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On the Finds of *Pliobatrachus* (Anura, Palaeobatrachidae) in Eastern Europe

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Abstract—Fossil remains of the genus *Pliobatrachus* from nine east European localities ranging in age from late Pliocene to early Pleistocene are described. The taxonomic status and variability range of the material are discussed.

INTRODUCTION

A significant number of localities yielding *Pliobatrachus* fossil remains are known at present. Nevertheless, the taxonomic status of these remains is not conclusively resolved yet. Originally *Pliobatrachus langhae* was described (Fejervary, 1917) from the Betfia locality (=Pusp6kfurdo) in Romania on the basis of the sacrum and urostyle and assigned to the Bufonidae. Later this species was also found in Poland, Hungary, and Germany; other skeletal parts were additionally described. Vergnaud-Grazzini and Mlynarski (1969) revised all known skeletal parts and placed the genus within the Palaeobatrachidae. Sanchiz and Mlynarski (1979) extended the generic diagnosis with features obtained from new skeletal elements. Thus, *Pliobatrachus,* including the only species *P. langhae* Fejervary, became the second genus within the Palaeobatrachidae, differing from *Palaeobatrachus* in the structure of certain bones and including this only species. Its stratigraphical distribution ranges within the interval Pliocene-Gunz-Mindel interglaciation (Vergnaud-Grazzini and Miynarski, 1969; M-lynarski, 1977), in contrast to *Palaeobatrachus* that existed from the Late Paleocene to the Miocene (Vergnaud-Grazzini and JVHynarski, 1969; Spinar, 1972). Such distribution in age probably influenced assignments of all fossils with Palaeobatrachidae features to a single species *P.* cf. *langhae* (Sanchiz and Miynarski, 1979). Admittedly, Mlynarski (1977) remarked, that slight morphological differences exist between some homonymous bones originating from various Polish localities and that these may indicate the presence of different taxa although population variability could not be ruled out.

The usage of the term *cf.* was explained later (Sanchiz and M-lynarski, 1984). These authors remark, that the elements used for the original description are of slight taxonomic value because of low morphological variability among the Palaeobatrachidae. Because of this they believed it impossible to use the species name *Pliobatrachus langhae* for remains described from outside the type locality without limitations implied by this term.

Finds of new localities containing *Pliobatrachus* fossil remains complicated even more the evaluation of their taxonomic status. Hodrova (1982) who studied the fauna of the Ivanovce locality suggested that there existed at least two forms that were similar in the morphology of frontoparietals, urostyles and coracoids to those of different subgenera of the genus *Palaeobatrachus.* The ilia are highly variable in the shape of the *tuber superior* which ranges from single, as in the *Pliobatrachus* diagnosis (Sanchiz and Miynarski, 1979), to bilobate, characteristic of most of the *Palaeobatrachus* species (Vergnaud-Grazzini and M-lynarski, 1969). Hodrova (1981, 1982) identified *Pliobatrachus* remains only to generic level and suggested to regard the possibility, that different taxa belonging to this genus originated from different *Palaeobatrachus* subgenera. In contrast to her opinion, Miynarski *et al.* (1984) identified two Palaeobatrachidae ilia from the Pliocene of the Weze II locality as *Palaeobatrachus* sp. and *Pliobatrachus* cf. *langhae.*

Thus, the opinions of different European experts on the systematic composition of the genus *Pliobatrachus* do not match. At the same time, the stratigraphic significance of this group is great, an additional factor for further study. It is especially important to find out how many palaeobatrachid species existed during the Pliocene and Pleistocene in Europe. Morphological dissimilarities of homonymic bone structure originating from diverse localities may be explained in different ways with serious implications. Suggestion of the existence of more than one species necessitates subdivisional criteria. In such a case specific identifications of most of the *Pliobatrachus* cf. *langhae* fossil remains become pointless, not only because numerous bones are not generally identifiable to species level (Sanchiz and Miynarski, 1979), but also because of the necessity to decide which elements correspond to the originally described species (Fejervary, 1917), and which to a new one.

Distribution of studied specimens in the localities

	Uryv 1	Apastovo	Staraya Kalitva 1	Liventsovka 5	Korotoyak (Belogor'e)	Veret'e	Staraya Kalitva 2	Yablonovets	Kozii Ovrag
Sphinithmoideum					1				
Frontoparietale					1				
Goniale		1	2		15		1		1
Vertebrae			1		6			1	
Sacrum					1				
Urostyl	1	1							
Sapula					4				
Coracoideum					2				
Humerus		1			6				
Radioulna			1		8	2			
Ilium	2		5	1	14	1		1	
Tibiofibula					7				
Astragalus					1				
Total	3	3	9	1	66	3	1	2	1

Acknowledgment of a single species existence characterized by significant intraspecific variability makes the establishment of the genus *Pliobatrachus* doubtful due to the similarity of its skeletal morphology to that of *Palaeobatrachus* (Vergnaud-Grazzini and Miynarski, 1969; Sanchiz and Miynarski, 1979; Hodrova, 1982).

This problem can hardly be solved until representative material, obviously lacking currently, is obtained.

This paper presents, with the hope of future investigations, the palaeobatrachid finds in the territory of the East-European Platform.

MATERIAL

Fossil material are found in the following localities:

Apastovo—a quarry by Apastovo village, Apastovo District of the Tatarstan Republic; Upper Pliocene;

Korotoyak (Belogor'e)—a locality on the steep original bank of the Don River the road between the Korotoyak and Pokrovka close to villages of the Ostrogozhsk District of Voronezh Region; Upper Pliocene;

Kozii Ovrag—a steeply-sloped ravine facing the flood-lands of the Tikhaya Sosna River near the rains of school of the villages of Korotoyak-Pokrovka, Ostrogozhsk District of the Voronezh Region; Lower Pleistocene;

Liventsovka 5—a quarry by the village of Liventsovka close to Rostov-on-Don; Upper Pliocene;

Staraya Kalitva—a left tributary of Lipovyi ravine at the north edge of the village of Staraya Kalitva, Rossoshan' District of the Voronezh Region; two stratigraphic levels: Staraya Kalitva 1—Upper Pliocene, Staraya Kalitva 2—Lower Pleistocene;

Uryv 1—the right steep bank of the Don River, 300 m upstream from the village of Uryv ferry wharf, Voronezh Region; Upper Pliocene;

Veret'e—a small quarry on the left slope of the Ol'shanka River valley 300 m to the northwest of the village of Veret'e of the Ostrogozhsk District of Voronezh Region; Upper Pliocene;

Yablonovets—a locality on a steep slope of the Matyra River right bank at the north edge of the village of Yablonovets, Tambov Region; Lower Pleistocene.

Geological descriptions of some localities are already published (Aleksandrova, 1967, 1976; Krasnenkov and Agajanyan, 1976; Liberman *et al.*, 1984; Kholmovoi *et al,* 1985; Krasnenkov *et ah,* 1995); others are in press or in prep.

Identification of palaeobatrachid skeletal parts was carried out by comparisons with illustrations of corresponding bones in the papers of Western workers, as well as by the conjoint location with other identifiable palaeobatrachid elements. The quantity of elements in the localities studied is shown in the table. It may be seen that only the Korotoyak locality yielded more or less extensive material. The others produced only solitary bones.

Original bone determinations were carried out up to different taxonomic levels based on the state of preservation and the identification level of corresponding bones in the literature. Taking into account the origin of all East-European material from young deposits in which *Palaeobatrachus* elements have not been found and the existence of other *Pliobatrachus* species not established, I found it possible to assign the material to *Pliobatrachus* cf. *langhae* Fejervary, 1917.

SYSTEMATIC PALEONTOLOGY

Sphenethmoid (Fig. la). This bone is considerably eroded. Its dorsal surface is completely missing, but the preserved anterior part of the ventral surface shows two longitudinal elevations running along the olfactory tracts (Sanchiz and Miynarski, 1979, fig. 8) that leaves no doubt of this specimen belonging to the Palaeobatrachidae. The above cited authors remark that this element structure is identical in *Pliobatrachus* and other palaeobatrachids.

Frontoparietal (Fig. \b). This fragment, in my opinion, is the right half of the parietal part of the frontoparietal; it is thick and smooth. There is a flat area

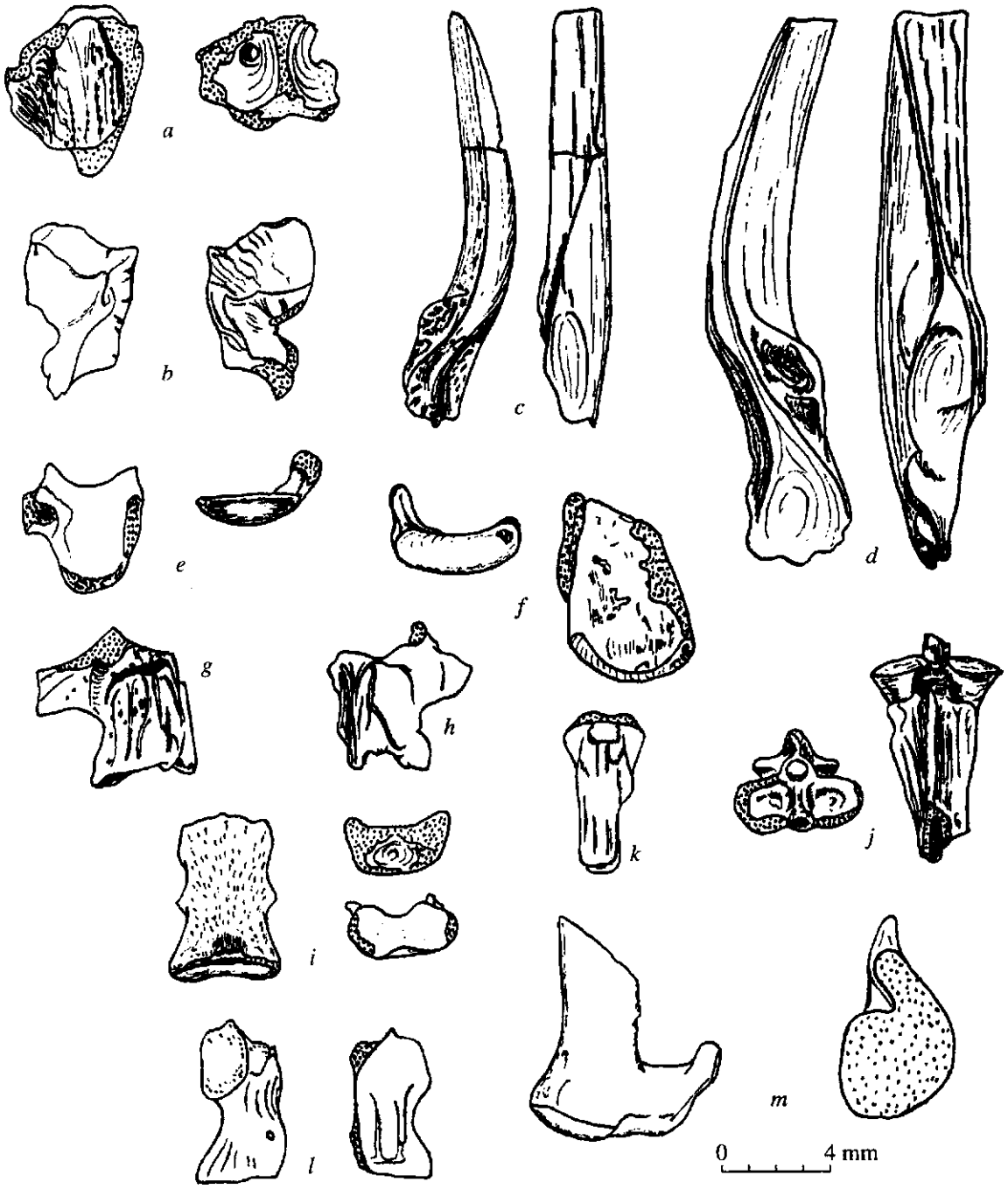

Fig. 1. ***Pliobatrachus*** **cf.** ***langhae*** **from Eastern Europe; (a) sphenethmoid, specimen no. 530/352, from below and anteriorly, Korotoyak;** ***(b)*** **frontoparietal, specimen no. 530/103, from above and below, Korotoyak; (c) gonial, specimen no. 530/105, from above and laterally, Korotoyak;** ***(d)*** **gonial, specimen no. 567/10, from above and laterally, Staraya Kalitva 1; (e) centrum, specimen no. 530/120, from above and anteriorly, Korotoyak;** ***(f)*** **centrum, specimen no. 567/17, posteriorly and from above, Staraya Kalitva 1;** ***(g*** **and** ***h)*** **neural arch fragments, specimen nos. 530/121 and 530/122; from above, Korotoyak; (i) synsacrum body, specimen no. 530/201, from below, anteriorly and posteriorly, Korotoyak;** ***(j)*** **urostyle, specimen no. 539/52, anteriorly and from above, Apastovo;** ***(k)*** **urostyle, specimen no. 531/3, from above, Uryv 1; (0 scapula, specimen no. 530/87, laterally and mesially, Korotoyak; (m) coracoid, specimen no. 530/94, from above and laterally, Korotoyak.**

bordered by a moderately sized shelf on the dorsal surface, behind which the bone becomes thinner towards the edges. The preserved part of the ventral thickening tapers laterocaudally. This specimen is assigned to ***Pliobatrachus*** **here on the basis of its significant similarity to the frontoparietal of the genus in an illustration in Hodrova (1982, PI. 1, figs. 1, 2) and its joint occurrence with other undoubtedly** ***Pliobatrachus*** **elements.**

Hodrova (1982) indicated that the frontoparietals in her possession probably belonged to two diverse, morphologically different forms, and vary from a fragment fromWeze (Sanchiz and Miynarski, 1979).

Gonial (Figs. \c and *Id)*. This is one of the most common skeletal elements, similar in shape to the drawing of the corresponding bone of *Pliobatrachus* produced by Hodrova (1981, pi. 2, fig. 3). It is very robust and slightly S-shaped. Its posterior edge is expanded and spoon-shaped. There are two processes anteriorly to it at the dorsomedial surface, directed dorsolaterally *(processus coronoideus lateralis)* and dorsomedially *{processus coronoideus medialis)* correspondingly. A subovoid area, bearing as a rule a pair of pits situated one after another, separates the coronoid processes. Developmental rate of these pits varies in different specimens and ranges from wide and deep to almost unnoticeable. A flat surface is found on the lateral bone area against the coronoid processes. Its outlines in some specimens are well expressed and clear, in the others they are practically indistinguishable. This bone also varies in regard to the relative size of the area between the coronoid processes. The Meckelian cartilage depression being narrow below the coronoid process increases forwards to attain the total bone depth.

Vertebrae. Only one almost completely preserved vertebra determined as *Pliobatrachus* cf. *langhae* is known at present from the territory of Eastern Europe (Ratnikov, 1993). Other specimens have elongated dorsoventrally compressed centra, their cotyles are deeply embayed in the horizontal plane and condyles are convex. Horizontal parts of the neural arche fragments have an uneven dorsal surface bearing long swollen crests along the longitudinal vertebral axis (Figs, \e-\h).

Sacrum. In *Pliobatrachus* it is always complex, formed by fusion of three vertebrae (seventh, eighth, and ninth) (Fejervary, 1917; Vergnaud-Grazzini and Miynarski, 1969; Hodrova, 1982). The vertebral centra fuse without visible sutures, hence the synsacrum ventral surface is smooth. The seventh vertebra is procoelous, and the ninth articulates with the urostyle by two condyles. One of the specimens from the Korotoyak locality corresponds to this description (Fig. li). Unfortunately, the neural arches of fused vertebrae are completely eroded. There is a short wide depression on the ventral surface of the posterior vertebral centrum that begins approximately from its middle and ends between the condyles. It probably housed the urostyle *processus intercondylicus.* The specimen shape is similar to the corresponding parts of the sacrum of *Pliobatrachus langhae* (Miynarski, 1960, pi. 17, fig. 5a).

Urostyle. Two specimens from the present collection may be confidently assigned to *Pliobatrachus.* Both are the proximal parts of the bone and possess paleourostyle characters, mentioned in the literature (Fejervary, 1917). A specimen from Apastovo (Fig. *If)* is better preserved. This is a rather robust bone slightly extended at the anterior extremity. The cotyle is paired, its articulation surfaces being slightly concave in contrast to those in toads and frogs, in which the concavity is more pronounced. The ventral surface bears a clearly marked subcylindric *processus intercondylicus.* The neural canal is narrow and rounded. The *lamina horizontalis* is clearly marked and is visible from behind the *corpus urostyli* when viewed from below. The *crista neuralis* is well developed and can be traced along the whole specimen length. Hodrova (1982) distinguishes between A and B urostyle types. The specimen from Apastovo resembles type A in shape.

The specimen from Uryv 1 (Fig. *Ik)* is more poorly preserved; its *processus intercondylicus* is missing, the cotylar facet edges are destroyed and the specimen generally is worn. Nevertheless, rounded shape of the neural canal, although of relatively larger diameter, and the remains of the *lamina horizontalis* confirm its assignment to *Pliobatrachus.* The urostyle belongs to the A type. In contrast to the previous specimen, the *crista neuralis* is practically absent.

In previous papers, Ratnikov (1990,1994) assigned urostyles with damaged neural arches to *Pliobatrachus* on the basis of the gap between the two condyle articulation facets that may perhaps occur (Hodrova, 1981, pi. 1, fig. 3; Sanchiz and Miynarski, 1979, fig. 5: 9). Study of supplementary comparative material on extant anurans identified an infrequent occurrence of this gap in frogs, and thus cannot serve as a solid basis for assignment to palaeobatrachids.

Scapula (Fig. *It).* All four available specimens originate from the Korotoyak locality. These are robust bones with a short *corpus scapulae,* perhaps with an uncleft head. Despite the wear, the anterior surface of the scapula show a somewhat pronounced *tenuitasQrarualis.* These specimens correspond, by their morphology^ to the scapulae illustrations of *Pliobatrachus* cf. *langhae* (Sanchiz and Miynarski, 1979, fig. 7: 1-5). A characteristic foramen at the external surface of the *corpus scapulae* is present.

Coracoid (Fig. lm). Two specimens of this bone were found in the same locality. One of them demonstrates a completely preserved *pars scapularis,* carrying a robust *processus rostriformis* characteristic of the palaeobatrachids (Spinar, 1972); in the second specimen this process is destroyed. The anterior bone edge is sharply crested. The *fades scapularis* configuration is similar to digit "6" due to its beak-shaped process and is comparable to the B type (Hodrova, 1982).

Humerus (Figs. 2a and *2b).* Sanchiz and Miynarski (1979) remarked, that the bone morphology is constant in all Palaeobatrachidae, but nevertheless determined their material to the species level. Our specimens are similar to those figured in their paper and are characterized by the absence of the cubital fossa. The ventral crest is very long, it runs from the proximal extremity up to the distal bone head. The secondary ventral crest lying mediad is shorter, but also well expressed. The *epicondylus medialis* is slightly more pronounced

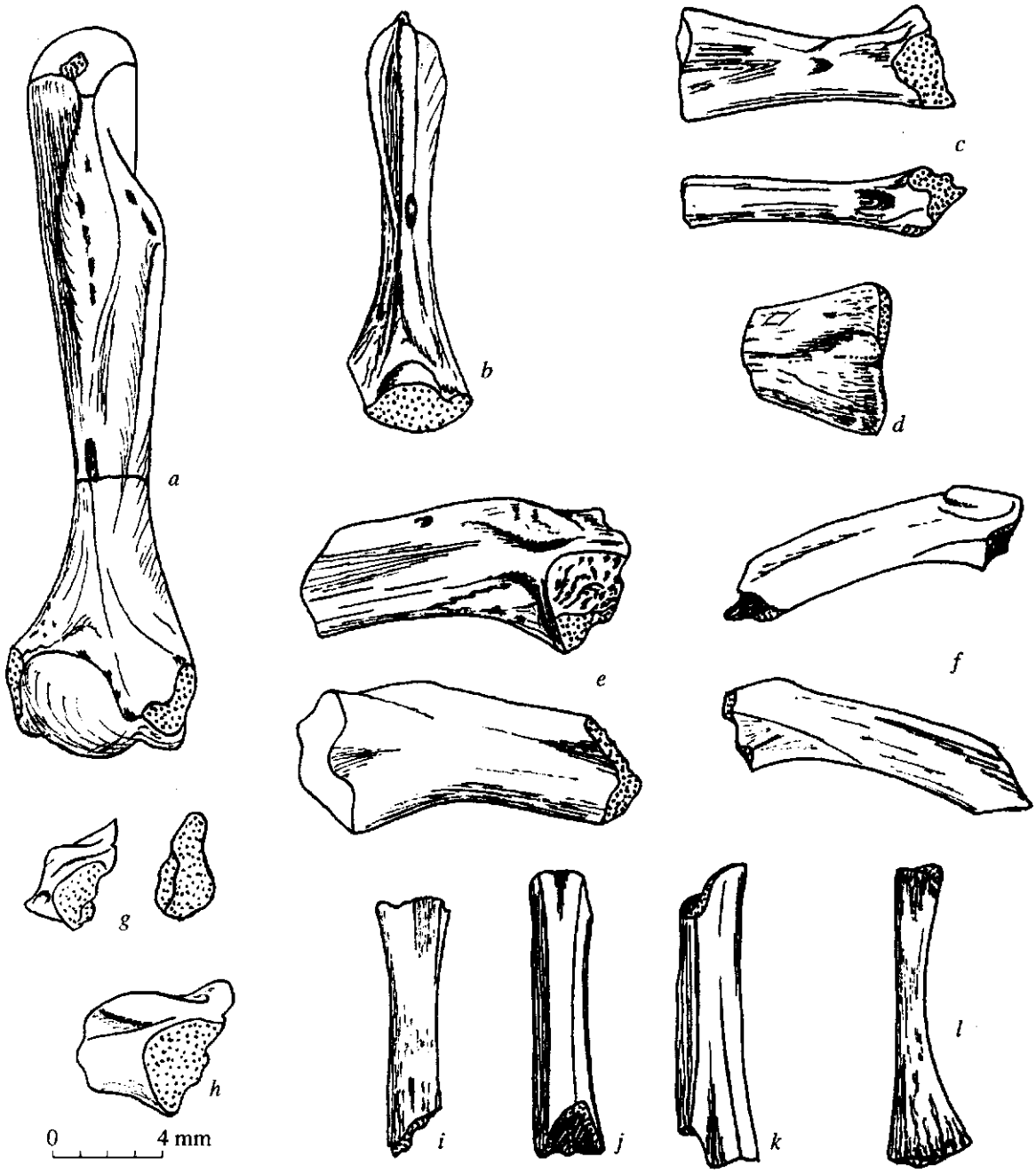

Fig. 2. *Pliobatrachus* cf. *langhae* from Eastern Europe: *(a* and *b)* humeri, specimen nos. 530/64 and 530/368, from below, Korotoyak; (c) radioulna, specimen no. 530/354, laterally and from above, Korotoyak, (tf) radioulna, specimen no. 530/355, laterally, Korotoyak; (e and *f)* ilia, specimen nos. 530/3 and 530/4, laterally and mesially, Korotoyak; *(g)* ilium, 530/2, laterally and posteriorly, Korotoyak; *(h)* ilium, specimen no. 531/1, laterally, Uryv 1; *(i-k)* tibiofibula fragments, specimen nos. 530/360-530/362, Korotoyak; (0 astragalus, specimen no. 530/367, Korotoyak.

than the *epicondylus lateralis,* and the distal end of the humerus is almost symmetrical in the articulation plane. The *olecranon* scar is very short and not shifted laterally. The best preserved specimen is the largest and measures: length 27 mm, distal humeral head width 7 mm.

R a d i o u l n a . This skeletal element is considered to be of minor taxonomic importance. It is usually not cited in the material lists in the paleontological literature even in family descriptions, and in such comprehensive papers as Spinar (1972) only the general structural pattern of this bone is supplied. Meanwhile, fossil radioulnae and their fragments are frequently found. The Korotoyak locality also yielded a large amount of these elements, one of which attracted attention since it clearly stands out morphologically from the lot (Fig. *2c).*

In contrast to frogs and toads that have an oval or near oval cross-section of the fusion of the radius and ulna, in this specimen it is less regular due to dorsal compression, in the center of which there is a semilunar pit for tendon insertion. I examined a large amount of toad, frog and pelobatid specimens, that is the forms in which radioulna can attain dimensions comparable to those of the fossil specimens, but found no similarly shaped pit. Usually it is rounded or elliptical, sometimes poorly expressed or absent, sometimes bordered with a crest, but never semilunar. The *sulcus longitudinalis* at the mesial surface is wide and shallow and can be hardly traced at the lateral one. This also distinguishes the specimen from similar elements in pelobatids, in which described structures are better expressed, and even more from toads and frogs, possessing deep, symmetrically placed longitudinal furrows. Distinction from recent forms and occurrence in the assemblage containing numerous *Pliobatrachus* remains give grounds to assign the fossil to this genus.

Several more distal and proximal fragments are assigned here to *Pliobatrachus*. The distal fragments are asymmetrical and longitudinal grooves are poorly expressed (Fig. *2d)*. Proximal elements show semilunar-shaped pits on the dorsal surface. It should be noted, that their cross-section is a more regular oval and the deviation angle between the radius and ulna in some specimens is possibly less, than that in the specimen described above. This may result from morphological variation or a possible mistake in the identification but it is indeterminable for the present.

Ilium. Taking into account the material from Eastern Europe, the most common fragment of this bone is the posterior part of the shaft *(ala ilii)* bearing the *tuber superior*. The corpora and shafts of these bones anterior to the *tuber superior* are much more rare. At present, the only almost completely preserved ilium is found in the Yablonovets locality (Ratnikov, 1993). Absence of the dorsal crest, lateral shaft compression in the presence of more or less expressed longitudinal grooves at the lateral and mesial shaft surfaces, making its cross-section figure "6" or "8"-like, position of the *tuber superior* almost totally anterior to the acetabulum, absence of the *pars descendens ilii,* notable thickening of the *corpus ilii* and presence of a wide furrow in its middle are characteristic of this skeletal element (Figs. *2e-2h)*. It was previously noted by Hodrova (1982), that the *tuber superior* on the ilia of *Pliobatrachus* is a very variable structure. East European material are not different in this. Developmental rate of the *tuber superior* may vary from hardly noticeable lateral thickening in the posterior part of the shaft in front of the acetabulum to a rather prominent protruding boss. Most of these structures are smooth, but some specimens demonstrate uneven surfaces, small grooves and tubercles.

Tibiofibula. Unfortunately, descriptions of this *Pliobatrachus* bone are unavailable in the literature in my possession. Those specimens which are assigned to this genus here are fragmentary and there is not a single one with an epiphysis in place, not to mention complete bones. Nevertheless, samples show fusion of two long bones (tibia and fibula), as in extant anurans. However, in contrast to those, fossil elements are somewhat faceted instead of being rounded or oval in cross-section. Not a single specimen shows a see-through foramen for the passage of the tibial artery, characteristic of all East-European anurans, although a small opening is present on one side of the bone. Comparison with illustrations of the palaeobatrachid *os cruris* (Spinar, 1972) demonstrated a significant similarity (Figs. *2i-2k)*. Hence, together with their occurrence in an assemblage with numerous palaeobatrachid bones assignment to *Pliobatrachus* was possible.

Astragalus (= tibiale) (Fig. *21)*. This bone is narrowest in its central part, expands towards the ends, and the proximal extremity is considerably narrower than the distal. The lateral bone edge is practically straight, whereas the medial one is strongly curved, a condition that corresponds to that of the palaeobatrachid astragalus (Spinar, 1972). More intensive elaboration of the spongy tissue and minute folding at the bone extremities should also be noted, conditions that makes it different from corresponding bones of extant East-European anurans.

CONCLUSIONS

Pliobatrachus finds in a series of East-European localities confirms that this animal was no less abundant in this territory, than in Central Europe, and existed almost up to the end of the early Pleistocene (two youngest localities yielding *Pliobatrachus* material, Yablonovets and Kozii Ovrag belong to the Muchkap Horizon of the Lower Pleistocene).

Unfortunately, all material at my disposal is fragmentary, which does not make it possible to come to definite systematic conclusions at present. Notable morphological variability is demonstrated by the gonial and ilium, but transition from one extreme variation to another goes very smoothly hence giving no possibility of dividing the specimens into separate morphological groups. Of other bones showing morphological variation (Hodrova, 1982), the frontoparietal, urostyle, and coracoid are present, but due to their rareness and poor preservation it is neither possible to confirm, nor to reject Hodrova's opinion on the existence of two *Pliobatrachus* forms (species).

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