Online ISSN 2435-0931 Print ISSN 0385-0900
DOI: 10.50897/bmfm48.0_43

Bulletin of the Mizunami Fossil Museum, no. 48, 43–76, 14 figs, 2 tables.

Manuscript accepted on July 3, 2021; online published on August 20, 2021
http://zoobank.org/urn:lsid:zoobank.org:pub:10992F6D-77A0-4068-9F95-7F05D2D427BA

The marine arthropods from the Solnhofen Lithographic Limestones (Late Jurassic, Germany) in the collection of the Museo di Storia Naturale of the University of Pavia, Italy

Paolo Guaschi[1)], Giuseppe Santi[2)], and Alessandro Garassino[3)]

1) "Kosmos" Museo di Storia Naturale dell'Università di Pavia, P.zza Botta 9/10, 27100 Pavia, Italy
<paolo.guaschi@unipv.it>

2) Dipartimento di Scienze della Terra e dell'Ambiente, Università degli Studi di Pavia, Via Ferrata 1, 27100 Pavia, Italy
<giuseppe.santi@unipv.it>

3) Research Adjunct, Department of Earth and Biological Sciences, Loma Linda University, Loma Linda, CA 92350, USA; Department of Paleontology, North Carolina Museum of Natural Sciences, Raleigh, NC 27601, USA
<alegarassino@gmail.com>

Abstract

The palaeontological collections of the Museo di Storia Naturale of the University of Pavia, Italy, house marine arthropods from the Solnhofen Lithographic Limestones (Late Jurassic, Germany). These arthropods include decapod crustaceans and limulids. A commented systematic list is proposed in order to give to the specialists an instrument of comparison and reference.

Key words: Crustacea, Decapoda, Late Jurassic, Kimmeridgian, Germany, palaeontological collection

1. Short history of the Museo di Storia Naturale of the University of Pavia and its collections

The Museo di Storia Naturale of the University of Pavia (MSNPV), recently encompassed within the "Kosmos" museum in Pavia, has an ancient origin and a prestigious history. Indeed, it was founded in 1771 by Lazzaro Spallanzani (1729–1799) (Fig. 1A). In 1769, the scientist had received the tenure in natural history of the same University, which had been profoundly renovated and reformed during those years by the Austrian government of Lombardy through the influence of the Empress Maria Teresa of Austria. Spallanzani was a true pioneer in natural history and conducted numerous in-depth studies on different topics, for example on the spontaneous generation of organisms, on reproduction, on the circulatory system and on the digestive tract, using very rigorous scientific experimental techniques (Rostand, 1963).

In parallel with his laboratory activity, this scientist organized thirteen large excursions on geological-morphological and naturalistic topics, and published detailed accounts of each (Milani, 1999). Throughout his scientific career, Spallanzani never forgot to enrich the Museum that he had founded, and it became pivotal to the understanding and divulgation of the science of natural history. The "mineral kingdom" was present in the Museum since its foundation composed of a first nucleus of seven crates of minerals. This section with its presence of rocks, fossils and minerals "...*abbracciava la mineralogia e la geologia* (embraced both mineralogy and geology)" (Anonimo, 1873; Pieroni and Guaschi, 2018). Among the ancient collection of fossils, 65 slates of fossilized fish from

the Eocene of Monte Bolca (Verona) were acquired by Spallanzani in 1782. These slates are identified by handwritten original labels prepared by Giovanni Serafino Volta, the museum's custodian and author of the first publication in the world devoted to fossil ichthyology: 123 species have been described and represented graphically, many of which for the first time in scientific history (Fig. 2A, B) (Volta, 1789).

Another collection that was present during Spallanzani's time was that belonging to Quaternary mammals, among which human fossils were also found (Pavesi, 1901). The latter were highly criticized by Georges Cuvier, who examined them during his stay in Pavia (Ciardi, 2000). Cuvier believed that humans were a recent product of Divine creation and used to deny that fossilized human bones could be found (Ciardi, 2000). After Spallanzani's death, the natural history tenure and its museum were held by Giuseppe Mangili (1799–1817) and by Gian Maria Zendrini (1819–1852). The latter is considered to be, after Spallanzani, the second founder of the "Gabinetto di Geologia", for his dynamism and his great energy in widening the knowledge of the different areas of natural history. Indeed, among many other fossils ten large slates of fish from Bolca were acquired as well as "... *pezzi splendidi di Belgioioso, Spessa, Portalbera, Arena e Casteggio di* Elephas meridionalis and Rhinoceros incisicus (wonderful specimens from Belgioioso, Spessa, Portalbera, Arena, and Casteggio of *Elephas meridionalis* and *Rhinoceros incisicus*)" (Terenzio, 1867). Over time and under the direction of Giuseppe Balsamo Crivelli, from 1852 to 1874, the acquisitions for the Museum continued. In particular, Crivelli unified the collections of bryozoa, myriapods and fossils, acquiring numerous mammals among which there were a giraffe, a giant anteater, birds, and reptiles. He was professor of minerology and zoology and in 1862 he became professor of geology and held the course of comparative anatomy (1863). Among his many accomplishments, the first geological description of Italy and in 1850 the compilation of a geological atlas of Italy complete with tables dedicated to the single geological area, can be attributed to him. The prior Antonio Stoppani (1824–1891) (Fig. 1B) worked alongside with Crivelli, was nominated extraordinary professor, and in 1861 he received the tenure in geology (Brambilla et al., 2007). Stoppani is universally considered to be the founder of Italian geology and palaeontology. He taught geology at the University of Pavia, taught at the Polytecnic University of Milan and was a founder of the Museo Civico di Scienze e Filosofia Naturali in Milan, now known as Museo di Storia Naturale in Milan. His main fields of study were the morphological aspects of the Quaternary glacial deposits, the origin of erratic masses as well as the Triassic and Lower Jurassic sediments in northern Italy. During his tireless activity as a great scientific divulgator, he published the monographies of "*Paléontologie Lombarde ou description des fossiles de la Lombardie*" (Stoppani, 1858–1881).

Because of a continuous specialization of the areas of study and with the reform of Higher Education, in 1875 the tenure in natural history was divided into zoology, comparative anatomy and minerology, to each of which were assigned the respective museum collections, which were organised in independent museums. Comparative anatomy was assigned to Leopoldo Maggi (1840–1906), geominerology to Torquato Taramelli (1845–1922) (Fig. 1C), and zoology was taught by Pietro Pavesi (1844–1907). In 1888, after a new subdivision in the field of minerology, a separate tenure in geology was developed and taught by Taramelli until 1920. As had occurred thirteen years before in 1875, the museum was again subdivided into the two branches of earth sciences, namely minerology and geology, the latter of which comprehended paleontology. Taramelli certainly was a profound addition for the natural history sciences (Fig. 2D), but he was also polyhedric in his scientific activity as well as being a fervent Italian patriot, who followed Garibaldi, and later became senator. He initially started to study palaeontology, but later dedicated his time and research to stratigraphy; he also studied seismic events, and along with Giuseppe Mercalli, he published important studies of earthquakes in Spain and Italy (Taramelli and Mercalli, 1886; 1888). His wide-ranging mind led him often into the fields of civil engineering and agriculture. Because of his great interest in geology, he founded

along with a few other scientists, the Italian Geological Society and vigorously believed in the necessity that Italy should have an adequate official geological cartography. To this end, he actively participated in the formation of the Royal Geological Committee that planned the geological survey of the entire national territory (Taramelli, 1880). During this period, there was a progressive disinterest in the museum, an attitude that had already begun soon after Taramelli's direction, notwithstanding the fact that the museum conserved prestigious collections of fossils from the most important European fossiliferous locations, studied by numerous researchers of the geology and palaeontology institutes, among them Michele Gortani (1883–1966) (Fig. 1D) in particular.

Michele Gortani is considered a highly eminent geologist at both the national and international level, and his eclectic mind ranged from numerous and at times widely diverse fields of interest. In fact, besides geology he was interested in politics and in assisting refugee artists. Besides being president of the Italian Geological Society (in 1926 and 1947), he founded the Italian Speleological Institute. With a growing need for greater spaces in the Institute of Geology and the steady decline in interest for the museum's collections, the museum was moved. In 1956, the collections were transferred according to an agreement between the University of Pavia and the city municipality to the Castello Visconteo and remained there for many years while waiting for the construction of a Civic Museum. However, the collections were in fact abandoned until 1989, when the University decided to reunite them with the collections from comparative anatomy and from zoology in order to reconstitute a Museum of Natural History in the Castello Visconteo of Pavia. Since then the museal heritage has begun to be reinvigorated with the inauguration in 2019 of the new Natural History Museum, named "Kosmos". With this new location the collections have returned to have a role within the University as an object of study for teaching purposes and for research, and in parallel can be seen and enjoyed by schoolchildren and private citizens.

2. Material and methods

The "Solnhofen" collection of the Museo di Storia Naturale of the University of Pavia (now known as "Kosmos" Museo di Storia Naturale) is composed of 93 fossil specimens, three of which are housed within the collection of the Earth and Environmental Sciences Department of the University of Pavia.

Well-preserved invertebrates, fish, and plants are represented belonging to 11 different classes (Tab. 1). Almost all of the slates have an old label of the "Museo di Geologia" with an old inventory number probably assigned to them when they arrived in Pavia (Fig. 2I). Each specimen carrying a label has as an indication of provenance of "Solnhofen" which is certainly also valid for those fossils without an indication of their geographical origin; indeed the type of matrix is undoubtedly attributable to the lithographic limestone typical of this location. When looking in greater detail, the slates show evidence of differences in the kind of limestone, which would suggest that their origins albeit clearly from the deposits of Solnhofen, were probably from different sites of this area.

Unfortunately, with time the historical catalogues of the collections were lost and with them the information belonging to the specimens and how they were acquired. However, on the backside of many of the fossils, the original identification labels have remained intact, and their examination allows us to trace the period with a good accuracy, in which these specimens arrived to the Museum. Moreover, these labels from the providers indicate that the fossils were bought and not the result of own excavations by the geologists of Pavia. Four providers, all well known for their eminent role in commercializing minerals and fossils, can be identified: Comptoir Minéralogique et Géologique de Suisse, Comptoir Minéralogique et Géologique de Genève, Dr. F. Krantz Rheinisches Mineralien-Contor, and K.S. Mineralogie-Niederlage zu Freiberg (Fig. 2E, G, H).

- Comptoir Minéralogique et Géologique de Genève A. Baldou. The identification card carries the name of Aimé Baldou, who founded a concessionary for the commercialization of minerals and fossils around 1890. In the University archives we have found a receipt signed by A. Baldou for the provision of 250 fossil specimens of "Echinids, Molluscs, Asterids and Crustaceans of various terrains and from different European and other localities" dated 1890 and addressed

to Torquato Taramelli (Fig. 2D) after its request to Ministry of the Public Education (Fig. 2C). Notwithstanding the fact that our specimen belongs to the class of insects, it is highly probable that it belongs to this provision (Wilson, 2021).

- The Comptoir Minéralogique et Géologique de Suisse was founded by Henry Minod in 1890 in rue S. Leger 6, Genève. With the approval of the Swiss government, he obtained permission to sell rocks and minerals from the excavations of the Simplon tunnel. The company was taken over in 1903 by Grebel, Wendler & Cie located in 3, Course des Bastions, Genève, and at first both shops operated together. From 1905 onwards, the name Minod no longer appears alongside the commercial company that continued until 1926, at least. The identification cards in our possession are typewritten with purple ink, and do not carry any reference to H. Minod, and the commercial address is 3 Courses des Bastions, Genève (Fig. 2E). Considering the fact that in 1907 the graphics of the identification cards were changed with the name of "Grebel Wendler & Cie" we believe that this material dates from the period between 1905–1907 (Wilson, 2021).

Table 1. Amount of the invertebrate, vertebrate, and plant class in the Solnhofen collection of the "Kosmos" Museum of Natural History of the University of Pavia.

Class	Quantity
Crinoidea	6
Scyphozoa	1
Insecta	25
Actinopterygii	10
Cephalopoda	13 (6 Ammonitida)
Pinopsida	2
Bivalvia	1
Polypodiopsida	1
Ophiuroidea	6
Malacostraca	25
Merostomata	2

- The 13th of November 1765 the general commissioner for the mines F. A. von Heynitz and the captain of the mines F. W. von Opel founded the Mineral Academy in Freiberg, Saxony. More or less during the same period, the Bergakademie began a campaign to sell the extranumerary material. The K. S. Mineralogie-Niederlage zu Freiberg's main goal was to amplify the permanent collection of the Bergakademie with specimens from Germany and foreign countries through exchanges, acquisitions and sales. This institution remained independent until 1956 and is now encompassed within the Technical University Bergakademie Freiberg, Geosciences section. The identification cards that accompany the material (Fig. 2H), although having the same pre-printed base, are written by hand with two different handwritings that are in accordance with the kinds in use from 1880 to 1920. One of the handwritten cards in particular would seem to be that of Wilhelm Maucher, who was the director from 1904 to 1909 (Wilson, 2021).

- The Dr. F. Krantz Rheinisches Mineralien-Kontor company was founded by August Krantz in 1833, while being still a student at the Freiberg Mine Academy, and it became the first company specialized in the commercialization of geopalaeontological material with business relations throughout the world. After A. Krantz's death, his nephew Fridrich Krantz continued the tradition and the company changed its name to Dr. F. Krantz Rheinisches Mineralien-Contor with its main operating location in Bonn. The company is still active. The identification cards of the specimens from this company are of the kind used from 1890 onwards (Fig. 2G). A search in the company's archives has evidenced that the handwriting would seem to be that of the very same F. Krantz, prepared around 1920. Indeed, he personally prepared hundreds of specimens that were also commercialized after his death in 1926, and that are still conserved (Ursula Mueller-Krantz pers. comm., 2021). In the records of the Krantz's company, a receipt was found for a catalogue of fossil material in 1926 addressed to the "Istituto Geologico della Regia Università di Pavia" to the attention of Prof. Vinassa de Regny who was the director of the institute at that time (Fig. 2F) (Wilson, 2021).

By analyzing the numbers of the old catalogues, it is possible to form homogenous groups of specimens

Table 2. Main providers of some decapod crustaceans from the Solnhofen collection with the current catalogue number and the old catalogue numeration.

N°cat	Ex cat.	Species	Provider
15771	9988	*Mecochirus longimanatus*	K. S. Mineralogie-Niederlage zu Freiberg
15767	10001	*Mecochirus longimanatus* (*ex Mecochirus bayeri*)	K. S. Mineralogie-Niederlage zu Freiberg
24670	(2)	*Pseudastacus pustulosus*	K. S. Mineralogie-Niederlage zu Freiberg
24671	9984	*Acanthochirana cordata* (*ex Acanthochirus angulatus*)	K. S. Mineralogie-Niederlage zu Freiberg
24673	9990	*Aeger spinipes* (*ex Aeger tipularuis*)	K. S. Mineralogie-Niederlage zu Freiberg
24675	9994	*Bombur complicatus*	K. S. Mineralogie-Niederlage zu Freiberg
24676	10002	*Eystaettia intermedia*	K. S. Mineralogie-Niederlage zu Freiberg
24678	10000	*Antrimpos speciosus*	K. S. Mineralogie-Niederlage zu Freiberg
24679	10011	*Cycleryon orbiculatus* (*ex Eryon orbiculatus*)	K. S. Mineralogie-Niederlage zu Freiberg
24681	10003	*Buergerocaris psittacoides*	K. S. Mineralogie-Niederlage zu Freiberg
24667	16663	*Eryma modestiforme*	Dr. F. Krantz Rheinisches Mineralien-Contor Bonn
15772	18960	*Eryon cuvieri* (*ex Eryon arctiformis*)	Dr. F. Krantz Rheinisches Mineralien-Contor Bonn

that correspond to the providers, and that can be collocated in an increasing amount, with except for a few specimens. Considering the whole Solnhofen collection, the old catalogue numbers from 9950 to 10017 come from K. S. Mineralogie-Niederlage zu Freiberg; the numbers from 16662 to 18960 belong to the F. Krantz's company; the catalogue numbers 19885 to 21926 are from the Comptoir Minéralogie et Géologie de Suisse, 3 course des Bastions, Genève, whereas the only sample from the Comptoir Minéralogie et Géologie de Genève A. Baldou does not preserve its old catalogue number (see Tab. 2 referred to crustaceans only). Based upon this analysis, we can therefore hypothesize that the acquisition of the specimens from Solnhofen began in 1905 under Taramelli's direction and continued with his successors for two decades until 1926, which is the date of the mailing of the Krantz company's catalogue to Vinassa de Regny. Indeed, there are no further specimens from Solnhofen in the museum's collections. The fact that the identification labels were prepared some time before the fossils were sold should not surprise us because the providers had collected and catalogued many specimens that were sold only later on, conserving the same labels without being updated, as has been confirmed by the Krantz's company for example (Tab. 2).

3. Systematic palaeontology

The following listing of decapod crustaceans housed in the MSNPV collection is arranged taxonomically. This commented systematic list includes 27 specimens identified as follows:

AEGERIDAE
Aeger tipularius (Schlotheim, 1822) (1 specimen);
Aeger spinipes (Desmarest, 1817) (1 specimen);
Acanthochirana cordata (Münster, 1839) (1 specimen).

PENAEIDAE
Antrimpos speciosus Münster, 1839 (1 specimen);
Bylginella sp. indet. (1 specimen);
Eystaettia intermedia (Oppel, 1862) (1 specimen);
Franconipenaeus meyeri (Oppel, 1862) (1 specimen);
Rauna angusta Münster, 1839 (1 specimen).

CARIDEA
Bombur complicatus Münster, 1839 (1 specimen);

Buergerocaris psittacoides Schweigert and Garassino, 2004 (1 specimen).

ERYMIDAE
Eryma modestiforme (Schlotheim, 1822) (2 specimens); *Palaeastacus fuciformis* (Schlotheim, 1822) (1 specimen).

STENOCHIRIDAE
Pseudastacus pustulosus (Münster, 1839) (1 specimen).

MECOCHIRIDAE
Mecochirus longimanatus (Schlotheim, 1820) (4 specimens).

PALINURIDAE
Palinurina longipes Münster, 1839 (2 specimens); phyllosoma larva type A (1 specimen).

ERYONIDAE
Cycleryon orbiculatus (Münster, 1839) (1 specimen); *Eryon cuvieri* Desmarest, 1817 (3 specimens).

LIMULIDAE
Mesolimulus walchii (Desmarest, 1817) (2 specimens).

Abbreviations:
Institutions – **BSPG**: Bayerische Staatssammlung für Paläontologie und Geologie, Munich, Germany; **MNHA**: Muséum d'Histoire naturelle Jacques-de-La-Comble, Autun, France; **MNHN**: Muséum national d'Histoire naturelle, Paris, France; **MSNPV**: "Kosmos" Museo di Storia Naturale of the University of Pavia.
Anatomy – mxp3: third maxilliped; P1–P5: pereiopods 1–5; s1–s6: pleonal somites 1–6.

4. Commented systematic list

Order Decapoda Latreille, 1802
Suborder Dendrobranchiata Bate, 1888
Superfamily Penaeoidea Rafinesque, 1815
Family Aegeridae Burkenroad, 1963

Genus *Aeger* Münster, 1839

Type species: *Macrourites tipularius* Schlotheim, 1822, subsequent designation by Woods (1925).

Solnhofen species: *Aeger insignis* Oppel, 1862; *A. spinipes* (Desmarest, 1817); *A. tipularius* (Schlotheim, 1822).

Aeger spinipes (Desmarest, 1817)

(Fig. 3A, B)

Palaemon spinipes Desmarest, 1817, p. 513, 514.
Palaemon spinipes Desmarest; Desmarest, 1822, p. 134, 135, pl. 11, fig. 4.
Aeger spinipes (Desmarest); Schweigert et al., 2016, p. 8, 9, pl. 8, fig. 6, pl. 9, fig. 1 (see this reference for previous synonymies).

Diagnosis: Extremely elongate rostrum, with one medium ventral tooth; mxp3 extremely long, with movable spines; chelate P1–P3; P1–P2 bearing long movable spines; P3 with smooth chelae; achelate P4–P5 and spineless; P3 slightly larger than P1–P2; well-developed pleopods; uropodal exopod with rounded diaeresis (from Schweigert et al., 2016).

Studied material: 1 specimen from Solnhofen (MSNPV 24673: purchased from the K. S. Mineralien-Niederlage, Freiberg, Saxony, Germany).

Comments: This specimen exhibits a long, narrow rostrum, which is typical of *A. spinipes,* whereas *Aeger tipularius* (Schlotheim, 1822) exhibits a very short, hook-like rostrum (see below). See Schweigert (2001b) and Schweigert et al. (2016) for a more detailed discussion.

Aeger tipularius (Schlotheim, 1822)

(Fig. 3C, D)

Macrourites tipularius Schlotheim, 1822, p. 32, pl. 2, fig. 1.
Aeger tipularius (Schlotheim); Schweigert et al., 2016, p. 6, 7, pl. 1, fig. 1, pl. 8, figs. 1–3 (see this reference for previous synonymies).

Diagnosis: Very short, smooth rostrum; mxp3 extremely long, with movable spines; chelate P1–P3; P1–P2 bearing long, movable spines; P3 with spiny chelae; achelate P4–P5 and spineless; P3 slightly larger than P1–P2; well-developed pleopods; uropodal exopod with rounded diaeresis (from Schweigert et al., 2016).

Studied material: 1 specimen from Solnhofen (MSNPV 15770).

Comments: Schweigert (2001b) revised *A. tipularius*,

establishing that *A. bronni* Oppel, 1862 and *A. armatus* Oppel, 1862 are both junior synonyms of the type species. The more common form, with an extremely long rostrum and the P3 lacking spines, which since Oppel has been thought to represent typical "*tipularius*", however, does not belong to this species. The oldest available name for Oppel's "*tipularius*" form is *A. spinipes* (see above). The true *A. tipularius* differs from the other species of *Aeger* in having a very short, hook-like rostrum (see Schweigert, 2001b and Schweigert et al., 2016 for a more detailed discussion). Note that *A. insignis* Oppel, 1862 also known from the Solnhofen Lithographic Limestones, it is not present in the MSNPV collection.

Genus *Acanthochirana* Strand, 1928

Type species: *Udora cordata* Münster, 1839 (partim), subsequent designation by Glaessner (1929).

Solnhofen species: *Acanthochirana cordata* (Münster, 1839); *A. longipes* (Oppel, 1862).

***Acanthochirana cordata* (Münster, 1839)**

(Fig. 4A, B)

Udora cordata Münster, 1839, p. 70, pl. 27, figs. 3, 4.

Acanthochirana cordata (Münster); Schweigert et al., 2016, p. 9, pl. 1, fig. 2, pl. 9, fig. 2 (see this reference for previous synonymies).

Diagnosis: Carapace subrectangular, laterally flattened; rostrum elongate with six dorsal teeth; mxp3 slightly elongate, well developed with a row of setae along the ventral margin of each element; uropodal exopod with a subrounded diaeresis (from Schweigert et al., 2016).

Studied material: 1 specimen from Solnhofen (MSNPV 24671: purchased from the K. S. Mineralien-Niederlage, Freiberg, Saxony, Germany).

Comments: The studied specimen is labelled as *Acanthochirana angulata* Oppel, 1862. The review of the only syntype still available (BSPG AS 707) figured by Oppel (1862, pl. 27, fig. 4) allowed to consider *A. angulata* as a juvenile of *A. cordata* (see Schweigert et al., 2016 for a more detailed discussion). The study of the specimen housed in the MSNPV collection allowed us to identify the relatively short mxp3, a diagnostic character of the type species *A. cordata*, to which the specimen has been assigned.

Superfamily Penaeoidea Rafinesque, 1815

Family Penaeidae Rafinesque, 1815

Genus *Antrimpos* Münster, 1839

Type species: *Antrimpos speciosus* Münster, 1839, subsequent designation by Glaessner (1929).

Solnhofen species: *Antrimpos nonodon* Münster, 1839; *A. speciosus* Münster, 1839.

***Antrimpos speciosus* Münster, 1839**

(Fig. 4C, D)

Antrimpos speciosus Münster, 1839, p. 50, 51, pl. 17, figs. 1–5.

Antrimpos speciosus Münster; Schweigert et al., 2016, p. 10, 11, pl. 2, fig. 1, pl. 9, figs. 5, 6 (see this reference for previous synonymies).

Diagnosis: Carapace subrectangular, laterally flattened; rostrum elongate slightly turned upward distally, with nine dorsal teeth and one ventral tooth distally; epigastric tooth; mxp3 short and smooth; uropodal exopod with a subrounded diaeresis (from Schweigert et al., 2016).

Studied material: 1 specimen from Solnhofen (MSNPV 24678: purchased from the K. S. Mineralien-Niederlage, Freiberg, Saxony, Germany).

Comments: Münster (1839) described this species from Solnhofen and Eichstätt, later considered the type species for the genus by Glaessner (1929). Moreover, Münster (1839) described *A. nonodon* from a quarry close to Painten (Bavaria, Germany), differing from the type species in the rostral shape and smaller P3 chelae (see Schweigert, 2001a, fig. 6).

Genus *Bylginella* Schweigert, Garassino, and Pasini, 2016

Type species: *Bylgia hexadon* Münster, 1839, by original designation.

Solnhofen species: *Bylginella haeberleini* (Münster, 1839); *B. hexadon* (Münster, 1839).

***Bylginella* sp. indet.**

(Fig. 5A, B)

Diagnosis: Carapace subrectangular, laterally flattened; elongate, prominent, and straight rostrum, bearing six dorsal teeth and one median ventral tooth; epigastric tooth; chelate P1–P3, increasing in length from P1 to P3 (from Schweigert et al., 2016).

Studied material: 1 specimen from Solnhofen (MSNPV 24669).

Comments: Schweigert et al. (2016) established *Bylginella* that differs from *Bylgia* for the denser arranged dorsal rostral teeth, lacking the typical trident tip. Two species have been assigned to *Bylginella*, *B. hexadon* and *B. haeberleini*, the former differs from the latter in having a prominent rostrum, with six dorsal teeth (*vs*. rostrum with eight to ten dorsal teeth in *B. haeberleini*). Schweigert et al. (2016, 13) established a lectotype and paralectotype based upon the sole two available specimens of the original type series by Münster (1839) and Oppel (1862). Based upon the diagnosis provided by Schweigert et al. (2016), the studied specimen can be assigned to *Bylginella* in having carapace subrectangular, laterally flattened, epigastric tooth, and chelate P1–P3, increasing in length from P1 to P3. However, although the label reports *Bylgia haeberleini*, the lack of the rostrum of the studied specimen does not allow us to establish its specific assignment within *Bylginella*. In conclusion, we prefer to leave it in open nomenclature.

Genus *Eystaettia* Schweigert, Garassino, and Pasini, 2016

Type species: *Penaeus intermedius* Oppel, 1862, by original designation.

Solnhofen species: *Eystaettia intermedia* (Oppel, 1862).

***Eystaettia intermedia* (Oppel, 1862)**

(Fig. 5C, D)

Penaeus intermedius Oppel, 1862, p. 95, pl. 26, fig. 4.

Eystaettia intermedia (Oppel); Schweigert et al., 2016, p. 14, pl. 10, fig. 6 (see this reference for previous synonymies).

Diagnosis: Carapace subrectangular, laterally flattened; rostrum short, with five dorsal teeth; epigastric tooth; mxp3 short and smooth; uropodal exopod with crescent-shaped diaeresis (from Schweigert et al., 2016).

Studied material: 1 specimen from Solnhofen (MSNPV 24676: purchased from the K. S. Mineralien-Niederlage, Freiberg, Saxony, Germany).

Comments: *Penaeus intermedius* was formerly assigned to *Penaeus* or *Antrimpos* (see complete list of synonymies in Schweigert et al., 2016), like many other penaeid shrimps from the Solnhofen Lithographic Limestones. However, Schweigert et al. (2016), revising the Solnhofen penaeids, established *Eystaettia* that differs from the above-mentioned genera in the P1–P3 chelae almost equal in shape and size.

The studied specimen represents the second report for this species from the Solnhofen Lithographic Limestones after the institution of the neotype by Schweigert et al. (2016: 14).

Genus *Franconipenaeus* Schweigert, Garassino, and Pasini, 2016

Type species: *Penaeus meyeri* Oppel, 1862, by original designation.

Solnhofen species: *Franconipenaeus meyeri* (Oppel, 1862).

***Franconipenaeus meyeri* (Oppel, 1862)**

(Fig. 6A, B)

Penaeus meyeri Oppel, 1862, p. 96, pl. 26, figs. 2, 3.

Franconipenaeus meyeri (Oppel); Schweigert et al., 2016, p. 17, pl. 4, fig. 1, pl. 12, fig. 5 (see this reference for previous synonymies).

Diagnosis: Medium-sized shrimp with short downward curved densely serrate rostrum; epigastric tooth present; chelate P1–P3 equal in size; achelate P4–P5; uropodal exopod with rounded diaeresis (from Schweigert et al., 2016).

Studied material: 1 specimen from Solnhofen (MSNPV 15769).

Comments: Schweigert et al. (2016), revising the superfamily Penaeoidea from the Late Jurassic of Solnhofen based upon the type series, described the new genus *Franconipenaeus* with *F. meyeri* (Oppel, 1862), as type and sole species. The serrate rostrum, the epigastric tooth, and the chelate P1–P3 equal in size confirm the assignment of the studied specimen to this species.

It represents the third report of *Franconipenaeus* from the Solnhofen Lithographic Limestones after the discovery of one additional specimen in the MNHA

collection (see Charbonnier et al., 2021).

Genus *Rauna* Münster, 1839 *nomen dubium*

Type species: *Rauna angusta* Münster, 1839, subsequent designation by Oppel (1862).

Solnhofen species: *Rauna angusta* Münster, 1839.

***Rauna angusta* Münster, 1839**

(Fig. 6C, D)

Rauna angusta Münster, 1839, p. 79, pl. 28, fig. 10.

Rauna angusta Münster; Schweigert et al., 2016, p. 19, pl. 13, fig. 5 (see this reference for previous synonymies).

Studied material: 1 specimen from Solnhofen (MSNPV 24672).

Comments: Münster (1839) established *Rauna* based upon one sole specimen, still housed in the BSPG collection (see Schweigert et al., 2016, pl. 13, fig. 5). Schweigert et al. (2016) revised this specimen, pointing out that the smooth carapace and the incomplete rostrum are not enough characters to establish a genus. Charbonnier and Garassino (2012) reported a second specimen of this species housed in the MNHN collection. However, the study of this specimen did not allow to identify morphological characters useful to solve the systematic assignment of the genus due to its poor state of preservation. The specimen in the MSNPV collection represents the third specimen of this species. Except the carapace with a longitudinal crest near the dorsal line, common in all available specimens, no other characters, such as grooves and carinae on the carapace or rostral shape, have been identified. Therefore, the systematic position of *Rauna* is still unsolved.

In conclusion, *Rauna* must be considered as a *nomen dubium* due to the lack of diagnostic characters.

Suborder Pleocyemata Burkenroad, 1963

Infraorder Caridea Dana, 1852

Superfamily and Family uncertain

Genus *Bombur* Münster, 1839 *nomen dubium*

Type species: *Bombur complicatus* Münster, 1839, by monotypy.

Solnhofen species: *Bombur complicatus* Münster, 1839.

***Bombur complicatus* Münster, 1839**

(Fig. 7A, B)

Bombur complicatus Münster, 1839, p. 75, pl. 28, figs. 4–7.

Bombur complicatus Münster; Förster, 1967, p. 170, 172.

Studied material: 1 specimen from Solnhofen (MSNPV 24675: purchased from the K. S. Mineralien-Niederlage, Freiberg, Saxony, Germany).

Comments: Münster (1839) established *Bombur* with *B. complicatus* Münster, 1839 as type species, by monotypy. Later, Bronn (1858) described *B. aonis* from the Late Triassic (Carnian) of Raibl (Cave del Predil) (Tarvisio, Udine, Friuli-Venezia Giulia, NE Italy).

Although Schweitzer et al. (2010) assigned this genus to the Penaeidae, Förster (1967) had already suggested that *Bombur* could represent a juvenile of the caridean *Hefriga* Münster, 1839. However, there are other caridean taxa from the Solnhofen Lithographic Limestones having a similar ornamentation of the cuticle and *Hefriga* itself includes many species (Winkler et al., 2019). Therefore it is impossible to establish to which species the juvenile specimens of *Bombur* could belong. Since the type series of *Bombur* consists of very poorly preserved juveniles of carideans, it is impossible to identify diagnostic characters useful for their systematic assignment.

In conclusion, *Bombur* must be considered as a *nomen dubium* due to the lack of diagnostic characters.

Genus *Buergerocaris* Schweigert and Garassino, 2004

Type species: *Buergerocaris psittacoides* Schweigert and Garassino, 2004, by monotypy.

Solnhofen species: *Buergerocaris psittacoides* Schweigert and Garassino, 2004.

***Buergerocaris psittacoides* Schweigert and Garassino, 2004**

(Fig. 7C, D)

Buergerocaris psittacoides Schweigert and Garassino, 2004, p. 24, 27, figs. 19–22.

Diagnosis: Small caridean with smooth carapace and pleon; rostrum serrate dorsally; P1–P3 chelate, P1 strongest, bearing propodites with short, strong, isochelous fingers (from Schweigert and Garassino, 2004).

Studied material: 1 specimen from Solnhofen (MSNPV 24681: purchased from the K. S. Mineralien-Niederlage, Freiberg, Saxony, Germany).

Comments: The studied specimen is labelled as *Penaeus latipes* Oppel, 1862 (= *Oppelicaris latipes*). Based upon Schweigert et al. (2016), the specimen does not have the main morphological characters of this species, such as the straight rostrum with nine dorsal teeth and chelate P1–P3 strong and relatively broad, increasing in size distally. The careful study of the specimen highlighted the subrounded s2 pleuron overlapping those of s1 and s3, clearly diagnostic character of Caridea (Holthuis, 1993). Several species of caridean shrimps are known to date from the lithographic limestones of Solnhofen recorded by Schweigert and Garassino (2004), Schweigert (2011), Winkler (2013, 2014, 2015, 2018, 2020, 2021), and Winkler et al. (2019). Comparing the studied specimen with the known fossil caridean species, some characters, such as the smooth carapace and pleon, the rostrum serrate dorsally, the mxp3 long and slender, and the strong P1 with isochelous propodus, and beak parrot-shaped chela, fit well with those of *Buergerocaris psittacoides* Schweigert and Garassino, 2004, known by four specimens (type series) from the lower Tithonian of S Franconia (Bavaria, Germany) and one fragmentary specimen from the upper Kimmeridgian of Nusplingen (Swabia, Germany).

In conclusion, the studied specimen represents the third report for this rare species from the Solnhofen Lithographic Limestones.

Infraorder Astacidea Latreille, 1802
Superfamily Erymoidea Van Straelen, 1925

Family Erymidae Van Straelen, 1925

Note: *Eryma modestiforme* (Schlotheim, 1822), *Palaeastacus fuciformis* (Schlotheim, 1822), and *Pustulina minuta* (Schlotheim, 1822) (the last species not present in the MSNPV collection) are the three most common erymids found in the Solnhofen Lithographic Limestones. The identification of the carapace grooves, which are important for the systematic of the Erymidae, is difficult due to the compression of the studied specimens. Therefore, we use the general ornamentation and the features of the P1 chelae (shape and ornamentation) to distinguish the erymid lobsters. Indeed, *P. fuciformis* has P1 chelae with a subrectangular propodus bearing short and wide fingers, whereas the fingers of *E. modestiforme* are longer than the propodus and are progressively narrowing to their distal extremity. Moreover, *E. modestiforme* is ornamented by small tubercles and depressions, whereas *P. fuciformis* bears strong spines on carapace and P1 propodus.

Genus *Eryma* Meyer, 1840

Type species: *Macrourites modestiformis* Schlotheim, 1822, subsequent designation by Glaessner (1929).

Solnhofen species: *Eryma modestiforme* (Schlotheim, 1822); *E. veltheimii* (Münster, 1839).

***Eryma modestiforme* (Schlotheim, 1822)**
(Fig. 8A, B)

Macrourites modestiformis Schlotheim, 1822, p. 29, pl. 2, fig. 3.

Eryma modestiforme (Schlotheim); Devillez and Charbonnier, 2021, p. 42, 45, figs. 8, 9 (see this reference for previous synonymies).

Diagnosis: Fusiform intercalated plate; deep cervical groove, joined to dorsal margin and to antennal groove; short gastro-orbital groove originating as a slight median inflexion of cervical groove; postcervical groove joined medially to branchiocardiac groove; branchiocardiac groove strongly inclined, joined to hepatic groove; concavo-convex hepatic groove, joined to cervical groove; inferior groove convex posteriorly, joined to hepatic groove and to ventral margin; inflated ω area; cephalic region with two divergent rows of tubercles: orbital row with strong distal spine and antennal row with strong distal antennal spine; chelate P1–P3; P1 chelipeds without prominent spines and with homogeneous ornamentation; P1 propodus dorso-ventrally compressed with narrow inner and outer margins; P1 with narrow dactylar bulge; fingers longer than P1 propodus, equal in length, narrowing gradually to distal extremity; index wider than dactylus (from Devillez and Charbonnier, 2017).

Studied material: 2 specimens from Solnhofen (MSNPV 24667, 24668: the first one purchased from Dr. F. Krantz Rheinisches Mineralien-Contor, Bonn, North Rhine-Westphalia, Germany).

Comments: Based upon Devillez and Charbonnier

(2021), five species of *Eryma* are encountered in the Solnhofen Lithographic Limestones and *E. modestiforme* is the most common. Indeed, *E. modestiforme* is known by numerous specimens, almost complete, stored notably in European palaeontological collections (e.g. Paris, Berlin, London, Brussels, Basel). The two studied specimens clearly show the intercalated plate characteristic for the erymid lobsters. Based upon Devillez and Charbonnier (2021), they are ascribed to *E. modestiforme* for the cephalothoracic groove pattern, the elongate, spineless rostrum, and the subrectangular P1 chela with slender, straight dactylus and index, longer than propodus.

Genus *Palaeastacus* Bell, 1850

Type species: *Astacus sussexiensis* Mantell, 1833, subsequent designation by Glaessner (1929).

Solnhofen species: *Palaeastacus fuciformis* (Schlotheim, 1822).

***Palaeastacus fuciformis* (Schlotheim, 1822)**

(Fig. 8C, D)

Macrourites fuciformis Schlotheim, 1822, p. 30, pl. 2, fig. 2.

Palaeastacus fuciformis (Schlotheim); Devillez and Charbonnier, 2021, p. 50, 52, fig. 12 (see this reference for previous synonymies).

Diagnosis: Fusiform intercalated plate; deep cervical groove, joined to dorsal margin and to antennal groove; short gastro-orbital groove, originating as a slight median inflexion of the cervical groove; postcervical and branchiocardiac grooves subparallel, joined to hepatic groove; hepatic groove concavo-convex, joined to cervical groove; inferior groove convex posteriorly, joined to hepatic groove; chelate P1; P1 propodus short, thick, slightly globose, with a narrow dactylar bulge; P1 fingers usually wide, slightly longer than propodus, progressively narrowing to their distal extremity, occlusal margin curved at the basis of the index (from Devillez and Charbonnier, 2021).

Studied material: 1 specimen from Solnhofen (MSNPV 24674).

Comments: Some diagnostic characters, such as the P1 chelae with a subrectangular propodus bearing short and wide fingers, and the strong spines on carapace and P1 propodus confirm the assignment of the studied specimen to *P. fuciformis*. Based upon Devillez and Charbonnier (2019, 2021) just 2 species are known to date from the Late Jurassic, *P. rothgaengerae* Schweigert and Röper, 2001 (Kimmeridgian, Germany) and *P. fuciformis* (Tithonian, Germany).

Superfamily Stenochiroidea Beurlen, 1928

Family Stenochiridae Beurlen, 1928

Genus *Pseudastacus* Oppel, 1861

Type species: *Bolina pustulosa* Münster, 1839, subsequent designation by Glaessner (1929).

Solnhofen species: *Pseudastacus pustulosus* (Münster, 1839).

***Pseudastacus pustulosus* (Münster, 1839)**

(Fig. 9A, B)

Bolina pustulosa Münster, 1839, p. 23, pl. 9, fig. 13.

Pseudastacus pustulosus (Münster); Garassino and Schweigert, 2006, p. 12, 13, fig. 8, pl. 2, fig. 2, pl. 12, figs. 3, 4 (see this reference for previous synonymies).

Diagnosis: Carapace cylindrical, laterally flattened; cervical, gastro-orbital, antennal, and hepatic grooves deep; postcervical groove weak; branchiocardiac groove absent; dorsal suture absent; rostrum long with three strong supralateral teeth; antennal spine weak; P1–P3 chelate; P1 larger and stronger than P2–P3; uropodal exopod with diaeresis (from Garassino and Schweigert, 2006).

Studied material: 1 specimen from Solnhofen (MSNPV 24670: purchased from the K. S. Mineralien-Niederlage, Freiberg, Saxony, Germany).

Comments: *Pseudastacus* Oppel, 1861 was assigned for long time to the Nephropidae Dana, 1852, as reported by Van Straelen (1925), Beurlen (1928), Glaessner (1929, 1969), and Chong and Förster (1976). Later, Albrecht (1983) included this genus in his new family Proastacidae, whereas Tshudy and Babcock (1997) included it in their new family Chilenophoberidae. Garassino and Schweigert (2006) preferred to assign *Pseudastacus* to the Protoastacidae, considering the analysis by Tshudy and Babcock (1997) not founded by a morphological review of the type material. Later, De Grave et al. (2009) and Schweitzer et al. (2010) maintained this genus in the Chilenophoberidae. Finally,

Karasawa et al. (2013) proposed to synonymize the Chilenophoberidae with the Stenochiridae Beurlen, 1928, assigning *Pseudastacus* to this family. We concur.

The studied specimen has the main characters of *Pseudastacus*, such as the typical groove pattern of the carapace (deep cervical groove crossing dorsal midline and well-developed branchiocardiac groove, joined ventrally to hepatic groove); the elongate triangular rostrum with dorsal spines; and the short, stout P1 chela.

Oppel (1862, pl. 11, fig. 2a, b) described *P. muensteri* from Solnhofen different from the type species in having smaller size and longer and slender P1. Garassino and Schweigert (2006) revised this species, considered as a junior synonym of *P. pustulosus*. Moreover, the authors supposed that these taxa represent sexual dimorphism of a single species. Indeed, sexual dimorphism may affect the lengths of P1 and their articles with the longer ones in the males, as in the extant glypheid *Neoglyphea inopinata* Forest and de Saint Laurent, 1975 (Forest and de Saint Laurent, 1981, 1989) and in the fossil glypheids *Glyphea regleyana* and *Glyphea muensteri* (Charbonnier et al., 2012b). Therefore, it can be supposed that *P. muensteri* is the male and *P. pustulosus* the female.

Based upon Charbonnier and Audo (2020), *Pseudastacus* includes just two species, *P. lemovices* Charbonnier and Audo, 2020 from the Early Jurassic (Sinemurian) of France and *P. pustulosus* from the Late Jurassic (Tithonian) of Germany.

Infraorder Glypheidea Winkler, 1881
Superfamily Glypheoidea Winkler, 1881
Family Mecochiridae Van Straelen, 1925

Genus *Mecochirus* Germar, 1827

Type species: *Macrourites longimanatus* Schlotheim, 1820, subsequent designation by Woods (1927).

Solnhofen species: *Mecochirus dubius* (Münster, 1839); *M. longimanatus* (Schlotheim, 1820).

***Mecochirus longimanatus* (Schlotheim, 1820)**
(Figs. 9C, D; 10A, B)

Macrourites longimanatus Schlotheim, 1820, p. 38.

Mecochirus longimanatus (Schlotheim); Garassino and Schweigert, 2006, p. 18–20, fig. 9, pl. 5, fig. 1, pl. 13, fig. 6, pl. 14, fig. 1 (see this reference for previous synonymies).

Diagnosis: Carapace cylindrical, laterally flattened; rostrum short and edentate; cervical groove deep in the third anterior of carapace; antennal and hepatic grooves deep; postcervical and branchiocardiac grooves weak extending parallel; three carinae strong and tuberculate in the gastric and antennal regions; extraordinary extension of P1 subchelate; P2 subchelate; P3–P5 achelate; uropodal exopod with diaeresis (from Garassino and Schweigert, 2006).

Studied material: 4 specimens from Solnhofen [MSNPV 24665 (part and counterpart), 24666, 15767, 15571: the last two purchased from the K. S. Mineralien-Niederlage, Freiberg, Saxony, Germany].

Comments: Secrétan (1968) described *Mecochiria*, with *M. foresti* as type species. According to Förster (1971), this genus shows the main diagnostic characters of *Mecochirus* and *Mecochiria* must be considered as a junior synonym of *Mecochirus.* This view was followed by Schweitzer et al. (2010: 20), who, however, maintained *Mecochirus foresti* as a separate species. Odin et al. (2019) reviewed Secrétan's syntypes not highlighting significant morphological differences to distinguish *M. foresti* from the type species of *Mecochirus*. Therefore, *M. foresti* must be considered as junior synonym of *M. longimanatus.*

Garassino and Schweigert (2006) revised *M. longimanatus*, based upon several specimens belonging to Münster's and Oppel's collections, housed in the BSPG collection. The studied specimens fit the main characters of this species to which they are assigned. Garassino and Schweigert (2006: 18) established that *Megachirus brevimanus* Münster, 1839 must be considered as junior synonym of *M. longimanatus*. Indeed, the former differs from the latter just for the shorter P1, supposing that these forms represented sexual dimorphism of a single species. Garassino and Schweigert (2006) supposed that *M. brevimanus* was the male and *M. longimanatus* the female. However, it is currently the opposite, because in the extant *Neoglyphea inopinata* Forest and de Saint Laurent 1975 (Forest and de Saint Laurent, 1981, 1989) and in the fossil *Glyphea regleyana* and G. *muensteri* (Charbonnier et al., 2012b), the sexual dimorphism affects the lengths of P1 and its articles, with the longer occuring in the males.

Infraorder Achelata Scholtz and Richter, 1995
Family Palinuridae Latreille, 1802

Genus *Palinurina* Münster, 1839

Type species: Palinurina longipes Münster, 1839, subsequent designation by Woods (1925).

Solnhofen species: Palinurina longipes Münster, 1839; *P. tenera* Oppel, 1862.

***Palinurina longipes* Münster, 1839**

(Figs. 10C, D; 11A, B)

Palinurina longipes Münster, 1839, p. 37, pl. 14, fig. 8.

Palinurina longipes Münster; Garassino and Schweigert, 2006, p. 32–34, fig. 12, pl. 18, fig. 5, pl. 19, fig. 1 (see this reference for previous synonymies).

Diagnosis: Carapace subrectangular ventrally flattened; rostrum short, shorter than supraorbital spine; cervical and postcervical groove deep; hepatic and branchiocardiac grooves thin and weak; supraorbital and antennal spines well developed; suborbital spine small; pleon longer than carapace; P1 shorter and stronger than P2–P5; well-developed articles of the antennae; very elongate flagellum of antennae; uropodal exopod without diaeresis (from Garassino and Schweigert, 2006).

Studied material: 2 specimens from Solnhofen (MSNPV 24663, 24664).

Comments: *Palinurina* is known from the Solnhofen Lithographic Limestones with *P. longipes* and *P. tenera* Oppel, 1862. The latter differs from the former in having a shorter antennal flagellum and longer P1–P5. The studied specimens have been assigned to the type species for the strongly tuberculate pereiopods and carapace (*vs*. smooth pereiopods in *P. tenera*; carapace not preserved) (see Haug and Haug, 2016 for a detailed "intermetamorphic" discussion of *P. tenera*).

Phyllosoma larva type A

(Fig. 11C, D)

Solnhofen species: Type A (= *Phalangites priscus* Münster, 1836); type B (= *Palpipes cursor* Roth, 1851); type C (= "*Dolichopus*" *tener* Walther, 1904); type D (unnamed).

Studied material: 1 specimen from Solnhofen (MSNPV 24680).

Comments: According to Haug et al. (2010), the Solnhofen Lithographic Limestones have yielded thousands of specimens of malacostracan larvae of the so-called 'phyllosoma' type, the zoëa-stage equivalent (*sensu* Williamson, 1969) of the Achelata. This taxon comprises the spiny lobsters (Palinuridae Latreille, 1802), the slipper lobsters (Scyllaridae Latreille, 1825) and the rock lobsters (Synaxidae Spence Bate, 1881) (Polz, 1984).

Three different types of phyllosoma larvae have been described from the Solnhofen deposits, at first as different species, *Palpipes cursor* Roth, 1851, *Phalangites priscus* Münster, 1836 and "*Dolichopus*" *tener* Walther, 1904. As these larvae probably correspond to certain achelate adults, their taxonomic names are most likely synonyms, either junior or senior synonyms (*Dolichopus* is pre-occupied, cf. Polz, 1986). Polz has, therefore, argued for an abandoning of these names and referring to the three types as A (= *Phalangites priscus*), B (= *Palpipes cursor*) and C (= "*Dolichopus*" *tener*) until the larvae can be definitively assigned to adult species. These three larval types are not known from single developmental stage, but from series of stages. Indeed, not less than seven stages have been reconstructed for type A (Polz, 1972), eight for type B (Polz, 1973) and, based upon the diagrams depicted in Polz (1987), at least three for type C. Finally, in addition to the three phyllosoma types, Polz (1995) described a single giant specimen, termed type D, which was interpreted as a specimen killed and preserved while moulting from a phyllosoma stage into a *puerulus* stage. The specimen is much larger than the three other phyllosoma larvae types, and cannot be connected to one of them nor to any of the adult species known to date.

The studied specimen has been assigned to the phyllosoma larva type A based upon Polz (1972). According to Haug et al. (2010) type A and type B have a high potential of being a larval stage of *Palinurina longipes* Münster, 1839.

Infraorder Polychelida Scholtz and Richter, 1995
Family Eryonidae De Haan, 1841

Genus *Cycleryon* Glaessner, 1965

Type species: *Macrourites propinquus* Schlotheim, 1822, by original designation.

Solnhofen species: *Cycleryon elongatus* (Münster, 1839); *C. orbiculatus* (Münster, 1839); *C. propinquus*

(Schlotheim, 1822); *C. wulfi* Garassino and Schweigert, 2004.

***Cycleryon orbiculatus* (Münster, 1839)**

(Fig. 12A, B)

Eryon orbiculatus Münster, 1839, p. 7, pl. 5, figs. 1, 2.

Cycleryon orbiculatus (Münster); Garassino and Schweigert, 2006, p. 27, 28, figs. 7a, 10, pl. 16, figs. 1–4 (see this reference for previous synonymies).

Diagnosis: Carapace subcircular ventrally flattened; median postcervical carina and branchial carinae absent; cervical and postcervical incisions deep dividing margin into three parts; suborbital outer orbital teeth strong; P1–P4 chelate; P5 achelate; P1 larger and stronger than P2–P5; pereiopods successively shorter posteriorly; uropodal exopod petaloid without diaeresis (from Garassino and Schweigert, 2006).

Studied material: 1 specimen from Solnhofen (MSNPV 24679: purchased from the K. S. Mineralien-Niederlage, Freiberg, Saxony, Germany).

Comments: Münster (1839) described *C. orbiculatus* different from the type species in having shorter, thicker P1 chela. Moreover, the strong suborbital tooth, the strong outer orbital tooth, the lack of the carinae on the carapace, and the smooth frontal margin allow to assign the studied specimen to this species, relatively rare in the Solnhofen Lithographic Limestones (see Garassino and Schweigert, 2006).

Genus *Eryon* Desmarest, 1817

Type species: *Eryon cuvieri* Desmarest, 1817, by monotypy.

Solnhofen species: *Eryon cuvieri* Desmarest, 1817.

***Eryon cuvieri* Desmarest, 1817**

(Figs. 12C, D; 13A, B)

Eryon Cuvieri [sic] Desmarest, 1817, p. 512, 513.

Eryon cuvieri Desmarest; Charbonnier et al., 2012a, p. 851, 853, figs. 1, 2 (see this reference for previous synonymies).

Diagnosis: Subcircular carapace, ventrally flattened; median postcervical and branchial ridges weak; deep cervical and postcervical incisions dividing margin into three parts; P1–P4 chelate; P5 achelate; P1 larger and stronger than P2–P5; pereiopods successively shorter posteriorly; uropodal exopod petaloid, lacking diaeresis (from Charbonnier et al., 2012a).

Studied material: 3 specimens from Solnhofen [MSNPV 24677, 15744 (ventral view), 15772: the last one purchased from Dr. F. Krantz Rheinisches Mineralien-Contor, Bonn, North Rhine-Westphalia, Germany].

Comments: During the last centuries and up to the present day, many authors considered *Eryon cuvieri* "Desmarest, 1822" to be the junior synonym of *Macrourites arctiformis* Schlotheim, 1820. They classically referred to this taxon as *Eryon arctiformis* (Schlotheim, 1820). They were unaware of the fact that Desmarest had already described *Eryon cuvieri* formally in 1817 in the *Nouveau dictionnaire d'Histoire naturelle.* Therefore, *Eryon* is valid as of 1817 (Desmarest, 1817), its type species being *E. cuvieri.* In accordance with the Principle of Priority (ICZN, 1999: article 23.1), Charbonnier et al. (2012a) established *E. cuvieri* Desmarest, 1817 as the valid name, of which *M. arctiformis* is a junior, subjective synonym.

Order Xiphosurida Latreille, 1802

Family Limulidae Zittel, 1885

(= Mesolimulidae Størmer, 1952; = Heterolimulidae Vía Boada and De Villalta, 1966)

Genus *Mesolimulus* Størmer, 1952

Type species: *Limulus walchii* Desmarest, 1817, by monotypy.

Solnhofen species: *Mesolimulus walchii* (Desmarest, 1817).

***Mesolimulus walchii* (Desmarest, 1817)**

(Figs. 13C, D; 14A, B)

Limulus walchii Desmarest, 1817, p. 516.

Limulus walchii Desmarest; Desmarest, 1822, p. 139, 140, pl. 14, fig. 2.

Mesolimulus walchii (Desmarest); Lamsdell, 2020, p. 23, 25, fig. 1K.

Diagnosis: Limulid with prosoma wider than long; cardiac lobe narrow with scalloped margins, parallel sided with keel developed into median cardiac ridge with rounded cross section, flanked by deep axial furrows; thoracetron wider than long, bearing apodemal pits; pleura of free lobe reduced, terminating before thoracetron margin; thoracetron

margins bearing five moveable and six fixed spines; lateral ridge running along fulcrum (from Lamsdell, 2020).

Studied material: 2 specimens from Solnhofen (MSNPV 15774, 15775).

Comments: Desmarest (1817) described *Limulus walchii,* a new limulid from the Jurassic of Solnhofen (Bavaria, Germany). In his famous monograph with A. Brongniart, Desmarest (1822) made the same description and figured this species for the first time. Later numerous authors, ignoring Desmarest's earlier work, referred this taxon with the date of 1822. The correct combination is instead *Mesolimulus walchii* (Desmarest, 1817).

5. Acknowledgements

We thank the Archivio Storico of the University of Pavia and the F. Krantz's company, Bonn, for help in historical research; E. Razzetti, "Kosmos" Museo di Storia Naturale of the University of Pavia, for the photos of the figured specimens; Dr. N. B. Carlo-Stella, (Pavia Italy), for revision to English; and G. Schweigert, Naturkunde Museum (Stuttgart, Germany) and S. Charbonnier, Muséum national d'Histoire naturelle (Paris, France) for careful review and criticism.

6. References

Albrecht, H. 1983. Die Protoastacidae n. fam., fossile Vorfahren der Flußkrebse? Neues Jahrbuch für Geologie und Paläontologie, Monatshefte 1983(1): 5–15. DOI:10.1127/njgpm/1983/1983/5

Anonimo. 1873. Cenno storico sulla R. Università di Pavia. Successori Bizzoni. Pavia. 159 p.

Bate, C. S. 1888. Report on the Crustacea Macrura collected by H. M. S. "Challenger" during the years 1873–1876. Reports on the Scientific Results of the Voyage of H. M. S. Challenger, Zoology, Section V, Vol. 24. Published by Order of Her Majesty. London. 942 p.

Beurlen, K. 1928. Die Decapoden des Schwäbischen Jura mit Ausnahme der aus den oberjurassischen Plattenkalken stammenden. Palaeontographica 70: 115–278.

Bell, T. 1850. Notes on the Crustacea of the Chalk Formation. In F. Dixon, ed., The Geology and Fossils of the Tertiary and Cretaceous Formations of Sussex. Brown, Green, and Longmans. London. p. 344–345.

Brambilla, G., C. Rovati, and E. Bernuzzi. 2007. Cenni storici sulla sezione paleontologica del Museo di Storia Naturale dell'Università di Pavia e Catalogo dei molluschi pliocenici di Volpedo (Alessandria) della collezione Parona. Bollettino del Museo Regionale di Scienze Naturali Torino 24: 233–280.

Bronn, H. G. 1858. Beiträge zur triasischen Fauna und Flora der bituminösen Schiefer von Raibl. Neues Jahrbuch für Mineralogie, Geologie, und Paläontologie, Stuttgart 1858: 1–32.

Burkenroad, M. D. 1963. The evolution of the Eucarida (Crustacea, Eumalacostraca) in relation to the fossil record. Tulane Studies in Geology 2: 3–16.

Charbonnier, S., and D. Audo. 2020. A new stenochirid lobster (Crustacea, Decapoda, Stenochiridae) from the Early Jurassic of France. Geodiversitas 42(7): 93–102. DOI:10.5252/geodiversitas2020v42a7

Charbonnier, S., and A. Garassino. 2012. The marine arthropods from the Solnhofen Lithographic Limestones (Late Jurassic, Germany) in the collections of the Muséum national d'Histoire naturelle, Paris. Geodiversitas 34(4): 857–871. DOI:10.5252/g2012n4a8

Charbonnier, S., A. Garassino, D. Audo, and D. Chabard. 2021. Fossil crustaceans in the collections of the Natural History Museum of Autun, France. Neues Jahrbuch für Geologie und Paläontologie, Abhandlungen 299(2): 171–184. DOI:10.1127/njgpa/2021/0963

Charbonnier, S., A. Garassino, J.-M. Pacaud, and G. Schweigert. 2012a. Rediscovery of the type material of *Eryon cuvieri* Desmarest, 1817 (Crustacea, Decapoda, Eryonidae) and nomenclatural consequences. Geodiversitas 34(4): 849–855. DOI:10.5252/g2012n4a7

Charbonnier, S., D. Pérès, and C. Letenneur. 2012b. Exceptionally preserved crustaceans from the Oxfordian of eastern France (Terrain à Chailles Formation, Haute-Saône). Geodiversitas 34(3): 531–568. DOI:10.5252/g2012n3a5

Chong, G., and R. Förster. 1976. *Chilenophoberus atacamensis,* a new decapod crustacean from the Middle Oxfordian of the Cordillera de Domeyko, northern Chile. Neues Jahrbuch für Geologie und Paläontologie, Monatshefte 1976(3): 145–156.

Ciardi, M. 2000. Spallanzani, Lechevalier e le rovine di Troia: un capitolo delle relazioni tra storia della scienza e storia dell'archeologia. In W. Bernardi, and M. Stefani (eds.), La sfida della Modernità. Atti del Convegno Internazionale di Studi nel bicentenario della morte di Lazzaro Spallanzani (Scandiano 11–13 febbraio 1999). Firenze. p. 241–262 (see note n. 75, p. 258).

Dana, J. D. 1852. Parts I and II, Crustacea. U.S. Exploring Expedition during the Years 1838, 1839, 1840, 1841, 1842, under the Command of Charles Wilkes, U.S.N., 13. C. Sherman. Philadelphia. 1618 p.

De Grave, S., N. D. Pontcheff, S. T. Ahyong, T.-Y. Chan, K. A. Crandall, P. C. Dworschak, D. L. Felder, R. M. Feldmann, C. M. J. M. Fransen, L. Y. D. Goulding, R. Lemaitre, M. E. Y. Low, J. W. Martin, P. K. L. Ng, C. E. Schweitzer, S. H. Tan, D. Tshudy, and R. Wetzer. 2009. A classification of living and fossil genera of decapod crustaceans. The Raffles Bulletin of Zoology Supplement 21: 1–109.

De Haan, W. 1833–1850. Crustacea. In P. F. von Siebold (ed.), Fauna Japonica sive Descriptio Animalium, quae in Itinere per Japoniam, Jussu et Auspiciis Superiorum, qui summum in India Batava Imperium Tenent, Suscepto, Annis 1823–1830 Collegit, Notis, Observationibus et Adumbrationibus Illustravit. J. Müller et Co. Leyden. p. i–xvii, i–xxxi, ix–xvi, p. 1–243.

Desmarest, A. G. 1817. Crustacés. Nouveau Dictionnaire d'Histoire Naturelle, appliquée aux arts, à l'agriculture, à l'Économie rurale et domestique, à la Médecine, etc. Tome VIII. De l'Imprimerie d'Abel Lanoe. Paris. p. 487–519.

Desmarest, A. G. 1822. Histoire naturelle des Crustacés fossiles. Les Crustacés proprement dits. F. G. Levrault. Paris. p. 67–154.

Devillez, J., and S. Charbonnier. 2017. The genus *Eryma* Meyer, 1840 (Crustacea: Decapoda: Erymidae): new synonyms, systematic and stratigraphic implications. Bulletin de la Société géologique de France, Earth Sciences Bulletin 188: 15 p. DOI:10.1051/bsgf/2017178

Devillez, J., and S. Charbonnier. 2019. Review of the Early and Middle Jurassic erymid lobsters (Crustacea: Decapoda). Bulletin de la Société géologique de France, Earth Sciences Bulletin 190(6): 38 p. DOI:10.1051/bsgf/2019005

Devillez, J., and S. Charbonnier. 2021. Review of the Late Jurassic erymoid lobsters (Crustacea: Decapoda). Geodiversitas 43(2): 25–73. DOI:10.5252/geodiversitas2021v43a2

Forest, J., and M. Saint Laurent de. 1975. Présence dans la faune actuelle d'un représentant du groupe mésozoïque des Glyphéides: *Neoglyphea inopinata* gen. nov., sp. nov. (Crustacea Decapoda Glypheidae). Comptes Rendus de l'Académie des Sciences, Paris (Série D) 281: 155–158.

Forest, J., and M. Saint Laurent de. 1981. La morphologie externe de *Neoglyphea inopinata* espèce actuelle de Crustacé Décapode Glyphéide. Résultats des campagnes MUSORSTOM, Volume 1. Mémoires du Muséum national d'Histoire naturelle 91: 51–84.

Forest, J., and M. Saint Laurent de. 1989. Nouvelle contribution à la connaissance de *Neoglyphea inopinata* Forest & de Saint Laurent, à propos de la description de la femelle adulte. In Forest, J. (ed.), Résultats des Campagnes MUSORSTOM, Volume 5. Mémoires du Muséum national d'Histoire naturelle (Série A, Zoologie) 144: 75–92.

Förster, R. 1967. Zur Kenntnis natanter Jura-Dekapoden. Mitteilungen der Bayerischen Staatssammlung für Paläontologie und historische Geologie 7: 157–174.

Förster, R. 1971. Die Mecochiridae, eine spezialisierte Familie der mesozoischen Glypheoidea (Crustacea, Decapoda). Neues Jahrbuch für Geologie und Paläontologie, Abhandlungen 137: 396–421.

Garassino, A., and G. Schweigert. 2004. *Cycleryon wulfi* n. sp. (Crustacea: Decapoda: Eryonidae) from the Upper Jurassic of Eichstätt (Bavaria, S Germany). Atti della Società italiana di Scienze naturali e del Museo civico di Storia naturale in Milano 145(2): 243–250.

Garassino, A., and G. Schweigert. 2006. The Upper Jurassic Solnhofen decapod crustacean fauna: review of the types from old descriptions. Part I. Infraorders Astacidea, Thalassinidea, and Palinura.

Memorie della Società italiana di Scienze naturali e del Museo civico di Storia naturale di Milano 34(1): 3–44.

Germar, E. F. 1827. Ueber die Versteinerungen von Solenhofen. Teutschland geognostisch-geologisch dargestellt und mit Charten und Zeichnungen erläutert 4: 89–110.

Glaessner, M. F. 1929. Crustacea Decapoda. In F. J. Pompeckj (ed.), Fossilium catalogus, 1: Animalium, vol. 41. W. Junk. Berlin. p. 1–464.

Glaessner, M. F. 1965. Vorkommen fossiler Dekapoden (Crustacea) in Fisch-Schiefern. Senckenbergiana Lethaia 46(a): 111–122.

Glaessner, M. F. 1969. Decapoda. In R. C. Moore (ed.), Treatise on Invertebrate Paleontology. Part R, Arthropoda 4, vol. 2. The Geological Society of America, Inc. & The University of Kansas Press. Boulder, Colorado & Lawrence, Kansas. p. 400–533 + 626–628.

Haug, J. T., and C. Haug. 2016. "Intermetamorphic" developmental stages in 150 milion-year-old achelatan lobsters – The case of the species *tenera* Oppel, 1862. Arthropod Structure & Development 45(2016): 108–121.
DOI:10.1016/j.asd.2015.10.001

Haug, J. T., C. Haug, D. Waloszek, and G. Schweigert. 2010. The importance of lithographic limestones for revealing ontogenies in fossil crustaceans. Swiss Journal of Geosciences 104(1): S85–S98.
DOI:10.1007/s00015-010-0033-1

Holthuis, L. B. 1993. The recent genera of the caridean and stenopodidean shrimps (Crustacea, Decapoda) with an appendix on the order Amphionidacea. In C. H. J. M. Fransen, and C. van Achterberg (eds.). Leiden. 328 p.

ICZN. 1999. International Code of Zoological Nomenclature. International Trust for Zoological Nomenclature. The Natural Museum. London, v-xxix + 306 p.

Karasawa, H., C. E. Schweitzer, and R. M. Feldmann. 2013. Phylogeny and systematics of extant and extinct lobsters. Journal of Crustacean Biology 33(1): 78–123.
DOI:10.1163/1937240X-00002111

Lamsdell, J. C. 2020. The phylogeny and systematics of Xiphosura. PeerJ 8: c10431.
DOI:10.7717/peerj.10431

Latreille, P. A. 1802. Histoire Naturelle, Générale et Particulière, des Crustacés et des Insectes, Vol. 3. F. Dufart. Paris. p. 1–467.

Latreille, P. A. 1825. Familles naturelles du règne animal: Exposées succinctment et dans un ordre analytique, avec l'indication de leurs genres. J. B. Baillière. Paris. 570 p.

Mantell, G. 1833. The Geology of the South-East of England. London. 435 p.

Meyer, H. von. 1840. Briefliche Mittheilungen an Prof. Bronn. Neues Jahrbuch für Mineralogie, Geognosie, Geologie und Petrefaktenkunde 1840: 1–587.

Milani, R. 1999. Lazzaro Spallanzani innovatore e precursore scomodo. Greppi editore. Pavia. p. 1–158.

Münster, G. Graf zu. 1836. Mittheilungen an Professor Bronn gerichtet. Neues Jahrbuch für Mineralogie, Geognosie, Geologie und Petrefactenkunde. p. 580–583.

Münster, G. Graf zu. 1839. Abbildung und Beschreibung der fossilen langschwänzigen Krebse in den Kalkschiefern von Bayern. Beiträge zur Petrefactenkunde 2: 1–88.

Odin, G. P., S. Charbonnier, J. Devillez, and G. Schweigert. 2019. On unreported historical specimens of marine arthropods from the Solnhofen and Nusplingen Lithographic Limestones (Late Jurassic, Germany) housed at the Muséum national d'Histoire naturelle, Paris. Geodiversitas 41(17): 643–662.
DOI:10.5252/geodiversitas2019v41a17

Oppel, A. 1861. Die Arten der Gattungen *Eryma*, *Pseudastacus*, *Magila* und *Etallonia.* Jahreshefte des Vereins für Vaterländische Naturkunde in Württemberg 17: 355–361.

Oppel, A. 1862. Ueber jurassische Crustaceen. Palaeontologische Mittheilungen aus dem Museum des koeniglich Bayerischen Staates 1: 1–120.

Pavesi, P. 1901. L'abbate Spallanzani a Pavia. Memorie della Società italiana di Scienze naturali e del Museo civico di Storia naturale di Milano 6(3): 1–68.

Pieroni, V., and P. Guaschi. 2018. La Collezione Tommasi dei fossili della "Lumachella di Ghegna" (Roncobello, Val Brembana, BG) conservata nel Museo di Storia Naturale dell'Università di Pavia, ed altre collezioni triassiche. Quaderni del Museo Civico di Storia Naturale di Ferrara 6: 15–29.

Polz, H. 1972. Entwicklungsstadien bei fossilen Phyllosomen (Form A) aus den Solnhofener Plattenkalken. Neues Jahrbuch für Geologie und Paläontologie, Monatshefte 1972(11): 678–689.

Polz, H. 1973. Entwicklungsstadien bei fossilen Phyllosomen (Form B) aus den Solnhofener Plattenkalken. Neues Jahrbuch für Geologie und Paläontologie, Monatshefte 1973(5): 284–296.

Polz, H. 1984. Krebslarven aus den Solnhofener Plattenkalken. Archaeopteryx 2: 30–40.

Polz, H. 1986. Die Originale zu "*Dolichopus*" *tener* Walther 1904. Archaeopteryx 4: 37–45.

Polz, H. 1987. Zur Differenzierung der fossilen Phyllosomen (Crustacea, Decapoda) aus den Solnhofener Plattenkalken. Archaeopteryx 5: 23–32.

Polz, H. 1995. Ein außergewöhnliches Jugendstadium eines palinuriden Krebses aus den Solnhofener Plattenkalken. Archaeopteryx 13: 67–74.

Rafinesque, C. S. 1815. Analyse de la nature, ou tableau de l'univers et des corps organisées. L'Imprimerie de Jean Barravecchia. Palermo. p. 1–224.

Rostand, J. 1963. Lazzaro Spallanzani e le origini della biologia sperimentale. Einaudi. Torino. p. 1–206.

Roth, J. 1851. Ueber fossile Spinnen des lithografischen Schiefers. In Gelehrte Anzeigen, Herausgegeben von Mitgliedern der Königlichen. Bayerischen Akademie der Wissenschaften zu München 32: 164–167.

Schlotheim, E. F. 1820. Die Petrefactenkunde auf ihrem jetzigen Standpunkte durch die Beschreibung seiner Sammlung versteinerter und fossiler Uberreste des Thier- und Pflanzenreichs der Vorwelt erläutert. Becker. Gotha (Thuringia). 437 p.

Schlotheim, E. F. 1822. Nachträge zur Petrefactenkunde. Beiträge zur näheren Bestimmung der versteinerten und fossilen Krebsarten. Becker. Gotha (Thuringia). 214 p.

Scholtz, G., and S. Richter. 1995. Phylogenetic systematics of the reptantian Decapoda (Crustacea, Malacostraca). Zoological Journal of the Linnean Society 113: 289–328. DOI:10.1111/j.1096-3642.1995.tb00936.x

Schweigert, G. 2001a. Eine neue Art der Gattung *Antrimpos* Münster (Crustacea, Decapoda, Penaeidae) aus dem Nusplinger Plattenkalk (Oberjura, Ober-Kimmeridgium, SW-Deutschland). Stuttgarter Beiträge zur Naturkunde, Serie B 307: 1–33.

Schweigert, G. 2001b. The late Jurassic decapod species *Aeger tipularius* (Schlotheim, 1822) (Crustacea: Decapoda: Aegeridae). Stuttgarter Beiträge zur Naturkunde, Serie B 309: 1–10.

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(2): 131–140. DOI:10.1127/0077-7749/2011/0162

Schweigert, G., and A. Garassino. 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.

Schweigert, G., A. Garassino, and G. Pasini. 2016. The Upper Jurassic Solnhofen decapod crustacean fauna: review of the types from old descriptions. Part II. Superfamily Penaeoidea and Infraorder Caridea. Memorie della Società italiana di Scienze naturali e del Museo civico di Storia naturale di Milano 41: 3–26.

Schweigert, G., and M. Röper. 2001. Neue Krebse der Gattung *Palaeastacus* (Crustacea: Decapoda: Erymidae) aus oberjurassischen Plattenkalken Süddeutschlands. Stuttgarter Beiträge zur Naturkunde, Serie B (Geologie und Paläontologie) 313: 1–10.

Schweitzer, C. E., R. M. Feldmann, A. Garassino, H. Karasawa, and G. Schweigert. 2010. Systematic list of fossil decapod crustacean species. Crustaceana Monographs 10: 1–222.

Secrétan, S. 1968. *Mecochira foresti,* nouveau Crustacé du Jurassique supérieur de Solnhofen. Annales de Paléontologie Invertébrés 54(2): 227–238.

Spence Bate, C. S. 1881. On *Synaxes*, a new genus of Crustacea. Annals and Magazine of Natural History (5)7: 220–228.

Stoppani, A. 1858–1881. Paléontologie Lombarde ou description des fossiles de Lombardie publiée à l'aide de plusieurs savants par l'abbé Antoine Stoppani. 4e serie. Imprimerie Bernardoni De C. Rebeschini & C.e Milan. 158 p.

Størmer, L. 1952. Phylogeny and taxonomy of fossil horseshoe crabs. Journal of Paleontology 26: 630–640.

Strand, E. 1928. Miscellanea nomenclatoria zoologica et palaeontologica. I-II. Archiv für Naturgeschichte 92(A)(8): 40–41.

Taramelli, T. 1880. Della necessità in Italia di un istituto geologico indipendente del R. corpo degli ingegneri delle miniere. Rendiconti del Reale Istituto Lombardo di Scienze e Letterre 13: 294–307.

Taramelli, T., and M. Mercalli. 1886. I terremoti andalusi cominciati il 25 Dicembre 1884. Atti della classe di Scienze fisiche, matematiche e naturali della Regia Accademia dei Lincei serie 4(3): 116–222.

Taramelli, T., and M. Mercalli. 1888. Il terremoto ligure del 23 Febbraio 1887. Memoria. Estratto dagli Annali dell'Ufficio Centrale di Meteorologia e Geodinamica parte 4 volume 8. Roma, Tipografia Metastasio. 296 p.

Terenzio, P. 1867. Il Museo di Storia Naturale. In Ragionamenti intorno alle Università e quella di Pavia in particolare con note sui gabinetti di quest'ultima. Tipografia dell'Artista Grossi e C. Pavia. p. 121–162.

Tshudy, D., 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: 253–263.

Van Straelen, V. 1925. Contribution à l'étude des crustacés décapodes de la période jurassique. Mémoires de la Classe des Sciences de l'Académie royale de Belgique, 2e série 7: 1–462.

Vía Boada, L., and J. F. De Villalta. 1966. *Heterolimulus gadeai* nov. gen. nov. sp. representante de una nueva familia de Limulacea, en el Triássico español. Compte rendu sommaire de Séances de la Societé géologique de France 1966: 57–59.

Volta, G. S. 1796. Ittiolitologia veronese del museo bozziano ora annesso a quello del conte Giovambattista Gazola e di altri gabinetti fossili veronesi, con la versione latina. 2 vols. Stamperia Giuliari. Verona. p. 5–323.

Walther, J. 1904. Die Fauna der Solnhofener Plattenkalke, bionomisch betrachtet. Medizinisch-Naturwissenschaftliche Gesellschaft zu Jena. Jena. 214 p.

Williamson, D. I. 1969. Names of larvae in the Decapoda and Euphausiacea. Crustaceana 16: 210–213.

Wilson, W. E. 2021. Mineralogical Record Biographical Archive, at www.mineralogicalrecord.com [accessed 1st February 2021].

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. DOI:10.5282/ubm/epub.19015

Winkler, N. 2014. A new caridean shrimp (Crustacea: Decapoda: Dendrobranchiata) from the Upper Jurassic Solnhofen Lithographic Limestones of Schernfeld (S Germany). Zitteliana, (A) 54: 83–90. DOI:10.5282/ubm/epub.22325

Winkler, N. 2015. Revision of the fossil crustacean *Blaculla brevipes* and description of a new caridean shrimp (Crustacea: Decapoda: Dendrobranchiata) from the Upper Jurassic Solnhofen Lithographic Limestones of Schernfeld (Germany). Zitteliana, (A) 55: 31–39. DOI:10.5282/ubm/epub.26933

Winkler, N. 2018. Two new species of shrimps (Crustacea: Decapoda: Caridea) from the Solnhofen Lithographic Limestones (Upper Jurassic, southern Germany). Neues Jahrbuch für Geologie und Paläontologie, Abhandlungen 287(3): 317–333. DOI:10.1127/njgpa/2018/0719

Winkler, N. 2020. A new caridean shrimp (Crustacea: Decapoda) from the Solnhofen Lithographic Limestones (Upper Jurassic, southern Germany). Neues Jahrbuch für Geologie und Paläontologie, Abhandlungen 295(2): 117–128. DOI:10.1127/njgpa/2020/0873

Winkler, N. 2021. One new genus and three new species of caridean shrimps (Crustacea: Decapoda) from the Upper Jurassic Solnhofen Lithographic Limestones (Southern Germany). Neues Jahrbuch für Geologie und Paläontologie, Abhandlungen 299(1): 49–70. DOI:10.1127/njgpa/2021/0954

Winkler, N., G. Schweigert, A. Winkler, U. Resch, and R. Frattigiani. 2019. Additional observations in species of *Hefriga* Münster, 1839 (Crustacea: Decapods: Caridea) from the Upper Jurassic Solnhofen-type lagerstätten, Germany. Neues Jahrbuch für Geologie und Paläontologie, Abhandlungen 292(2): 191–210. DOI:10.1127/njgpa/2019/0817

Winkler, T.-C. 1881. Étude carcinologique sur les genres "*Pemphix,*" "*Glyphea*" et "*Araeosternus.*" Archive du Musée Teyler (series 2) 2:73–124.

Woods, H. 1925–1931. A Monograph of the Fossil Macrurous Crustacea of England. Palaeontographical Society. London. 122 p.

Zittel, K. A. von. 1885. Handbuch der Palaeontologie. Abtheilung I, Palaeozoologie. Band II, Mollusca und Arthropoda. Oldenbourg. München. 893 p.

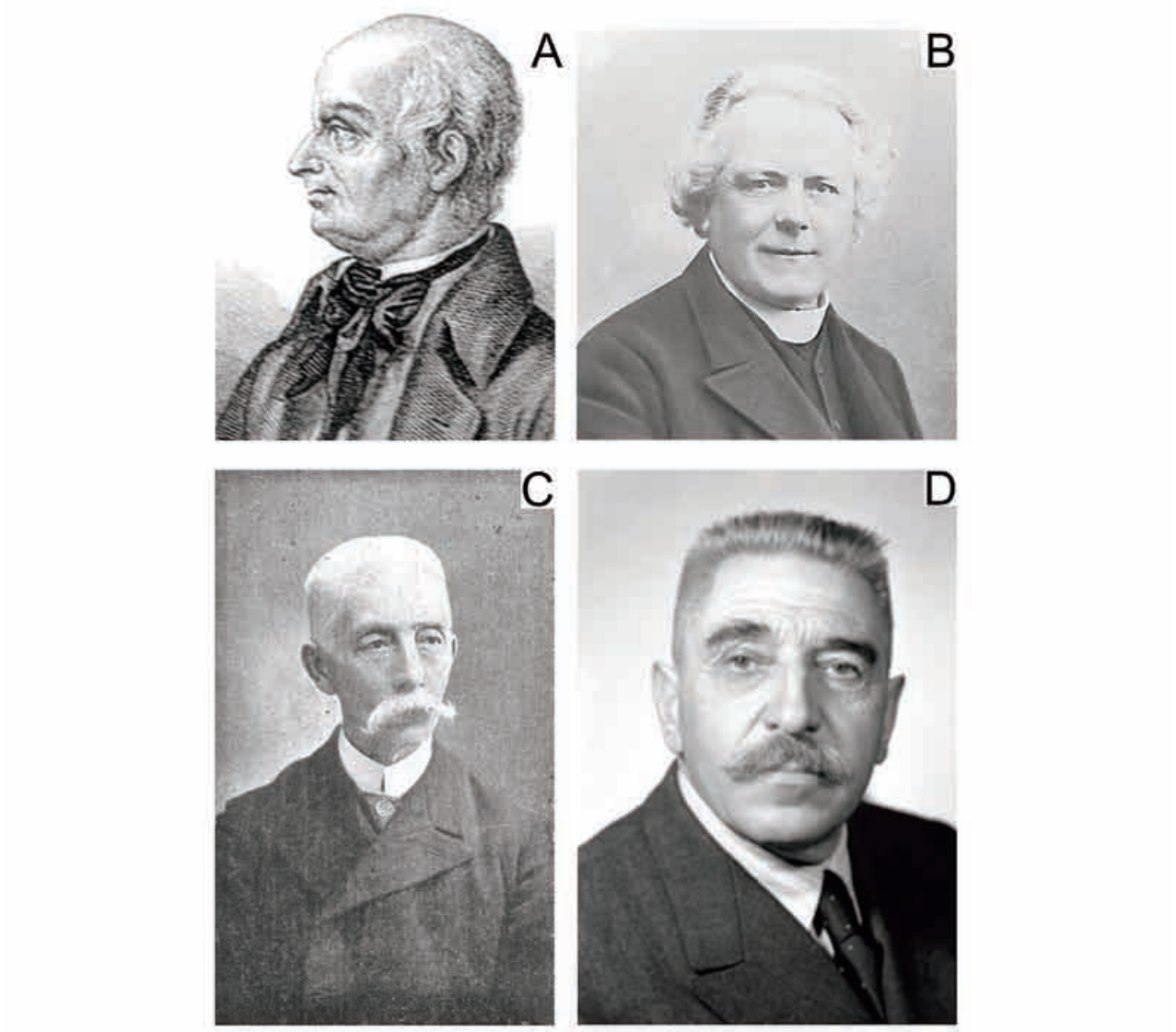

Fig. 1. The "Founding fathers" of the "Kosmos" Museo di Storia Naturale of the University of Pavia. **A**) Lazzaro Spallanzani. **B**) Antonio Stoppani. **C**) Torquato Taramelli. **D**) Michele Gortani.

Fig. 2. A–B) Example of a slate with fish from Bolca (Verona, Veneto) bought by Spallanzani with the handwritten authentic card prepared by G. S. Volta. **C**) Authorization dated 5.7.1904 of the "Ministro della Istruzione Pubblica" to buy a collection of fossils for the "Gabinetto di Geologia" of the University of Pavia. **D**) Taramelli's declaration of the buying of a collection of fossils for the "Gabinetto di Geologia" of the University of Pavia. **E, G, H**) Examples of labels of the providers companies. **F**) Part of the inventory of the Dr. Krantz company in which the University of Pavia is reported (arrow). **I**) Example of a label of the "Museo di Geologia" of the "Regia Università di Pavia" relating to a specimen from Solnhofen.

Fig. 3. Aegeridae from the Late Jurassic Solnhofen Lithographic Limestones (Bavaria, Germany). **A, B**) *Aeger spinipes* (Desmarest, 1817), MSNPV 24673, lateral view, natural and UV light. **C, D**) *Aeger tipularius* (Schlotheim, 1822), MSNPV 15770, lateral view, natural and UV light. Scale bar equals 5 cm.

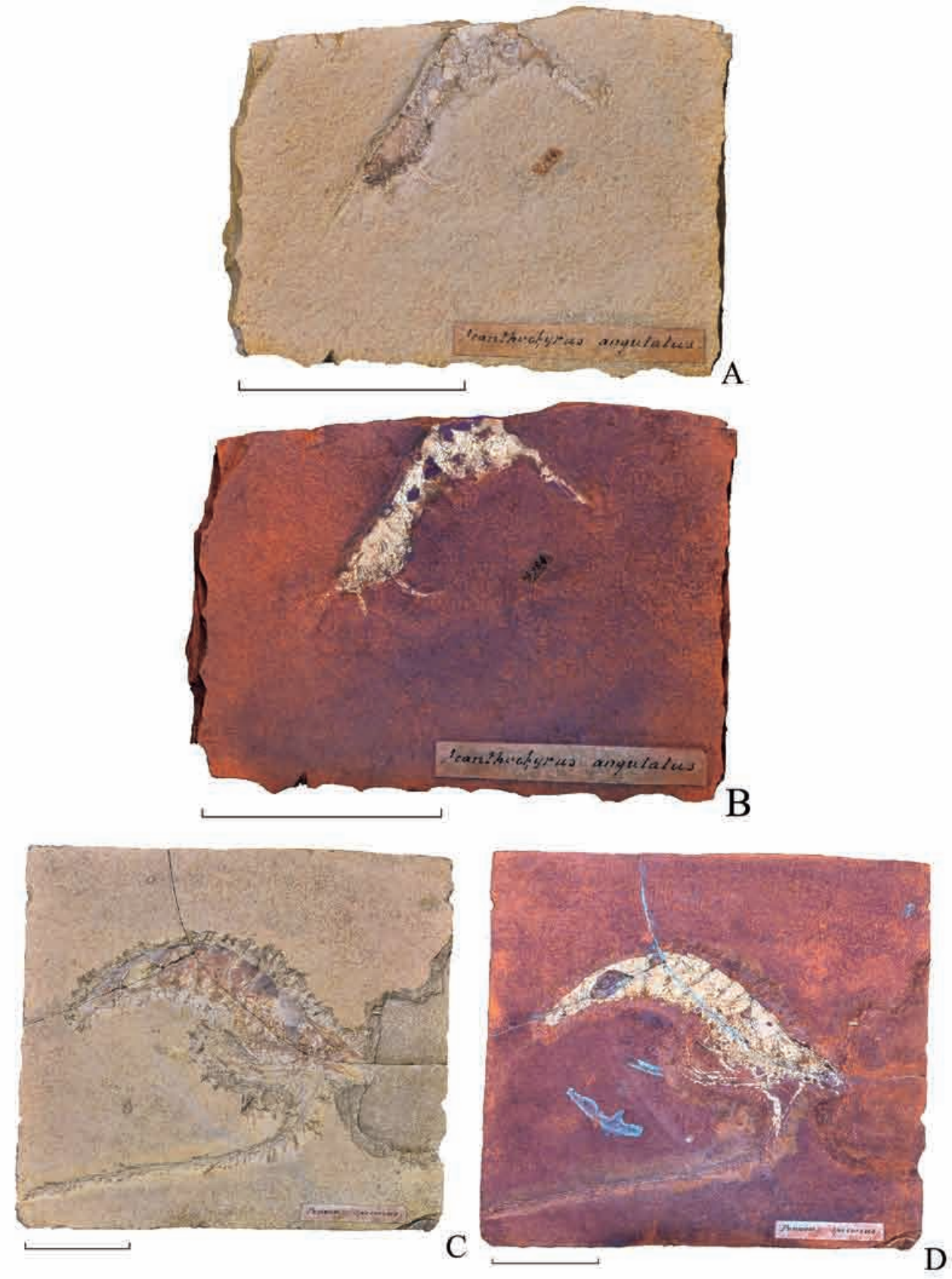

Fig. 4. Aegeridae and Penaeidae from the Late Jurassic Solnhofen Lithographic Limestones (Bavaria, Germany). **A, B**) *Acanthochirana cordata* (Münster, 1839), MSNPV 24671, lateral view, natural and UV light. **C, D**) *Antrimpos speciosus* Münster, 1839, MSNPV 24678, lateral view, natural and UV light. Scale bar equals 5 cm.

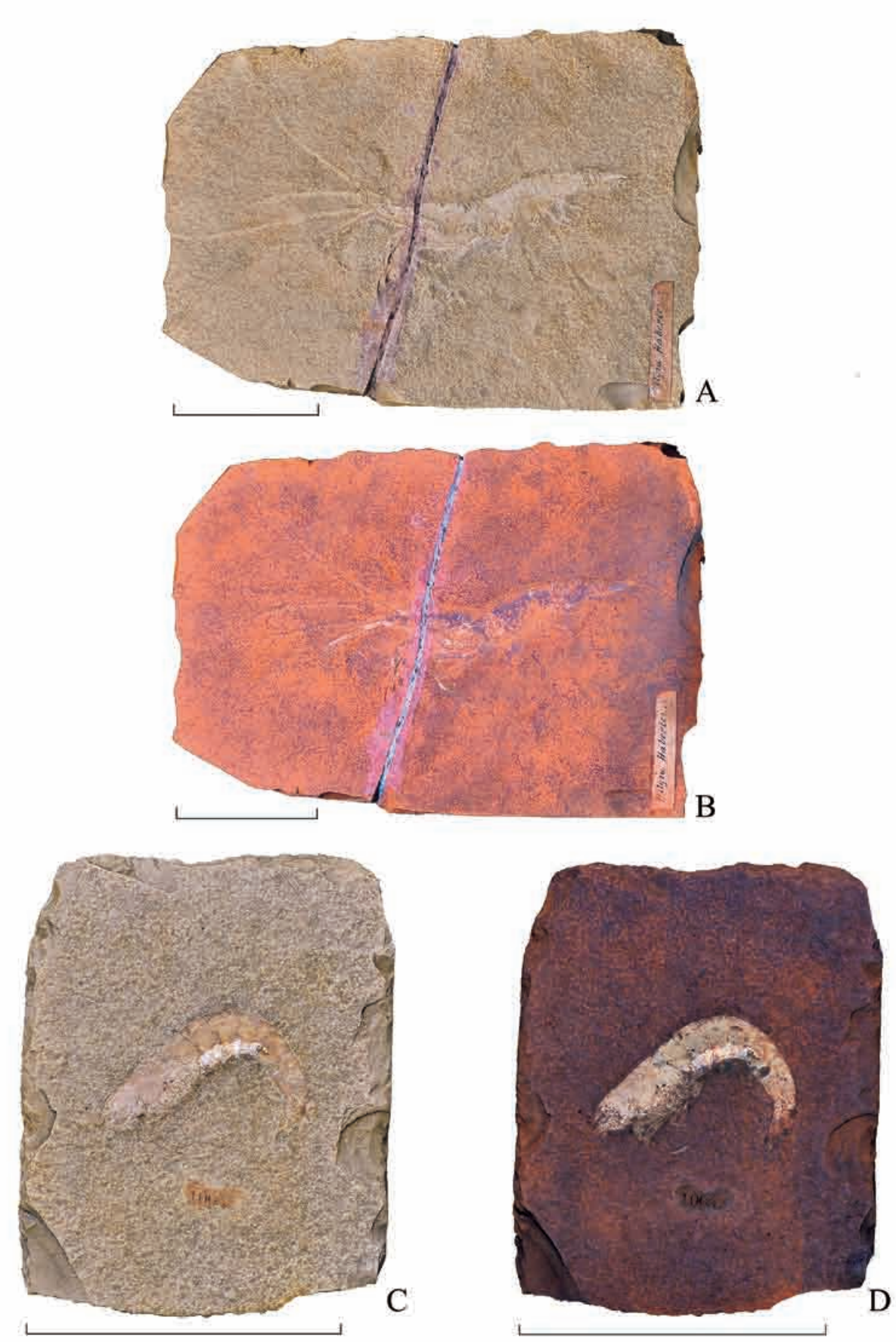

Fig. 5. Penaeidae from the Late Jurassic Solnhofen Lithographic Limestones (Bavaria, Germany). **A, B**) *Bylginella* sp. indet., MSNPV 24669, lateral view, natural and UV light. **C, D**) *Eystaettia intermedia* (Oppel, 1862), MSNPV 24676, lateral view, natural and UV light. Scale bar equals 5 cm.

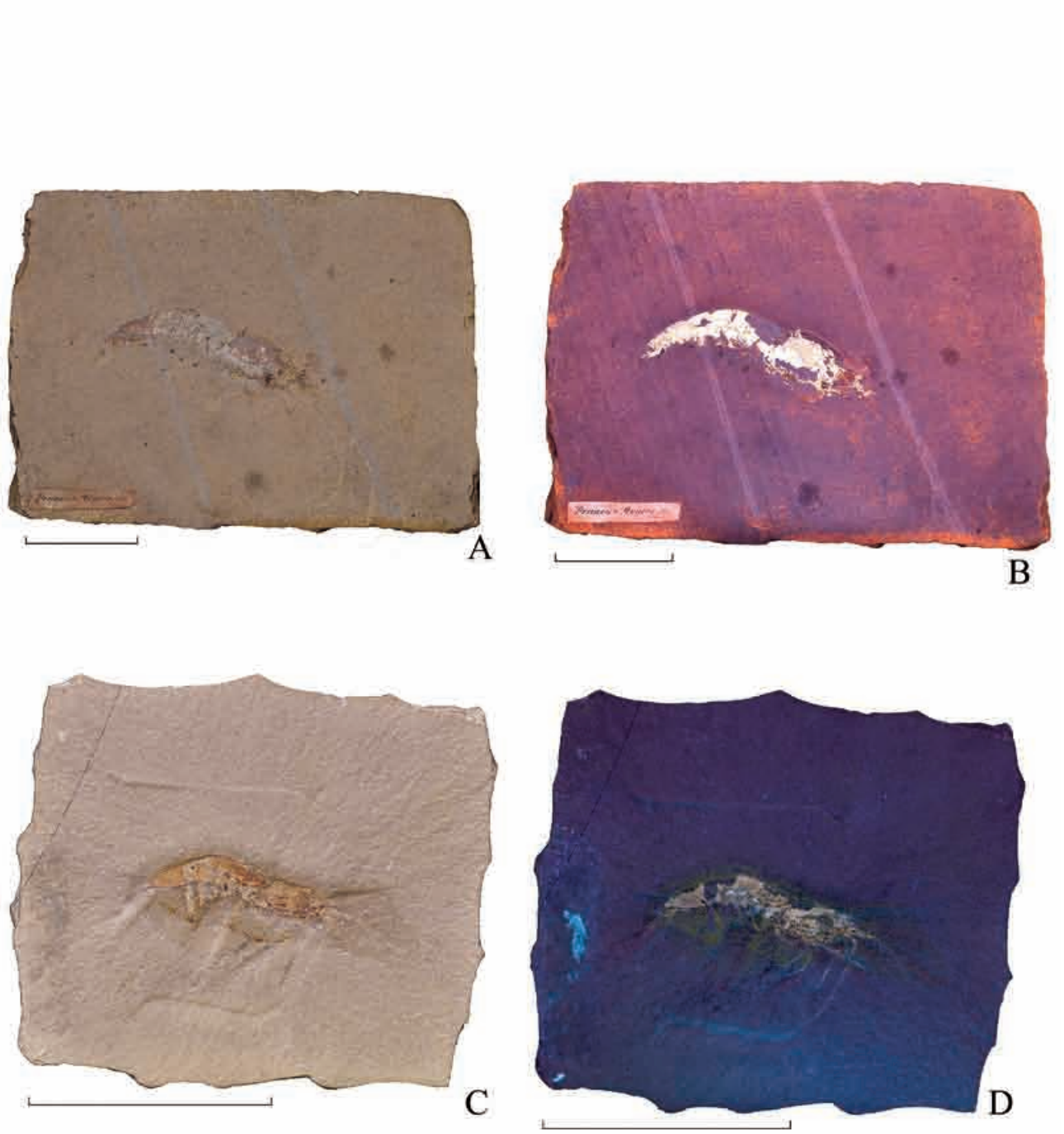

Fig. 6. Penaeidae and Caridea from the Late Jurassic Solnhofen Lithographic Limestones (Bavaria, Germany). **A, B**) *Franconipenaeus meyeri* (Oppel, 1862), MSNPV 15769, lateral view, natural and UV light. **C, D**) *Rauna angusta* Münster, 1839, MSNPV 24672, lateral view, natural and UV light. Scale bar equals 5 cm.

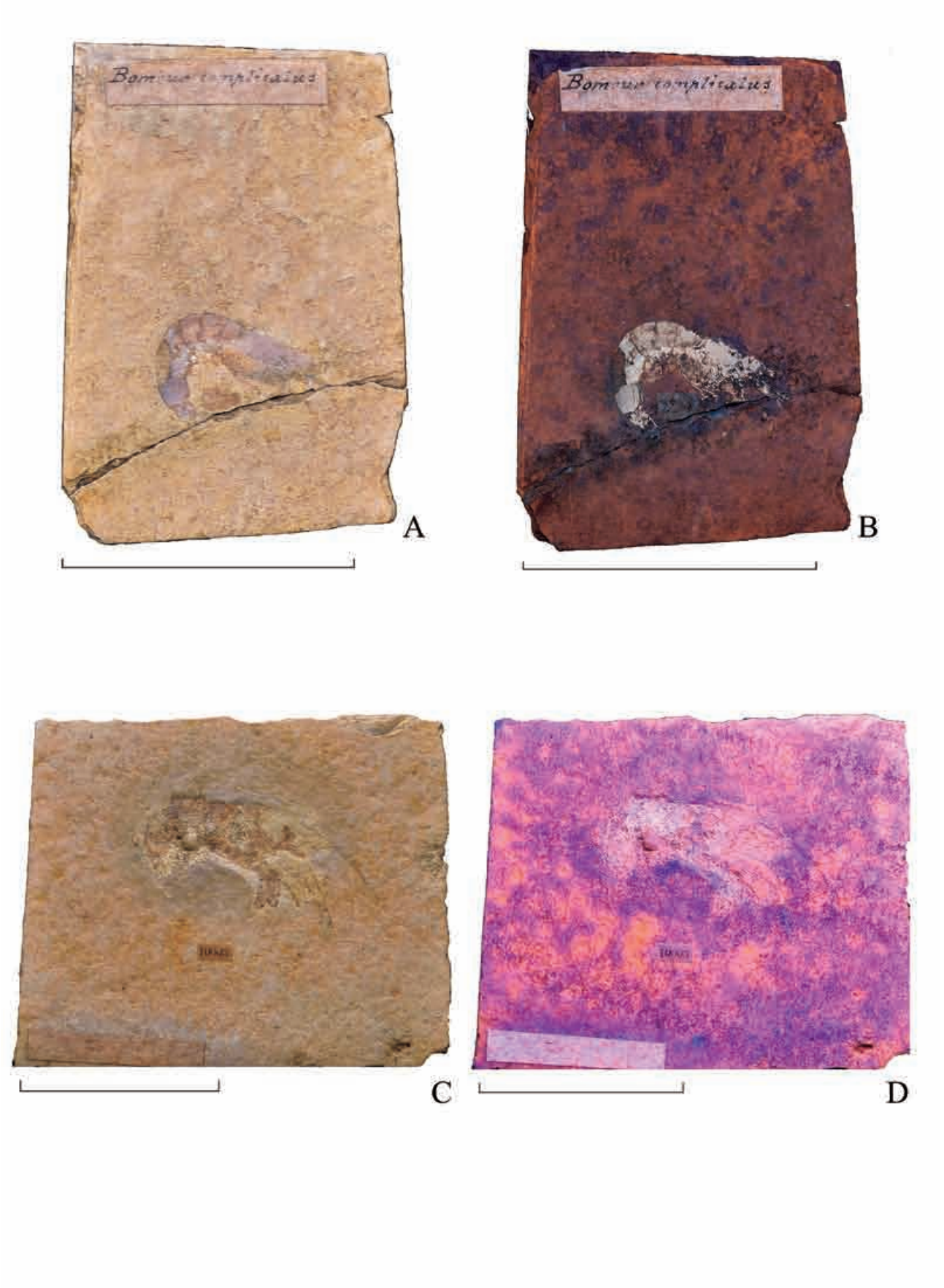

Fig. 7. Caridea from the Late Jurassic Solnhofen Lithographic Limestones (Bavaria, Germany). **A, B**) *Bombur complicatus* Münster, 1839, MSNPV 24675, lateral view, natural and UV light. **C, D**) *Buergerocaris psittacoides* Schweigert and Garassino, 2004, MSNPV 24681, lateral view, natural and UV light. Scale bar equals 5 cm.

Fig. 8. Erymidae from the Late Jurassic Solnhofen Lithographic Limestones (Bavaria, Germany). **A**, **B**) *Eryma modestiforme* (Schlotheim, 1822), MSNPV 24667, dorsal view, natural and UV light. **C, D**) *Palaeastacus fuciformis* (Schlotheim, 1822), MSNPV 24674, dorso-lateral view, natural and UV light. Scale bar equals 5 cm.

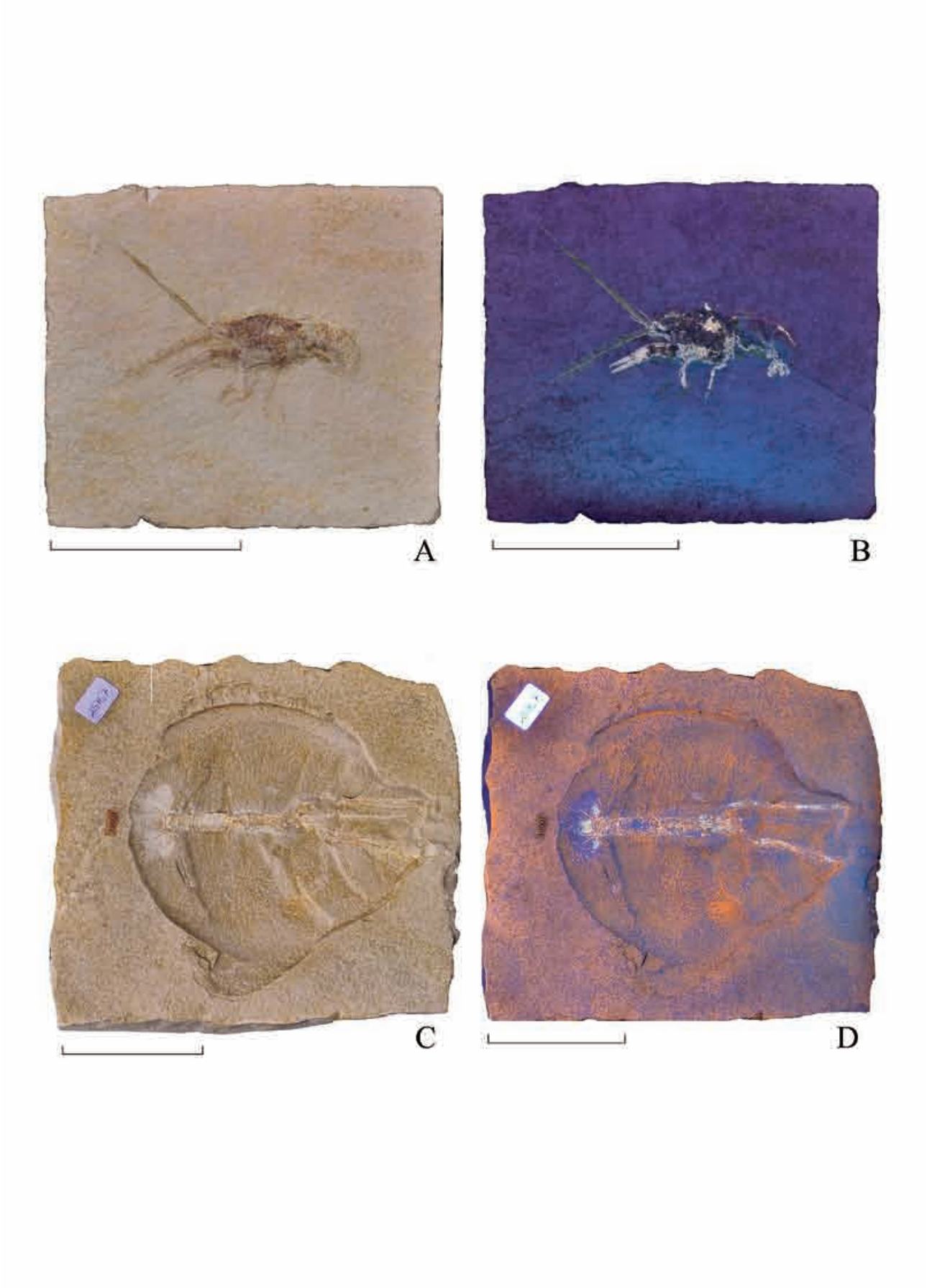

Fig. 9. Stenochiridae and Mecochiridae from the Late Jurassic Solnhofen Lithographic Limestones (Bavaria, Germany). **A, B**) *Pseudastacus pustulosus* (Münster, 1839), MSNPV 24670, lateral view, natural and UV light. **C, D**) *Mecochirus longimanatus* (Schlotheim, 1820), MSNPV 15767, dorsal view, natural and UV light. Scale bar equals 5 cm.

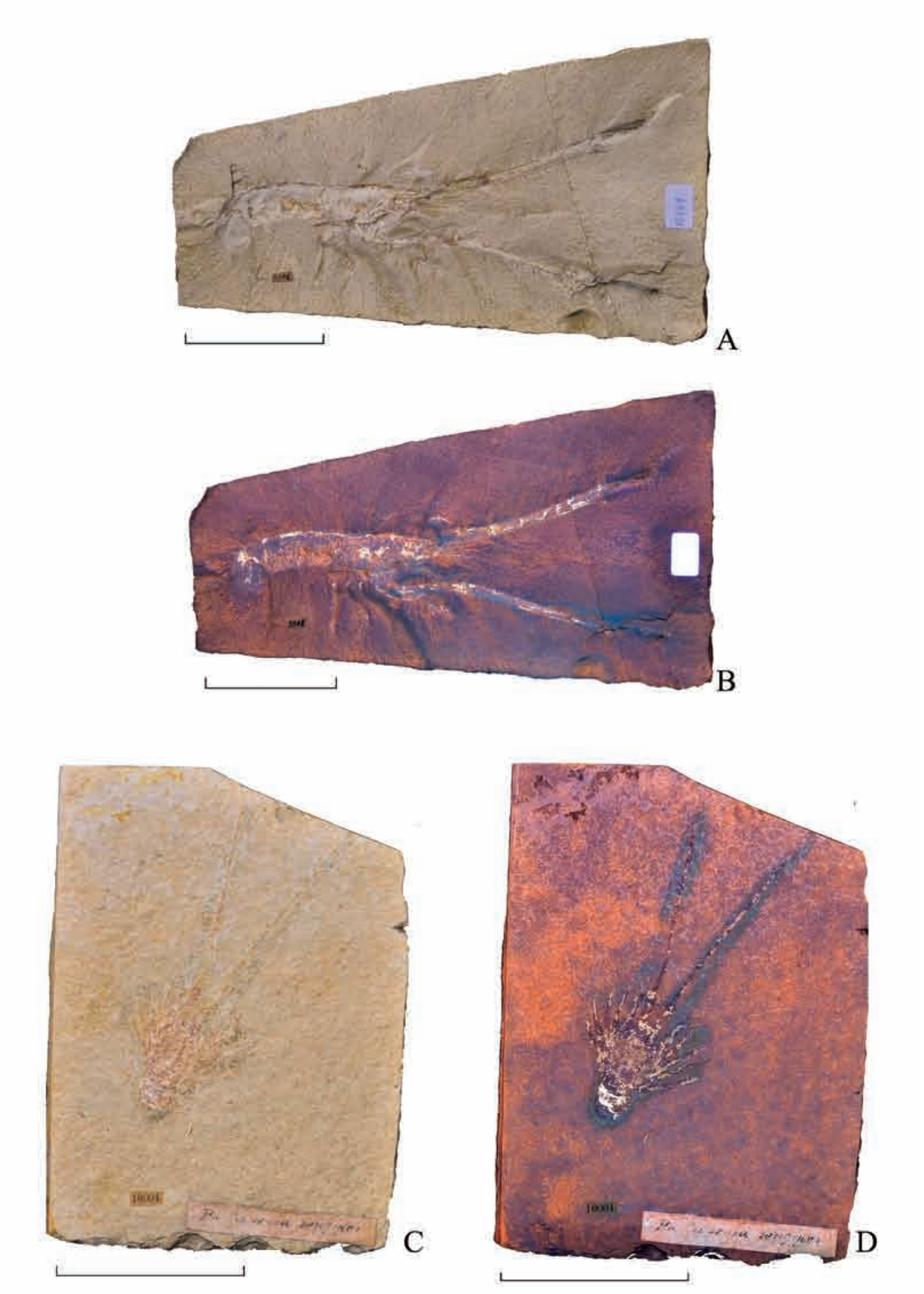

Fig. 10. Mecochiridae and Palinuridae from the Late Jurassic Solnhofen Lithographic Limestones (Bavaria, Germany). **A, B**) *Mecochirus longimanatus* (Schlotheim, 1820), MSNPV 15771, lateral view, natural and UV light. **A, B**) *Palinurina longipes* Münster, 1839, MSNPV 24663, dorsal view, natural and UV light. Scale bar equals 5 cm.

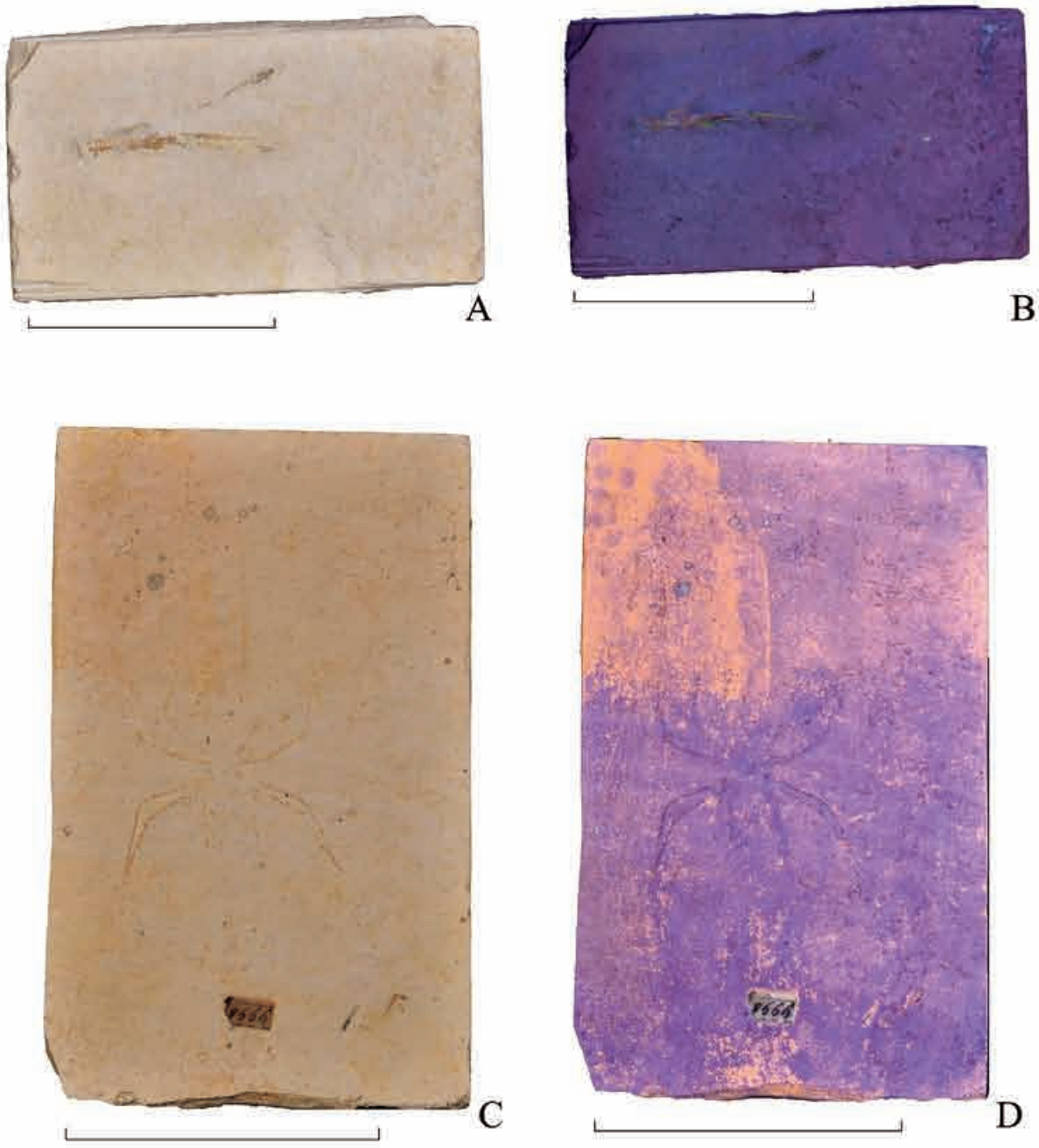

Fig. 11. Palinuridae from the Late Jurassic Solnhofen Lithographic Limestones (Bavaria, Germany). **A**, **B**) *Palinurina longipes* Münster, 1839, MSNPV 24664, dorsal view, natural and UV light. **C**, **D**) Phyllosoma larva type A, MSNPV 24680, dorsal view, natural and UV light. Scale bar equals 5 cm.

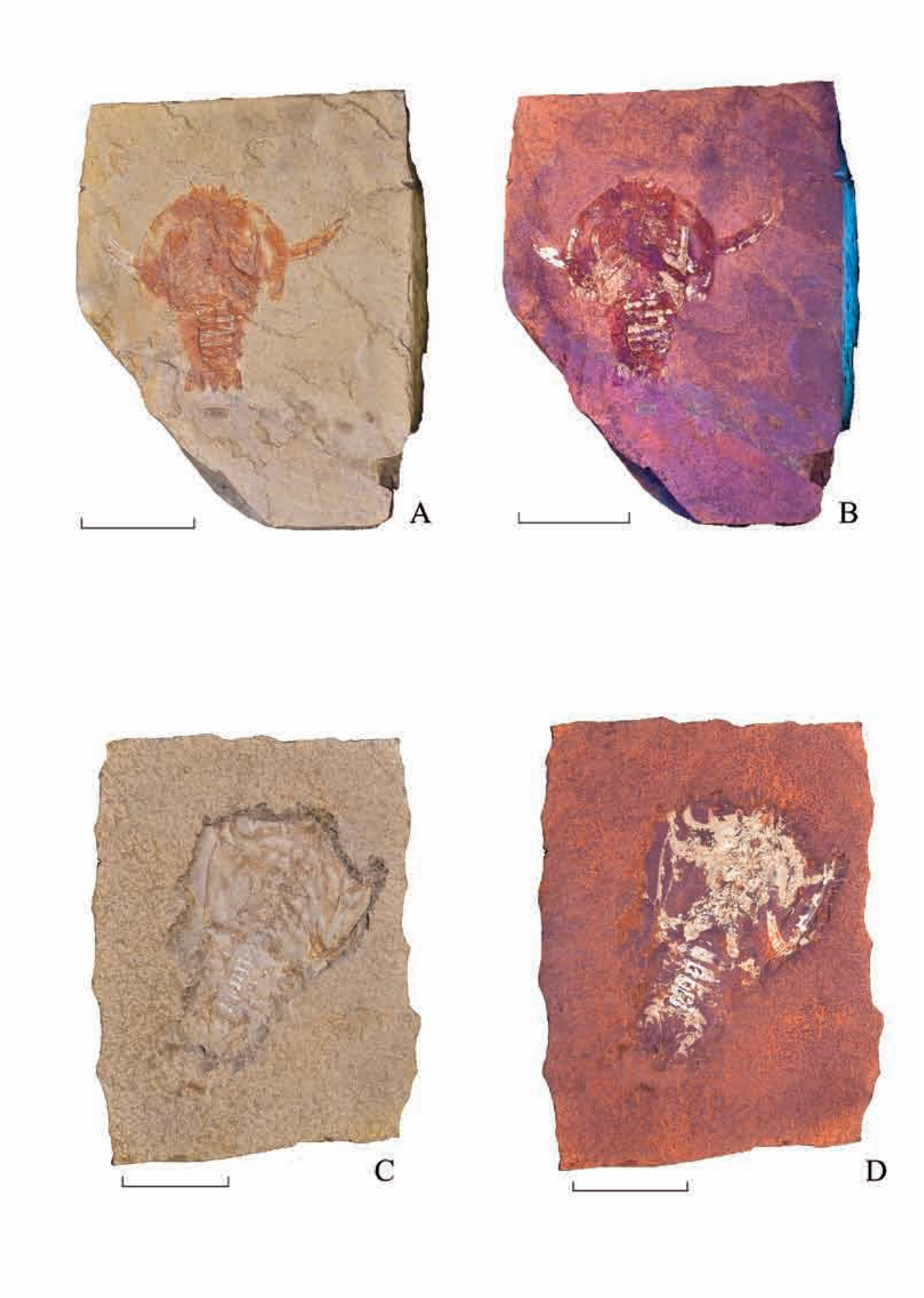

Fig. 12. Eryonidae from the Late Jurassic Solnhofen Lithographic Limestones (Bavaria, Germany). **A, B**) *Cycleryon orbiculatus* (Münster, 1839), MSNPV 24679, dorsal view, natural and UV light. **C, D**) *Eryon cuvieri* Desmarest, 1817, MSNPV 24677, dorsal view, natural and UV light. Scale bar equals 5 cm.

Fig. 13. Eryonidae and Limulidae from the Late Jurassic Solnhofen Lithographic Limestones (Bavaria, Germany). **A, B**) *Eryon cuvieri* Desmarest, 1817, MSNPV 15772, dorsal view, natural and UV light. **C, D**) *Mesolimulus walchii* (Desmarest, 1817), MSNPV 15774, dorsal view, natural and UV light. Scale bar equals 5 cm.

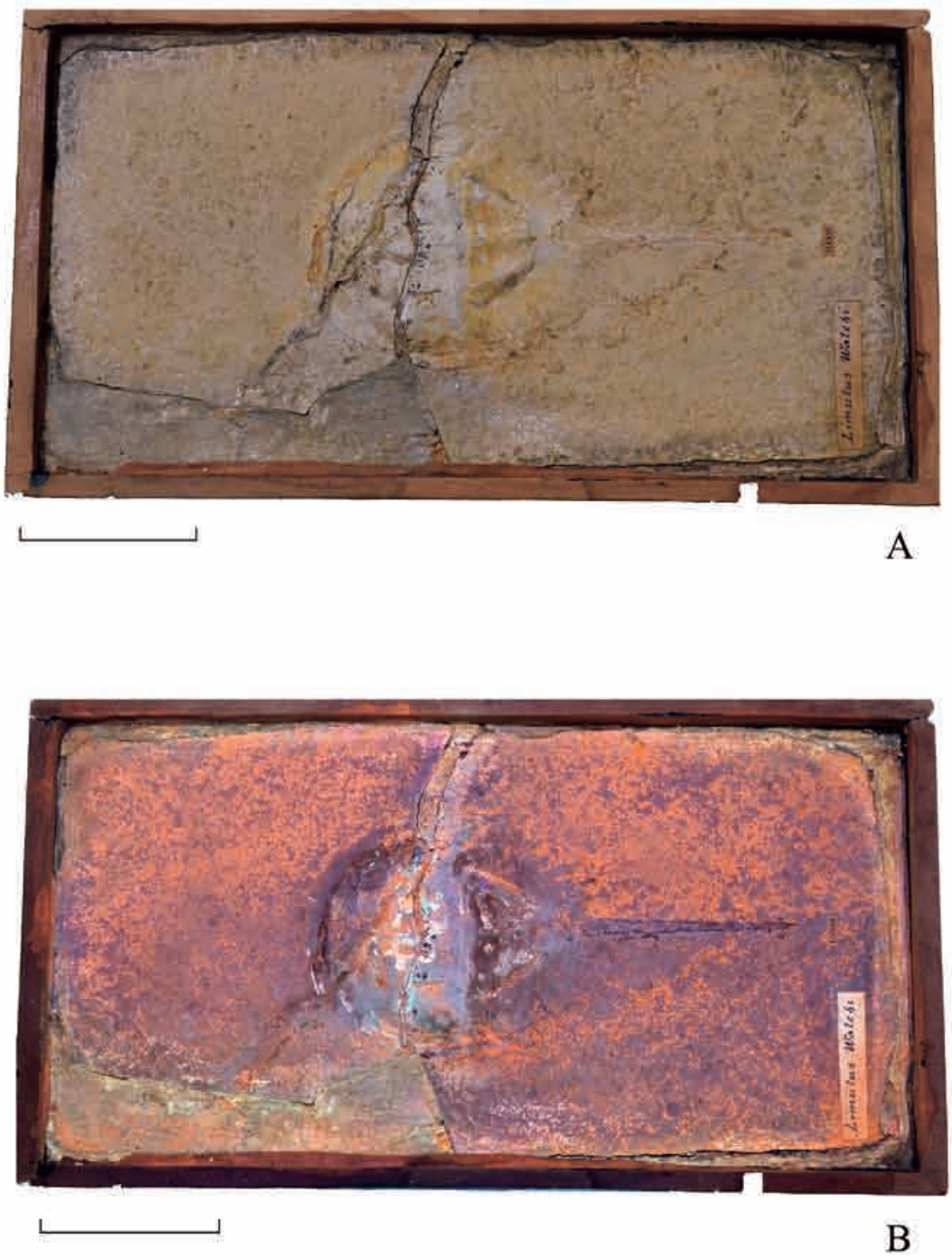

Fig. 14. Limulidae from the Late Jurassic Solnhofen Lithographic Limestones (Bavaria, Germany). **A, B**) *Mesolimulus walchii* (Desmarest, 1817), MSNPV 15775, dorsal view, natural and UV light. Scale bar equals 5 cm.