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New lobsters (Decapoda, Nephropoidea) from the Cretaceous–Paleogene section of the Middle Vistula valley, east-central Poland

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ABSTRACT:

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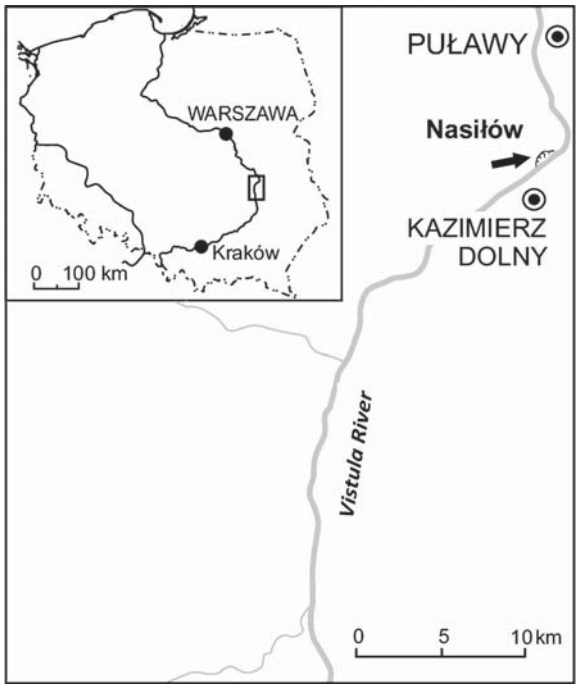
During fieldwork in the early 1990s at the then still active quarry near Nasiłów, on the left bank of the River Vistula (Wisła), accompanied by Professor Andrzej Radwański, some lobster remains were collected. A fragmentary anterior portion of a decapod crustacean carapace, recovered from a level about 2 m below the Cretaceous–Paleogene (K/Pg) boundary, in a siliceous chalk unit locally referred to as 'opoka', constitutes the oldest record of the thaumastocheliform genus *Dinochelus* Ahyong, Chan and Bouchet, 2010, *D. radwanskii* sp. nov. The other, more complete, individual is from c. 3 m above the K/Pg boundary, coming from marly gaizes or 'siwak'; this is ascribed to a new species of *Hoploparia* M'Coy, 1849, *H. nasilowensis* sp. nov., the first to be recorded from Danian (lower Paleocene) strata. Although both 'opoka' and 'siwak' facies in the Nasiłów area are very rich in diverse biota, including some brachyurans, no macruran remains had so far been recorded from the region.

Key words: Crustaceans; Astacidea; K/Pg boundary; New species; Central Europe.

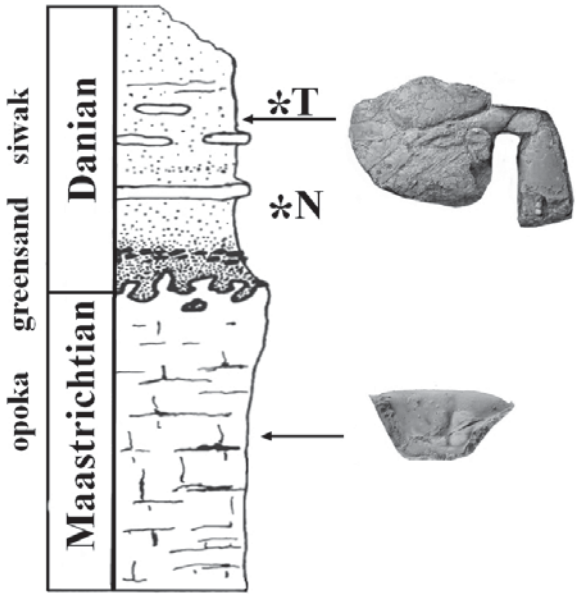
INTRODUCTION

Siliceous chalks ('opoka'), greensand (glauconitic sandstone) and marly gaizes ('siwak') that crop out in the Kazimierz Dolny area (Text-fig. 1) constitute the Upper Cretaceous–lower Paleocene sequence in the Middle Vistula valley (e.g., Marcinowski and Radwański 1983; Machalski and Walaszczyk 1987). The upper part of the 'opoka' yields cephalopod index taxa such as the coleoid *Belemnella* (*Neobelemnella*) gr. *kazimiroviensis* (Skołozdrówna, 1932) and the ammonites *Menuites terminus* (Ward and Kennedy, 1993), *Pachydiscus jacquoti* Seunes, 1890, *Sphenodiscus binckhorsti* Böhm, 1898, *Baculites* spp. and *Hoploscaphites constrictus crassus* (Łopuski, 1911) (see Machalski 2005; Keutgen *et al*. 2017), of late (but not latest) Maastrichtian age.

The top of the 'opoka' at Nasiłów and Bochotnica is characterised by an up to 1-m-thick hardened limestone with a very uneven upper surface. The most characteristic feature of this hardground are clearly visible burrows of the *Thalassinoides* Ehrenberg, 1944 and *Ophiomorpha* Lundgren, 1891 types (Machalski and Walaszczyk 1987; Machalski and Jagt 2018). The



Text-fig. 1. Map showing the locality of Nasiłów along the left bank of the River Vistula (modified after Machalski *et al*. 2003)



Text-fig. 2. Stratigraphic column of the K/Pg boundary section (total height c. 10 m) at Nasiłów (modified after Machalski and Jagt 2018, fig. 1C)), with provenance of the new macruran taxa indicated and levels from which the brachyurans *Titanocarcinus polonicus* Fraaye, 1994 (T) and *Necrocarcinus senonensis* Schlüter in von der Marck and Schlüter, 1868 (N) were recorded by Fraaye (1994)

'greensand', which overlies the hardground, is a c. 0.5-m-thick layer of pale to dark green, marly glauconitic sandstone (Text-fig. 2). The age of this glauconitic unit has been hotly debated. Some authors combined the glauconitic sandstone with the overlying 'siwak' and interpreted it to represent the basal, transgressive unit of a Danian depositional cycle (e.g., Machalski 1998, 2005). Recently, Remin *et al*. (2015) have considered the glauconitic sandstone to be of latest Maastrichtian age, while Świerczewska-Gładysz and Olszewska-Nejbert (2006) recorded two assemblages of sponges from the glauconitic sandstone, all of them being typically Maastrichtian in age (Keutgen *et al*. 2017). The matter has lately been discussed further by Machalski and Jagt (2018), on the basis of an early Danian echinoid assemblage from the greensand.

The greensand is overlain by the so-called 'siwak', composed of gaizes with intercalations of nodular limestone beds (Pożaryska 1952; Pożaryski 1956). Earlier age assignments of the 'siwak' have varied, but the lower part of this unit as exposed at Nasiłów was assigned by Hansen *et al*. (1987) to the dinoflagellate *Senoniasphaera inornata* Subzone within the lower Danian *Danea mutabilis* Zone.

DECAPOD CRUSTACEAN RECORD FROM THE NASIŁÓW AREA

The occurrence of scaphitid ammonite shells with typical predation traces (Radwański 1996; but see also Machalski and Malchyk 2018), considered to be indicative of feeding by swimming crabs (Fraaye 1996), the presence of ichnofossil taxa reflecting burrowing by macruran and/or thalassinoid crustaceans (e.g., Radwański 1985; Machalski 1998) and the fact that a large portion of macrobiota from the hardened 'opoka' are fragmentary, possibly due to the activity of shell-crushing predators and scavengers in a shallow-water, regressive setting (Abdel-Gawad 1986; Radwański 1996), contrast sharply with the poor record of macro-remains of decapod crustaceans in the K/Pg boundary sections of the Middle Vistula valley. From Nasiłow, Fraaye (1994) recorded rare examples of brachyurans such as *Necrocarcinus senonensis* Schlüter in von der Marck and Schlüter, 1868 from about 1 m above the 'opoka'/greensand transition and a poorly preserved specimen of *Titanocarcinus polonicus* Fraaye, 1994 from c. 3.5 metres above this level. Other than those, we do not know of any brachyuran or macruran finds from this locality, with the exception of the specimens described below.

SYSTEMATIC PALAEONTOLOGY

Order Decapoda Latreille, 1802
Infraorder Astacidea Latreille, 1802
Superfamily Nephropoidea Dana, 1852
Family Nephropidae Dana, 1852
Genus *Dinochelus* Ahyong, Chan and Bouchet, 2010

TYPE SPECIES: *Dinochelus ausubeli* Ahyong, Chan and Bouchet, 2010, by original designation.

Dinochelus radwanskii sp. nov.
(Text-figs 3, 4A, B)

DIAGNOSIS: Postcervical groove (pc) extending anteroventrally from dorsomedian at an angle of c. 150º; more strongly anteriorly (c. 160º) as intercervical groove (ic). Branchiocardiac groove (bc) extending to hepatic groove (h) in convex-forward arc. Hepatic groove underlining semi-circular prominence chi (χ). Cervical groove (c) merging smoothly with antennal groove (a). Prominence omega (ω) triangular. Antennal region flat overall, lacking antennal carina and antennal spine. Carapace dorsal surface anterior to cervical groove densely pitted; sparse granules on dorsal surface between postcervical and cervical grooves. Prominent dorsomedian line smooth, without granules or pits.

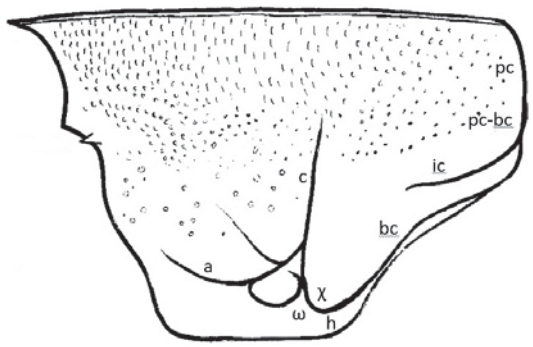
TYPE MATERIAL: Holotype, and sole known specimen, is MAB k.1866, the anterior portion of a carapace (collected early 1990s), contained in the collections of the Oertijdmuseum Boxtel, the Netherlands (formerly Museum de Ammonietenhoeve, Boxtel).

ETYMOLOGY: The specific epithet honours the late Professor Andrzej Radwański, who guided many field trips in the Holy Cross Mountains and the Middle Vistula River valley during the 1980s and 1990s for groups of students and collectors from the Oertijdmuseum (Boxtel, the Netherlands).

LOCALITY AND STRATIGRAPHIC POSITION: Former (now defunct) quarry on the left bank of the River Vistula, Poland, parallel to the small village of Nasiłów; upper portion of 'opoka' facies (upper Maastrichtian), c. 2 m below the K/Pg boundary.

MEASUREMENTS: Maximum length (as preserved) 17 mm, maximum height 9 mm, width of dorsal carapace 12 mm.

DESCRIPTION: Postcervical groove (pc) extending anteroventrally from dorsomedian at an angle of c. 150º; more strongly anteriorly (c. 160º) as intercervical groove (ic). Branchiocardiac groove (bc) extending to hepatic groove (h) in convex-forward arc. Hepatic groove underlining semi-circular prominence chi (χ). Cervical groove well impressed, originating distinctly at level of end of intercervical groove; more vertical than ventral extension of branchiocardiac groove. Cervical groove merging smoothly with antennal groove; latter curving anteroventrally, then slightly anterodorsally. Prominence omega triangular, strongly inflated; apex pointing posterodorsally. Subtle inferior groove underlining prominence omega. Antennal region flat overall, lacking antennal carina but with suggestion of short buccal groove. Antennal spine present. Subtle, subdorsal carina present. Carapace dorsal surface anterior to cervical groove densely pitted; sparse granules on dorsal surface between postcervical and cervical grooves. Prominent dorsomedian line smooth, without granules or pits. Carapace laterally with sparse granules of varying size; smooth ventrally.



Text-fig. 3. *Dinochelus radwanskii* sp. nov., holotype (MAB k.1866); line drawing of left lateral side of carapace; former Nasiłów quarry (collected early 1990s), 'opoka' facies (upper Maastrichtian), c. 2 m below K/Pg boundary. See text for explanations of symbols (line drawing by R.H.B. Fraaije)

REMARKS: Most diagnostic of thaumastocheliforms are: 1) a major (catcher) claw with short, bulbous palm and long, slender fingers with acicular dentition, and 2) short, quadrate pleonal pleura. Unfortunately, these anatomical regions are not preserved on the new specimen. As far as groove pattern and ornamentation are concerned, this specimen is reminiscent of the genus *Thaumastocheles* Wood-Mason, 1874. Most notably, the branchiocardiac (ventral extension) and cervical grooves are not parallel; the specimen lacks an antennal carina, but does have a smooth dorsomedian and pitting dorsally on the cephalic region. Proportions

of the carapace (as preserved) also are suggestive of thaumastocheliforms; these have a relatively large cephalic region (between postcervical groove and rostrum) as compared to the thoracic region (between postcervical groove and posterior margin).

The specimen is referred to *Dinochelus*, rather than to *Oncopareia* Bosquet, 1854, on account of the following features. The branchiocardiac groove (ventral extension) and cervical groove are not parallel (*vs* parallel in *Oncopareia* and *Hoploparia*) and carapace proportions, in particular the inflated cephalic region, are as in *Dinochelus* and extant thaumastocheliforms and unlike the configuration in *Oncopareia* (and *Hoploparia*).

MAB k.1866 shows some similarities to the late Maastrichtian *Jagtia kunradensis* Tshudy and Sorhannus, 2000a from the Kunrade area (southern Limburg, the Netherlands), but differs in having a ventral extension of the branchiocardiac groove that continues to the hepatic groove and in lacking a suprahepatic groove.

Dinochelus radwanskii sp. nov. is the second, and older, extinct member of the genus. It is differentiated from the Early Eocene *D. steeplensis* Tshudy and Saward, 2012 from southern England in having a less granulated carapace (particularly the more ventrally positioned portion), a more prominent and broad smooth dorsomedian line, a subdorsal carina and a more ventrally located cervical/hepatic groove. Bathymetrically, the occurrence of *Dinochelus radwanskii* sp. nov. is consistent with the previously hypothesised retreat of thaumastocheliforms (Tshudy and Sorhannus 2000b) from the inner shelves during the Late Cretaceous (Maastrichtian) to the outer shelves during the Eocene and into deeper waters during the later Cenozoic.

Genus *Hoploparia* M'Coy, 1849

TYPE SPECIES: *Astacus longimanus* Sowerby, 1826, by subsequent designation of Rathbun (1926).

Hoploparia nasilowensis sp. nov.
(Text-fig. 4C)

DIAGNOSIS: *Hoploparia* with combined branchiocardiac/postcervical groove under angle of approximately 145º to dorsomedian, connecting to well-developed hepatic groove. Cervical groove parallel to combined branchiocardiac/postcervical groove. Prominence chi (χ) flat; prominence omega (ω) low. Antennal groove well developed. Carapace granulose posteriorly and, in particular, ventrally. Tergites simple, unornamented, with pits and posteromarginal furrow. Right/crusher claw with manus robustly constructed, width nearly equalling height of carapace.

TYPE MATERIAL: Holotype and sole specimen is MAB k.1498, an incomplete carapace with attached pleon and partially preserved pereiopods (collected early 1990s), contained in the collections of the Oertijdmuseum Boxtel, the Netherlands (formerly Museum de Ammonietenhoeve, Boxtel).

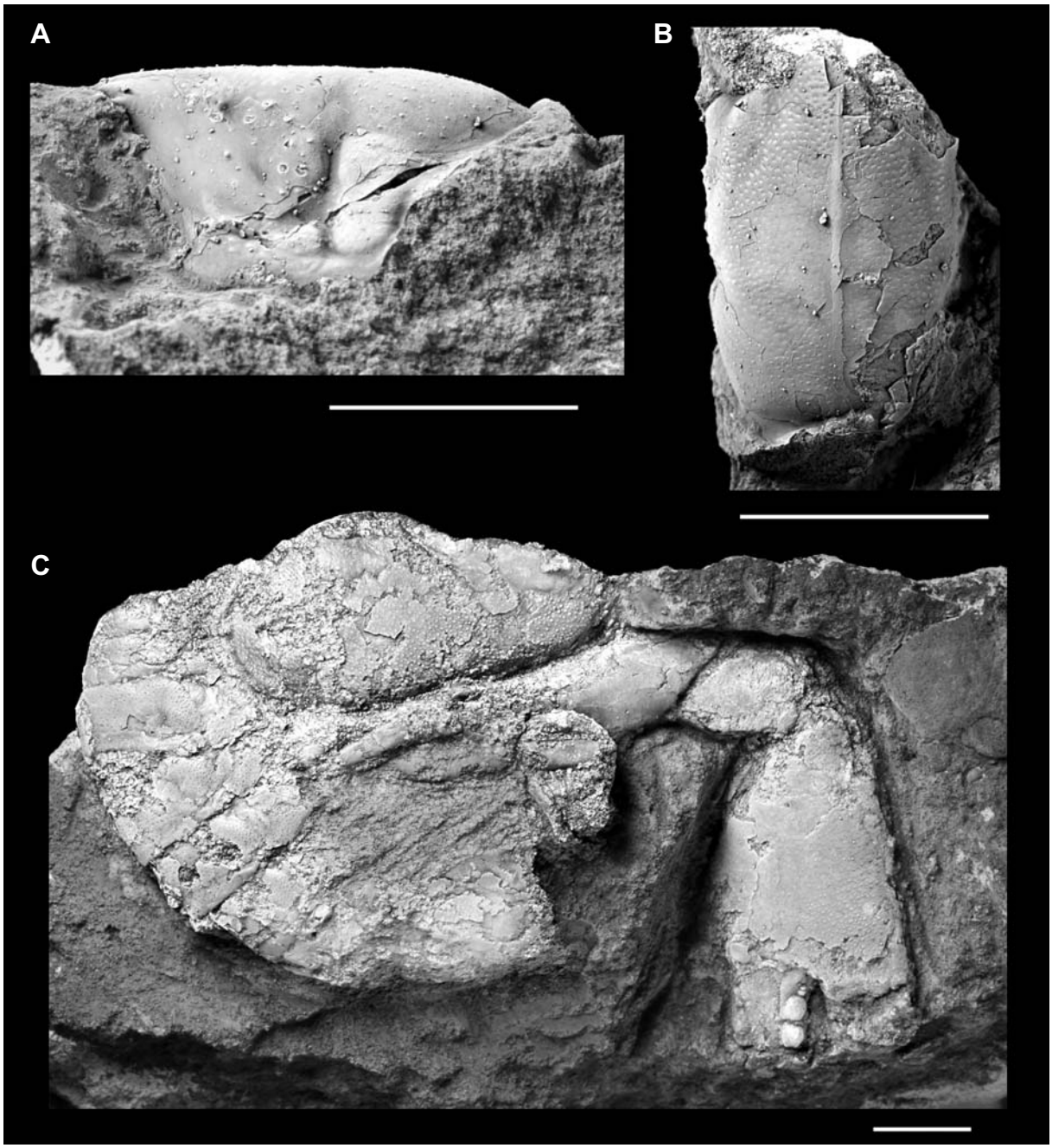
ETYMOLOGY: The specific epithet refers to the village of Nasiłów close to the famous K/Pg outcrop along the River Vistula in Poland.

LOCALITY AND STRATIGRAPHIC POSITION: Former (now defunct) quarry on the left bank of the River Vistula, Poland, parallel to the small village of Nasiłów; lower portion of 'siwak' facies (lower Maastrichtian), c. 3 m above the K/Pg boundary.

MEASUREMENTS: Maximum length of carapace (as preserved) 39 mm, maximum height 20 mm, maximum length of carpus 11 mm, maximum length of palm to base of dactylus 27 mm.

DESCRIPTION: Combined branchiocardiac/postcervical groove under angle of approximately 145º to dorsomedian; nearly straight overall, curving anteroventrally over upper half. Lower half extending more ventrally, connecting to hepatic groove. Cervical groove parallel to combined branchiocardiac/postcervical groove. Hepatic groove well developed, connecting postcervical and cervical grooves in smooth loop. Prominence chi (χ) flat; prominence omega (ω) low. Antennal groove well developed, curving smoothly anteroventrally from cervical groove. Carapace granulose posteriorly (behind combined branchiocardiac/post-cervical groove) and, especially, ventrally. Granulations becoming transversely elongate near posterior margin. Antennal region mostly smooth, with sparse granules. Posteromarginal furrow broad, well developed.

Pleon preserves parts of somites 1–6 and partial telson. Tergites simple, unornamented, with posteromarginal furrow. Tergites smooth, without granules, but with pits. Tergite-pleuron boundary indistinct, marked only by slight elevation on top of pleuron. Surfaces of pleura only slightly convex and without marginal furrows. Pleuron 2 ending in posteriorly directed point. Pleura 3 and 4 chordate, terminate under slight posterior angle.



Text-fig. 4. Lobsters from the former Nasiłów quarry (collected early 1990s). A-B − *Dinochelus radwanskii* sp. nov., holotype (MAB k.1866); left lateral side and dorsal views of carapace, respectively; 'opoka' facies (upper Maastrichtian), c. 2 m below K/Pg boundary (see Text-fig. 2). C − *Hoploparia nasilowensis* sp. nov., holotype (MAB k.1498); right lateral view of incomplete carapace with attached pleon and partially preserved pereiopods; lower portion of 'siwak' facies (lower Danian), c. 3 m above the K/Pg boundary (see Text-fig. 2). Scale bars equal 10 mm

Three or four pereiopods partially preserved. Right P1 (major cheliped) fairly completely preserved, including merus, carpus and propodus. Merus and carpus of shape typical of *Homarus–Hoploparia*. Outer surfaces of merus and carpus nearly smooth, with sparse, very fine granules. Right (crusher) claw with manus robustly constructed, width almost equalling carapace height. Manus subrectangular, narrowest proximally, widening distally. Lower surface of manus convex, more so proximally. Manus granulated

towards margins, especially distally. Propodus strong, proximally with variably sized, molar-like denticles on dactylus, some very large.

REMARKS: Previously, only *Hoploparia longimana* (Sowerby, 1826) and *Hoploparia* cf. *minima* de Tribolet, 1874 have been recorded from Polish territory, from Valanginian (Lower Cretaceous) strata to be precise. The present taxon is the third species of the genus from Poland, and the youngest. Similar to numerous other examples in the literature, MAB k.1498 shows attributes of both *Homarus* Weber, 1795 and *Hoploparia*. The difficulty in assigning species to either *Homarus* or *Hoploparia* is a long-standing problem that has been discussed most recently by Tshudy *et al.* (in press). At present, there is not a single character that can be used on its own to distinguish these genera. Several species of either genus show similarities to those of the other (Tshudy *et al*., in press, appendix 1). We refer the present specimen to *Hoploparia* because it is most readily distinguished from *Homarus* by the ventral extension of the branchiocardiac groove (absent in *Homarus*) and granulation of the exoskeleton (almost entirely absent in *Homarus*). Unfortunately, the carapace part on which an antennal carina and/or spines and supraorbital and subdorsal carinae would be present is missing.

Hoploparia nasilowensis sp. nov. is differentiated from congeners by its unique combination of a *Hoploparia*-like carapace with a plain pleon and a strongly constructed crusher claw.

CONCLUSIONS

The anterior portion of a carapace, from c. 2 m below the K/Pg boundary, in the upper Maastrichtian 'opoka' facies constitutes the oldest record to date of the thaumastocheliform genus *Dinochelus*, *D. radwanskii* sp. nov. The second, more complete nephropoid lobster (carapace with pleon and partially preserved pereiopods), is an individual from c. 3 m above the K/Pg boundary, from marly gaizes or 'siwak'. The latter is assigned to the genus *Hoploparia*, *H. nasilowensis* sp. nov., constituting the first record from Danian (lower Paleocene) strata.

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