébrés (Éocène basal, MP7): Le Quesnoy (Oise, France). CR Acad Sci Paris Sci de la Terre et des planètes 329: 65–72.

Nel A., Simov N., Bozukov V., Marinov M. 2016 New dragonflies and damselflies from Middle Miocene deposits in SW Bulgaria (Insecta: Odonata). Palaeontologia Electronica 19.3.35A: 1–13. https://doi.org/10.26879/642

Nieuwkoop P.D., Faber J. 1956 Normal table of Xenopus laevis (Daudin). A Systematical and Chronological Survey of the Development from the Fertilized Egg till the End of Metamorphosis. North Holland Publ. Co., Amsterdam, 282 pp.

Nöllert A. 1990 Die Knoblauchkröte. Pelobates fuscus. Die Neue Brehm-Bücherei, A. Ziemsen Verlag, Wittenberg Lutherstadt, 144 pp.

Rage J.-C., Roček Z. 2003 Evolution of anuran assemblages in the Tertiary and Quaternary of Europe, in the context of palaeoclimate and palaeogeography. Amphibia-Reptilia 24: 133–177.

Rot-Nikcevic I., Wassersug R.J. 2003 Tissue sensitivity to thyroid hormone in athyroid Xenopus laevis larvae. Development, Growth and Differentiation 45: 321–325. https://doi.org/10.1046/j.1440-169x.2003.00700.x

Rückert-Ülkümen N., Maus M., Glaw F., Franzen M. 2002 Kaulquappen von Pelobates sp. (Amphibia: Pelobatidae) aus dem Miozän von Beşkonak Köyü, Zentralanatolien, Türkei. Mitteilungen der Bayerischen Staatssammlung für Paläontologie und historische Geologie 42: 75–82.

Sanchíz B., Młynarski M. 1979 Remarks on the fossil anurans from the Polish Neogene. Acta Zoologica Cracoviensia 24: 175–188.

Roček Z. 1988 Origin and evolution of the frontoparietal complex in anurans. Amphibia-Reptilia, 1988: 385–403.

Roček Z. 2005 Late Miocene Amphibia from Rudáňa. Palaeontographia Italica 90: 11–29.

Roček Z. 2013 Mesozoic and Tertiary Anura of Laurasia. Palaeobiodiversity and Palaeoenvironments 93 (4): 397–439. https://doi.org/10.1007/s12549-013-0131-y

Roček Z., Böttcher R., Wassersug R. 2006 Gigantism in tadpoles of the Neogene frog Palaeobatrachus. Paleobiology 32 (4): 666–675. https://doi.org/10.1666/05073.1

Roček Z., Rage J.C. 2000 Tertiary Anura of Africa, Asia, Europe, North America, and Australia. In: Heatwole H., Caroll R.L. (eds) Amphibian Biology. 4: Paleontology, pp. 1334–1389, Chipping Norton, Surrey Beatty.

Roček Z., Wuttke M. 2010 Amphibia of Enspel (Late Oligocene, Germany). Palaeobiodiversity and Palaeoenvironments 90: 321–340. https://doi.org/10.1007/s12549-010-0042-0

Sanchiz B. 1998 Encyclopedia of Paleoherpetology. Part 4 – Salientia. Verlag Dr. Friedrich Pfeil, Munich, 275 pp.

Sanchiz B., Mlynski M. 1997 Remarks on the fossil anurans from the Polish Neogene. Acta Zoologica Cracoviensia 24: 175–188.
Siderovska V., Ljubisavljevic K., Dzukic G., Kalezic M.L. 2001 Tadpole morphology of two spadfoot toads (Pelobates fuscus and P. syriacus). Spixiana 25 (2): 183–191.

Simov N., Langourov M., Pavlova A., Hubenov Z., Bozukov V. 2021a First record of fossil Diptera (Insecta) in Miocene deposits in Bulgaria. Comptes rendus de l’Académie bulgare des Sciences 74 (2): 233–240. https://doi.org/10.7546/crabs.2021.02.10

Simov N., Langourov M., Sakalian V., Bozukov V. 2021b First fossil jewel beetle (Insecta: Coleoptera: Buprestidae) from Middle Miocene deposits in Bulgaria. Historia naturalis bulgarica 42: 31–34. https://doi.org/10.48027/hnb.42.052

Smirnov S.V. 1992 The influence of variation in larval period on adult cranial diversity in Pelobates fuscus (Anura: Pelobatidae). Journal of Zoology London 226: 601–612.

Skutschas P.P., Bannikov A.F. 2009 The first find of a spadefoot toad (Anura, Pelobatidae) in the Miocene of Moldova. Paleontological Journal 43: 433–437.

Smith R. 2003 Les vertébrés terrestres de l’Oligocène inférieur de Belgique (Formation de Borgloon, MP 21): inventaire et interprétation des données actu-elles. Coloquios Paleont 1: 647–657.

Špinar Z.V. 1952 Eopelobates bayeri – a new frog from the Tertiary of Bohemia. Sborník Ústředního ústavu geologického 19: 457–488.

Špinar Z.V. 1972 Tertiary frogs from Central Europe. Academia, Prague.

Stefanov A. 1951 Die erste fossil Frosch (Amphibie – Rana) aus Bulgarien. Bulletin de l’Institut de Géologie, Académie Bulgare des Sciences 1: 33–40. (In Bulgarian)

Syromyatnikova E.V. 2017 Two pelobatid frogs from the late Miocene of Caucasus (Russia). Palaeontologia Electronica 20.2.36A: 1–12.

Talavera R.Ma. del R. 1990 Evolución de pelobatidos y pelitidos (Amphibia, Anura): morfología y desarollo del sistema esquelético. Tesis doctorales (Universidad Complutense de Madrid), Madrid, 282 pp.

Trueb L., Hanken L. 1992 Skeletal development in Xenopus laevis (Anura: Pipidae). Journal of Morphology 214: 1–41.

Venczel M. 2001 Anurans and squamates from the Lower Pliocene (MN14) Osztramos 1 locality (northern Hungary). Fragmenta Palaeontologica Hungarica 19: 79–90.

Venczel M. 2004 Middle Miocene anurans from the Carpathian Basin. Palaeontographica, Abteilung A 271: 151–174.

Venczel M., Štiucă E. 2008 Late middle Miocene amphibians and squamate reptiles from Taut, Romania. Geodiversitas 30: 731–763.

Villa A., Blain H.-A., van den Hoek Ostende L.W., Delfino M. 2018 Fossil amphibians and reptiles from Tegelen (Province of Limburg) and the early Pleistocene palaeoclimate of The Netherlands. Quaternary Science Reviews 187: 203–219. https://doi.org/10.1016/j.quascirev.2018.03.020

Villa A., Carnevale G., Pavia M., Rook L., Sami M., Szyndlar Z., Delfino M. 2021 An overview of the late Miocene vertebrates from the fissure fillings of Monticino Quarry (Brisighella, Italy), with new data on non-mammalian taxa. Rivista Italiana di Paleontologia e Stratigrafia 127: 297–354. https://doi.org/10.13130/2039-4942/15774

Wuttke M. 2012a Redescription of the Middle Eocene frog Lutetiobatrachus gracilis Wuttke in Sanchiz, 1998 (Lower Geiseltalian, »Grube Messel«, near Darmstadt, southern Hesse, Germany). Kaupia 18: 29–41.

Wuttke M. 2012b The genus Eopelobates (Anura, Pelobatidae) from Messel, Geiseltal, and Eckfeld (Middle Eocene, Germany). Part I: Redescription of Eopelobates wagneri (Weitzel, 1938) from Messel (Lower Geiseltalium, Germany). Kaupia 18: 43–71.

Zweifel R.G. 1956 Two pelobatid frogs from the Tertiary of North America and their relationships to fossil and recent forms. American Museum Novitates 1762: 1–45.

Giant pelobatid fossil larva from the middle Miocene of Bulgaria

Historia naturalis bulgarica 43 (2021) 39
Appendix I

Pelobatid fossils in Europe.
*Not included on the map of the distribution (Fig. 4)

| Species                  | Locality and publication                                      | Epoch            | Country        |
|--------------------------|----------------------------------------------------------------|------------------|----------------|
| Eopelobates anthracinus  | (MP 30) Rott, Germany (Koenigswald et al., 1992)              | late Oligocene   | Germany        |
| Špinar, 1952             | (MP 21) Hoogbutsel, Belgium (Smith, 2003)                      | early Eocene     | Belgium        |
| Špinar, 1952             | (MP 21) Boutersem, Belgium (Smith, 2003)                      | early Eocene     | Belgium        |
| Špinar, 1952             | (MP 21) Hoeleden, Belgium (Smith, 2003)                       | early Eocene     | Belgium        |
| Špinar, 1952             | Bechlejovice Czech Republic (Bellon et al. 1998; Špinar, 1972)| late Oligocene   | Czech Republic |
| Špinar, 1952             | Merkur mines near Kadaň, Czech Republic (Špinar, 1972)        | early Miocene    | Czech Republic |
| Špinar, 1952             | Hrabák mine near Most and Nástup (Špinar, 1972)               | early Miocene    | Czech Republic |
| Špinar, 1952             | (Badenian) Devínska Nová Ves-Bonanza, Slovakia (Hodrová, 1988)| middle Miocene   | Slovakia       |
| Špinar, 1952             | (Csarnotan) Ivanovce, Slovakia (Hodrová, 1981)                | Pliocene         | Slovakia       |
| (Kuhn, 1941)             | (Lower Geiseltium) Geiseltal near Halle, Germany (Franzen & Haubold, 1986) | middle Eocene | Germany          |
| (Weitzel, 1938)          | Grube Messel near Darmstadt, Hessen, Germany (Wuttke, 2012b)  | middle Eocene    | Germany        |
| Eopelobates sp., cf. Eopelobates | Headon Hill in UK (Rage & Ford, 1980)                | late Eocene      | England        |
| Eopelobates sp., cf. E. hinschei (Kuhn, | Hordle Cliff, England, (Milner et al., 1982)     | late Eocene      | England        |
| Eopelobates sp.          | (MP30) Oberleichtersbach, Germany (Böhme, 2008)               | late Oligocene   | Germany        |
| Eopelobates sp.          | Sandelzhausen, Germany (Böhme, 2010)                          | early Miocene    | Germany        |
| Eopelobates sp.          | (Orleanian, MN4) Dolnice, Czech Republic (Hodrová, 1987)     | early Miocene    | Czech Republic |
| Eopelobates sp.          | (MN14) Osztramos 1, Hungary (Venczel, 2001)                   | Pliocene         | Hungary        |
| Eopelobates aff. bayeri Špinar, 1952 | Volchaya Balka (= Fortepianka) (Syromyatnikova, 2017) | late Miocene    | Russia         |
| Eopelobates cf. bayeri Špinar, 1952 | Satovcha Village, this study                               | middle Miocene   | Bulgaria       |
| Fossil Name                        | Location Details                                      | Age               | Location     |
|-----------------------------------|-------------------------------------------------------|-------------------|--------------|
| *Lutetiobatrachus gracilis* Wuttke in Sanchiz, 1998 | Lower Geiseltalium Grube Messel near Darmstadt, Hessen, Germany (Wuttke, 2012a) | Middle Eocene    | Germany      |
| *Pelobates decheni* Troschel, 1861 | (MP 30) Rott, Germany (Koenigswald et al. 1992)       | Late Oligocene    | Germany      |
| *Pelobates cf. decheni* Troschel, 1861 | Enspel, Germany (Roček & Wuttke, 2010)               | Late Oligocene    | Germany      |
| *Pelobates fahlbuschi* Böhme, 2010 | Sandelzhausen, Germany (Böhme, 2010)                  | Early Miocene     | Germany      |
| *Pelobates sanchizi* Venczel, 2004 | (MN4) Mokrá-Western Quarry, Czech Republic (Ivanov, 2008) | Early Miocene     | Czech Republic |
| *Pelobates sanchizi* Venczel, 2004 | (Badenian, MN6) Mátraszlőlős 1, Hungary (Venczel, 2004) | Middle Miocene    | Hungary      |
| *Pelobates sanchizi* Venczel, 2004 | (Badenian, MN6) Mátraszlőlős 2, Hungary (Venczel, 2004) | Middle Miocene    | Hungary      |
| *Pelobates sanchizi* Venczel, 2004 | (Badenian, MN6) Sámsonház 3, Hungary (Venczel, 2004) | Middle Miocene    | Hungary      |
| *Pelobates syriacus* Boettger, 1889 | Pirro Nord P13 (Apulia, southeastern Italy) (Blain et al., 2016) | Early Pleistocene | Italy        |
| *Pelobates fiscus* (Laurenti, 1768) | Russel-Tigilia-Egypte pit near the village of Tegelen (Early Pleistocene, The Netherlands) (Villa et al., 2018) | Early Pleistocene | Netherlands |
| *Pelobates cultripes* (Cuvier, 1829) | Almenara-Casablanca-3 (near the city of Almenara, Spain) (Blain et al., 2007) | Early Pleistocene | Spain        |
| *Pelobates cultripes* (Cuvier, 1829) | Sierra de Atapuerca (Sim del Elefante, Burgos, North-Western Spain) (Blain et al., 2011) | Middle Pleistocene | Spain        |
| *Pelobates cultripes* (Cuvier, 1829) | (MMQ3) Almenara (Castellón), Valencian Community, Almenara-Casablanca-3 (ACB-3) (Blain, 2009) | Early Pleistocene | Spain        |
| *Pelobates cultripes* (Cuvier, 1829) | (MMQ3-MMQ4) Guadix-Baza Depression (Granada), Andalusia Community, Barranco-León (Blain, 2009) | Early Pleistocene | Spain        |
| *Pelobates cultripes* (Cuvier, 1829) | Atapuerca (Burgos), Castile and León Community, Gran Dolina (= Trinchera Dolina) (Blain, 2009) | Early Pleistocene | Spain        |
| *Pelobates cf. cultripes* (Cuvier, 1829) | Begur (Girona), Catalonia Community, Bagur-1 (B-1) (Blain, 2009) | Middle Pleistocene | Spain        |
| *Pelobates cf. cultripes* (Cuvier, 1829) | (MMQ3) Begur (Girona), Catalonia Community, Bagur-2 (B-2) (Blain, 2009) | Early Pleistocene | Spain        |
| Specimen | Location | Age | Country |
|----------|----------|-----|---------|
| *Pelobates cf. cultripes* (Cuvier, 1829) | (MmQ 2-3) Castelldefels, Massif de Garraf (Barcelona), Catalonia Community, Can Altisench (Blain, 2009) | Early Pleistocene | Spain |
| *Pelobates sp.* | (MP30) Oberleichtersbach, Germany (Böhme, 2008) | late Oligocene | Germany |
| *Pelobates sp.* | (Astaracian, MN6) Sansan, France (Rage & Hossini, 2000) | middle Miocene | France |
| *Pelobates sp.* | (Sarmatian) Taut, Romania (Venczel & Șîtucă, 2008) | middle Miocene | Romania |
| *Pelobates sp.* | (Villanyian) Včeláre, Slovakia (Hodrová, 1985) | Pliocene | Slovakia |
| Pelobatidae indet. larvae | Enspel, Germany (Maus & Wuttke, 2002, 2004; Roček & Wuttke, 2010) | late Oligocene | Germany |
| Pelobatidae indet. adults | (MP 7) Le Quesnoy, France (Nel et al., 1999) | early Eocene | France |
| Pelobatidae indet. adults | (MP7) Silveirinha, Portugal (Rage & Auge, 2003) | early Eocene | Portugal |
| Pelobatidae indet. adults | (Sarmatian) Karpov Yar, Moldova (Skutschas & Bannikov, 2009) | middle Miocene | Moldova |
| Pelobatidae indet. adults | (Vallesian, MN9) Rudabánya, Hungary (Roček, 2005) | late Miocene | Hungary |
| *Pelobates sp.* | Gaverdovsky (Syromyatnikova, 2017) | late Miocene | Russia |
| *Pelobates sp.* | Volchaya Balka (= Fortepianka) (Syromyatnikova, 2017) | late Miocene | Russia |
| *Pelobates sp.* | Beşkonak Köyü, Anatolia (Rückert-Ülkümen, 2002) | Miocene | Turkey |
| *Pelobates sp.* | Baranica Cave near Knjaževac (Eastern Serbia) (Durić et al., 2016) | late Pleistocene | Serbia |
| *Pelobates sp.* | Tresjuncos (Cuenca, Spain) (Bustillo et al., 2017) | late Miocene | Spain |
| *Pelobates sp.* | Monticino Quarry (latest Miocene, Italy) (Villa et al., 2021) | late Miocene | Italy |
| *Eopelobates cf. E. bayeri* Špinar, 1952 | Gorishnaya Vygnanka, Ukraine (K.A. Tatarinov in Chkhikvadze 1981, 1984) | Pliocene | Ukraine |
| *Pelobates fuscus* (Laurenti, 1768) | (Ruscinian) Europe (Sanchiz 1998) | Pliocene | Europe |