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Pleistocene amphibian fauna from Kozi Grzbiet in the Holy Cross Mts

ABSTRACT: The Pleistocene (Mindel *I*/Mindel *II*) site of Kozi Grzbiet in the Holy Cross Mts, Central Poland, has provided remains of the following amphibians: *Triturus cristatus* and *Triturus* cf. *vulgaris* (Salamandridae); *Bombina bombina* (Discoglossidae); *Pliobatrachus* cf. *langhae* (Palaeobatrachidae); *Pelobates fuscus* (Pelobatidae); *Bufo bufo* (Bufonidae); *Hyla arborea* species-group (Hylidae); *Rana temporaria*, *Rana dalmatina*, cf. *Rana arvalis* and *Rana „esculenta"* species-group (Ranidae); as well as the remains of probably *Pelodytes* sp. (Pelodytidae), being first recorded as a fossil in Central Europe. No significant faunistic differences are recognizable among particular layers of the site, with a clear preponderance of *Triturus cristatus* (33 to 76% of individuals). The investigated Pleistocene amphibian fauna is briefly compared with the Pliocene one, to show the absence of any drastic faunistic change at the Pliocene/Pleistocene boundary.

INTRODUCTION

The karstic fillings at the Kozi Grzbiet Hill near Chęciny in the Holy Cross Mts, Central Poland, contains a bone breccia deposit, dated on the Mindel *I*/Mindel *II* interglacial, which has provided a very abundant and diversified vertebrate assemblage. Data on the location, geological aspects and excavation of the site can be found elsewhere (Głazek & *al.* 1976, 1977). Studies on some faunistic groups are already available (see references *in:* Stworzewicz 1981). Concerning herpetology, a general introduction was presented by Młynarski (1977), and the reptiles subjected to detailed studies by the junior author (Szyndlar 1981, 1984).

The purpose of this paper, based on a sample selection (*see* Methodology), is to supplement the herpetological records of the past biota of Poland.

METHODS AND TECHNICAL PROCEDURES

The lithological Unit *2* of the site (Text-fig. 1), where most of the material comes from, was divided during the excavation into three layers (*1*, *2*, and *3*) based on sedimentological criteria (Głazek & *al.* 1978), and they are here separately treated, as well as the presumably mixed samples from some contact zones. A separate sample, termed the „dump", corresponds to elements found in the scree formed during the commercial quarrying prior to the scientific excavation.

All the collected material is composed of loose, isolated (non-articulated) fragments. The total number of remains is high, and it reaches over 112 000 reptile (Szyndlar 1981) and over 30 000 amphibian bones. In order to provide reliable taxonomic determinations and to make the inference of the *Minimum Number of Individuals* (herein referred to as *MNI*), the most conspicuous and resistant elements were sorted out from the general mixture of bones. The *MNI* was estimated based on the most abundant individual elements, a taxonomic inference on which was possible. For urodeles the highest numbers have been found on the first vertebrae („atlas", V_1), right/left dentaries and parasphenoids; for anurans the right/left ilium has provided most of the estimations. Being sufficient for the taxonomic purposes, it is to be stressed that, nevertheless, there are many other paleontological researches (such as the study of anomalies, differential taphocoenotic preservation, etc.) that would require a more precise sorting of the material, and that is hoped to be done in the future.

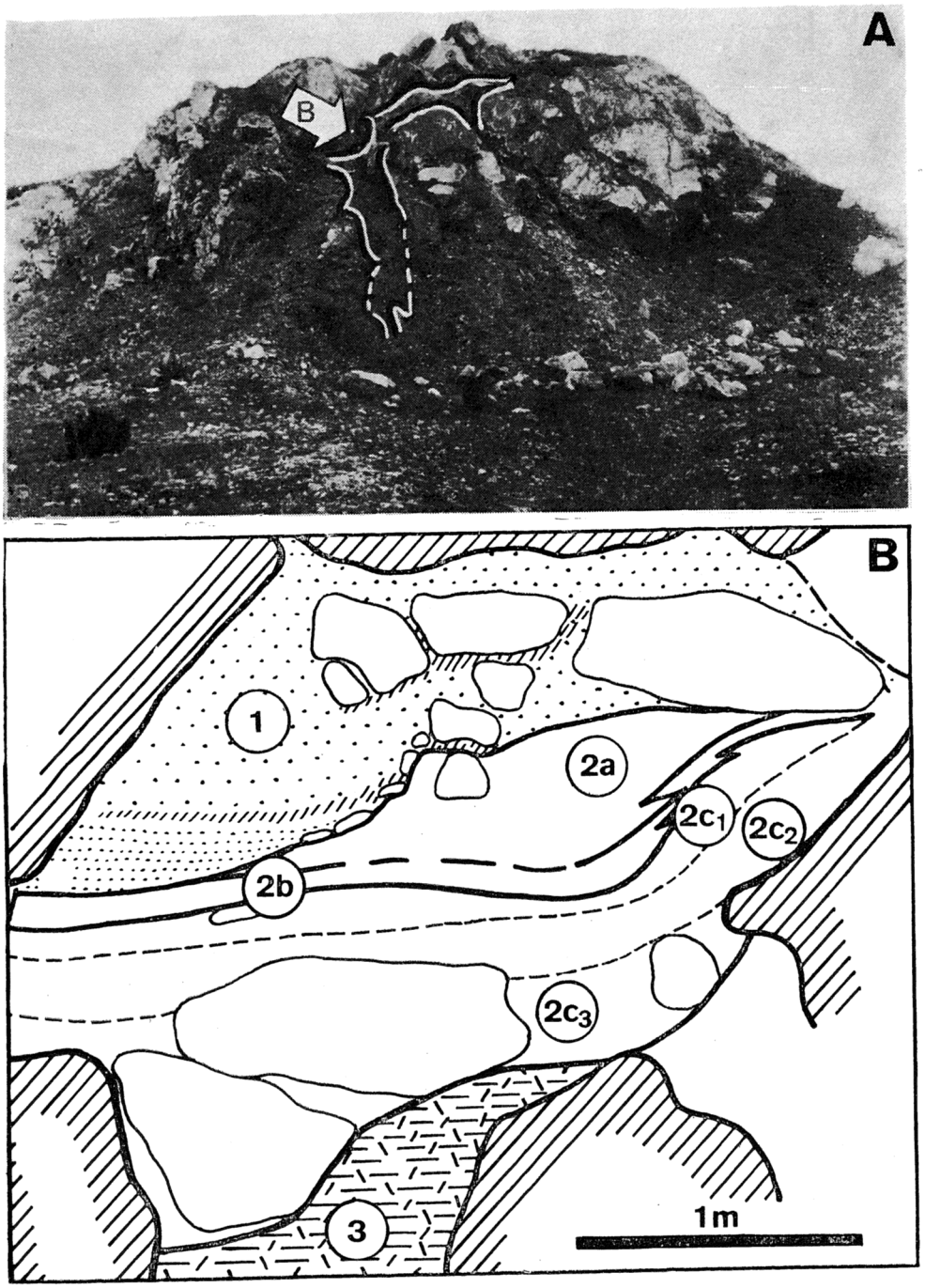
The fossil material is stored at the collection of the Institute of Systematic and Experimental Zoology, Polish Academy of Sciences, Cracow.

SYSTEMATIC PART

Order **CAUDATA** Oppel, 1811
Family **Salamandridae** Gray, 1825
Genus *TRITURUS* Rafinesque, 1815
Triturus cristatus (Laurenti, 1768)

Minimum Number of Individuals: 2A = 438; 2B = 56; 2C = 82; 2A+B+C = 34; 2B+C = 9; dump = 126.

Remarks. — The recognition of the species is based on relevant elements from many corporal regions, in agreement both in size and morphology with the living form. Sanchiz & Szyndlar (1984) presented criteria, with a minimum of artificial selection of characters, to differentiate among the three species that could be included in the subgenus *Neotriton*, as well as a summary of the phylogenetic and biogeographic history of the group. The material from Kozi Grzbiet was also used to examine, in part, the variability of some osseous structures (Sanchíz & Szyndlar 1984).



General view of the karst fissure exposed at the Kozi Grzbiet Hill near Chęciny in the Holy Cross Mts (**A**), and a sketch of the part of the fissure (arrowed in *A*) to show position of the bone-bearing layers distinguished in the text (**B**); adopted from Głazek & *al.* (1976, Text-figs 2 and 4, and Pl. 1, Fig. 1)

Triturus cf. *vulgaris* (Linnaeus, 1758)
(Text-fig. 2)

Minimum Number of Individuals: 2A = 1; 2B = 1; 2C = 1; 2A+B+C = 1; dump = 1.

Remarks. — Only trunk and sacral vertebrae have been found. The latter differ from those of *Triturus cristatus* in their much smaller size, development of a high neural spine, wider plates connecting pre- and postzygapophyses with dorsal rib-bearers, greater ventral foramina and centrum connection with ventral rib-bearer

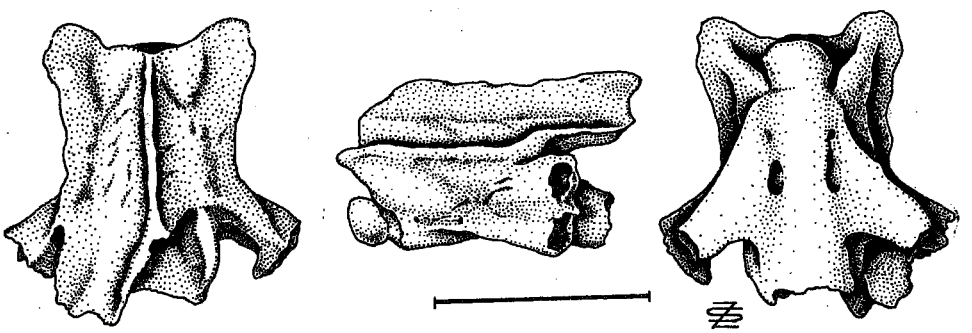


Fig. 2. Trunk vertebra of *Triturus* cf. *vulgaris* (Linnaeus); dorsal, lateral and ventral views; scale equals 2 mm

with a characteristic arched anterior edge, a combination of features that clearly points to the subgenus *Triturus (Paleotriton)*. Furthermore, these elements might be differentiated from *Triturus montandoni* (Boulenger), the only other member of the subgenus living in Poland, and from *T. boscai* (Lataste), at least by the narrower width of the neural spine. Differentiation from the very similar *T. helveticus* (Razoumowsky) and *T. italicus* (Peracca) on isolated vertebrae is difficult. Accordingly, the „cf." taxonomic particle is used *sensu* Sanchíz (1977).

The species *Triturus vulgaris* has a very reduced fossil record, not being inequivocally known from the Tertiary (Sanchiz & Młynarski 1979b; Estes 1981).

Order **ANURA** Giebel, 1847
Family **Discoglossidae** Guenther, 1858
Genus *BOMBINA* Oken, 1816
Bombina bombina (Linnaeus, 1758)
(*1* in Text-fig. 4)

Minimum Number of Individuals: 2A = 82; 2B = 7; 2C = 10; 2A+B+C = 10; 2B+C = 2; dump = 13.

Remarks. — The presence of the genus *Bombina* is indicated by its rather peculiar morphology, which can be observed on almost any of the several fragments recovered. Within the genus, which shows a high structural stability and accordingly very similar mophologies among species, the fossils under consideration could be differentiated from the Asiatic species, *B. maxima* Boulenger and *B. orientalis* (Boulenger), on several grounds, as for example by a much lesser development of the pseudo-zygosphene type of vertebral articulations.

The material is most similar to the two living European species. *B. bombina* (Linnaeus) and *B. variegata* (Linnaeus), osteologically very similar, in particular to the former. On recent paleontological studies concerning those species the ilium has been used to base the taxonomic attribution (Böhme 1977, 1979; Sanchiz & Młynarski 1979a; Hodrová 1981). An examination has been made of 82 right ilia from layer *2A* for the criteria of Böhme (1977) and Sanchíz & Młynarski (1979a), with the following results: oriented the bone to a maximum view of the acetabulum, the pars descendens showed the *B. bombina* type on 46 of the 47 specimens with this selection preserved, being the remaining one of intermediate morphology; the tuber superius (sample size = 72) approached the *B. bombina* typical development on the 76.4% of the cases, intermediate on the 11.1% and showed the *B. variegata* type on the 12.5%, 85.13% on a sample of 76 presented a noticiable (although small) insertion for the m. iliacus internus (=preacetabular fossa), as *B. bombina;* considering all the features, on 41 proximally complete elements, 26 were the most typical *B. bombina* by all criteria, on 13 the *B. bombina* features were predominant (with only an intermediate or *B. variegata* morphology on one of the features) and just on two the general aspect was intermediate between the living species. The full *B. variegata* type was not observed.

Family **Palaeobatrachidae** Cope, 1847
Genus *PLIOBATRACHUS* Fejérváry,, 1917
Pliobatrachus cf. *langhae* Fejérváry, 1917
(Text-fig. 3)

Material: 2A — right maxillae (2); vertebra (1); ilia (2 right, 1 left); right humerus (1); 2B — vertebrae (5); left humerus (1); left ilium (1); 2C — premaxilla (1); maxillary fragment (1); left humerus (1); 2A+B+C — right ilium (1); 2B+C — maxilla (1); vertebral centrum (1); ilium (1); dump — right angular (1); left ilium (1).

Minimum Number of Individuals: 2A = 3; 2B = 1; 2C = 1; 2A+B+C = 1; 2B+C = 1; dump = 1.

Remarks — The presence of this characteristic genus is clear after the recovered fragments (*see* Sanchíz & Młynarski 1979a; Hodrová 1982, for an anatomical summary), being demonstrated with it the persistence of palaeobatrachids at least until the Middle Pleistocene (Młynarski 1977).

Hodrová (1982) suggests the presence of more than one species of *Pliobatrachus* in the Czech Pliocene, although it is possible that one of the forms could be attributed directy to *Palaeobatrachus* as in Węże *II* (Sanchíz 1984). In any case, the recovered elements (vertebrae, ilia and humeri) are very similar among palaeobatrachids in general, and the taxonomic attribution in Kozi Grzbiet is based on the iliac synchondrosis and tuber superius (undivided and reduced) shaps as well as on the peculiar maxillae and teeth (Szyndlar 1981, Text-fig. 6; erroneously considered there as *Lacerta* remains).

The type (and only described) species of *Pliobatrachus* is known through urostyle and sacrum (Fejérváry 1917), a pair of elements with very little morphological variation among palaeobatrachids. Other bones (such as frontoparietals, maxillae, premaxilla, etc.) have been attributed to it from chronologically and spatially similar localities, validating the generic separation from the only other known palaeobatrachid genus (*Palaeobatrachus*), but in the absence of a description of other elements from the type locality (Betfia = Püspökfürdö), it is not

possible to use the specific name *Pliobatrachus langhae* without some kind of restrain. Accordingly, the taxonomic particle „cf." in the sense of Sanchíz (1977) is introduced.

Family **Pelobatidae** Lataste, 1879
Genus *PELOBATES* Wagler, 1830
Pelobates fuscus (Laurenti, 1768)
(*2* in Text-fig. 4)

Material: 2A — ilia (1 right, 1 left); 2B — frontoparietal fragment (1); V_1 (1); trunk vertebra (1); left coracoid (1); right humerus (1); left ilium (1); 2C — vertebra (1); ilium (1); 2B+C — vertebrae (2); left ilium (1).

Minimum Number of Individuals: 2A = 1; 2C = 1; 2B+C = 1.

Remarks. — The specific attributions are based on a frontoparietal fragment showing the not very dense tubercle sculpture, different from that of other members of the genus, and on the iliac morphology, with a reduced striation on the medial side of the pars descendens .

There are other elements, in particular small ilia, that could belong either to a juvenile of this species or to *Pelodytes* (see below), but their preservation precludes a more precise assignment.

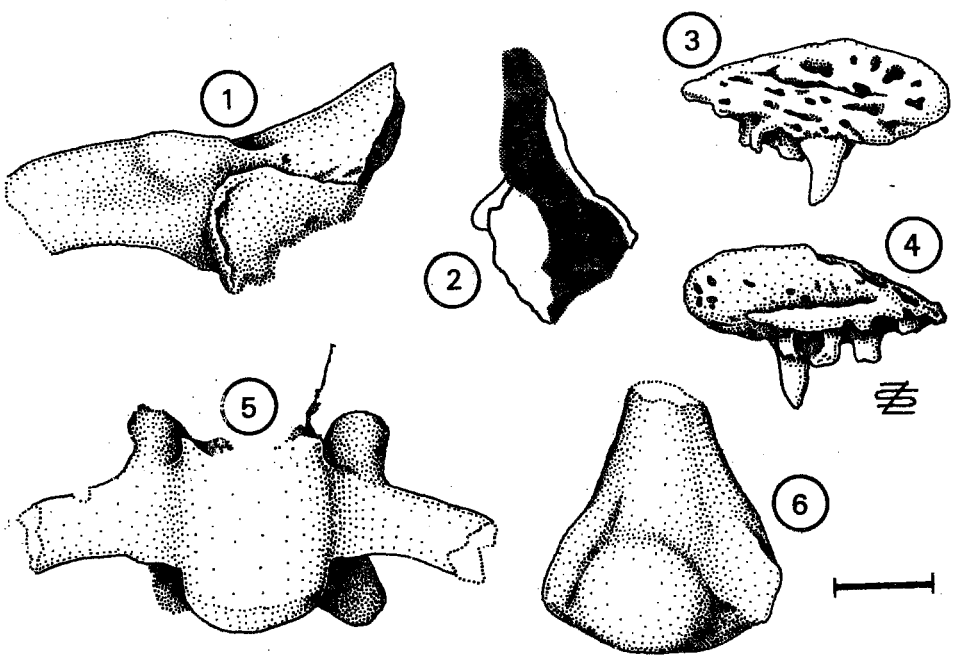


Fig. 3. *Pliobatrachus* cf. *langhae* Fejérváry

1, **2** — left ilium (*1* lateral, *2* posterior views); **3**, **4** — right maxilla (*3* lateral, *4* lateral medial views); **5** — trunk vertebra, ventral view; **6** — humerus, ventral view; scale equals 2 mm

Family **Pelodytidae** Cope, 1867
Genus *PELODYTES* Bonaparte, 1838
? *Pelodytes* sp.

Material: 2A — ilia (1 right, 2 left); 2B — vertebra (1); tibial-fibulare (1); 2C — right humerus (1♂) (taxonomic attribution ?).

Minimum Number of Individuals: 2A = 2?; 2B = 1; 2C = 1.

Remarks. — The presence of this genus is suspected basically after a fragment from layer *2B* that could be interpreted as a tibial-fibulare, that differs from the nomal tibio-fibulare of the anuran species recovered. The family Pelodytidae is the only one in Europe that shows a complete fusion of tibiale and fibulare = calcaneum and astragalum). Other elements, in agreement with *Pelodytes*, can also be referred to juvenile *Pelobates*. Two-third of the assumed fossil tibialfibulare are preserved, being determinable completely the narrow central part. Its measurements (mm) are: maximal proximal width = 1.91; minimal central width = 0.80; width an index min. central/max. proximal × 100 = 41.9.

Although with a smaller absolute size, proportions are similar to those presented in the single skeleton of *P. caucasicus* Boulenger available in the Dresden Museum (MTKD-D-9740: min. central = 1.40; max. proximal width = 3.45), while an example of the only other living species, *P. punctatus* (Daudin), shows a ratio of 32.1 (min. central = 0.76; max. prox. = 2.37), and representatives of the Iberian fossil form *P. arevacus* Sanchíz show ratios between 37 and 57 (Sanchíz 1978). In the absence of more complete fossil material and of detailed quantitative osteological studies of the living forms, this record cannot be referred to either the Eastern or the Western line. On biogeographical grounds this record is somewhat intermediate between the recent ranges of the two living species (*e.g.* Arnold & Burton 1978, for *P. punctatus;* Darevsky & *al.* 1971, for *P. caucasicus*), although the distribution of the Pelodytidae was much larger in the Neogene (Sanchíz 1978).

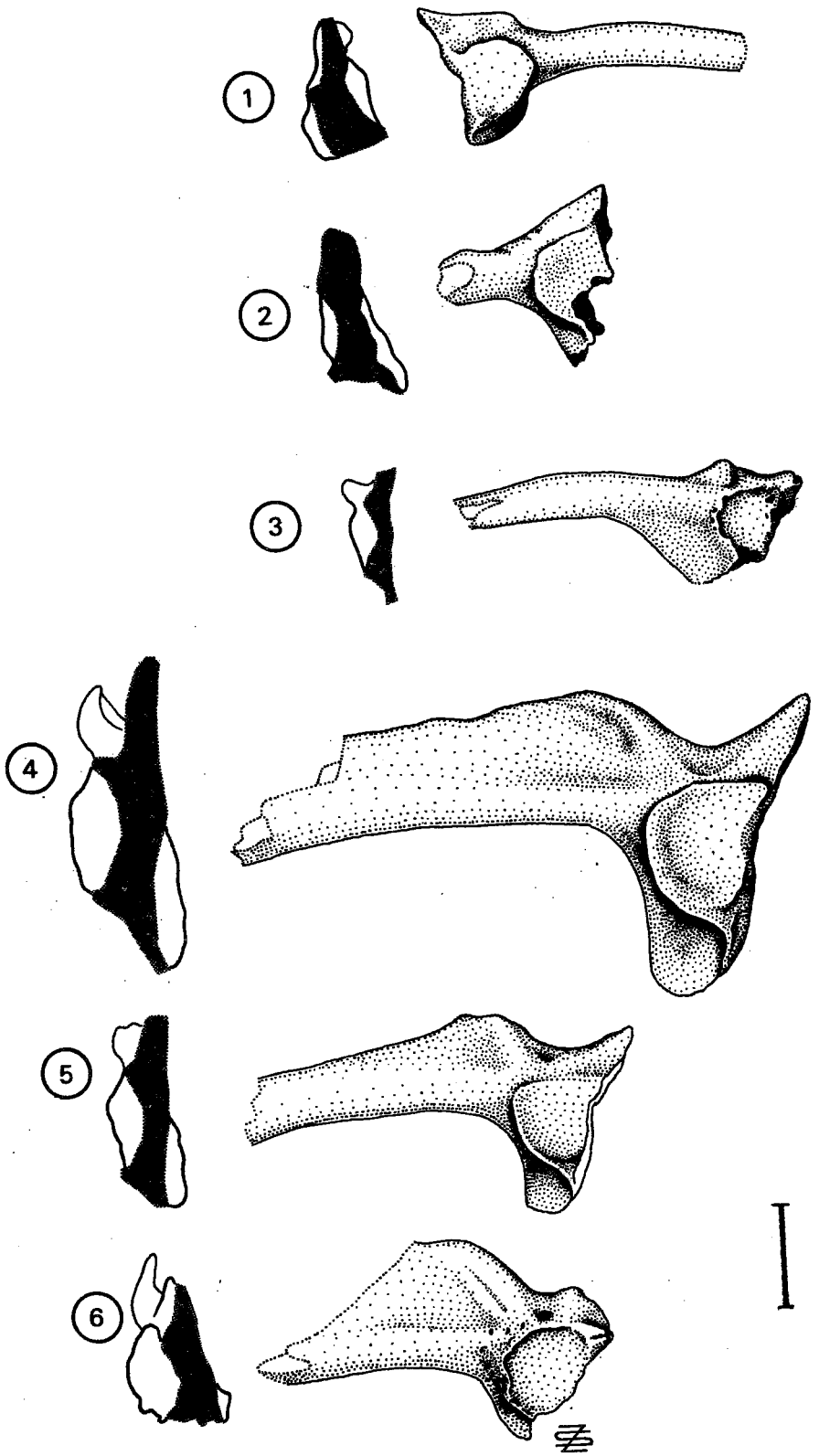
Family **Bufonidae** Hogg, 1841
Genus *BUFO* Laurenti, 1768
Bufo bufo (Linnaeus, 1758)

Minimum Number of Individuals: 2A = 19; 2B = 25; 2C = 7; 2A+B+C = 8; 2B+C = 6; dump = 13.

Remarks. — According to the criteria given by Sanchíz (1977), only *Bufo bufo* seems to be present in the deposit, although it shows a high degree of variability, that could account for an earlier mention (Młynarski 1977) of *B. viridis* Laurenti. The species *B. bufo* (Linnaeus is konwn since the Middle Miocene (MN 8 of the continental biozonation of Mein 1975; Hodrová 1980) and later (see review *in:* Sanchíz 1977).

Fig. 4. Anuran ilia, posterior and lateral views

1 — *Bombina bombina* (Linnaeus), right; **2** — *Pelobates fuscus* (Laurenti), left; **3** — *Hyla arborea/H. meridionalis*, left; **4** — *Rana dalmatina* Bonaparte, left; **5** — *Rana temporaria* Linnaeus, left; **6** — *Rana* sp., left; scale equals 2 mm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Family **Hylidae** Günther, 1858
Genus *HYLA* Laurenti, 1768

Hyla arborea (Linnaeus, 1758) *Hyla meridionalis* Boettger, 1874
(*3* in Text-fig. 4)

Material: 2B — left ilium (1).
Minimum Number of Individuals: 2B = 1.

Remarks. — The fragment preserved is quite characteristic for *Hyla* and in full agreement with the *H. arborea* species-group morphology, although the distinction between the two living European species, *H. arborea* (Linnaeus) and *H. meridionalis* Boettger, is not possible with such a fragment. The fossil record of European hylids has been recently summarized by Sanchíz (1981).

Family **Ranidae** Bonaparte, 1845
Genus *RANA* Linnaeus, 1758

Rana sp.
(*4-6* in Text-fig. 4)

Minimum Number of Individuals: 2A = 31; 2B = 61; 2C = 13; 2A+B+C = 16; 2B+C = 8; dump = 31.

Remarks. — In spite of recent and valuable studies (see Böhme 1979, and references therein; Böhme & Günther 1979) recognition of European species of *Rana* on isolated bony fragments is not easy, and more data on the morphological variation as geographic function are needed. Within the investigated material, it is present the most typical morphology of *R. temporaria* Linnaeus (*5* in Text-fig. 4) as well as scanty material of the *R. "esculenta"* Linnaeus — *R. lessonae* Camerano complex (about 13% in a sample of 30 ilia from layer 2*A*), although not that of *R. ridibunda* Pallas — *R. perezi* Seoane. The majority of the material seems closest to *R. dalmatina* Bonaparte — *R. arvalis* Nilsson, but its fragmentation precludes further estimations. The typical *R. dalmatina* Bonaparte (*4* in Text-fig. 4), seems nevertheless to be present, but no clear example of *R. arvalis* Nilsson is available without extensive damage.

FINAL REMARKS

Comparison between the Pleistocene amphibians from Kozi Grzbiet and those from the Polish Pliocene localities shows no significant changes of faunas at the boundary between the Neogene and Quaternary (Text-fig. 5), therefore unlike as in the case of reptiles (Szyndlar 1984). At the same time, Kozi Grzbiet is the youngest known fossil locality of the extinct family Palaeobatrachidae, represented here by *Pliobatrachus*, being the evidence of survival of these amphibians at least until the Middle Pleistocene (*cf.* Młynarski 1977). Kozi Grzbiet is also the latest fossil site containing faunistic elements not occurring in Poland

Species	Presence in Pliocene localities	References
Triturus cristatus /Laurenti/	W-I, RK-I, RK-II	Sanchíz & Młynarski /1979b/
Triturus cf. vulgaris /Linnaeus/	unknown	
Bombina bombina /Linnaeus/	W-I, RK-I	Sanchíz & Młynarski /1979a/
Pliobatrachus cf. langhae Fejérváry	W-I, RK-I, RK-II	Sanchíz & Młynarski /1979a/
Pelobates fuscus /Laurenti/	RK-I, W-II	Młynarski /1977/, Sanchíz /1984/
Bufo bufo /Linnaeus/	PO,W-I,W-II,RK-I,RK-II	Młynarski /1977/, Sanchíz & Młynarski /1979a/, Sanchíz /1984/
Hyla arborea/H. meridionalis	RK-I, RK-II	Sanchíz & Młynarski /1979a/
Rana temporaria Linnaeus	RK-I	Sanchíz /1983/
Rana dalmatina Bonaparte	W-II	Sanchíz /1984/
Rana arvalis Nilsson	RK-I, W-I	Sanchíz /1983/
Rana "esculenta" Linnaeus	W-II	Sanchíz /1984/
?Pelodytes sp.	unknown	

Fig. 5. Occurrence of amphibian species from Kozi Grzbiet, compared to the Pliocene localities in Poland

PO — Podlesice (biozone MN 14), **RK-I** — Rębielice Królewskie *I* (MN 16), **RK-II** — Rębielice Królewskie *II* (MN 16), **W-I** — Węże *I* (MN 15), **W-II** — Węże *II* (MN 16)

today, i.a. *Rana dalmatina* and *Pelodytes* sp. Amphibians from younger fossil localities of the Polish Quaternary belong exclusively to Recent species, inhabiting presently the territory of Poland (*cf.* Bałuk &*al.* 1979).

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FAUNA PLEISTOCÉNICA DE ANFIBIOS DE KOZI GRZBIET EN POLONIA

(Resumen)

El yacimiento pleistocénico (Mindel *I*/Mindel *II*) de Kozi Grzbiet (Montes de Santa Cruz, Polonia) ha proporcionado restos (Fig. 1—4) de los siguientes anfibios: *Triturus cristatus* y *T.* cf. *vulgaris* (Salamandridae); *Bombina bombina* (Discoglossidae); *Pliobatrachus* cf. *langhae* (Palaeobatrachidae); *Pelobates fuscus* (Pelobatidae); *Bufo bufo* (Bufonidae); grupo de especies de *Hyla arborea* (Hylidae); *Rana temporaria, R. dalmatina,* cf. *R. arvalis* y grupo de *R. „esculenta";* así como probablamente *Pelodytes* sp. (Pelodytidae), encontrado por primera vez en Europa central en estado fósil. No se han detectado diferencias significativas entre los distintos niveles del yacimiento, existiendo una clara preponderancia de *Triturus cristatus* (33 a 76% en número mínimo de individuos). Se compara la herpetofauna polaca del Pleistoceno medio con la pliocénica (Fig. 5), poniéndose de manifesto la ausencia de cambios faunísticos drásticos asociados al límite Plio-Pleistoceno.

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PLEJSTOCEŃSKA FAUNA PŁAZÓW ZE STANOWISKA KRASOWEGO NA KOZIM GRZBIECIE W GÓRACH ŚWIĘTOKRZYSKICH

(Streszczenie)

Praca niniejsza * przedstawia opis plejstoceńskiej (Mindel *I*/Mindel *II*) fauny płazów ze stanowiska Kozi Grzbiet w Górach Świętokrzyskich *(patrz* fig. 1; *oraz* Głazek & *al.* 1976, 1977) i stanowi uzupełnienie opublikowanego wcześniej opisu szczątków gadów pochodzących z tego stanowiska (Szyndlar 1981, 1984).

Szczątki płazów z Koziego Grzbietu, których liczba sięga 30 000 fragmentów kostnych, należą przynajmniej do 11 gatunków traszek i żab *(patrz* fig. 2—4). W zebranym materiale reprezentowane są spośród płazów ogoniastych: traszka grzebieniasta — *Triturus cristatus* (Laurenti) i traszka zwyczajna — *Triturus* cf. *vulgaris* (Linnaeus), zaś spośród płazów bezogonowych: kumak zwyczajny — *Bombina bombina* (Linnaeus), wymarły gatunek *Pliobatrachus* cf. *langhae* Fejérváry, grzebiuszka ziemna — *Pelobates fuscus* (Laurenti), ropucha zwyczajna — *Bufo bufo* (Linnaeus), rzekotka — *Hyla arborea* (Linnaeus), żaba trawna — *Rana temporaria* Linnaeus, żaba dalmatyńska — *Rana dalmatina* Bonaparte, żaba moczarowa — *Rana arvalis* Nilsson, żaba wodna — *Rana „esculenta"* Linnaeus, oraz płd.-wschodnio-europejska żaba *?Pelodytes* sp., znaleziona po raz pierwszy w materiale kopalnym środkowej

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Europy. Nie stwierdzono istotnych różnic faunistycznych pomiędzy poszczególnymi warstwami stanowiska (*por.* fig. 1), zaś gatunkiem zdecydowanie dominującym w całym materiale jest *Triturus cristatus* (co najmniej 745 osobników).

W przeciwieństwie do gadów z Koziego Grzbietu fauna płazów z tego stanowiska nie różni się znacząco od faun płazów plioceńskich z obszaru Polski (fig. 5). Kozi Grzbiet jest najmłodszym stanowiskiem, w którym stwierdzono obecność przedstawicieli wymarłego rodzaju żab *Pliobatrachus;* jednocześnie odnaleziono tu szczątki ciepłolubnych form współczesnych (*?Pelodytes* sp., *Rana dalmatina),* które obecnie nie występują w Polsce.