



Bayerische  
Staatssammlung  
für Paläontologie und Geologie

- Zitteliana A 54, 83 – 90
- München, 31.12.2014
  
- Manuscript received  
30.06.2014; revision  
accepted 24.07.2014
  
- ISSN 1612 - 412X

## A new caridean shrimp (Crustacea: Decapoda: Dendrobranchiata) from the Upper Jurassic Solnhofen Lithographic Limestones of Schernfeld (South Germany)

Norbert Winkler

*D-14532 Stahnsdorf, Germany*

*E-Mail: norbert\_winkler@t-online.de*

### Abstract

A new genus and species of caridean shrimps, *Occultocaris frattigianii* nov. gen. et sp., is described from the Upper Jurassic Solnhofen Lithographic Limestones of Schernfeld near Eichstätt (Lower Tithonian, Hybonotum Zone). It differs from other genera of carideans primarily in the armature of the rostrum in combination with the shape of the chelae of the first and second pereopods.

**Key Words:** Caridea, Solnhofen Lithographic Limestones, Tithonian.

### Zusammenfassung

Eine neue Gattung und Art von Garnelen aus der Unterordnung Caridea, *Occultocaris frattigianii* nov. gen. nov. sp., wird aus den oberjurassischen Solnhofener Plattenkalken von Schernfeld bei Eichstätt beschrieben (Unter-Tithonium, Hybonotum-Zone). Sie unterscheidet sich von anderen Gattungen der Caridea in erster Linie in der Bezeichnung des Rostrums in Kombination mit der Gestalt der Scheren der ersten und zweiten Pereiopoden.

**Schlüsselwörter:** Caridea, Solnhofener Plattenkalke, Tithonium

## 1. Introduction

The decapod infraorder Caridea Dana, 1852 is comprised of 3438 extant species in 389 genera (De Grave & Fransen 2011). Moreover, 52 fossil species of carideans are listed in 33 genera (Schweitzer et al. 2010). The Upper Jurassic lithographic limestones of the region of Eichstätt represent an important source of well preserved fossil assemblages. Besides vertebrates, invertebrates as well as plants are preserved in the limestones; however, apart from mass occurrences of the planktonic crinoid *Saccocoma tenella* these limestones are relatively poor in fossils. Among the invertebrates, natantian shrimps play an important role (Röper et al. 2000). Within the natantians, the carideans are very diverse. Among them, only the well-known *Hefriga serrata* Münster, 1839 appears to be quite frequent (Schweigert & Garassino 2003). In addition to this long since known fossil caridean, several other taxa from this area have recently been added, including *Schmelingia wulfi* Schweigert, 2002, *Buergerocaris psittacoides* Schweigert & Garassino, 2004, *Udora koschnyi*

Schweigert & Garassino, 2004, *Pleopteryx kuempeli* Schweigert & Garassino, 2004, *Harthofia blumenbergi* Polz, 2007, *Harthofia bergeri* Polz, 2007, *Alcmonacaris winkleri* Polz, 2008, *Hefriga rogerfrattigianii* Schweigert, 2011, *Hefriga norbertwinkleri* Schweigert, 2011, *Harthofia polzi* Schweigert, 2011, and *Schernfeldia schweigerti* Winkler, 2013 (Münster 1839; Schweigert 2002; Schweigert & Garassino 2004; Polz 2007, 2008; Schweigert 2011; Winkler 2013). Most of these new genera or species are very rare or known only from single specimens. The bulk of the decapod fossils are represented by exuviae in various stages of decay (Schweigert 2011). This paper describes a new natantian genus based on several exquisitely preserved fossils.

## 2. Material and methods

The description is based on 12 specimens: S1 Holotype (CL 11.0, TL 52.8, L Schernfeld); S2 Paratype (CL 8.5, TL 40.5, L Wintershof); S3 (CL 10.0, L Schernfeld, coll. Winkler, Stahnsdorf); S4 (CL 6.5,

L Schernfeld, coll. Winkler, Stahnsdorf); S5 (CL 9.0, L Schernfeld, coll. Winkler, Stahnsdorf); S6 (CL not to scale, L Schernfeld, coll. Winkler, Stahnsdorf); S7 (CL 11.5, L Birkhof, coll. Frattigiani, Laichingen); S8 (CL 6.5, TL 33.0, L Eichstätt, coll. Frattigiani, Laichingen); S9 (CL 10.0, L Eichstätt, coll. Resch, Eichstätt); S10 (CL 11.5, L unknown, coll. Felthaus, Vlotho); S11 (CL 10.5, L unknown, coll. Felthaus, Vlotho); S12 (CL 11.5, L Schernfeld, coll. Winkler, Stahnsdorf).

The total length of the specimens range between 29.9 mm (S4) and 53.0 mm (S10). The holotype comes from the Upper Jurassic Solnhofen Lithographic Limestones (Eichstätt Formation; Lower Tithonian, Hybonotum Zone) in southern Germany. The specimen occurs on a limestone slab that is 9 mm thick. Specimen preparation was carried out with a vibrograph and various needles and scrapers. Because the sclerotisation of the exoskeleton of crustaceans preserved in lithographic limestone brightly fluoresces, fluorescence was used in the analysis of the fossil. In this way even the most delicate features, which otherwise would not or only barely be discernible, could be observed and adequately documented photographically. For the documentation of the holotype specimen, a macro-fluorescence set up was used (Haug et al. 2011). Digital images were taken with a Canon Rebel T3i camera with a MP-E 65mm macro lens. Light was provided by three evenly distributed LED torches, each equipped with a cyan filter. A red filter was mounted onto the lens. With this, mainly the light emitted from the fossil (roughly of orange colour) was detected by the camera. Processing of images followed Haug & Haug (2011); only the red channel is informative (other channels originate from scattered light), the image is then desaturated and the histogram optimised. Several images were stitched together using the Photomerge function of Adobe Photoshop CS3 to produce a high-resolution image. The paratype and S4 were documented on a Keyence BZ-9000 fluorescence microscope. A 2x objective was used, resulting in a magnification of approximately 20x. An excitation wavelength of 543 nm (green) was used. To overcome the limited depth of field a stack of images was recorded and fused into a single sharp image. Several of these images (of different image details) were stitched to yield a high-resolution image (e.g., Haug et al. 2008, 2009, 2011).

#### Abbreviations:

S1-S12 = specimen 1-12  
CL = carapace length (approximately), measured in mm from the level of the posterior margin of the orbit to the midpoint of the posterodorsal margin of the carapace

TL = total body length, measured in mm from the tip of the rostrum to the end of the telson  
L = locality  
PI-PV = pereopods I-V  
SMNS = Staatliches Museum für Naturkunde Stuttgart, Germany  
coll. = collection

### 3. Systematic palaeontology

Diagnostic characters of the Caridea: The classification of Caridea follows McLaughlin (1980) and is largely based on extant taxa. All members of Caridea exhibit the following complement of external features: (1) the second pleonal pleura overlap the pleura of both the first and third pleomeres; (2) the first two pairs of pereopods chelate (except in Procarididae); (3) pereopods III, IV and V achelate; (4) the rostrum is extremely variable in both length and armature; (5) antennular peduncle with three articles; (6) a telson bearing several small movable spines. Mouthpart morphology is usually difficult to assess in fossil shrimps and prawns from the Solnhofen Limestones due to the mostly lateral embedding of fossils.

The classification to the superfamily Bresilioidea predicates on the key to Recent Superfamilies of Caridea, which is based largely on the form of the anterior pairs of pereopods (Chace & Manning 1972; modified from Holthuis 1955). However, Martin & Davis (2001) regard the superfamily Bresilioidea as an admittedly artificial taxon.

Order Decapoda Latreille, 1803  
Infraorder Caridea Dana, 1852  
Superfamily ?Bresilioidea, Calman, 1896  
Family uncertain

Genus *Occultocaris* nov. gen.

Type species: *Occultocaris frattigianii* nov. sp.

Etymology: The genus name is a combination of the Latin *occultus* (= hidden) and the Greek *caris* (= shrimp), and refers to the first and second pereopods that are hardly discernible in most specimens.

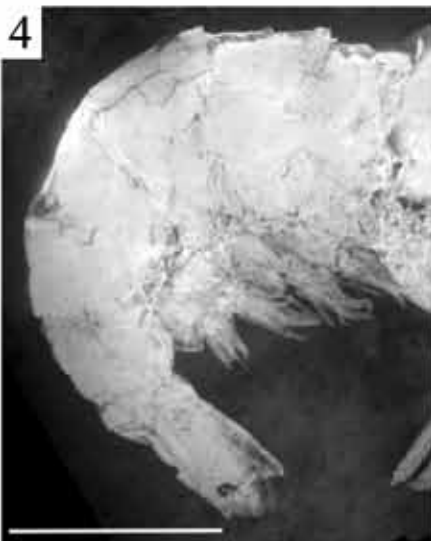
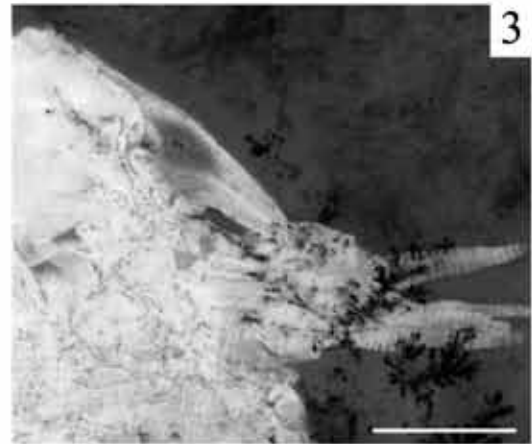
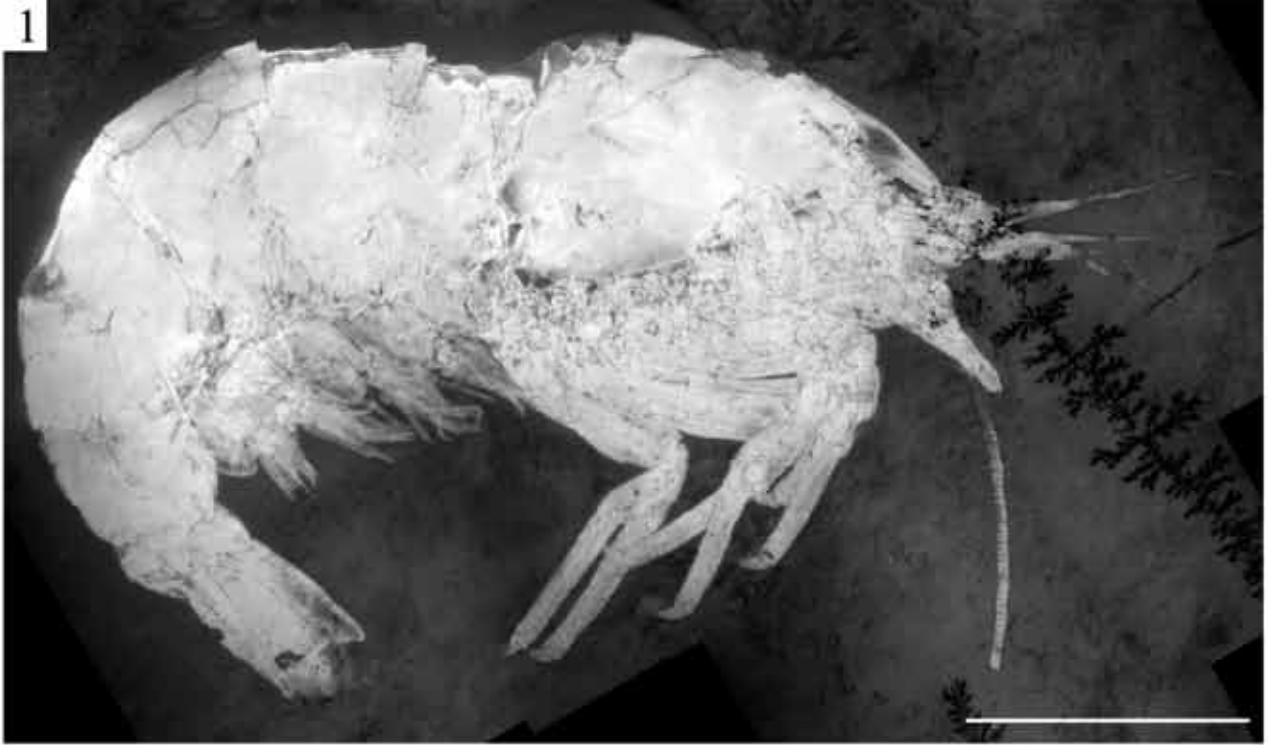
Diagnosis: See diagnosis of the type species.

Included species: Monospecific.

*Occultocaris frattigianii* nov. sp.  
PIs 1, 2

Holotype: Specimen illustrated in Pl. 1, Fig. 1, de-

**Plate 1:** *Occultocaris frattigianii* nov. gen. nov. sp. Quarry district of Eichstätt (Schernfeld); Solnhofen Lithographic Limestones (Upper Eichstätt Formation), Lower Tithonian, Hybonotum Zone. Holotype, SMNS 70224/1 and S3. (1) Overview of holotype specimen under fluorescence; scale bar = 10 mm. (2) Overview of holotype specimen; scale bar = 10 mm. (3) Rostrum and antennal scale of holotype specimen under fluorescence; scale bar = 3 mm. (4) Pleomere and telson of holotype specimen under fluorescence; scale bar = 10 mm. (5) Overview of specimen 3; scale bar = 10 mm.



posited in the SMNS, accession number 70224/1 (ex coll. N. Winkler).

Paratype: Specimen illustrated in Pl. 2, Fig. 1, deposited in the SMNS, accession number 70224/2 (ex coll. R. Frattigiani).

Etymology: The epithet is proposed for Mr. Roger Frattigiani, who kindly donated the paratype of the type species and first recognised the peculiarity of the specimen.

Gender: Feminine.

Type locality: Vicinity of Eichstätt (Schernfeld); S Franconia, Bavaria, southern Germany.

Type horizon and age: Solnhofen Group, Upper Eichstätt Formation (after Zeiss 1977), Lower Tithonian, Hybonotum Zone.

Studied material: 12 specimens.

Diagnosis: Slender caridean with inconspicuously punctate carapace and pleon; rostrum forwardly directed, dorsal and ventral margins unarmed; PI-PII chelate; PI slightly shorter than PII; PI chelae broader than PII chelae.

Description (based on the holotype specimen unless otherwise indicated): The holotype of *Occultocaris frattigianii* (Pl. 1, Fig. 1) is an excellently preserved moult embedded in lateral view; body well-sclerotised, curved; surface of body inconspicuously equipped with shallow punctations (Pl. 1, Fig. 2). For measurements, refer to Table 1.

Rostrum of holotype specimen directed forwardly, slightly curved ventrally with a pointed distal extremity (Pl. 1, Fig. 3), reaching distal margin of first article of antennular peduncle in S2; (Pl. 2, Fig. 1), not reaching the end of the antennal scale; dorsal and ventral margins unarmed, with lateral rostral carina extending to the tip of the rostrum; rostrum of juveniles unarmed and slightly curved ventrally, too (S8).

Carapace 0.8 times wider than long, subrectangular in outline, grooves not recognizable, ventral margin bent; with antennal spine directed forwardly in lateral view (S4) (Pl. 2, Fig. 4); no epigastric tooth; orbital margin evenly rounded, somewhat narrow (S7).

Pleon rounded dorsally, in lateral view pleomeres subrectangular in outline, third pleomere slightly longer than the others, sixth pleomere with posterior lobes partially embracing base of telson; pleura of all

**Table 1:** Measurements of the holotype specimen of *Occultocaris frattigianii* nov. gen. et sp.; l = left, r = right

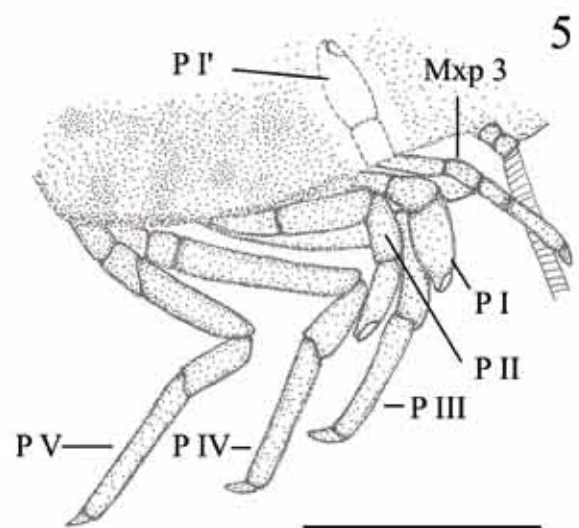
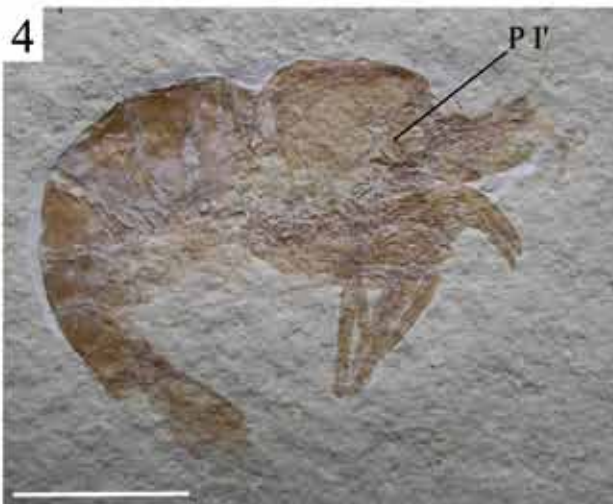
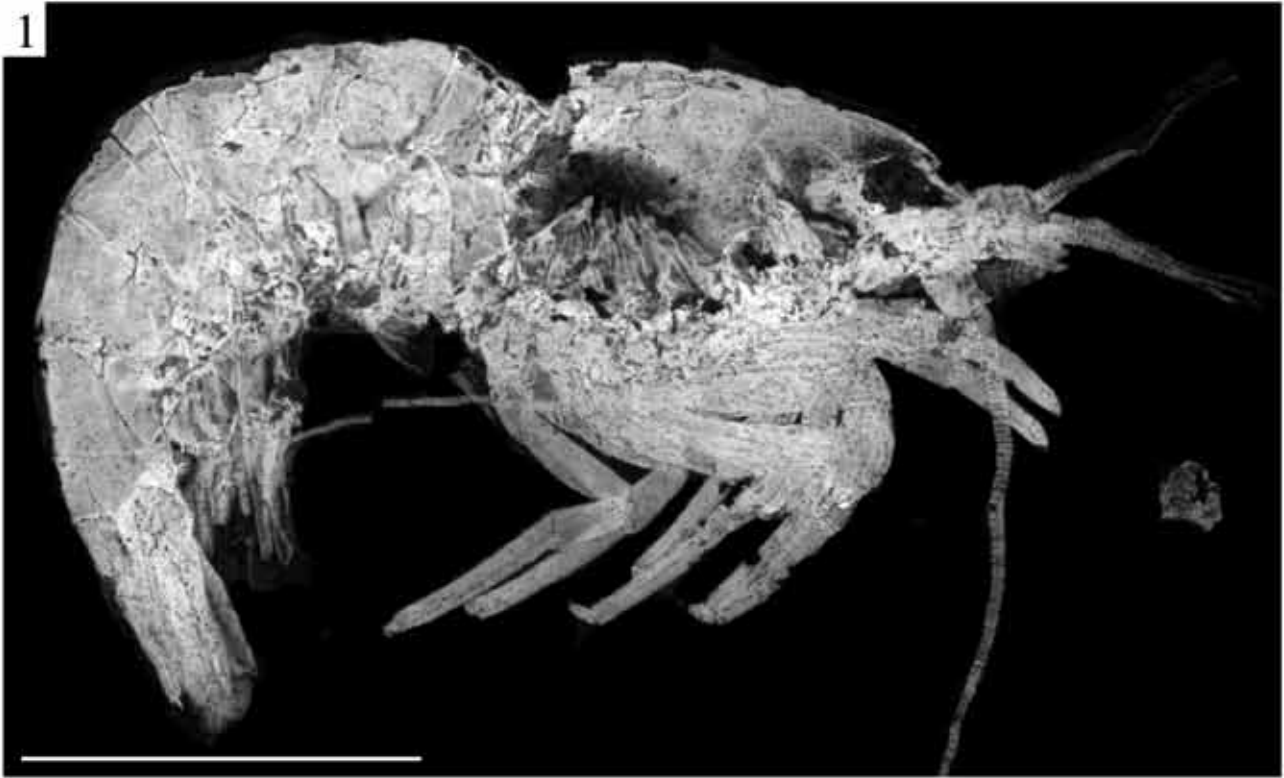
<i>Occultocaris frattigianii</i> (holotype)	Measurements (in mm)
Carapace width	8.7
Rostrum length	5.8
Antennular peduncle, total length	1.9
Antennal peduncle, total length	2.5
Antennal scale	3.0
Mxp3, total length	7.9
P I propodus (incl. fixed finger)	3.3
P II propodus (incl. fixed finger)	3.0
P II carpus	1.7
P II merus	3.0
P II ischium	1.0
P III dactylus (r)	1.0
P III propodus (r)	4.6
P III carpus (r), approximately	2.0
P III merus (r), approximately	4.8
P III ischium (r)	1.7
P IV dactylus (l) and (r)	1.0
P IV propodus (r)	5.4
P IV carpus (r)	2.3
P IV merus (r)	6.9
P IV ischium (r)	1.1
P V dactylus (l) and (r)	1.0
P V propodus (l) and (r)	5.5
P V carpus (l) and (r)	2.8
P V merus (l)	3.9
P V ischium (l)	1.0
P III - V, width approximately	0.9
Pleomere 1	3.4
Pleomere 2	5.8
Pleomere 3	7.1
Pleomere 4	5.0
Pleomere 5	4.6
Pleomere 6	4.6
Uropods	8.1
Telson	7.4

pleomeres broadly rounded, overlapping protopods of pleopods; pleura of the second pleomere partly overlapping those of pleomeres I and III, ventral margin of pleura smooth (Pl. 1, Fig. 4).

Telson not reaching posterior margin of uropodal endopod, distinctly narrowed posteriorly, somewhat

**Plate 2:** *Occultocaris frattigianii* nov. gen. nov. sp. Quarry district of Eichstätt (Schernfeld); Solnhofen Lithographic Limestones (Upper Eichstätt Formation), Lower Tithonian, Hybonotum Zone. Paratype, SMNS 70224/2 and S4. **(1)** Overview of paratype specimen under fluorescence; scale bar = 11 mm. **(2)** Overview of paratype specimen; scale bar = 11 mm. **(3)** Pereiopods I-V of paratype specimen under fluorescence; scale bar = 9 mm. **(4)** Overview of specimen 4; P = pereopod; scale bar = 6 mm. **(5)** Line-drawing of pereiopods I-V and third maxilliped, reconstruction after holotype specimen and paratype specimen; P = pereopod; Mxp3 = third maxilliped; scale bar = ~8 mm.





longer than the sixth pleomere, length 1.9 times anterior width, armed with at least one spine (Pl. 1, Fig. 4). Eyestalk remarkably short (S3) (Pl. 1, Fig. 5).

Antennular peduncle not reaching distal margin of antennal scale (S2, S4); surface smooth, basal article longest, ultimate and penultimate articles approximately of same length, all with equal width (S5, S9); superior lateral flagellum preserved up to 7.8 mm, superior mesial flagellum somewhat shorter than lateral flagellum, preserved up to 5.6 mm; proximal portions of antennular flagella considerably increasing in width.

Antenna with ischiocerite, merocerite, and carapocerite (third, fourth, and fifth articles of antennular peduncle) approximately of same length, surface smooth; antennal scale lanceolate, with a pointed distal extremity, somewhat longer than distal end of ultimate article of antennular peduncle (S2); flagella, as far as visible, preserved up to 21.0 mm (S2 23.0 mm, completely preserved), 0.6 of body length (S2).

Mandible, maxillula, maxilliped 1, and maxilliped 2 not preserved; third maxilliped overreaching antennal scale in lateral view, dactylus 0.35 of propodus length (S2, S4), propodus distinctly longer than carpus (S2, S4), carpus and merus approximately of same length, ischium somewhat longer (S4), all articles without setae or spines (Pl. 2, Fig. 2; Pl. 2, Fig. 4).

PI broader and slightly shorter than PII; PI approximately 0.9 of PII length (S2); PI ischium, merus and carpus not visible, PI chelate; propodus with palm stout, movable and fixed finger short and strong, of approximately the same length, 0.24 of palm length (S2) (Pl. 2, Fig. 3); PII merus longest, PII chelate, propodus with palm slender than palm of PI, shape of fingers resemble those of PI, PII fingers 0.25 of palm length (Pl. 1, Fig. 1); all specimens at least with one chela of PI and/or PII turned up (e.g., S4, S5, S6, S7, S9, S12) due to taphonomic circumstances (Pl. 2, Fig. 4); PIII-PV achelate and generally similar in length and structure, dactyli short, all articles unarmed with exception of PIV merus, PIV slightly longest of all pereopods due to elongation of merus (Pl. 2, Fig. 5), PIV merus with a few short spines, hardly discernible because of preservation.

Pleopods well preserved, biramous; protopods approximately as long as exopods, appendix interna or appendix masculina not visible (Pl. 1, Fig. 4).

Uropods with distinct protopod ending in a sharp point; uropodal endopod as long as exopod, lacking teeth; uropodal exopodites with diaeresis (Pl. 1, Fig. 4).

#### 4. Comparisons

The number of rostral teeth is of great importance in the discrimination of the different genera and species of Caridea (Holthuis 1951), but additional characters may also be significant for the identification of new fossils (e.g., von Rintelen & Cai 2009).

A comparison of the new form described in this paper with other fossil caridean genera (based on the original descriptions) shows that: (1) Besides *O. frattigianii* the following genera of fossil carideans possess a completely unarmed rostrum: *Udora koschnyi* Schweigert & Garassino, 2004 (Schweigert & Garassino 2004), and *Schmelingia wulfi* Schweigert, 2002 (Schweigert 2002) from the Upper Jurassic, as well as *Bannikovia maikopensis* Garassino & Teruzzi, 1996 (Garassino & Teruzzi 1996) from the Lower Miocene, and *Yongjicaris zhejiangensis* Garassino et al., 2002 (Garassino et al. 2002) from the Lower Cretaceous, as well as *Morscrangon acutus* Garassino & Jakobsen, 2005 (Garassino & Jakobsen 2005) from the Lower Eocene. However, all these taxa clearly differ from *O. frattigianii* in the shape of the pereopods. The shape and the armature of the rostrum of *O. frattigianii* is of great consistency since juveniles show the same rostrum-features as the adults; (2) The first pereopods of *O. frattigianii* are equipped with broad chelae and the first pereopod is slightly shorter than the second. A similar combination of features does not occur in any other fossil caridean; (3) *O. frattigianii* superficially resembles the Late Jurassic *Hefriga serrata* Münster, 1839 (Münster 1839), the type species of the genus *Hefriga*. However, there are several morphological details that discriminate *O. frattigianii* from *Hefriga*. Firstly, *O. frattigianii* differs from *H. serrata* in the armature of the rostrum (*H. serrata* with about 10 dorsal teeth). Secondly, the surface of the carapace and pleon of *H. serrata* show a delicate pattern of subparallel striae, whereas the surface of *O. frattigianii* shows inconspicuous shallow punctations. Thirdly, the shape of the chelae of PI and PII is distinctly different from those of *H. serrata*; (4) *O. frattigianii* differs from all other fossil carideans [i.e. *Pleopteryx kuempeli* Schweigert & Garassino, 2004, *Buergerocaris psittacoides* Schweigert & Garassino, 2004 (Schweigert & Garassino 2004), *Alcmonacaris winkleri* Polz, 2008 (Polz 2008), *Schernfeldia schweigerti* Winkler, 2013 (Winkler 2013), and the representatives of *Harthofia* Polz, 2007 (Polz 2007; Schweigert 2011)] in the armature and the shape of the rostrum, as well as in the shape of the pereopods.

*Occultocaris frattigianii* exhibits several morphological details that clearly distinguish this taxon from all earlier described fossil caridean genera, and we propose therefore a new genus and species to include the specimens with their unique combination of characters. Although the new genus *Occultocaris* has well-defined special characters, it is impossible to assign it to a family or superfamily with certainty. According to Chace & Manning (1972), however, it may be possible to assign this new taxon to the superfamily Bresilioidea Calman, 1896 because of the fact that the first pereopods are stouter and slightly shorter than the second pereopods.

## 5. Palaeoecology and taphonomy of *Occultocaris frattigianii*

The strong and broad chelae strongly suggest that *O. frattigianii* was a predator or scavenger (Schweigert & Garassino 2004). The rather long antennae probably was equipped with a variety of different receptors in order to detect and recognise nearby objects (Raabe & Raabe 2008). The co-occurrence of various ontogenetic stages of a single palaeobiospecies (here: *O. frattigianii*) may be a result of autochthonous lifestyle, or at least to a habitat in close proximity to the burial place (Schweigert 2007). Six of twelve specimens included in this study come from Schernfeld, four others from nearby localities. Very recently an additional specimen was discovered from Schernfeld (coll. Hoffmann, Spalt). The relative frequency of this taxon in a small area in the northern vicinity of Eichstätt corroborates the hypothesis that the place of burial was not far away from the original habitat of this shrimp (Schweigert 2007). Moreover, *O. frattigianii* probably was not rare in the palaeoecosystem, but has not been recognised previously because it occurs together with other superficially similar taxa, and the first and second pereopods, which are the most important distinguishing character, are not normally discernible.

The taphonomic circumstances that caused the typical preservational state of the *O. frattigianii* specimens are comparable to those of many eryonids. Whereas at least one chela of *O. frattigianii*'s PI and/or PII is turned up, the pereopods I of many eryonids are pointing backward. This was caused by the heavy chelae, which usually hang down from the drifting exuvia, became caught in the seafloor first (Schweigert 2007).

## Acknowledgements

My sincere thanks go to Dr. G. Schweigert (Stuttgart) for his enriching comments. I also sincerely thank Dr. C. Haug (Munich) and Dr. J. T. Haug (Munich) for providing excellent images and a detailed report. I am much obliged to A. Winkler (Stahnsdorf) for useful advice and skilful preparation of fossils, as well as for a detailed line-drawing, and to J. Winkler (Stahnsdorf) for compiling the two plates. I am indebted to the reviewer, Dr. A. Garassino (Milan), for insightful comments and suggestions, and to Dr. M. Krings (Munich) for proofreading the manuscript. Furthermore, my thanks are due to R. Frattigiani (Laichingen) for providing the paratype and two additional specimens, and U. Resch (Eichstätt) and Dr. A. Felthaus (Mlotho) for providing additional material for this study.

## 6. References

- Chace FA, Manning RB. 1972. Two new caridean shrimps, one representing a new family, from marine pools on Ascension Island (Crustacea: Decapoda: Natantia). *Smithsonian Contributions to Zoology* 131, 1–18.
- De Grave S, Fransen CHJM. 2011. *Carideorum Catalogus: The recent species of the Dendrobranchiate, Stenopodidean, Procarididean and caridean shrimps* (Crustacea: Decapoda). *Zoologische Mededelingen* 85, 195–589.
- Garassino A, Teruzzi G. 1996. The genera *Longitergite* nov. and *Bannikovia* nov. in the Lower Miocene of N Caucasus (Russia) (Crustacea, Decapoda). *Atti della Società italiana di Scienze naturali et del Museo civico di Storia naturale di Milano* 136, 3–14.
- Garassino A, Jakobsen S. 2005. *Morscrangon acutus* n.gen. n.sp. (Crustacea, Decapoda, Caridea) from the Fur Formation (Early Eocene) of the Islands of Mors and Fur (Denmark). *Atti della Società italiana di Scienze naturali e del Museo civico di Storia naturale in Milano* 146, 95–107.
- Garassino A, Shen Y, Schram FR, Taylor RS. 2002. *Yongjicaris zhejiangensis* n. gen. n. sp. (Crustacea, Decapoda, Caridea) from the Lower Cretaceous of Zhejiang Province, China. *Bulletin of the Mizunami Fossil Museum* 29, 73–80.
- Haug JT, Haug C. 2011. Fossilien unter langwelligem Licht: Grün-Orange-Fluoreszenz an makroskopischen Objekten. *Archaeopteryx* 29, 20–23.
- Haug JT, Haug C, Ehrlich M. 2008. First fossil stomatopod larva (Arthropoda: Crustacea) and a new way of documenting Solnhofen fossils (Upper Jurassic, Southern Germany). *Palaeodiversity* 1, 103–109.
- Haug C, Haug JT, Waloszek D, Maas A, Frattigiani R, Liebau S. 2009. New methods to document fossils from lithographic limestones of southern Germany and Lebanon. *Palaeontologica Electronica* 12(3), 12 6T.
- Haug JT, Haug C, Kutschera V, Mayer G, Maas A, Liebau S, Castellani C, Wolfram U, Clarkson ENK, Waloszek D. 2011. Autofluorescence imaging, an excellent tool for comparative morphology. *Journal of Microscopy* 244, 259–272.
- Holthuis LB. 1951. A general revision of the Palaemonidae (Crustacea, Decapoda, Natantia) of the Americas. I – The subfamilies Euryrhynchinae and Potoniinae. *Occasional Papers of the Allan Hancock Foundation* 11, 1–322.
- Holthuis LB. 1955. The recent genera of the Caridean and Stenopodidean shrimps (Class Crustacea, Order Decapoda, Supersection Natantia) with keys for their determination. *Zoologische Verhandelingen Uitgegeven door het Rijksmuseum van Natuurlijke Historie te Leiden* 26, 1–15.
- Martin JW, Davis GE. 2001. An updated classification of the Recent Crustacea. *Natural History Museum of Los Angeles County, Science Series* 39, 1–124.
- McLaughlin PA. 1980. *Comparative morphology of recent crustacean, part I Crustacea – Anatomy*. San Francisco, CA, W.H. Freeman and Company, 175 pp.
- Münster G. Graf zu 1839. *Decapoda Macroura*. *Abbildung und Beschreibung der fossilen langschwänzigen Krebse in den Kalkschiefern von Bayern. Beiträge zur Petrefacten-Kunde* 2, 1–88.
- Polz H. 2007. Die Garnelengattung *Harthofia* g. nov. (Crustacea: Pleocyemata: Caridea) mit zwei neuen Arten aus den Solnhofener Plattenkalken von Eichstätt. *Archaeopteryx* 25, 1–13.
- Polz H. 2008. *Alcmonacaris winkleri* g. nov. sp. nov. (Crustacea: Decapoda: Pleocyemata: Caridea) aus den Solnhofener Plattenkalken von Eichstätt. *Archaeopteryx* 26, 1–9.
- Raabe C, Raabe L. 2008. *Caridean Shrimp Glossary of Anatomical Terminology*. Mactan Island, The Philippines. Available online at <http://www.chucksaddiction.com/shrimpanatomy.html> [last accessed June 03, 2014]
- Rintelen K von, Cai Y. 2009. Radiation of endemic species flocks in ancient lakes: Systematic revision of the freshwater shrimp *Caridina* H. Milne Edwards, 1837 (Crustacea: Decapoda: Atyidae) from the ancient lakes of Sulawesi, Indonesia, with the description of eight new species. *The Raffles Bulletin of*

- Zoology 57, 343–452.
- Röper M, Rothgaenger M, Rothgaenger K. 2000. Die Plattenkalke von Schernfeld. Eichendorf, Eichendorf, 128 pp.
- Schweigert G. 2002. Zwei neue Garnelen (Decapoda: Dendrobranchiata, Eukyphida) aus oberjurassischen Plattenkalen Süddeutschlands. Stuttgarter Beiträge zur Naturkunde, Serie B 323, 1–11.
- Schweigert G. 2007. Preservation of decapod crustaceans in the Upper Jurassic lithographic limestones of southern Germany. In: A Garassino, RM Feldmann, G Teruzzi (Eds), 3rd Symposium on Mesozoic and Cenozoic decapod crustaceans, Milano, May 23–25, 2007. Memorie della Società italiana di Scienze naturali e del Museo civico di Storia naturale di Milano 35, 87–90.
- Schweigert G. 2011. The decapod crustaceans of the Upper Jurassic Solnhofen Limestones: A historical review and some recent discoveries. Neues Jahrbuch für Geologie und Paläontologie, Abhandlungen 260, 131–140.
- Schweigert G, Garassino A. 2003. New studies of decapod crustaceans from the Upper Jurassic lithographic limestones of southern Germany. Contributions to Zoology 72, 173–179.
- Schweigert G, Garassino A. 2004. New genera and species of shrimps (Crustacea: Decapoda: Dendrobranchiata, Caridea) from the Upper Jurassic lithographic limestones of S Germany. Stuttgarter Beiträge zur Naturkunde, Serie B 350, 1–33.
- Schweitzer CE, Feldmann RM, Garassino A, Karasawa H, Schweigert G. 2010. Systematic list of fossil decapod crustacean species. Crustaceana Monographs 10, 1–222.
- Winkler N. 2013. A new genus and species of caridean shrimps from the Upper Jurassic Solnhofen Lithographic Limestones of Schernfeld (S Germany). Zitteliana A 53, 77–83.
- Zeiss A. 1977. Jurassic stratigraphy of Franconia. Stuttgarter Beiträge zur Naturkunde, Serie B 31, 1–32.
-