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Yongjicaris zhejiangensis n. gen. n. sp. (Crustacea, Decapoda, Caridea) from the Lower Cretaceous of Zhejiang Province, China

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Abstract

Decapod crustaceans referred to the new genus and new species *Yongjiacaris zhejiangensis* in the infraorder Caridea Dana, 1852, family Palaemonidae Rafinesque, 1814, were discovered at two different localities in China: the C Member of the Moshishan Formation in Chengtian village (Yongjia County, Zhejiang Province) and the Showchang Formation in Dongkengli village, Showchang Town (Jiande County, Zhejiang Province). The crustaceans are associated with plants, conchostracans and insects. Based upon palynomorphs, plants, and conchostracans, the fossil-bearing beds are probably Barremian in age (Lower Cretaceous). It is the second report of freshwater carideans in Mesozoic rocks.

Key words: Crustacea, Decapoda, Lower Cretaceous, China

Introduction

Fossil freshwater caridenans are very rare in the world. The examined specimens were collected from two localities: the C Member of the Moshishan Formation in Chengtian village, Yongjia County and Showchang Formation in Dongkengli village, Showchang Town, Jiande County of Zhejiang Province, SE China (Fig. 1). Dr. Wei Feng (Natural History Museum of Hangzhou) had first discovered these interesting specimens at Dongkengli locality in December 1963. However, the specimens of this locality are very rare and not well preserved. The 3rd branch of the Regional Geological Surveying Team, Geological Bureau of Zhejiang Province found more specimens at the Chengtian location in October 1975. After this discovery, abundant specimens were collected

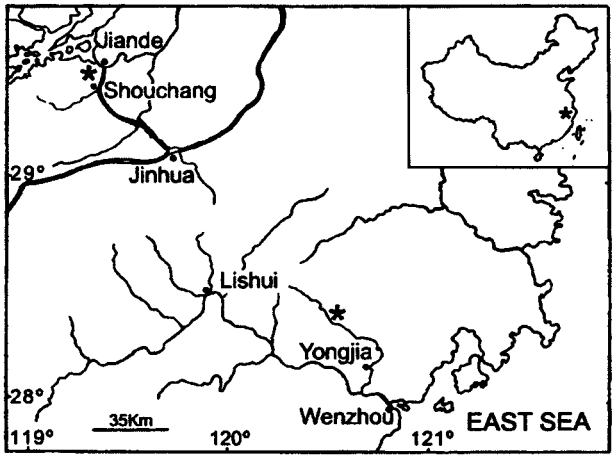


Fig. 1. Geographical map of the sites.

from this locality by Shen from 1985 to 1977, S. F. Morris (Natural History Museum of London) in 1990, and Taylor in 1997. The examined carideans include the collections of the above-mentioned investigations. The decapod crustaceans are associated with plants, conchostracans, ostracods, and insects. Based upon palynoflora, plants, and conchostracans, the fossil-bearing beds are of Early Cretaceous in age, probably Barremian (Chen and Shen, 1982; Cao, 1999; Chen, 2000). The study specimens are decapods referred to *Yongjiacaris zhejiangensis* n. gen. and n. sp. (infraorder Caridea Dana, 1852, family Palaemonidae Rafinesque, 1814). It is the second report of freshwater carideans in Mesozoic sediments.

Geological setting

Cretaceous rocks in China are mainly of continental origin, except in Southwestern Xinjiang, Tibet and probably Western Taiwan, as a result of a major marine regression in late Jurassic. The approximately 2.000 nonmarine Cretaceous basins are widely distributed in China (Zhu *et al.*, 1983). They contain a variety of sedimentary facies, and have yielded a substantial fossil fauna and flora. Following the Indosinian Movement, China began a new tectonic stage, the Yanshan Movement. Because of the subduction of the Pacific Plate toward the east part of the Asian block, numerous volcanic events occurred in different stages, resulting in the formation of a series of aligned volcanic faults in East China. In Zhejiang many basins were formed along the basal fault in a NE-NNE direction, and accumulated very thick volcano-sedimentary series. The volcanic rocks tend to increase in thickness from west to east (Jiang *et al.*, 1993). The Jiande Group is considered as the representative in the Showchang Basin, western Zhejiang. It is composed of four formations in descending order as follows: the Heshan Formation (mainly red beds), the Showchang Formation (variegated lacustrine and fluvial deposits), the Huangjian Formation (andesite lavas), and the Laocun Formation (volcanic rocks with red beds). A few specimens of carideans were discovered in the grey siltstones of the Showchang Formation near Dongkengli village, Showchang Town.

Subdivion and correlation of the Lower Cretaceous of Zhejiang

The Moshishan Formation of the Lower Cretaceous is widely distributed in Eastern Zhejiang and chiefly consisted of volcanic rocks. It is subdivided into four members (Fig. 2). The abundant fossil carideans were discovered in C Member of this Formation at Chentian village, Yongjia County. They are preserved in dark mudstone. The C Member is correlative with the Showchang Formation in Western Zhejiang. The stratigraphic section of this locality is reported in Fig. 3

Eastern Zhejiang			Western Zhejiang		Fossils	Isotopic age
Fomation	Member	Lithologic character	Fomation	Lithologic character		
Moshishan	D	Rhyolites, sandstone, felsite,perlite 210-2400m	Heshan	Red siltstone, sandstone	Plants, charophytes, bivalves, ostracods, conchostracans	117Ma
	C	Sandstone, shale, tuff, conglomerate, rhyolite 100-1600m	Showchang	Variegated sandstone, mudstone	Plants, charophytes, bivalves, ostracods, conchostracans, insects, carideans	120Ma
	B	Thick-bedded rhyocrystal welded tuff, crystal tuff 800-2300m	Huangjian	Andesite lava		128Ma
	A	Rhyocrystal welded tuff, tuffaceous sandstone 800-4700m	Laocun	Andesite lava with red sandstone	Conchostracans	129Ma

Fig. 2. Subdivision and correlation of the Lower Cretaceous of Zhejiang.

Upper part of the C Member of the Moshishan Formation	
----------Unconformity----------	
Middle part of the C Member of the Moshishan Formation, total thickness 706.7 m	
10.	Dark a massive basaltic andesites, 41.1 m
9.	Yellowish a tuffaceous conglomerate, 181.2 m
8.	Purple tuffaceous siltstone, 105.4 m
7.	Purple agglomerate and andesite, 62.3 m
6.	Light purple gray tuffaceous conglomerate, 67.6 m
5.	Gray andesite intercalated with purple siltstone at the upper part; purple siltstone containing pebble at the lower part, 39.2 m
4.	Yellowish gray coarse sandstone and dark mudstone yielding plants: *Cladophlebis* cf. *browniana* (Dunker) Seward, *Hysterites* sp., *Onychiopsis elongata* cf. *Coniopteris nympharum* (Heer) Vachrameev, cf. *Coniopteris burejensis* (Zal.), *Sphenopteris acrodentata* Fontaine, *Nilssonia vongjiangensis* Cao, *Cycadites* sp., *Ptilophyllum* cf. *arcticum* (Heer), *P. latipinnatum* Cao, *P.* spp., *Dictyozamites kawasakii* Tateiwa, *Otozamites* sp., *Zamites* sp., *Pityolepis* sp., *Cupressinocladus lii* Cao, *Sagenopteris petiolata* Oishi, *S.* cf. *showchangensis* Lee; conchostracans: *Yanjiestheria sinensis* (Chi), *Orthestheria intermedia* (Chi); insects: *Coptoclava longipoda* Ping and carideans: *Yongjianocaris zheiiangensis* n. gen. n. sp., 41.7 m
3.	Tuffaceous siltstone and sandstone intercalated with tuff at the upper part; silstone intercalated mudstone at the lower part, 80.1 m
2.	Light gray mid-thick bedded tuffites, 18.9 m
1.	Dark mudstone at the top part; gray siltstone at the mid-upper parts; light gray siltstone and mudstone at the lower part; tuffaceous sandstone at the base, 69.2 m
----------Conformity----------	
Lower part of the C Member of the Moshishan Formation: tuff and andesites	

Fig. 3. Stratigraphical section of the C Member of the Moshishan Formation.

(after the 3rd branch of Regional Geological Surveying Team of Zhejiang, 1977).

The fossil carideans in both localities are associated with plants, ostracods, conchostracans and insects. The conchostracans include *Yanjiestheria sinensis* (Chi) and *Orthestheria intermedia* (Chi) that are important elements of the Lower Cretaceous (Chen and Shen, 1982). The fossil floras belong to the Euro-Sinian region of Vachrameev and *Cladophlebis-Ptilophyllum* assemblage (Cao, 1999). This flora is identical with the several well-known Lower Cretaceous floras in the world, such as the Wealden Flora of Europe, the Nikan Flora from Southern Primorye of Russia and the Ryoseki Flora of Japan. The flora of Zhejiang contains relatively abundant Filicales and Bennettiales, with rare ginkgophytes, reflecting the locations of the flora in the tropical to subtropical region in that time. The pinnules of *Cladophlebis* are small in size, with thick matrix. The segments of cycadophytes are mostly provided with thickened " margins ". The conifers are dominated by those taxa with scale-like leaves, which have thick cuticle. All these characteristics indicate the relatively dry and hot climatic during that time (Cao, 1999). The isochronal age of the volcanics of the Showchang Formation by Rb-Ar is 118 ± 4 Ma, and the C Member of the Moshishan Formation is 120 Ma (Hu *et al*., 1982; Jiang *et al*., 1993). That indicates these beds are of the Lower Cretaceous in age, probably Barremian.

Systematic Palaeontology

Infraorder Caridea Dana, 1852

Family Palaemonidae Rafinesque, 1815

Genus *Yongjiacaris* n. gen.

Type species: *Yongjiacaris zhejiangensis* n. sp.

Diagnosis: Subquadrangular carapace without grooves and spines; short rostrum without supra- and subrostral teeth; somite II with subrounded pleura partly overlapping those of somite I and III; pereiopods I-II with thin, short chelae; telson with two pairs of spines on dorsal surface and a row of spines on distal extremity; exopod of uropod with diaeresis.

Etymology: The trivial name alludes to Yongjia County, the locality in which the examined specimens were discovered.

Yongjiacaris zhejiangensis n. sp.

(Figs. 4-6)

Etymology: The trivial name alludes to Zhejiang

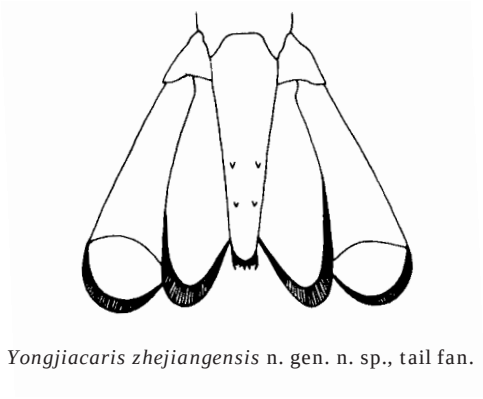


Fig. 4. *Yongjiacaris zhejiangensis* n. gen. n. sp., tail fan.

Province.

Holotype: 126296, the C Member of the Moshishan Formation, Chengtian village (Yongjia County, Zhejiang Province, China).

Paratypes: 126288, 126289, 126300 B, 126304 from the same locality. Holotype and paratypes are deposited in Nanjing Institute of Geology and Palaeontology, Chinese Academy of Sciences.

Measurements: The specimens have a total length of between 1.5 and 2 cm.

Occurrence: 138 specimens collected from the C Member of the Moshishan Formation (Yongjia County, Zhejiang Province, China), Barremian (Lower Cretaceous).

Description: Caridean with thin, smooth exoskeleton. Carapace subquadrangular in lateral view, narrows slightly along anterior margin due to slight curvature of ventral margin. Dorsal margin slightly convex; posterior margin with thin marginal carina, slightly sinuous, with slight concavity in lower third. Ventral margin curvilinear. Dorsal margin extends anteriorly into short rostrum, with pointed distal extremity, and without supra- and subrostral teeth. Orbit narrow and shallow; antennal and pterigostomial angles not well marked. No traces of grooves, carinae, or spines on carapace surface. Abdominal somites III subrectangular and bigger than somites I and IV. Somite II with subrounded pleura partly overlapping those of somites I and III. Somite VI subquadrangular. Posterior margin of somite III slightly sinuous; those of somite IV-V posteriorly projecting. Telson narrow, with rounded distal extremity and two pairs of spines of same size on dorsal surface, and a row of thin spines of same size at distal extremity (Fig. 4). Uropods about 1/3 longer than telson. Exopod with rounded diaeresis. Antennular peduncle with 1st article thin and elongate; the 2nd not much elongate; the 3rd short and stocky to which short flagella are articulated. Scaphocerite with laminar shape and pointed distal extremity; flagellum, twice body length, articulated to subrectangular carpus of peduncle. 3rd maxilliped thin, elongate, and spineless. Pereiopods I-II with short, thin chelae. Pereiopods III-V with terminal dactylus, articles thin, strongly elongate. Pleopods with subrectangular protopodite to which two elongate multiarticulate flagella are articulated.

Discussion: Carideans are very rare in the fossil record and their morphological characters are not easily recognized because of their frequent poor state of preservation. The oldest genera known to date, *Acanthinopus* Pinna, 1974 and *Leithorax* Pinna, 1974, were discovered in the Zorzino Limestone (Norian, Upper Triassic) of Bergamo Pre-alps (Cene, Seriana Valley, Bergamo, N Italy) (Pinna, 1974). Another form, *Pinnacaris* Garassino and Teruzzi, 1993, was described in the Argilliti di Riva di Solto (Sevatian, Upper Norian-Lower Rhaetian, Upper Triassic) of Ponte Giurino (Imagna Valley, Bergamo, N Italy) (Garassino and Teruzzi, 1993). Glaessner (1969) ascribed to the carideans

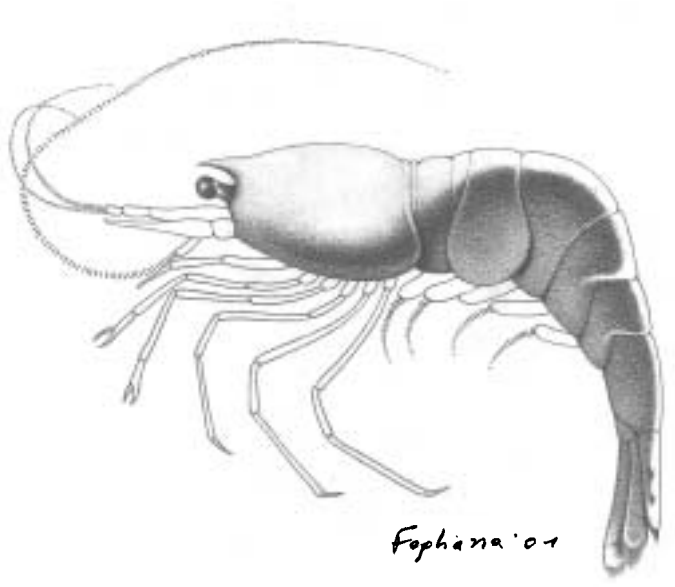


Fig. 5. *Yongjiacaris zhejiangensis* n. gen. n. sp., reconstruction.

the Jurassic genus *Udorella* Oppel, 1862 (family Udorellidae Van Straelen, 1925), and he also noted three additional Jurassic genera as *incertae sedis* to the carideans: *Blaculla* Münster, 1839, *Hefriga* Münster, 1839 and *Udora* Münster, 1839. We now recognize seven genera of Cretaceous carideans. First, Martins-Neto and Mezzalira (1991a) found a few specimens of carideans in the Crato Member of the Santana Formation (Lower Cretaceous) of Brazil. The perfect state of preservation of these specimens allowed the authors to describe *Beurlenia*

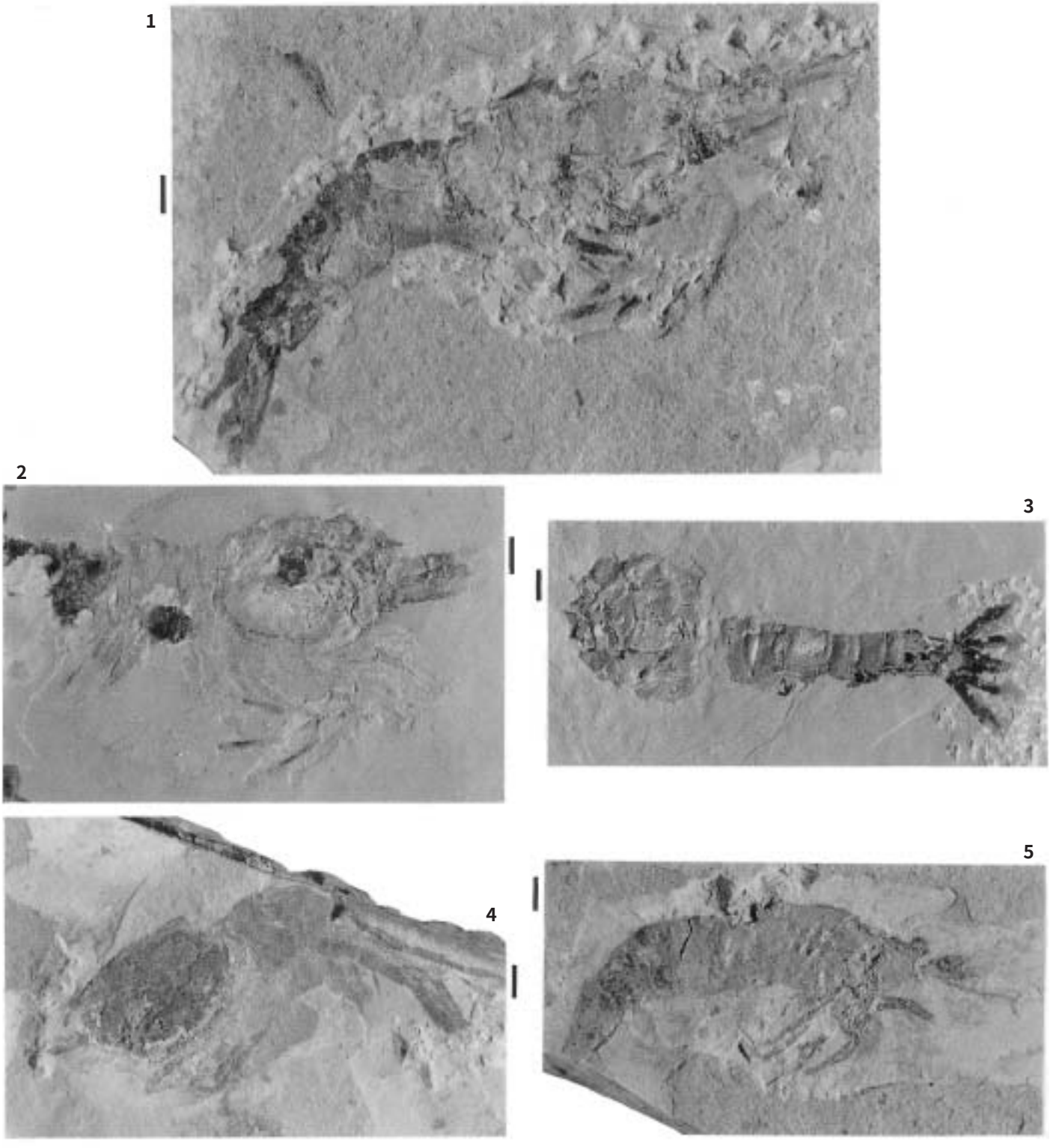


Fig. 6. *Yongjiacaris zhejiangensis* n. gen. n. sp. from Barremian age of Zhejiang Province (China). 1, lateral view of holotype, 126296, × 12; 2, lateral view of paratype, 126288, ×12; 3, dorsal view of paratype with a good preservation of tail fan, 126289, ×10; 4, lateral view of paratype with a good preservation of carapace and rostrum, 126300B, ×10; 5, lateral view of paratype with a good preservation of 3rd maxilliped, 126304, ×10.

(Palaeomonidae Rafinesque, 1815) with *B. araripensis* Martins-Neto and Mezzalira, 1991 as the type species. Second, Roger (1946) described *Notostomus cretaceus* in a sample of five specimens found in the Santonian (Upper Cretaceous) of Sahel Alma (Lebanon). However, this species was the subject of a review by Garassino (1994), who assigned Roger's species to *Odontochelion* Garassino, 1994 (Oplophoridae Dana, 1852). Third, Rabadà (1993) described *Delclosia* based upon *D. martinelli* Rabadà, 1993, based upon a sample of 60 specimens of the Lower Barremian (Lower Cretaceous) of Las Hoyas (Cuenca, Spain). This genus was the subject of a recent review by Garassino (1997). The fauna of Las Hoyas is the only freshwater decapod assemblage known to date in Mesozoic rocks. Fourth and fifth, Bravi and Garassino (1998a, b) described *Parvocaris* based upon *P. samnitica* Bravi and Garassino, 1998 (indeterminate family) from 14 specimens of the Lower Albian (Lower Cretaceous) of Pietraroia (Benevento, S Italy) and *Alburnia* based upon *A. petinensis* Bravi and Garassino, 1998 (Palaemonidae Rafinesque, 1815) from a sample of 3 specimens of the Middle Albian (Lower Cretaceous) of Petina (Salerno, S Italy). Sixth, Garassino (1998) described 3 specimens from the Lower Cretaceous of the valley of Cornappo River (Udine, NE Italy), and named *Tonellocaris* based upon *T. brevirostrata* Garassino, 1998 (Oplophoridae Dana, 1852). Seventh, Bravi *et al*. (1999) described *Palaemon vesolensis* (Palaemonidae Rafinesque, 1815) from a sample of 93 fragmentary and complete specimens from the Campanian-Maastrichtian (Upper Cretaceous) of Vesole Mount (Salerno, S Italy). *Palaemon antonellae* n. sp. from the Aptian (Lower Cretaceous) of the Platydolomite of Profeti (Caserta, S. Italy) belongs to the same genus (Garassino and Bravi, in press). In addition to these named taxa, Garassino and Ferrari (1992) reported the presence of a single specimen of caridean in the Senonian (Upper Cretaceous) of Trebiciano (Trieste, NE Italy) without ascribing it to a known family, genus, or species. Garassino and Teruzzi (1995) reported the probable presence of a new caridean form in the upper Hauterivian-lower Barremian (Lower Cretaceous) of Vernasso (Udine, NE Italy). Only five genera of carideans are presently known from Tertiary deposits. First, there are four species belong to *Bechleja* Houša, 1956, a typical form of freshwater deposits: *B. rostrata* Feldmann *et al*., 1981, from the Eocene of the Green River Formation (Wyoming, United States); *B. inopinata* Houša, 1956 from the Oligocene of the Czech Republic; *B. bahiaensis* (Beurlen, 1950) and *B. robusta* Martins-Neto and Mezzalira, 1991 from the Oligocene of Brazil (Beurlen, 1950; Houša, 1956; Feldmann *et al*., 1981; Martins-Neto and Mezzalira, 1991b; Martins-Neto, 1998). Second, Martins-Neto and Mezzalira (1991b) ascribed to *Propalaemon* Woodward, 1903, the new species *P. longispinata* (Palaemonidae Rafinesque, 1815). Finally, three genera are known in the Miocene deposits of N Caucasus (Russia): *Palaemon* Weber, 1795, *Pasiphaea* Savigny, 1816 and *Bannikovia* Garassino and Teruzzi, 1996. These have been described with *Palaemon mortuus* Smirnov, 1929, *Pasiphaea mortua* Smirnov, 1929 and *B. maikopensis* Garassino and Teruzzi, 1996 respectively (Smirnov, 1929; Garassino and Teruzzi, 1996). Recently, Garassino and Teruzzi (2001) reviewed *Bannikovia* Garassino and Teruzzi, 1996, assigned it to the living *Crangon* Fabricius, 1798 (Crangonidae Haworth, 1825) and provided the first report of this family in the fossil record.

Yongjiacaris zhejiangensis n. gen. n. sp. shows some characters, such as the short rostrum without supra- and subrostral teeth, pereiopods I-II with thin and elongate chelae, and a telson with two pairs of spines on dorsal surface that could permit to ascribe this species to the family Palaemonidae Rafinesque, 1815. At present, four genera of this family are known in the fossil record: *Alburnia* Bravi and Garassino, 1998, *Bechleja* Houša, 1956, *Palaemon* Weber, 1795 and *Propalaemon* Woodward, 1903, from the Lower Cretaceous (Aptian) to Recent. The discovery of *Yongjiacaris* n gen. extends the stratigraphical range of this family to the Barremian and represents the second report of freshwater carideans in Mesozoic rocks. Only *Delclosia* Rabadà, 1993 in the Barremian of Spain has previously been reported from freshwater Mesozoic rocks.

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References

Beurlen, K. (1950), Alguns Restos de Crustáceos Decápodes d'água doce fósseis no Brasil. *Anais da Academia Brasileira Ciências*, **22**, 453-459.

Bravi, S. and A. Garassino (1998a), "Plattenkalk" of the Lower Cretaceous (Albian) of Petina, in the Alburni Mounts (Campania, S Italy), and its decapod crustacean assemblage. *Atti Società italiana Scienze naturali Museo civico Storia naturale Milano,* **138**(1-2), 89-118.

Bravi, S. and A. Garassino (1998b), New biostratigraphic and palaeoecologic observations on the "Plattenkalk" of the Lower Cretaceous (Albian) of Pietraroia (Benevento, S Italy), and its decapod crustacean assemblage. *Atti Società italiana Scienze naturali Museo civico Storia naturale Milano,* **138**(1-2), 119-171.

Bravi, S. M. G. Coppa, A. Garassino, and R. Patricelli (1999), *Palaemon vesolensis* n. sp. (Crustacea, Decapoda) from the Plattelkalk of Vesole Mount (Salerno, S Italy). *Atti Società italiana Scienze naturali Museo Storia naturale Milano,* **140**(2), 141-169.

Cao, Z. Y. (1999), Early Cretaceous flora of Zhejiang. *Palaeontologia Sinica, 187, New Ser. A,* **13**, 1-174.

Chen, P. J. (2000), The continental Cretaceous of China. 329-346. *In* Nanjing Institute of Geology and Palaeontology, Chinese Academy of Sciences (ed.), *Stratigraphical studies in China (1979-1999*). Press of University of Sciences and Technology of China, Hefui (in Chinese).

Chen, P. J. and Y. B. Shen (1982), Late Mesozoic conchostracans from Zhejiang, Anhui and Jiangsu Provinces. *Palaeontologia Sinica, 161, New Ser. B,* **17**, 1-117.

Dana, J. D. (1852), Crustacea. *In United States exploring expedition during the years 1838, 1839, 1840, 1841, 1842 under the command of Charles Wilkes, Part I,* **13**, 1-685.

Fabricius, I. C. (1798), *Supplementum Entomologiae Systematicae.* C. G. Proft, Hafniae.

Feldmann, R. M., L. Grande, C. P. Birkeimer, J. T. Hannibal, and D. L. McCoy (1981), Decapod fauna of the Green River Formation (Eocene) of Wyoming. *Journal of Paleontology*, **55**(4), 788-799.

Garassino, A. (1994), The macruran decapod crustaceans of the Upper Cretaceous of Lebanon. *Paleontologia Lombarda, Nuova Serie, III.*

Garassino, A. (1997), The macruran decapod crustaceans of the Lower Cretaceous (Lower Barremian) of Las Hoyas (Cuenca, Spain). *Atti Società italiana Scienze naturali Museo civico Storia naturale Milano,* **137**(1-2), 101-126.

Garassino, A. (1998), Nuovo studio sui crostacei decapodi del Cretacico inferiore (Barremiano-Aptiano) della Valle del Torrente Cornappo (Udine, NE Italia). *Gortania. Atti Museo Friulano Storia Naturale,* **20**, 59-73.

Garassino, A. and S. Bravi (in press), *Palaemon antonellae* n. sp. (Crustacea, Decapoda, Caridea) from the Lower Cretaceous "Platydolomite" of Profeti (Caserta, S Italy). *Journal of Paleontology.*

Garassino, A. and G. Teruzzi (1993), A new decapod crustacean assemblage from the Upper Triassic of Lombardy (N Italy). *Paleontologia Lombarda, Nuova Serie, I.*

Garassino, A. and G. Teruzzi (1995), I crostacei decapodi macruri del Cretacico inferiore di Vernasso (Udine, NE Italia). *Gortania. Atti Museo Friulano Storia Naturale,* **16**, 77-88.

Garassino, A. and G. Teruzzi (1996), The genera *Longitergite* nov. and *Bannikovia* nov. in the Lower Miocene of N Caucasus (Russia) (Crustacea, Decapoda). *Atti Società italiana Scienze naturali Museo civico Storia naturale Milano,* **136**(1), 3-14.

Garassino, A. and G. Teruzzi (2001), *Crangon miocenicus* (Garassino & Teruzzi, 1996) from the Lower Miocene of N Caucasus (Russia) (Crustacea, Decapoda). *Atti Società italiana Scienze naturali Museo civico Storia naturale Milano,* **142**(1), 135-143.

Garassino, A., and R. Ferrari (1992), I crostacei fossili di Trebiciano sul Carso triestino. *Paleocronache,* **2**(1992), 40-44.

Glaessner, M. F. (1969), Decapoda, 400-566. *In* R. C. Moore (ed.), *Treatise on Invertebrate Paleontology, Part R, Arthropoda 4*. Geological Society of America and University of Kansas Press, Lawrence.

Haworth, A. H. (1825), A new binary arrangement of the macrurous Crustacea. *Philosophical Magazine and Journal,* **65**, 183-184.

Houša, V. (1956), *Bechleja inopinata* n. g., n. sp. ein neuer Krebs aus dem bohmischen Tertiar (Decapoda, Palaemonidae). *Ustred Ustavu Geologische,* **23**, 365-377.

Hu, H. G., S. K. Hu, S. S. Wang, and M. Zhu (1982), On the ages of Jurassic and Cretaceous volcanic rocks by the radiomatric dating. *Acta Geologica Sinica,* **56** (4), 315-323 (in Chinese with English abstract).

Jiang, W. S., J. S. Zhen, L. T. Li, and K. D. Xu (1993), *The Cretaceous of Zhejiang Province, China.* Nanjing University Press, Nanjing, p. 1-188.

Martins-Neto, R. G. (1998), Novos aportes ao conhecimento sobre a morfologia de *Bechleja robusta* Martins-Neto & Mezzalira 1991, crustáceo carídeo da Formação Tremembé, Oligoceno do Estado de São Paulo. *Ciências Exatas e Tecnológicas*, **III**(4), 62-65.

Martins-Neto, R. G. and S. Mezzalira (1991a), Descrição de novos crustáceos (Caridea) da Formação Santana, Cretáceo Inferior do Nordeste do Brasil. *Anais da Academia Brasileira de Ciências,* **63**(2), 155-160.

Martins-Neto, R. G. and S. Mezzalira (1991b), Revisão dos Palemonídeos Terciários Brasileiros (Crustacea, Caridea) com Descrição de Novos Taxa. *Anais da Academia Brasileira de Ciências,* **63**(2), 155-160.

Münster, G. G. (1839), Abbildung und Beschreibung der fossilen langschwänzigen Krebse in den Kalkschiefern von Bayern. *Beitrage zur Petrefactenkunde, Heft II.*

Oppel, A. (1862), Ueber jurassische crustaceen. *Palaeontologische mittheilungen*, Stuttgart.

Pinna, G. (1974), I crostacei della fauna triassica di Cene in Val Seriana (Bergamo). *Memorie Società italiana Scienze naturali Museo civico Storia naturale Milano,* **XXI**(1), 5-34.

Rabadà, D. (1993), Crustacèos decàpodos lacustres de las calizas litogràficas del Cretàcico inferior de España. Las Hoyas (Cuenca) y el Montsec de Rùbies (Lleida). *Cuadernos de Geologia Iberìca, Madrid,* **17**, 345-370.

Rafinesque, C. S. (1814), *Précis des découvertes et travaux sémiologiques de Mr. C. S. Rafinesque-Schmaltz, entre 1800 et 1814, ou choix raisonné de ses principales découvertes en zoologie et in botanique, pour servir d'introduction à ses ouvrages futurs.* Palermo, 55 p.

Roger, J. (1946), Les invertébrés des couches a poissons du Crétacé du Liban. *Mémoires Société Géologique Française*, **23**, 1-92.

Savigny, J. C. (1816), *Mémoires sur les animaux sans vertébres.* Chez Deterville, Paris.

Smirnov, V. P. (1929), Decapoda aus den Fisch-Schiefern am Schwarzen Fluss in der Nähe von Wladikarkas. *Arbeiten Nord-Kaukasus Verbindung wissenschaftlichen Forschungsinstitut*, **59**, 1-48.

The 3rd branch of Regional Geological Surveying Team (1977), Fossil shrimps from the Upper Jurassic, Yongjia County, Zhejiang. *Regional Geological Surveying of Zhejiang*, **11** (1), 51-53 (in Chinese).

Van Straelen, V. (1925), Contribution a l'étude des Crustacés décapodes de la période Jurassique. *Mémoires Académie Royale de Belgique, Sér. II,* **VII**, 1-458.

Weber, F. (1795), *Nomenclator entomologicus secundum entomologiam systematicum ill. Fabricii, adjectis speciebus recens detectis et varietatibus.* Chilonii (Keil) et Hamburgi.

Woodward, H. (1903), On some fossil prawns from the Osborne beds of the Isle of Wight. *Geology Magazine, London,* **10** (4), 97-99.

Zhu, X., H. J. Chen, Z. C. Sun, and Y. C. Zhang (1983), The Mesozoic tectonics and petroliferous basins of China. *Geology*, **57** (3), 235-242.

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