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Galicia marianae n. gen., n. sp. (Crustacea, Decapoda, Astacidea) from the Oxfordian (Upper Jurassic) of the Southern Polish Uplands

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Abstract

Galicia marianae n. gen., n. sp. is described from the Middle Oxfordian limestones of the Southern Polish Uplands, in vicinity of Kraców. *Glyphea* (*Glyphea*) *muensteri* (Voltz), together with numerous dromiacean prosopid crabs, are associated with the decapod lobster described in this study. The decapod fauna occupied sponge megafacies, well known from throughout Europe, from Portugal, Spain, France, Germany, Poland and Romania. The decapods prefer inter- and/or peri (or extra)-bioherm environments surrounding the cyanobacteria-sponge bioherms.

Streszczenie

Z utworów wapieni plytowych środkowego oksfordu okolic Krakowa opisano nowy gatunek (należący do nowego rodzaju) dziesięcionogiego homara *Galicia marianae,* oraz gatunek *Glyphea* (*Glyphea*) *muensteri* (Voltz, 1835), znany wcześniej z obszaru Polski centralnej. Zilustrowano również zespól krabów (z rodziny Prosopidae) który dominuje w obrębie malych bioherm wapieni gąbkowych, znajdujących się w obrębie wapieni plytowych tych samych stanowisk (np. dolina Szklarki). Opisana fauna homarów preferowala paleośrodowiska śródbiohermowe lub peryferycznych części bioherm cjanobakteryjno-gąbkowych, szeroko rozprzestrzenionej w Europie oksfordzkiej megafacji gąbkowej znanej w calej Europie (od Portugali, poprzez Hiszpanię, Francję, Niemcy, Polskę aż do Rumunii).

Key words: Crustacea, Decapoda, Astacidea, Upper Jurassic, Poland

Introduction, geological setting and palaeoecological remarks

The fossil record of decapod crustaceans seems to be very poor when compared to that of most other shelled marine invertebrates. This is mainly due to their poor preservation potential (Plotnick, 1986). Decapod crustaceans have a higher chance to be preserved on low-energy bottoms when they are quickly buried and preserved mainly in non-bioturbated sediments (Müller *et al*., 2000).

In the Middle Oxfordian limestones of the Southern Polish Uplands, astacidean decapod crustaceans (glypheoid lobsters and erymids) occur together with numerous dromiacean prosopid crabs (Krobicki, 1994; Krobicki and Müller, 1998a, 1998b; Müller *et al*., 2000).

Material described in this paper comes from the Middle Oxfordian platy limestone distributed in vicinity of Kraków (Southern Poland). The Oxfordian outcrops which yielded the examined decapod crustaceans occur near Krzeszowice city (Fig. 1): Szklary village – Dolina Szlarki valley, Nowa Krystyna – in an abandoned quarry in the

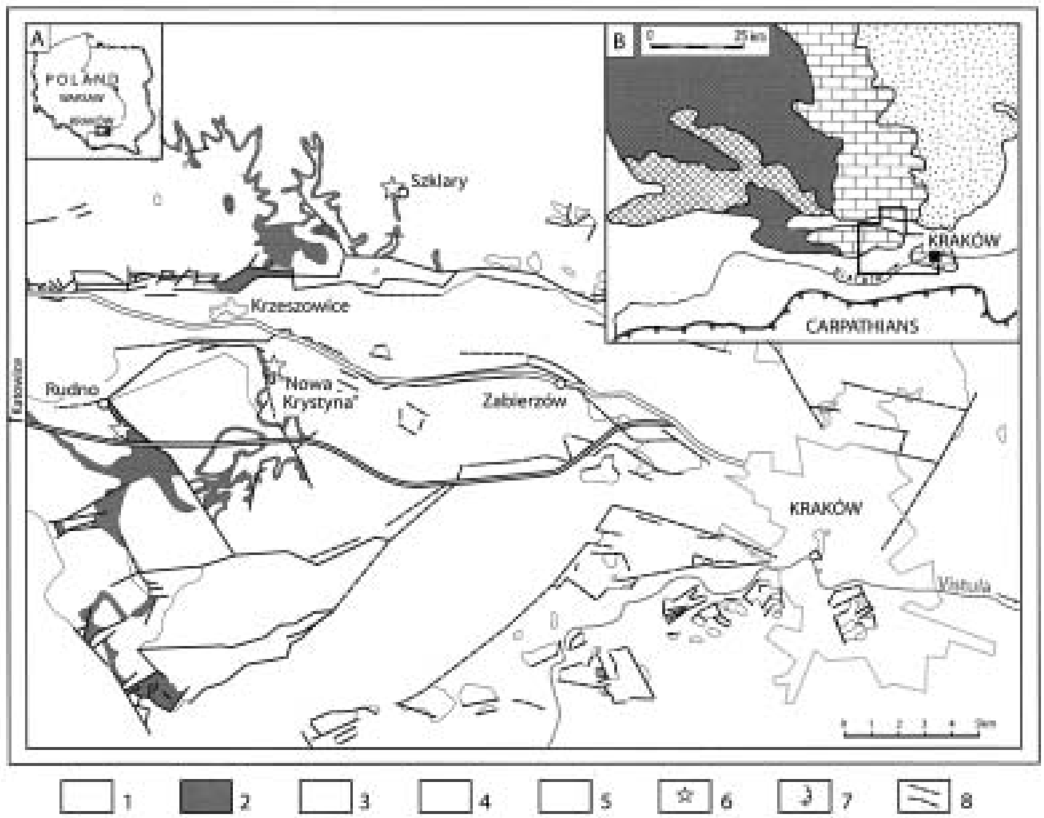

Fig. 1. Location of the Oxfordian outcrops with decapod crustaceans within southem part of Polish Jura. Geological map (afer Gradziński, 1972, simplifIed). 1) pre-Jurassic deposists; 2) Middle Jurassic; 3) Upper Jurassic; 4) Cretaceous; 5) Tertiary; 6) locations with decapod fauna; 7) quarries; 8) faults.

forest south of Krzeszowice, and Rudno village – smal hill near a new highway from Kraków to Katowice that is covered by vegetation now but cropped out during construction of this road.

The Upper Jurassic, Oxfordian carbonates, were sponge megafacies and were wide-spread in Europe during that time. They now crop out from Portugal through Spain, France, Germany and Poland to Romania (Trammer, 1982; Gaillard, 1983; Matyja and Wierzbowski, 1995). The megafacies was formed in a deep-neritic environment parallel to the northern margin of the Tethys (Leinfelder *et al*., 1994).

In the vicinity of Kraków, the Middle Oxfordian strata are developed in two facies (Fig. 2). They begin with (i) well-bedded micritic, platy limestone which contain numerous ammonites, rare benthic fauna (brachiopods, bivalves), and macruran decapod crustaceans. Subsequently, the massive limestones (ii), representing small sponge bioherms (about 2 m high and 3-4 m wide), were developed within these limestone (Figs. 2, 3). Numerous crabs (e.g. *Pithonoton serratum* (von Meyer), *P. insigne* (von Meyer), *Nodoprosopon spinosum* (von Meyer)) have been discovered in these small, loose sponge bioherms (Fig. 4), while isolated glypheoid lobsters (*Glyphea* (*Glyphea*) *muensteri* (Voltz)) exclusively occur within platy limestone surrounding the bioherms (Dolina Szlarki valley – Fig. 3; Müller *et al*., 2000). Similar relations also were recognised in the Polish Jura and the SW margin of the Holy Cross Monutains. At these locations, numerous crab fossils (mainly prosopids) were described from the Middle and Upper Oxfordian (Barczyk, 1961; Collins and Wierzbowski, 1985) where separate findings of the same lobster species also occur within the platy limestone (Förster and Matyja, 1986). In the Upper Oxfordian (Kraków area), the massive facies (ii) dominates volumetrically and interfingers with the next facies (iii) of well-bedded limestone with abundant cherts (Fig. 2). One of the oldest sponge bioherms which occurs within platy limestone, exists in the Dolina Szklarki (Fig. 2). Siliceous sponges formed the cyanobacteria-sponge bioherm structures which are characterised by a rigid framework during bioherm growth (Matyszkiewicz, 1994,

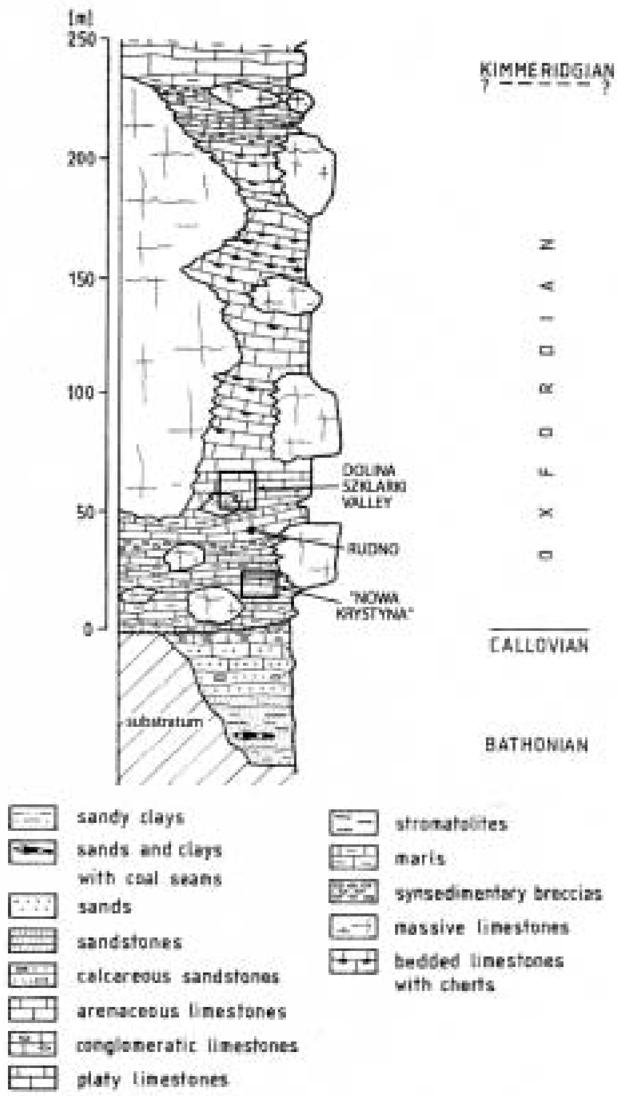

Fig. 2. Geological sequence of the Jurassic strata in the vicinity of Kraków (after Matyszkiewicz, 1994, simplified) with position of described outcrops.

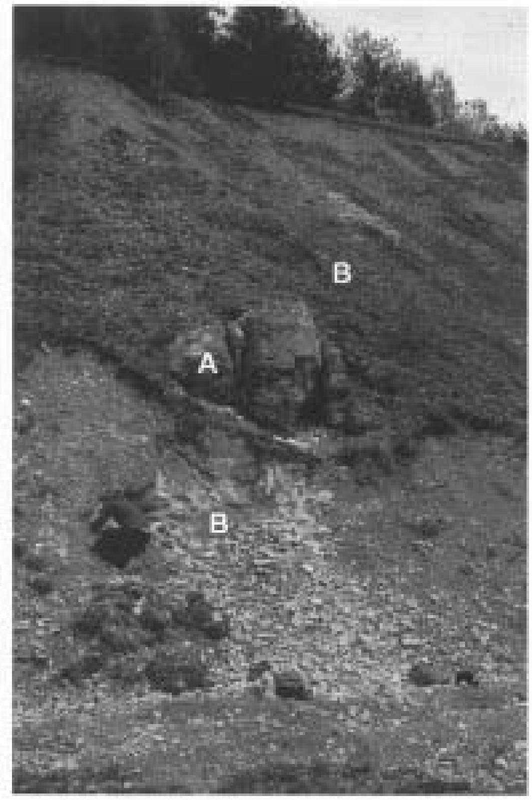

Fig. 3. View of the Dolina Szklarki valley outcrop with good visible small cyanobacteria1-sponge bioherm (A) which occur within platy limestones (B) (geologist for scale).

1997). Numerous crabs have been discovered in the cavities of these framework structures. The crabs are associated with brachiopods (e.g. *Terebratulina substriata* (Schlotheim)), serpulids and rare bivalves.

Intensive burrowing and bioturbation are common within platy limestone (e.g. ichnogenus *Thalassinoides*). Glypheoids and astacids might have created some or even most of these burrows, although none is found within the burrows (Hoffmann and Uchman, 1992; Bromley, 1990). The structures prove that the deeper parts of the sediment were colonized by burrowing animals. The intensive bioturbation of the top layer led to its homogenisation. The lack of an initial lamination also results from bioturbation. Burrowing behaviour is widespread among lobsters (e.g. within the modern genera *Nephrops* Leach and *Homarus* Weber and Cretaceous *Linuparus* White (Pemberton *et al.*, 1984), and numerous crabs (mainly species of *Uca* Leach, *Ocypode* Weber, *Sesarma* Say, *Macrophthalmus* Desmarest, and others (Frey *et al.*, 1984; Dworschak and Rodrigues, 1997). On the other hand, the decapod remains preserved within their burrows are very rare: several species of the lobster *Glyphea* von Meyer (Sellwood, 1971; Bromley and Asgaard, 1972), shrimps of *Callichirus*? (Stilwell *et al.*, 1997), *Cambarus*? Erichson (Hasiotis and Mitchel, 1989), modern species *Axianassa australis* Rodrigues and Shimizu (Dworschak & Rodrigues, 1997), and crabs (e.g. *Longusorbis* Richards, *Antarctidromia* Förster *et al.*) (Richards, 1975; Förster *et al.*, 1987).

The Oxfordian decapod crustaceans belong to two different life-style groups. The first group is represented by strong, mobile, benthic animals (glypheoids and astacids) and the second one (crabs) belongs to reef-symbiotic weak mobile decapods. Small prosopids might

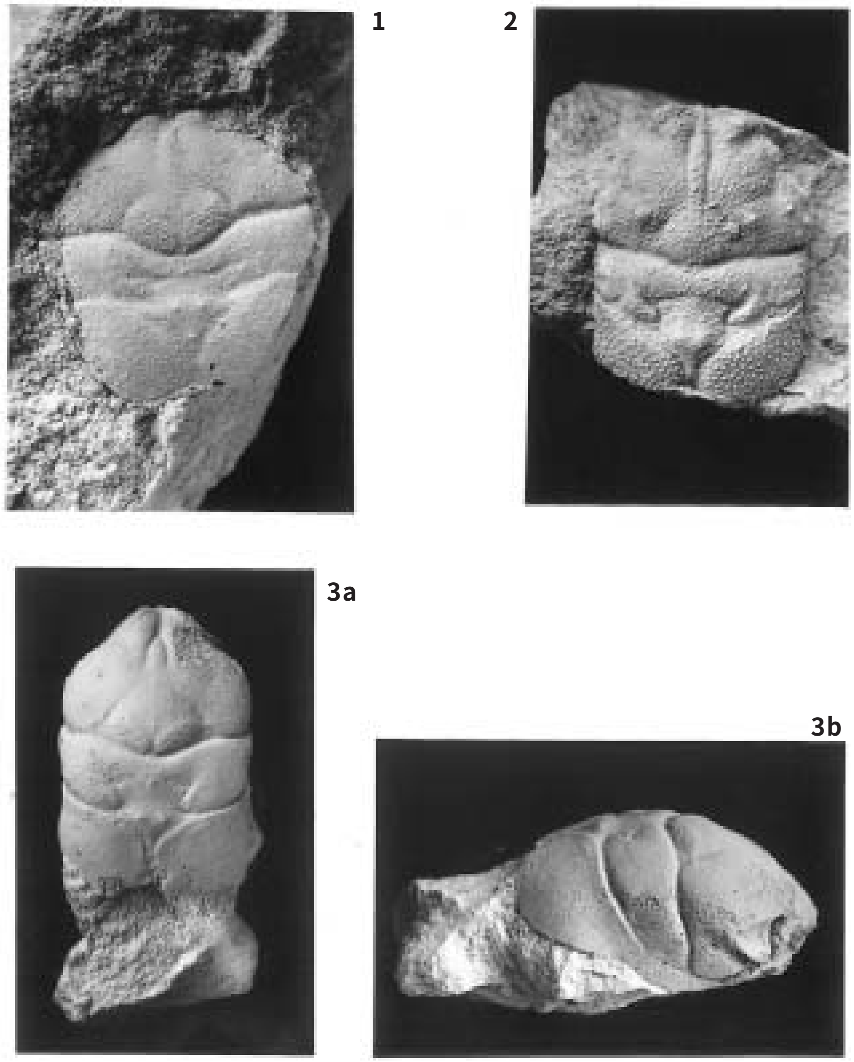

Fig. 4. Selected species of the decapod prosopid fauna derived from the small bioherms of the Dolina Szklarki valley. 1) *Pithonoton serratum* (Beurlen) (carapace length = 8 mm); 2) *Nodoprosopon spinosum* (von Meyer) (carapace length = 10.5 mm); 3) *Pithonoton insigne* (Von Meyer) (3a - dorsal view; 3b - lateral view) (carapace length = 13.5 mm).

have used the small sponge bioherms as hiding places from potential predators, especially during soft-shelled moulting stages and used the reef/bioherm rigid framework structures for their protection (Müller *et al*., 2000). On the contrary, large lobsters, having large appendages and stronger carapaces, could better move on soft carbonate mud in the inter- and /or peri-bioherm environments surrounding the bioherms. They probably produced the *Thalassinoides* burrows in the soft sea-floor.

The depth of water in which the Oxfordian cyanobacteria-sponge bioherm thrived is still matter of discussion (Schorr and Koch, 1985; Wirsing and Koch, 1986; Matyja and Wierzbowski, 1996; Matyszkiewicz, 1997, 1999; Pisera, 1997; Matyszkiewicz *et al*., 2001). The facies of cyanobacteria-sponge bioherms was initially regarded as the sediment on a deeper part of the shelf (D zulyński, 1952). The lack of fauna diagnostic of bathymetry additionally hindered the unequivocal determination of depth during sedimentation of these buildups. The most recent stratigraphic and sedimentologic investigations lead to the conclusion that these carbonate buildups occurred at a depth of a few hundred metres (Gradziński, 1972; Matyja and Wierzbowski, 1996; Matyszkiewicz, 1997, 1999; Pisera, 1997; Matyszkiewicz *et al*., 2001).

Preservation and material

The macruran decapod crustaceans of Kraków vicinity are preserved in platy limestone and exhibit three-dimensional preservation. The hard consistency of the surrounding rock makes their preparation difficult.

The examined sample consists of six specimens: four belong to *Glyphea muensteri* (Voltz, 1835) and two belong to *Galicia marianae* n. gen., n. sp. (family Erymidae Van Straelen, 1924). The samples are deposited in the palaeontological collection of Department of Stratigraphy and Regional Geology of the University of Minig and Metallurgy in Kraków. Since *G. muensteri* (Voltz, 1835), has already been the subject of several papers (Voltz, 1835, Glaessner, 1929, Cardinet, 1942, Martin, 1961, Förster and Matyja, 1986), this species will be not discussed taxonomically in this study.

Systematic Palaeontology

Infraorder Astacidea Latreille, 1802
Family Erymidae Van Straelen, 1924
Genus *Galicia* n. gen.

Type species: *Galicia marianae* n. sp.

Etymology: The trivial name alludes to Galicia Province, historical name of Southern Polish region.

Description: As for the type species.

Diagnosis: Subcylindrical carapace; short rostrum without supra- and subrostral teeth; well developed cervical groove from which gastro-orbital groove arises; postcervical groove joins branchiocardiac groove lower on flank; hepatic groove well developed; well developed inferior groove arises from postcervical groove.

Galicia marianae n. sp.
(Figs. 5-8)

Diagnosis: As for the genus.

Etymology: The trivial name alludes to Marian Lowczowski, donor of the holotype.

Types: The holotype, (KSGR/AGH/K/4), a complete carapace (Fig. 7) from Rudno; and paratype, (KSGR/AGH/K/5), an incomplete specimen (Fig. 8) from the same locality, are deposited in the Department of Stratigraphy and Regional Geology of the Univerisity of Mining and Metallurgy in Kraków.

Measurements: KSGR/AGH/K/4:
Cl (length of carapace) = 4 cm
R (length of rostrum) = 4 mm

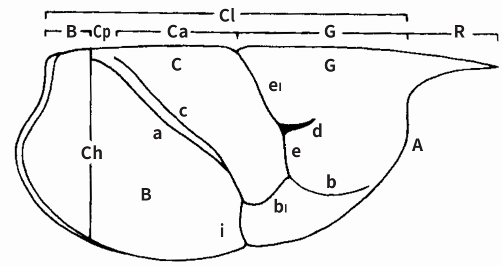

Fig. 5. *Galicia marianae* n. gen., n. sp., carapace with abbreviations. Cl) length of carapace; B) length of dorsal branchial region; Ca) length of anterior cardiac region; G) length of gastric region; R) length of rostrum; Ch) height of carapace; A) antennal region; G) gastric region; C) cardiac region; B) branchial region; a) branchiocardiac groove; c) postcervical groove; e1e) cervical groove; d) gastroorbital groove; b) antennal groove; b1) hepatic groove; i) inferior groove.

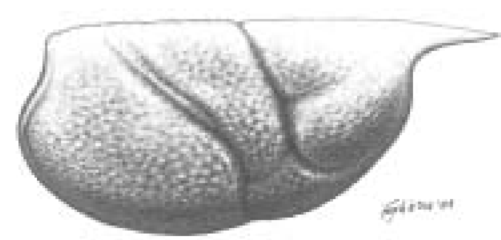

Fig. 6. *Galicia marianae* n. gen., n. sp., carapace reconstruction.

Ch (height of carapace) = 2 cm
G (length of gastric region) = 1.5 cm
Ca (length of anterior cardiac region) = 5 mm
Cp (length of posterior cardiac region) = 2 mm
B (length of dorsal branchial region) = 6 mm

Occurrence: Two specimens collected from Rudno, Oxfordian (Upper Jurassic).

Description: Carapace subcylindrical in lateral view with ventral margin rising slightly in anterior third. Short triangular rostrum, without supra- and subrostral teeth. Cervical groove deep, curving slightly anteroventrally at rounded junction with antennal groove. Well developed branchiocardiac groove extends parallel to cervical groove, curving slightly anteroventrally at rounded junction with inferior groove. Short, reduced postcervical groove, displaced forward and joining branchiocardiac groove lower on flank. Gastro-orbital groove shallow and narrow, arises from medium part of cervical groove. Well developed hepatic groove, joining branchiocardiac groove to cervical groove. Carapace with dorsal suture. Gastric and branchial regions wide; cardiac region narrow. Dorsal midline of carapace without intercalated plate. Carapace surface with small tubercles. Abdomen incomplete. Only somites V and VI are preserved. Somite V subtriangular; somite VI subrectangular. Dorsal surface of somites with small tubercles. Telson subrectangular with rounded distal extremity. Uropods without ornamentation and incomplete. Cephalic, thoracic and abdominal appendages not preserved.

Discussion: Many fossil families belong to infraorder Astacidea Latreille, 1802, known from Lower Triassic (Feldmann *et al*., 2002): Astacidae Latreille, 1803, Cambaridae Erichson, 1846, Chilephoberidae Thudy and Babcock, 1997, Chimaerastacidae Amati *et al*., in press, Cricoidoscelosidae Taylor *et al*., 1999, Erymidae Van Straelen, 1925, Mecochiridae Van Straelen, 1925, Nephropidae Dana, 1852, Palaeopalaemonidae Brooks, 1962, Parastacidae Huxley, 1878, Platychelidae Glaessner, 1969, Pemphicidae Van Straelen, 1928, Protoastacidae Alberecht, 1983 and Glypheidae Zittel, 1885. At present, following the classification by Feldmann *et al*. (2002), the infraorder Astacidea Latreille, 1802 includes three families (Mecochiridae, Pemphicidae and Glypheidae) ascribed to the infraorder Palinura Latreille, 1803 by Glaessner (1969). Among the families of the infraorder Astacidea only the family Erymidae exhibits some morphological characters, such as subcylindrical carapace with deep cervical groove, weak gastro-orbital groove, branchiocardiac and postcervical grooves almost parallel, short rostrum and flat abdomen with triangular somites. These traits are also observable also in *Galicia* and for this reason can be ascribed to this family.

The family Erymidae Van Straelen, 1924 is known from Lower Triassic to Upper Cretaceous and contains nine genera: *Clytiella* Glaessner, 1931 from the Carnian (Upper Triassic) of Austria; *Clytiopsis* Bill, 1914 from the Scythian (Lower Triassic) of Europe; *Enoploclytia* McCoy, 1849 from the Carnian (Upper Triassic) to the Paleocene? and the Eocene? of Europe, Africa, Antarctic Penisula, Unites States, Canada, South America, Australia and Madagascar; *Eryma* von Meyer, 1840 from the Sinemurian (Lower Jurassic) to the Cenomanian (Upper Cretaceous) of Europe, Africa, Iran, Madagascar, Lebanon, Antarctic Peninsula, Canada, United States and South America; *Olinaecaris* Van Straelen, 1924 from the Bajocian (Middle Jurassic) of France; *Palaeastacus* Bell, 1850 from the Aalenian (Middle Jurassic) to the Cenomanian (Upper Cretaceous) of Europe, Antarctic Peninsula, United States, South America and Australia; *Paraclytiopsis* Oravec, 1962 from the Carnian (Upper Triassic) of Hungary; *Phlyctisoma* Bell, 1863 from the Sinemurian (Lower Jurassic) to the Campanian-Maastrichtian (Upper Cretaceous) of Europe, Madagascar

Fig. 7. *Galicia marianae* n. gen., n. sp., holotype, KSGR/AGH/K/4, (×2.5).

Fig. 8. *Galicia marianae* n. gen., n. sp., paratype, KSGR/AGH/K/5, (×1.5)

and Canada; *Protoclytiopsis* Birstein, 1958 from the Permotrias of Russia (Feldmann *et al*., 2002; Garassino, 1996).

Among these species, only *Eryma*, *Olinaecaris*, *Palaeastacus* and *Phlyctisoma* dated to Jurassic, are comparable with the new genus. *Eryma* and *Phlyctisoma* distinguish from *Galicia* for the different course of cervical and branchiocardiac grooves, running parallel without meet like as in the new genus. The bad state of preservation of *Palaeastacus* and *Olinaecaris* do not allow a comparison with *Galicia*. On the basis of these considerations, we justify the institution of *Galicia* because the junction between postcervical and branchiocardiac grooves can be observed only in this genus, within the family Erymidae. In fact, in all the above mentioned genera, the postcervical and branchiocardiac grooves extend parallel one another and do not meet.

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References

Albrecht, H. (1983), Die Protoastacidae n.fam., fossile Vorfahren der Flußkrebse?. *Neues Jahrbuch für Geologie, und Paläontogie Mitteilungen*, Stuttgart, **1983**(1), 5-15.

Amati, L., R. M. Feldmann, and J. P. Zonneveld (in press), A new family of Triassic lobsters (Decapoda: Astacidea) from British Columbia and cladistic analysis of the infraoders Astacidea and Palinura. *Journal of Paleontology*.

Barczyk, W. (1961), Le Jurassique de Sulejów. *Acta Geologica Polonica*, **11**, 3-102.

Bell, Th. (1850), Notes on the Crustacea of the Chalk Formation. *In* F. Dixon, *The Geology and fossils of the Tertiary and Cretaceous Formations of Sussex*. London.

Bell, Th. (1863), A monograph of the fossil malacostracous Crustacea of Great Britain. Part II. Crustacea of the Gault and Greensand. *Palaeontological Society,* **14**, 1-40.

Bill, Ph. C. (1914), Ueber Crustaceen aus dem Voltziensandstein des Elsasses. *Besonderer Abdruck aus den Mitteilungen der Geologischen Landesanstalt von Elsaß-Lothringen,* **8**, 289-338.

Birsthein, J. A. (1958), Ein Vertreter der ältesten Ordo der Crustacea Decapoda *Protoclitiopsis antiqua* gen. nov. sp. nov. aus dem Permo West-Sibiriens. *Doklady Akademie Nauk SSSR*, **122**, 477-480.

Bromley, R. G. (1990), *Trace fossils: Biology and Taphonomy*. Unwin Hyman, London.

Bromley, R. G. and U. Asgaard (1972), The burrows and microcoprolites of *Glyphea rosenkrantzi*, a lower Jurassic palinuran crustacean from Jameson Land, East Greenland. *Geological Survey of Greenland Report*, **49**, 15-21.

Brooks, H. K. (1962), The Paleozoic Eumalacostraca of North America. *Bulletin of American Paleontology*, **44**, 163-338.

Cardinet, J. (1942), Note sur des restes de Crustacés fossiles du Jurassique supérieur de Jauze (Sarthe). *Bulletin de la Société Linnéenne de Normandie*, Sér. 9, **2**, 151-152.

Collins, J. S. H. and A. Wierzbowski (1985), Crabs from the Oxfordian sponge megafacies of Poland. *Acta Geologica Polonica*, **35**, 73-88.

Dana, J. D. (1852), Crustacea. *Unites States exploring expedition during the years 1838, 1839, 1840, 1841, 1842 under the command of Charles Wilkes, U.S.N.*, **13**, 1-1620.

Dworschak, P. C. and S. A. Rodrigues (1997), A modern analogue for the trace fossil *Gyrolithes:* burrows of the thalassinidean shrimp *Axianassa australis. Lethaia*, **30**, 41-52.

Dżulyński, S. (1952), The origin of the Upper Jurassic limestones in the Cracow area. *Rocznik Polskiego Towarzystwa Geologicznego*, **21**, 125-180 (In Polish, English summary).

Erichson, W. F. (1846), Uebersicht der Arten der Gattung *Astacus. Archiv für Naturgeschichte*, **12**(1), 86-103.

Feldmann, R. M., G. Crisp, and D. Pirrie (2002), A new species of glypheoid lobster *Pseudoglyphea foersteri* (Decapoda: Astacidea: Mecochiridae) from the Lower Jurassic (Pliensbachian) of Raasay, Inner Hebrides, UK. *Palaeontology*, **45**(1), 23-32.

Förster, R. and B. A. Matyja (1986), Glypheoid lobsters, *Glyphea* (*Glyphea*) *muensteri* (Voltz), from the Oxfordian deposists of the Central Polish Uplands. *Acta Geologica Polonica*, **36**(4), 317-324.

Förster, R., A. Gaždzicki, and R. Wrona (1987), Homolodromiid crabs from the Cape Mellville Formation (Lower Miocene) of King George Island, West Antarctica. *Palaeontologia Polonica*, **49**, 147-161.

Frey, R. W., A. Curry, and S. G. Pemberton (1984), Tracemaking activities of crabs and their environmental significance: the ichnogenus *Psilonichnus. Journal of Paleontology*, **58**, 333-350.

Gaillard, C. (1983), Les biohermes àspongiaires et leur environment dans l'Oxfordien du Jura meridional. *Documentation de Laboratoire de Géologie de Lyon*, **90**, 1-515.

Garassino, A. (1996), The family Erymidae Van Straelen, 1924 and the superfamily Glypheoidea Zittel, 1885 in the Sinemurian of Osteno in Lombardy (Crustacea, Decapoda). *Atti Società italiana di Scienze naturali e Museo civico di Storia Naturale di Milano*, **135**(2), 333-373.

Glaessner, M. F. (1929), Crustacea decapoda. *Fossilium Catalogus*, **41**, 1-464.

Glaessner, M. F. (1931), Eine Crustaceefauna aus dem Lunzer Schichten Niederösterreichs. *Abhandlungen der Geologischen Bundesanstalt*, **81**, 467-486.

Glaessner, M. F. (1969), Crustacea Decapoda. *In* R. C., Moore (ed.), *Treatise on Invertebrate Paleontology. Arthropoda* 4, R399-R533, R626. Geological Society of America and University of Kansas Press, Lawrence.

Gradziński, R. (1972), Przewodnik geologiczny po okolicach Krakowa. *Wydawnictwa Geologiczne.* (In Polish only).

Hasiotis, S. T. and C. E. Mitchell (1989), Lungfish burrows in the Upper Triassic Chinle and Dolores formations, Colorado Plateau – discussion: new evidence suggests origin by a burrowing decapod crustacean. *Journal of Sedimentary Petrology*, **59**, 871-875.

Hoffmann, M. and A. Uchman (1992), Trace fossils in the Oxfordian platy limestones in the vicinity of Cracow. (In Polish, English summary). *Przeglad Geologiczny*, **11**, 651-656.

Huxley, T. H. (1879), On the classification and the distribution of the crayfishes. *Proceedings of Zoological Society of London*, **1878**, 752-788.

Krobicki, M. (1994), Decapod Crustacea in the Oxfordian limestones in the vicinity of Cracow. *In*: 3th International Meeting of IGCP N°43, Excursion Guidebook, **52**.

Krobicki, M. and P. Müller (1998a), Jurassic primitive crabs (Prosopidae) – their palaeoecology and biogeography. *In 4th International Crustacean Congress, Proceedings and Abstracts, Amsterdam*, 76-77.

Krobicki, M. and P. Müller (1998b), Palaeoecology and biogeography of Jurassic primitive crabs (Brachyura, Prosopidae). *In 5th International Symposium on the Jurassic System, Abstracts and Program, Vancouver*, 50-51.

Latreille, P. A. (1802-1803), *Histoire naturelle génerale et particuliére, des crustacés et des insectes*. F. Dufart (Paris), **3**, 1-468.

Leinfelder, R. R., M. Laternser, R. Nose, M. Schmid, D. U. Schweigert, G. Werner, W. Keupp, H. Brugger, H. Hermann, R. Rehfeld-Kiefer, U. Schroeder, J. H. Reinhol, C. Koch, R. Zeiss, A. Schweizer, V. Christmann, H. Menges, and G. Luterbacher (1994), The origin of Jurassic reefs: current research developments and results. *Facies*, **31**, 1-56.

Martin, G. (1961), Les Crustacés décapodes du terrain à chailles du Jura franc-comtois. *Annales Scientifique de la Université de Besançon, Sér. 2 (Géol.)*, **14**, 43-71.

Matyja, B. A. and A. Wierzbowski (1995), Biogeographic differentiation of the Oxfordian and early Kimmeridgian ammonite faunas of Europe, and its stratigraphic consequences. *Acta Geologica Polonica*, **45**, 1-8.

Matyja, B. A. and A. Wierzbowski (1996), Sea-bottom relief and bathymetry of Late Jurassic sponge megafacies in Central Poland. *In* A. C. Riccardi (ed.), *Advances in Jurassic Research. GeoResearch Forum, 1-2, 333-340.*

Matyszkiewicz, J. (1994), Remarks on the deposition and diagenesis of pseudonodular limestones in the Cracow area (Oxfordian, southern Poland). *Berliner Geowissenschaftliche Abhandlungen,* **E13**, 419-439.

Matyszkiewicz, J. (1997), Microfacies, sedimentation and some aspects of diagenesis of Uper Jurassic sediments from the elevated part of the Northern peri-Tethyan Shelf: a comparative study on the Lochen area (Schwäbische Alb) and the Cracow area (Cracow-Wielu Upland, Poland). *Berliner Geowissenschaftliche Abhandlungen,* **E21**, 1-111.

Matyszkiewicz, J. (1999), Sea-bottom relief versus differential compaction in ancient platform carbonates: a critical reassessment of an example from Upper Jurassic of the Cracow-Wielu Upland. *Annales Societatis Geologorum Poloniae*, **69**, 63-79.

Matyszkiewicz, J., A. Gadomska, and E. Porebska (2001), Upper Jurassic carbonate buildups from the ogrodzieniec area. *Kwartalnik agh Geologia,* **27**(2-4), 219-241 (In Polish, English summary).

McCoy, F. (1849), On the classification of some British fossil Crustacea with notices of new forms in the University Collection at Cambridge. *Annals* and *Magazine of Natural History, ser. 2*, **4**, 161-179; 330-335.

Meyer, H. von (1840), *Neue gattungen Fossiler Krebse aus gebilden vom bunten sandstein bis die kreide*. Stuttgart.

Müller, P., M. Krobicki, and G. Wehner (2000), Jurassic and Cretaceous primitive crabs of the family Prosopidae (Decapoda: Brachyura) – their taxonomy, ecology and biogeography. *Annales Societatis Geologorum Poloniae,* **70**, 49-79.

Pemberton, S. G., R. W. Frey, and R. G. Walker (1984), Probable lobster burrows in the *Cardium* Formation (Upper Cretaceous) of southern Alberta, Canada, and comments on modern burrowing decapods. *Journal of Paleontology,* **58**, 1422-1435.

Pisera, A. (1997), Upper Jurassic siliceous sponges from the Swabian Alb: taxonomy and palaeoecology. *Palaeontologica Polonica,* **57**, 3-216.

Plotnick, R. E. (1986), Taphonomy of a modern shrimp: implications for the arthropod fossil record. *Palaios,* **1**, 286-293.

Oravec, J. (1962), Új Rákleleta a hazai triászból, *Földtani Közlöny,* **92**(3), 324-329.

Richards, B. C. (1975), *Longusorbis cuniculosus:* A new genus and species of Upper Cretaceous crab; with comments on Spray Formation at Shelter Point, Vancouver Island, British *Columbia. Canadian Journal of Earth Sciences,* **12**, 1850-1863.

Schorr, M., and R. Koch (1985), Fazieszonierung eines oberjurassischen Algen-Schwamm-Bioherme (Herrlingen, Schwäbische Alb). *Facies,* **13**, 227-270.

Sellwood, B. W. (1971), A *Thalassinoides* burrow containing the crustacean *Glyphea udressieri* (Meyer) from the Bathonian of Oxfordshire. *Palaeontology*, **14**, 589-591.

Stilwell, J. D., R. H. Levy, R. M. Feldmann, and D. M. Harwood (1997), On the rare occurence of Eocene callianassid decapods (Arthropoda) preserved in their burrows, mount Discovery, east Antarctica. *Journal of Paleontology,* **71**, 284-287.

Taylor, R. S., F. R. Schram, and Y. B. Shen (1999), A new crayfish Family (Decapoda: Astacidea) from the Upper Jurassic of China, with a reinterpretation of other Chinese crayfish taxa. *Paleontological Research,* **3**(2), 121-136.

Trammer, J. (1982), Lower to Middle Oxfordian sponges of the Polish Jura. *Acta Geologica Polonica,* **32**(1-2), 1-39.

Tshudy, D. M. and L. E. Babcock (1997), Morphology-based phylogenetic analysis of the clawed lobsters (family Nephropidae and the new family Chilenophoberidae). *Journal of Crustacean Biology,* **17**(2), 253-263.

Van Straelen, V. (1925), Contribution a l'étude des crustacés décapodes de la période Jurassique. *Mémoires de la Académie Royale de Belgique, Sér. II*, **7**, 1-462.

Van Straelen, V. (1928), Sur les Crustacés Décapodes Triasiques et sur l'Origine d'un Phylum de Brachyoures. *Bulletin du Musée royal d'Histoire naturelle de Belgique,* **14**, 496-516.

Voltz, A. (1835), *Palinurus Münsteri. Neues Jahrbuch für Geognosie, Geologie und Peterfakten-Kunde Mineralogie,* **1835**, 62.

Wirsing, G. and R. Koch (1986), Algen-Schwamm-Bioherme des Flachwasser-Bereiches (Schäbische Alb. Weissjura Delta 3). *Facies,* **14**, 285-308.

Zittel, K. A. von (1885), Handbuch der Paläontologie, **2**(2), 525-721.

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