

# Stuttgarter Beiträge zur Naturkunde

## Serie B (Geologie und Paläontologie)

Herausgeber:

Staatliches Museum für Naturkunde, Rosenstein 1, D-70191 Stuttgart

Stuttgarter Beitr. Naturk.	Ser. B	Nr. 369	13 S., 3 Abb., 2 Tab., 2 Taf.	Stuttgart, 29. 6. 2007
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### The petasma of *Antrimpos undenarius* SCHWEIGERT (Crustacea: Penaeidae) from the Nusplingen Litho- graphic Limestone (Upper Jurassic, SW Germany)

Das Petasma von *Antrimpos undenarius* SCHWEIGERT  
(Crustacea: Penaeidae) aus dem Nusplinger Plattenkalk  
(Oberjura, Südwestdeutschland)

HERMANN POLZ

#### Abstract

The petasma of *Antrimpos undenarius* SCHWEIGERT is compared with the petasmata of *A. speciosus* MÜNSTER and "*Penaeus*" *meyeri* OPPEL, and recognized as an important distinctive feature. In contrast to the petasma of *A. undenarius* with its long lateral lobe, distally forming a large gentle hook, thus ventral costa strongly curved, *A. speciosus* MÜNSTER shows a petasma with a lateral lobe distolaterally produced into a small auriculate, flaplike projection. The petasma of "*Penaeus*" *meyeri* OPPEL differs markedly by its lateral lobe, distally increasing in width and terminating in a thin, dorsally broadened spatula- to shovelshaped and presumably flexible part.

Nomenclatural changes of MÜNSTER's genera *Antrimpos* and *Koelga* are listed.

Key words: Upper Jurassic, Upper Kimmeridgian, Nusplingen, *Antrimpos undenarius*, *Antrimpos speciosus*, "*Penaeus*" *meyeri*, petasma.

#### Zusammenfassung

Das Petasma von *Antrimpos undenarius* SCHWEIGERT wird mit den Petasmata von *A. speciosus* MÜNSTER und „*Penaeus*“ *meyeri* OPPEL verglichen und als wichtiges artspezifisches Unterscheidungsmerkmal vorgestellt. Im Gegensatz zum Petasma von *A. undenarius* mit seinem langen Seitenstrang (lateral lobe), der distal einen großen Haken bildet, wodurch die ventrale Rippe kräftig gebogen ist, besitzt *A. speciosus* MÜNSTER ein Petasma, dessen lateral lobe distolateral eine ohrenförmige, lappenartige Ausbuchtung zeigt. Das Petasma von „*P.*“ *meyeri* unterscheidet sich ausgesprochen deutlich von den beiden vorigen, indem es in einem breiten dorsal ausgerichteten, spatel- bis schaufelförmigen, vermutlich flexiblen Abschnitt endet.

Nomenklatorische Änderungen bei den MÜNSTER'schen Gattungen *Antrimpos* und *Koelga* werden aufgelistet.

## 1. Introduction

Morphology of the reproductive structures is one of the key characters in crustaceans. The structure of gonopods in the Decapoda (e.g. KLAUS et al. 2006) has proved to be a helpful feature for gender- as well as for species-identification, and is equally important in phylogeny. In male Dendrobranchiata the characteristic secondary sexual structure is called the petasma (DALL et al. 1990, BAUER 1991, PÉREZ FARFANTE & KENSLEY 1997). It is a specialised appendage developed by modification of the hypothetical basic pattern of the uniform appendages of Crustacea. This also concerns male Penaeoidea, where the endopods of the first pair of abdominal appendages are coupled and changed into a folded to tubular shape (Pl. 2, Figs. 1 and 2).

In fossil crustaceans the discovery of clear identification characters is particularly welcome. The preservation of fossil petasmata is usually poor, even when they are discernible, and their state of preservation does not permit comparison with the condition of this character in living animals. Nevertheless, this external identification structure has already been applied in the systematic and phylogenetic interpretation of Penaeoidea from the Solnhofen Lithographic Limestones (POLZ 2002, 2003).

The Nusplingen Lithographic Limestone is a plattenkalk, approximately 0.5 million years older than that of Solnhofen. It is of Late Kimmeridgian age and the source of numerous crustaceans, more than 80 % representing the prawn genus *Antrimpos* (SCHWEIGERT 2001: 15). On account of morphological differences SCHWEIGERT (2001) erected the new species *A. undenarius*. Recently, in another case of excellent preservation from this site, a specimen of this species has been found to exhibit a well preserved petasma, which is described in this study.

### Acknowledgements

Thanks are due to Dr. GÜNTER SCHWEIGERT, Stuttgart, who encouraged to the author to report on this find. The Staatliches Museum für Naturkunde Stuttgart (SMNS) made available the specimen for this study. I am also indebted to Dr. W. D. I. ROLFE, Edinburgh, who provided valuable comments and kindly improved the English. Dr. G. SCHWEIGERT, Stuttgart, Dr. A. GARASSINO, Milan, and Dr. R. BÖTTCHER, Stuttgart, reviewed the manuscript and gave helpful comments.

## 2. Material

Among many other fossils found during the 2005 excavation in the Upper Kimmeridgian Nusplingen quarry was a specimen of *Antrimpos undenarius* with the petasma preserved. The thin slab containing the fossil comes from bed L, about 10 cm from top of the sequence (see section in DIETL et al. 1998).

Fossil shrimps and prawns are usually embedded in lateral position due to their lateral compression. Although this partly disintegrated specimen shows a nearly complete dorsal aspect, the petasma is not hidden underneath the body but has been displaced outside the first abdominal somite. The partial disintegration, especially of the appendages, may result from the circumstance that the animal was embedded with its back on the sediment layer, exposing the venter to various influences. Most of sixth abdominal somite and the tailfan are not available, as part of the slab is missing (Fig. 1).

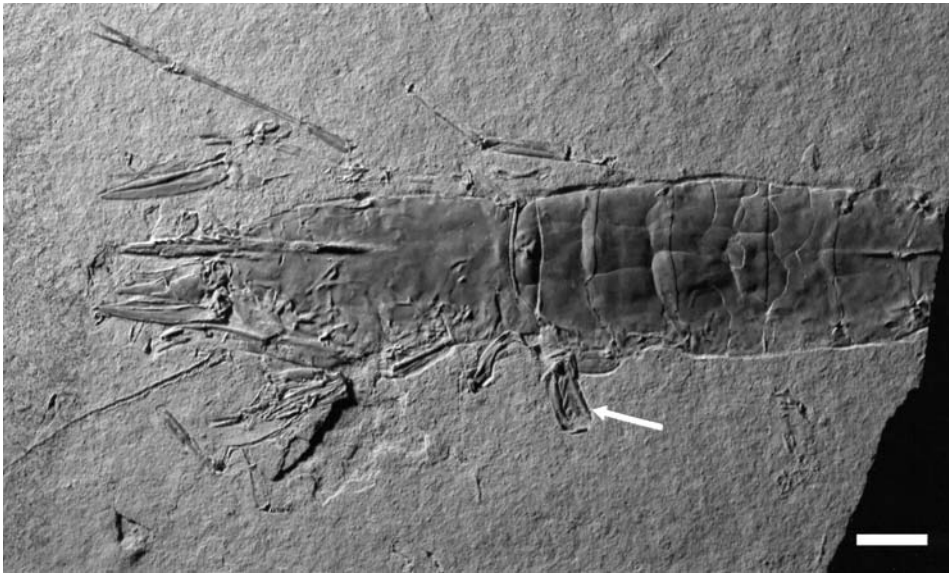
The specimen was prepared mechanically by the author, and is now housed in the collection of the SMNS, no. 66122.

### 3. Description

The studied specimen exhibits a well preserved left half, and the lateral lobe of the right half, of the petasma (Fig. 1). Presumably on account of partial disintegration and external mechanical effects, the petasma seems to be embedded in a turned position. The inner surface of the left half is visible now with the ventral margin directed anteriorly (Fig. 2). The lateral aspect (ventral part below) is sketched in Fig. 3A and B. Length is at least 11 mm, width 4.6 mm.

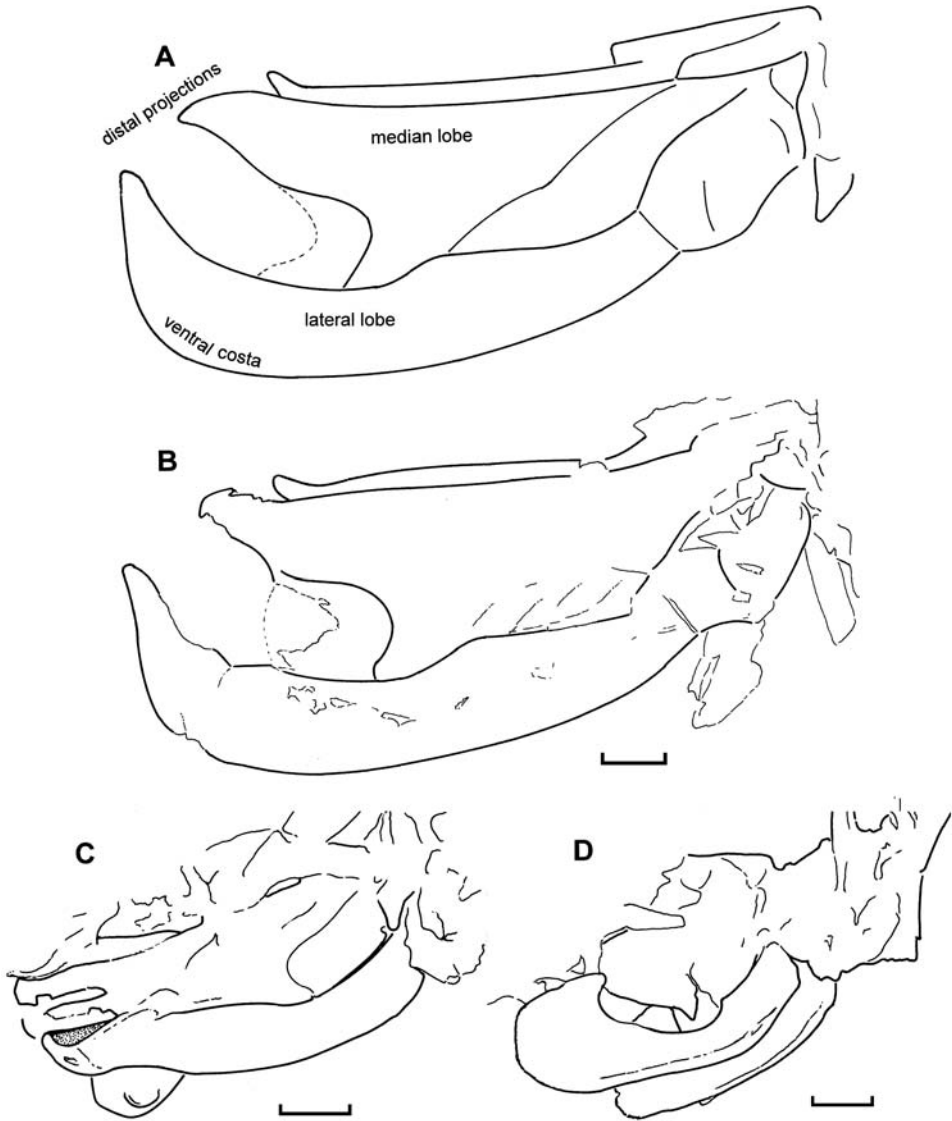
General shape: marked distinguishing features in petasmata are above all the distal (distolateral, distomedian) projections, apical parts of various structures (Plate 2, Fig. 3a and b). In this specimen the ventral costa of the lateral lobe is long, strongly curved and thus apically forms a blunt dorsally-directed hook, extending beyond the apex of the median lobe; the latter is relatively large, the anterior margin having a distinct medial concavity, the lobe terminating anteriorly in a blunt tip (Fig. 3A; Pl. 1, Figs. 1a and 2a).

Symmetry: a definite statement about this feature is not possible as only one half of the petasma is available. However, by chance the disintegrated lateral lobe of the second half of the petasma is preserved near by (Pl. 1, Figs. 1b and 2b). It is of the same shape as the corresponding part in the left half of the petasma, and therefore it is to be supposed that the petasma is a symmetrical one (PÉREZ FARFANTE & KENSLEY (1997): 24 of 26 listed penaeid genera have symmetrical petasmata; Tab. 1).



**Fig. 1.** *Antrimpos undenarius* SCHWEIGERT, with preserved petasma (→); Nusplingen Lithographic Limestone, Nusplingen quarry, bed L, Upper Kimmeridgian, Beckeri Zone, Ulmense Subzone. SMNS 66122. – Scale bar 1 mm.





**Fig. 3.** Comparison of petasmata. **A:** *Antrimpos undenarius* SCHWEIGERT; diagrammatic sketch with tentatively assigned terms used in penaeid taxonomy. **B:** *Antrimpos undenarius* SCHWEIGERT, (mirrored); Nusplingen Lithographic Limestone, Nusplingen quarry, bed L, Upper Kimmeridgian, Beckeri Zone, Ulmense Subzone; SMNS 66122. **C:** *Antrimpos speciosus* MÜNSTER; Solnhofen Lithographic Limestones, Lower Tithonian; author's collection no. 99032103. **D:** "*Penaeus*" *meyeri* OPPEL; Solnhofen Lithographic Limestones, Lower Tithonian; author's collection no. 94061601. C and D slightly altered after POLZ 2002. – Scale bars 1 mm.

petasma seems to be as well preserved as the cephalothorax or the abdominal somites, it must have been considerably sclerotized.

**Tab.2.** Penaeid species from the South German Jurassic Plattenkalks referred by MÜNSTER (1839) to his genera *Antrimpos* and *Koelga*, and their nomenclatural changes by selected subsequent authors. MÜNSTER (1839: 61, 62) mentioned in his description of *Koelga laevirostris* the name “*Squilla?*”, referring to BAIER’s *Squilla gibba* from 1757 (as pre-Linnean not valid). However, he did not indicate any reference to another taxon when describing *Koelga gibba*, thus, there is no connection with BAIER’s species name “*gibba*”.

BAIER 1757	WALCH 1773	MÜNSTER 1839	QUENSTEDT 1852	O. FRAAS 1855	QUENSTEDT 1858	OPPEL 1862	WALTHER 1904
	<i>Locusta marina</i>	<i>Antrimpos speciosus</i>	<i>Penaeus speciosus</i> (MÜNSTER)	<i>Penaeus speciosus</i> (MÜNSTER)	<i>Penaeus speciosus</i> (MÜNSTER)	<i>Penaeus speciosus</i> (MÜNSTER)	<i>Penaeus speciosus</i> (MÜNSTER)
		<i>Antrimpos angustus</i>	<i>Penaeus speciosus</i> (MÜNSTER)			<i>Penaeus speciosus</i> (MÜNSTER)	
		<i>Antrimpos bidens</i>	? <i>Penaeus speciosus</i> (MÜNSTER)			<i>Penaeus speciosus</i> (MÜNSTER)	
		<i>Antrimpos decemdens</i>	<i>Penaeus speciosus</i> (MÜNSTER)			<i>Penaeus speciosus</i> (MÜNSTER)	
		<i>Antrimpos nonodon</i>				<i>Penaeus speciosus</i> (MÜNSTER)	
		<i>Antrimpos tridens</i>				<i>Penaeus intermedius</i>	<i>Penaeus intermedius</i> OPPEL
		<i>Antrimpos trifidus</i>				<i>Penaeus speciosus</i> (MÜNSTER)	
		<i>Antrimpos senidens</i>				<i>Penaeus meyeri</i>	<i>Penaeus meyeri</i> OPPEL
		? <i>Antrimpos dubius</i>				<i>Penaeus intermedius</i>	
	<i>Squilla</i>	<i>Koelga quindens</i>	? <i>Penaeus speciosus</i> (MÜNSTER)			<i>Penaeus speciosus</i> (MÜNSTER)	
		<i>Koelga gibba</i> (after SCHWEIGERT 2001 nom. dub.)		<i>Penaeus speciosus</i> (MÜNSTER)	<i>Penaeus speciosus</i> (MÜNSTER)	<i>Penaeus speciosus</i> (MÜNSTER)	<i>Penaeus speciosus</i> (MÜNSTER)
		<i>Koelga septidens</i>				<i>Penaeus speciosus</i> (MÜNSTER)	
<i>Squilla gibba</i>		<i>Koelga laevirostris</i>				<i>Penaeus speciosus</i> (MÜNSTER)	
		<i>Koelga quadridens</i>				<i>Penaeus meyeri</i>	<i>Penaeus meyeri</i> (OPPEL)
		<i>Koelga curvirostris</i>					
		<i>Koelga dubia</i>				<i>Penaeus meyeri</i>	
		<i>Koelga tridens</i>				<i>Penaeus meyeri</i>	

Tab.2. Continuation.

ENGEL 1908	E. FRAAS 1910	BALSS 1922	VAN STRAELEN 1925	GLAESSNER 1929	DIETL et al. 2000	SCHWEIGERT 2001	SCHWEIGERT & GARASSINO 2004
		<i>Penaeus speciosus</i> (MÜNSTER)	<i>Antrimpos speciosus</i> MÜNSTER	<i>Antrimpos speciosus</i> MÜNSTER			
			<i>Antrimpos speciosus</i> MÜNSTER	<i>Antrimpos speciosus</i> MÜNSTER			
			<i>Antrimpos speciosus</i> MÜNSTER	<i>Antrimpos speciosus</i> MÜNSTER			
			<i>Antrimpos speciosus</i> MÜNSTER	<i>Antrimpos speciosus</i> MÜNSTER			
			<i>Antrimpos speciosus</i> MÜNSTER	<i>Antrimpos speciosus</i> MÜNSTER			
		<i>Penaeus intermedius</i> OPPEL	<i>Antrimpos intermedius</i> (OPPEL)	<i>Antrimpos intermedius</i> (OPPEL)			
			<i>Antrimpos speciosus</i> MÜNSTER	<i>Antrimpos speciosus</i> MÜNSTER			
		<i>Penaeus meyeri</i> OPPEL	<i>Antrimpos meyeri</i> (OPPEL)	<i>Antrimpos meyeri</i> (OPPEL)			
			<i>Antrimpos intermedius</i> (OPPEL)	<i>Antrimpos intermedius</i> (OPPEL)			
			<i>Antrimpos speciosus</i> MÜNSTER	<i>Antrimpos speciosus</i> MÜNSTER			
<i>Penaeus speciosus</i> (MÜNSTER)	<i>Penaeus speciosus</i> (MÜNSTER)		<i>Antrimpos speciosus</i> MÜNSTER	<i>Antrimpos speciosus</i> MÜNSTER	<i>Antrimpos aff. speciosus</i> MÜNSTER	<i>Antrimpos undenarius</i> SCHWEIGERT	
			<i>Antrimpos speciosus</i> MÜNSTER	<i>Antrimpos speciosus</i> MÜNSTER			
			<i>Antrimpos speciosus</i> MÜNSTER	<i>Antrimpos speciosus</i> MÜNSTER			
		<i>Penaeus meyeri</i> (OPPEL)	<i>Antrimpos meyeri</i> (OPPEL)	<i>Antrimpos meyeri</i> (OPPEL)			
				? <i>Drobna curvirostris</i> (MÜNSTER)		<i>Koelga curvirostris</i> MÜNSTER	
			<i>Antrimpos meyeri</i> (OPPEL)	<i>Antrimpos meyeri</i> (OPPEL)			
			<i>Antrimpos meyeri</i> (OPPEL)	<i>Antrimpos meyeri</i> (OPPEL)			

#### 4. Petasmata as distinguishing features in MÜNSTER's genera *Antrimpos* and *Koelga*

Fossil crustaceans which at present are referred to the genus *Antrimpos* MÜNSTER have undergone numerous nomenclatural changes since their first publication, partially depending on different estimation of their characters (Tab. 2). Discovering petasmata is therefore useful in discriminating them taxonomically.

The genera *Antrimpos* and *Koelga* were established by MÜNSTER (1839) comprising nine and eight species respectively, including nomina dubia: *Antrimpos speciosus*, the type species, designated by WOODS (1925), *A. angustus*, *A. bidens*, *A. decemdens*, *A. nonodon*, *A. tridens*, *A. trifidus*, *A. senidens*, and ?*A. dubius*, and *Koelga curvirostris*, as type species designated by SCHWEIGERT & GARASSINO (2004), *K. dubia*, *K. gibba*, *K. laevirostris*, *K. quadridens*, *K. quindens*, *K. septidens*, and *K. tridens*. He suggested crustaceans formerly mentioned by BAIER (1757) and WALCH (1773) as species of his new erected genera. BAIER dealt with fossils of his father's collection, among them "*Squilla gibba*", while WALCH divided his fossils into groups with or without bones. Among boneless animals he listed "Gamarrholithen und Trilobiten" as insects with a shell, including among others the crustaceans "*Locusta marina*" and "*Squilla*".

MÜNSTER (1839) pointed out the similarity of his genus *Antrimpos* to the modern genus *Penaeus* FABRICIUS, 1798, a similarity which induced OPPEL (1862), who considered a few of MÜNSTER's taxa to be nomina dubia, to synonymise the genus with *Penaeus*. He attributed MÜNSTER's *Antrimpos*- and *Koelga*-species from the Upper Jurassic to three species only: *Penaeus speciosus* (MÜNSTER), *P. intermedius* OPPEL, and *P. meyeri* OPPEL. VAN STRAELEN (1925) and GLAESSNER (1929) recognized only three of MÜNSTER's species in accepting OPPEL's revision and reactivating MÜNSTER's genus *Antrimpos*: *A. speciosus* MÜNSTER, *A. intermedius* (OPPEL), and *A. meyeri* (OPPEL).

DIETL et al. (2000) suggested the numerous fossil prawns from the Nusplingen Lithographic Limestone were of *A. speciosus* affinity, only. Finally SCHWEIGERT (2001) described these finds as a closely related but separate form, differing from the type species above all by one more dorsal tooth in the rostrum, the eleventh. He therefore erected the species *undenarius*.

Further evidence of *A. undenarius* as a separate species is now furnished by the well preserved petasma of the find described herein. Petasmata, key features in Sergestoidea, are not only a means of distinguishing between the sexes but are also important species characters, as are the thelyca in females. The petasmata of *A. undenarius* and of two related penaeids from the South German Upper Jurassic clearly differ from each other in the shape of the distal parts of their lateral lobes (Fig. 3):

*A. undenarius* SCHWEIGERT (MÜNSTER's "*Koelga gibba*") is considered as a nomen dubium by SCHWEIGERT 2001: 12): lateral lobe long, distally turning upwards in an angle of about 60 degrees and forming a large gently-curved hook, with strongly curved ventral costa (Fig. 3 B).

*A. speciosus* MÜNSTER: lateral lobe distolaterally produced into a small auriculate, flaplike projection (Fig. 3 C, dotted area).

"*Penaeus*" *meyeri* OPPEL (= MÜNSTER's *Antrimpos senidens*, *Koelga quadridens*, *K. dubia*, and *K. tridens*, considered as nomina dubia by OPPEL (1862)): lateral lobe strongly curved, increasing in width and terminating in a rather thin, presumably

flexible, dorsally broadened, spatula- to shovel-shaped part (Fig. 3 D). This petasma shows a clearly diverging shape compared with the other species. Though a penaeid, the species is probably not a member of the genus *Antrimpos*.

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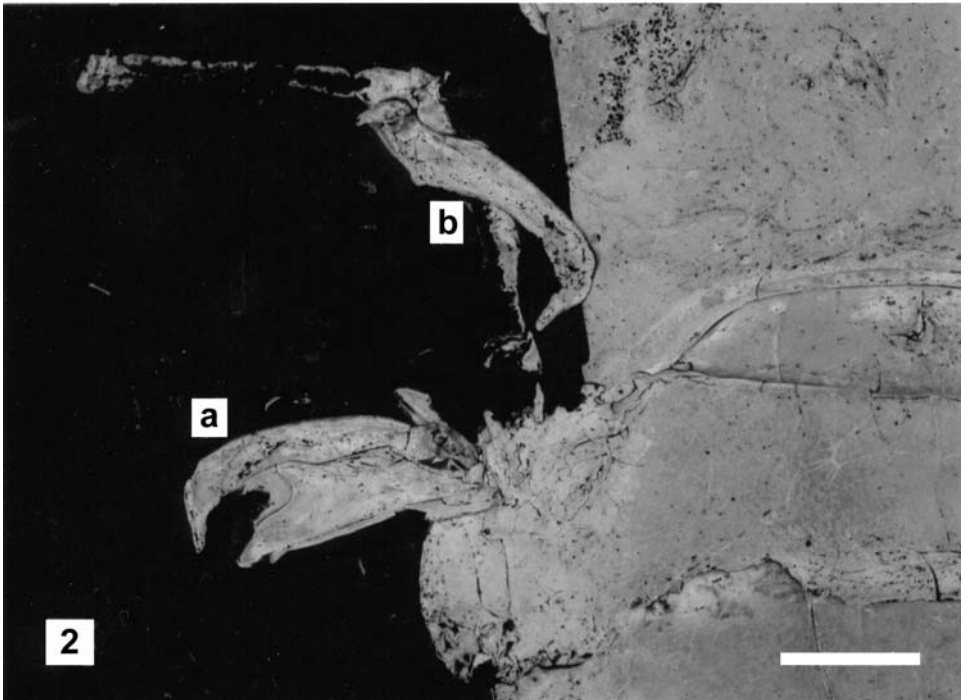
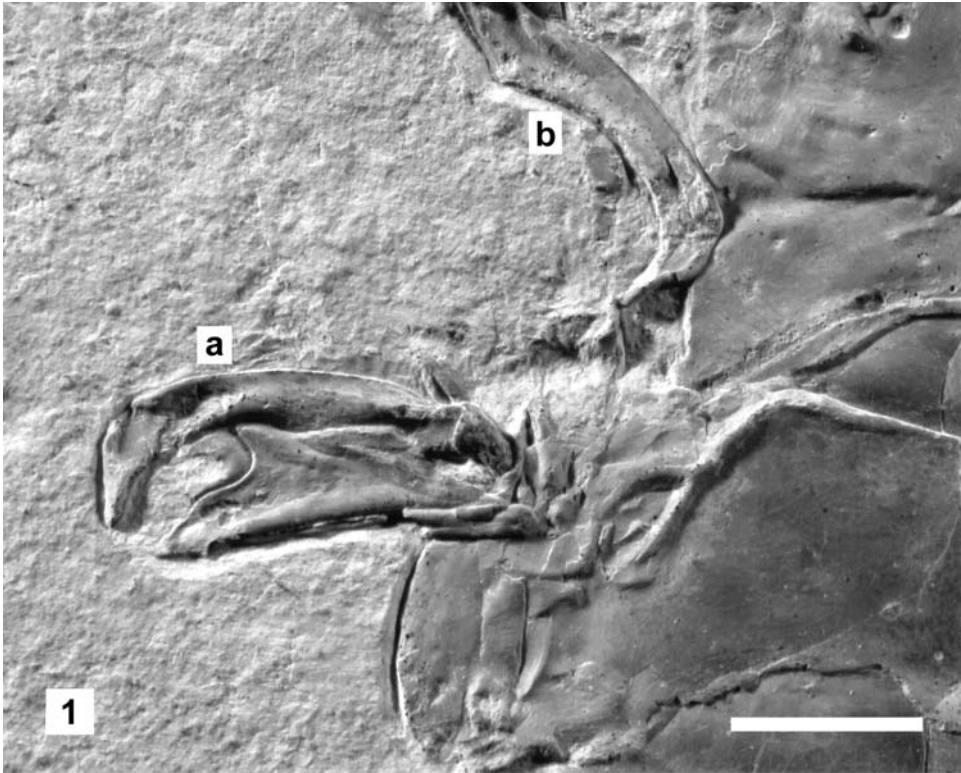
Manuscript received: 8.2.2007, accepted: 19.4.2007.

## Plate 1

*Antrimpos undenarius* SCHWEIGERT. Nusplingen Lithographic Limestone, Nusplingen quarry, bed L, Upper Kimmeridgian, Beckeri Zone, Ulmense Subzone. SMNS 66122. – Scale bars 1 mm.

Fig. 1. Petasma (a) and disintegrated lateral lobe of second half of petasma (b).

Fig. 2. As Fig. 1, in ultraviolet illumination.



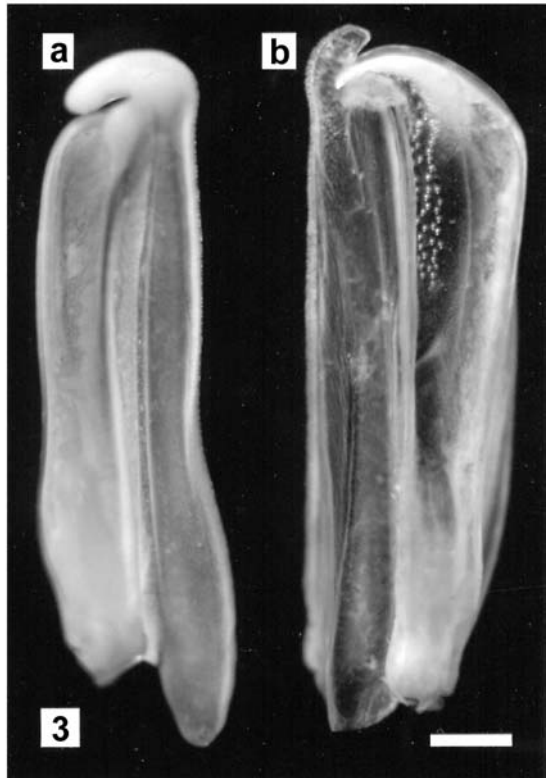
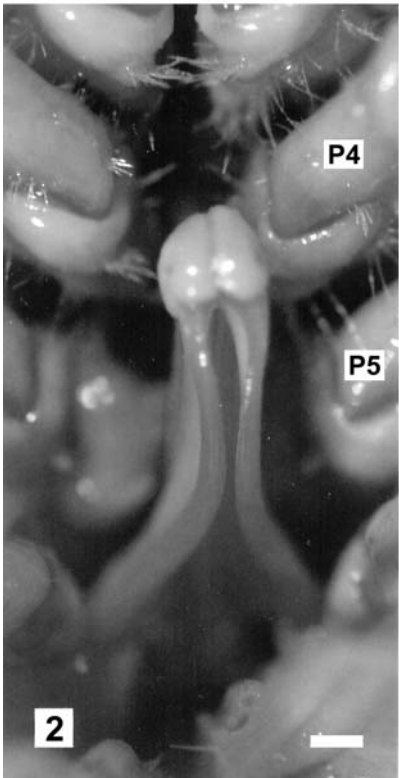
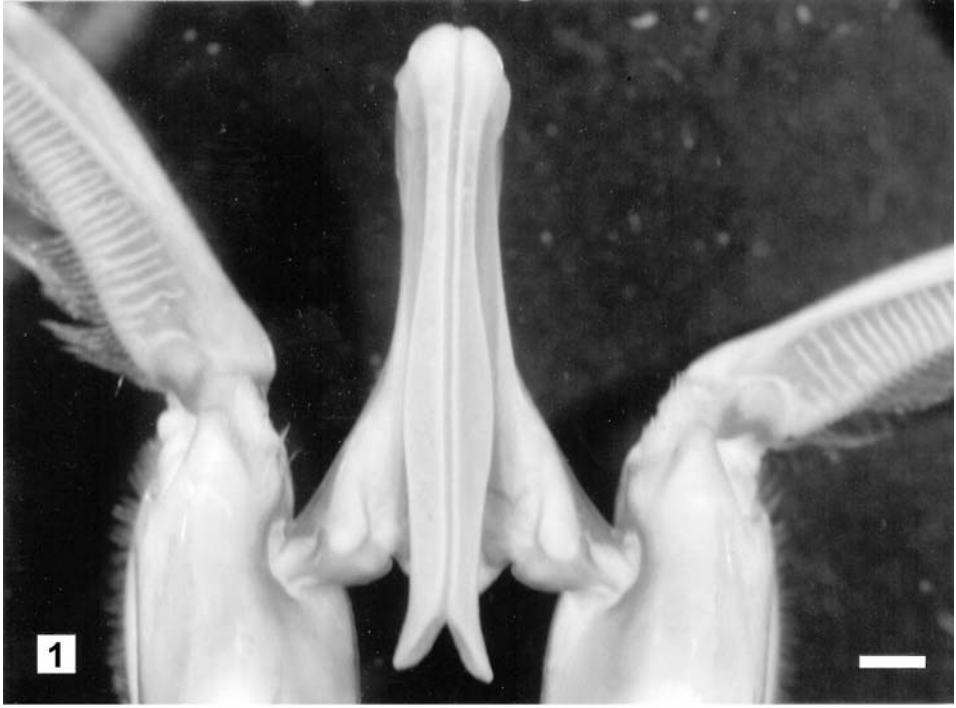
## Plate 2

Petasmata of living Penaeidae; author's collection. – Scale bars 1 mm.

**Fig. 1.** *Marsupenaeus japonicus* (BATE); petasma (= coupled endopods) between pleopods 1, dorsal view; coll. no. 06072302.

**Fig. 2.** *Marsupenaeus japonicus* (BATE); petasma anteriorly directed, distally extending to the bases of pereopods 4 (P4); coll. no. 06072301.

**Fig. 3.** Isolated sides of petasmata. **a:** *Marsupenaeus japonicus* (BATE); right half (= right endopod), ventrolateral view; median lobe on the right; coll. no. 06072303. **b:** *Fenneropenaeus indicus* (H. MILNE EDWARDS); left half (= left endopod), ventral view; lateral lobe and ventral costa on the right; coll. no. 06080101.







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ISSN 0341-0153

Autoren-Richtlinien: <http://www.naturkundemuseum-bw.de/stuttgart/schriften>  
Schriftleitung: Dr. Ronald Böttcher, Rosenstein 1, 70191 Stuttgart  
Gesamtherstellung: Gulde-Druck, 72072 Tübingen