A new pinnotherid crab (Decapoda: Brachyura: Pinnotheridae) from the Miocene Niijukutoge Formation, northeast Japan

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A new pinnotherid crab (Decapoda: Brachyura: Pinnotheridae) from the Miocene Niijukutoge Formation, northeast Japan

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Abstract. A new fossil pinnotherid crab, *Globihexapus kosekii* sp. nov. is described from the early to middle Miocene Niijukutoge Formation in Shichikashuku-machi, Miyagi Prefecture, northeast Japan. Based on the presence of five pairs of pereiopods as revealed in an examination of the present material and reexamination of the types of *Globihexapus* Schweitzer and Feldmann, 2001, this genus is transferred from the family Hexapodidae Miers, 1886 to the subfamily Asthenognathinae Stimpson, 1858 of the family Pinnotheridae de Haan, 1833.

Key words: Decapoda, *Globihexapus kosekii* sp. nov., Hexapodidae, Miocene, Niijukutoge Formation, Pinnotheridae

Introduction

Records of fossil pinnotherid crabs are relatively few, a fact undoubtedly due to these unique crabs being often weakly calcified and their peculiar host-dependent habitat, but despite these disadvantages for fossilization their records include a fair number of genera such as: ?*Pinnotheres* Latreille, 1802 (Philippi, 1887; Feldmann *et al.*, 1999), *Parapinnixa* Holmes, 1894 (Rathbun, 1932), *Pinnixa* White, 1846 (Rathbun, 1932; Birstein, 1956; Zullo and Chivers, 1969; Morris and Collins, 1991; Collins *et al.*, 2003), *Viapinnixa* Schweitzer and Feldmann, 2001 (Collins and Rasmussen, 1992; Vega *et al.*, 2001), ?*Tetrias* Rathbun, 1898 (Müller, 1993) and *Asthenognathus* Stimpson, 1858 (Casadío *et al.*, 2004; Schweitzer and Feldmann, 1999, 2001; Karasawa, 1990) (except for fossils of extant species from Holocene deposits).

The fossil pinnotherid crab described herein was obtained from exposures of the Niijukutoge Formation found upstream along the Yokokawa River, west of Mt. Byoubusan, Shichikashuku-machi, Katta-gun, Miyagi Prefecture, northeast Japan (38°5′20″N, 140°25′50″E) (Figure 1). The Niijukutoge Formation is distributed sporadically in the valleys south of Mount Zao (volcanic). The rocks of this formation are altered and cut by many faults due to the influences of post-Tertiary volcanism (Shimazu *et al.*, 1986). The decapod fossil-bearing horizon of this formation crops out in a very small area of just a few square meters and its lateral extension is therefore untraceable. Consequently, the age and correlation of this formation is still obscure. However, according to Shimazu *et al.* (1986), this formation is stratigraphically situated in the lowermost part of the Neogene in this area, and is comparable with the Taro and Yoshino Formations in the Yamagata-Akayu area, which are considered to be the late early Miocene: just below the planktonic foraminifera zone N8 of Blow (1969) and calcareous nannofossil zone CN4 of Okada and Bukry (1980). The geologic age of the Niijukutoge Formation is, therefore, roughly estimated as the late early to early middle Miocene. Molluscan and decapod fossils obtained from the formation such as *Mizuhopecten kimurai murayamai* (Yokoyama, 1926), *Anadara watanabei* (Kanehara, 1935), *Phos* cf. *minoensis* Itoigawa, 1960, and *Carcinoplax antiqua* (Ristori, 1889) (Sasaki *et al.*, 1995), support this conclusion.

The new pinnotherid crab, *Globihexapus kosekii* sp. nov. is enclosed in pebble-sized calcareous nodules (mainly less than 2 cm in diameter), scattered in dark gray-colored siltstone with a sparse number of molluscan fragments. The type and figured specimens of this new crab are deposited in the Natural History Museum and Institute, Chiba (CBM-PI) and Sendai Science Museum (SSME).

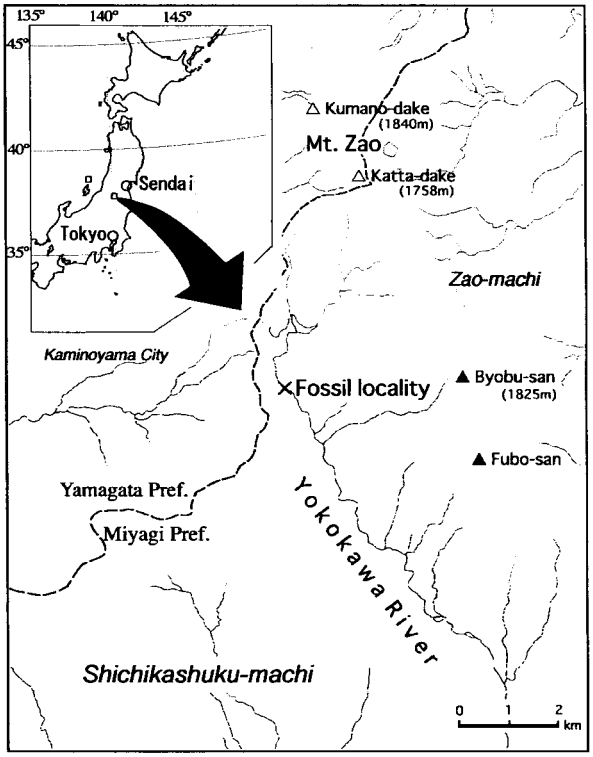

Figure 1. Map showing the fossil Locality.

Systematic paleontology

Superfamily Pinnotheroidea de Haan, 1833
Family Pinnotheridae de Haan, 1833
Subfamily Asthenognathinae Stimpson, 1858
Genus ***Globihexapus*** Schweitzer and Feldmann, 2001

Type species.—By monotypy *Globihexapus paxillus* Schweitzer and Feldmann, 2001.

Remarks.—The genus *Globihexapus* Schweitzer and Feldmann, 2001, was established as a new genus in the Hexapodidae Miers, 1886, based on material from the Miocene Astoria Formation, Oregon, U.S.A. Schweitzer and Feldmann (2001) proposed familial and subfamilial definitions of the Hexapodidae, Chasmocarcininae Seréne, 1964 in the Goneplacidae MacLeay, 1838, and Asthenognathinae Stimpson, 1858, in the Pinnotheridae de Haan, 1833 based on dorsal carapace characters, and rearranged several fossil records within. This revision was undertaken because members of these taxa exhibit similar carapace outlines in dorsal view and it is, therefore, difficult to make a systematic assignment for fossil material that is often represented by the carapace alone. Accordingly, even though the type material of *Globihexapus* did not contain a specimen showing ventral features, Schweitzer and Feldmann (2001) placed this new genus in the Hexapodidae based on its: transversely elongate carapace with ridges parallel to lateral margins, well developed rostrum and orbits, a maximum width of the carapace located near the posterior margin, and possession of ''only four pairs of pereiopods.'' However, several ventral features in *G. kosekii* sp. nov. such as a male thoracic sternum which is widest at sternite 6, a complete 8th sternite, and a male abdomen which is narrow without remarkable constrictions, suggest that *Globihexapus* is not very similar to a typical member of the Hexapodidae (Manning and Holthuis, 1981). Moreover, in the present reexamination, a pair of minute fifth pereiopods, which are significantly smaller than the second to fourth pereiopods, was eventually found in the type specimens for the genus (USNM501843, 501844, 501845, deposited in the National Museum of Natural History, Smithsonian Institution). A pair of minute fifth pereiopods is also recognized in *G. kosekii* sp. nov.; therefore, *Globihexapus* is removed from the Hexapodidae. *Globihexapus* can also be distinguished from the genera in the Chasmocarcininae in the Goneplacidae in having narrow orbits and a narrow front-orbital margin, a less developed posterolateral reentrant 1: of the carapace, and a male 8th thoracic sternite without a supplementary plate (Rathbun, 1918, p. 56; Blow and Bailey, 1992; Karasawa and Kato, 2003).

In addition, an extremely broad female abdomen, unlike those found in genera of the Chasmocarcininae, strongly suggests the placement of *Globihexapus* in the Pinnotheridae. The dactylus of the cheliped of *G. kosekii* sp. nov. has a conical tooth on the middle of the occlusal margin that is also typical of the Pinnotheridae.

Among the subfamilies in the Pinnotheridae, *Globihexapus* is assignable to the subfamily Asthenognathinae in having a rounded trapezoidal carapace, deflexed front, well defined front-orbital region, extremely small fifth pereiopod, and the merus of the third maxilliped which is separated from the ischium and is larger, but not extremely larger, than the ischium (Konishi and Noda, 1999).

Genera included in the Pinnotheridae and Asthenognathinae have recently been discussed and rearranged by Pohle and Marques (1998), Casadío *et al.* (2004), and Schweitzer and Feldmann (2001). Based on gill and gill-grooming appendages of adult and larval morphology, Pohle and Marques (1998) concluded that the Asthenognathinae is paraphyletic, and they did not arrange taxa within the subfamily. According to Casadío *et al.* (2004) and Schweitzer and Feldmann (1999), however, *Asthenognathus* Stimpson, 1858, and *Tritodynamia* Ortmann, 1894 show close resemblances in the morphology of carapace and ventral

features, and, therefore, at least these two genera can be confidently included within the subfamily. The author concurs with Casadío *et al.* (2004). *Globihexapus* closely resembles these two genera in having a rounded-trapezoidal anteriorly convergent carapace outline, a relatively well developed front with a median sulcus, and a very small fifth pereiopod.

In having a carapace which is not much wider than long, and slender second to fifth pereiopods, *Globihexapus* less resembles *Tritodynamia* than *Asthenognathus*. Moreover, although the dactylus of the palp of the third maxilliped of *Tritodynamia* is jointed at the inner base of the prododus, the segments of the palp of the third maxilliped in *Globihexapus* seem to be placed end to end, as far as the preserved part.

Thus, *Globihexapus* most resembles *Asthenognathus*, but it is clearly distinguished in not having a distinct facet at the posterolateral corner of the carapace, in having well-defined dorsal regions of the carapace, and in the merus of the third maxilliped which is larger than the ischium.

Geologic age.—Early to early middle Miocene.

Globihexapus kosekii sp. nov.

Figures 2. 1–5

Tymolus sp., Sasaki *et al.*, 1995, no. 337.

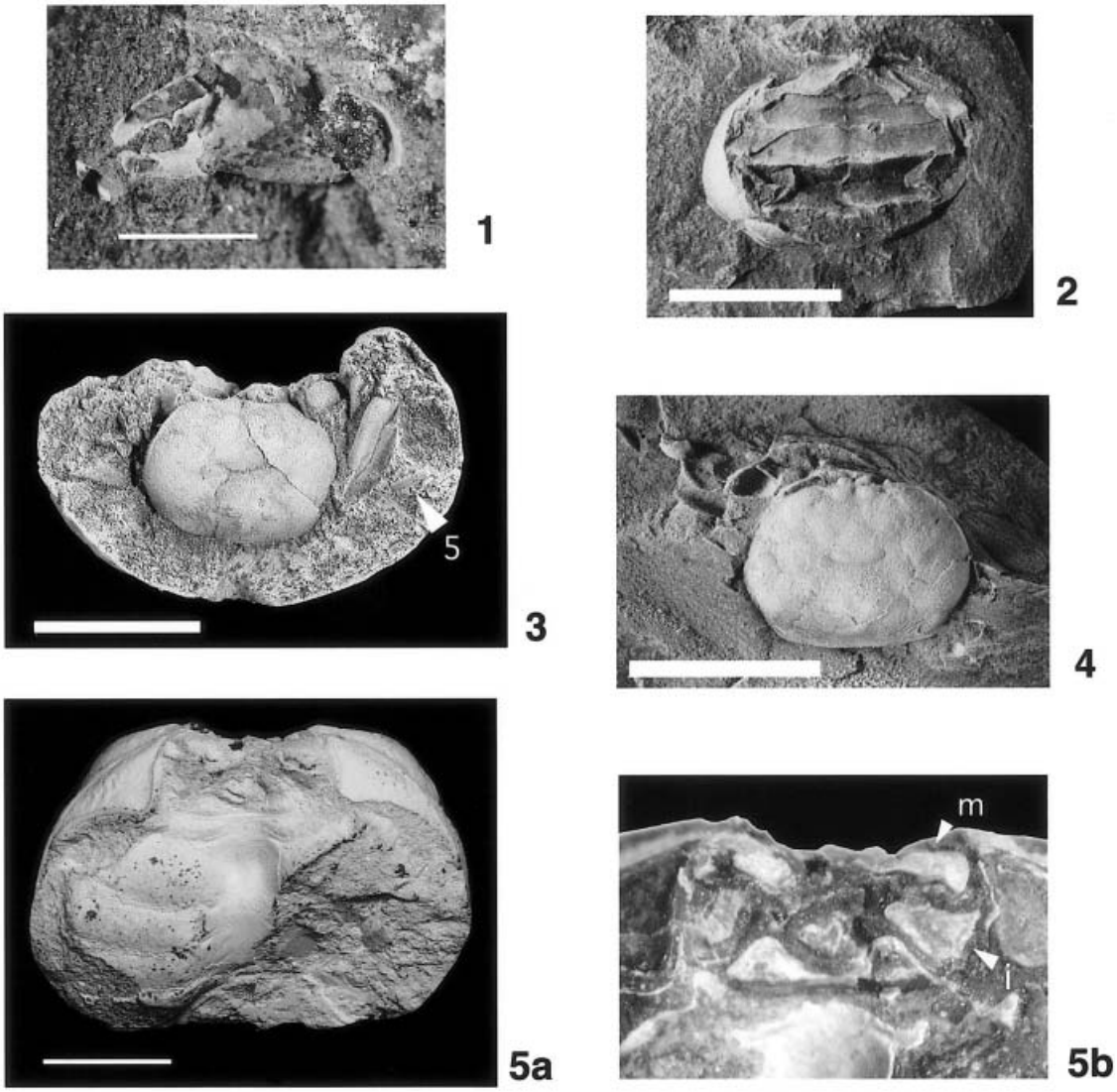

Figure 2. 1–5. *Globihexapus kosekii* sp. nov. **1.** Left chela. CBM-PI-0001069. **2.** Female abdomen, CBM-PI-0001498. **3.** carapace and appendages, CBM-PI-0001055. Arrow indicates merus of 5th pereiopod. **4.** Holotype, carapace, CBM-PI-0001072. **5.** carapace and thoracic sternum. CBM-PI-0001051, 5a, male thoracic sternum; 5b, buccal cavity (magnified). Arrows i and m indicate ischium and merus of 3rd maxilliped. Scale bars : 1 mm (1, 5a), 5 mm (3), and 10 mm (2, 4).

Material examined.—CBM-PI 0001498, 0001050–0001057, 0001059–0001072; SSME 13336–13339. Holotype: CBM-PI 0001072 (carapace and pereiopods), paratypes: CBM-PI 0001055 (carapace and pereiopods), CBM-PI 0001051 (carapace and thoracic sternum), CBM-PI 0001061 (carapace, pereiopod and thoracic sternum), CBM-PI 0001063, 0001069 (chela), CBM-PI 0001498 (female abdomen), CBM-PI 0001050, 0001052–0001054, 0001056–0001057, 0001059, 0001062, 0001066–0001068 (carapace); SSME 13336–13339 (carapace).

Occurrence.—Niijukutoge Formation.

Etymology.—The trivial name is dedicated to the late Mr. Osamu Koseki of Shiroishi City, Miyagi Prefecture, who contributed greatly to the geology and paleontology of the Tohoku district, northeast Japan, and provided invaluable assistance for the present field survey.

Diagnosis.—Carapace small for genus (mostly less than 10 mm), broader than long; rounded trapezoid in outline; regions well defined by broad furrows. Front narrow, bilobate; lobes separated by distinct median sulcus. Dorsal surface finely granulated. Granules coarser on branchial region. Lateral margin fringed by a row of granules. Posterolateral margin without distinct facets.

Description.—Carapace rounded trapezoidal, strongly inflated longitudinally; anterolateral and posterolateral angles rounded, lateral margins divergent posteriorly. Front bilobate, narrow, deflexed, projected anteriorly slightly beyond orbits; lobes separated by median sulcus. Frontal margin less than 20 percent of maximum carapace width. Orbital margin rounded; eye stalks clearly visible in dorsal view. Anterolateral margin fringed by row of minute spinous granules extending onto outer margin of branchial regions. Posterolateral reentrant relatively small. Dorsal regions well defined. Gastric regions demarcated by broad furrows. Short epigastric ridges aligned transversely. Hepatic and branchial regions inflated. Cardiac and epibranchial regions most prominent, demarcated by deep, broad cervical furrow. Dorsal surface covered with coarse granules; granules becoming coarser posterolaterally. Meso- and metabranchial regions evenly tumid, coarsely granulate.

Suture between third and fourth thoracic sternite of male transverse, shallow, broad. Male sternites 5–7 expanding posterolaterally. Male sterno-abdominal cavity almost reaching anterior margin of sternite 3.

Male abdomen narrow. Mature female abdomen extremely broad.

Chelipeds of equal size and shape. Manus moderately inflated transversely, surface smooth. Occlusal margin of fixed finger bearing small teeth. Dactylus with large conical proximal tooth. Tips of both fingers blackened.

Second to fourth pereiopods slender; upper margins of merus and carpus bearing minute spinous granules

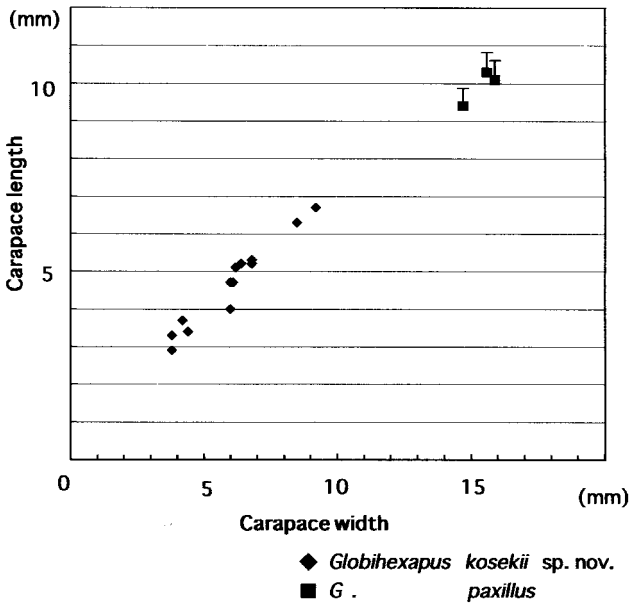

Figure 3. Relationships of the width and length of the carapace of *Globihexapus kosekii* sp. nov. and *G. paxillus* Schweitzer and Feldmann, 2001. Data for *G. kosekii* sp. nov. includes estimated width based on width of right or left half of the carapace, as available.

Table 1. Carapace measurements (in mm) of *Globihexapus kosekii* sp. nov. CL: carapace length; CW: carapace width; FW: frontal margin width; FOW: front-orbital margin width; PW: posterior margin width.

Specimen	CL	CW	FW	FOW	PW
CBM-PI-0001050	5.3	6.8	1.2	2.6	
CBM-PI-0001051	2.7+	3.8	1.2		
CBM-PI-0001052a			1.3	3.4	
CBM-PI-0001052b	2.4	2.5+			
CBM-PI-0001053	5.1	5.7+	1.1		
CBM-PI-0001054	5.2	6.8	1.2	3.0	4.4
CBM-PI-0001055	4.5+	6.0			
CBM-PI-0001056	5.2	6.4	1.1	2.8	
CBM-PI-0001057		5.9		2.8	4.0
CBM-PI-0001059		5.2			3.3
CBM-PI-0001061		6.3			3.7
CBM-PI-0001062	4.6+	6.1		2.6	
CBM-PI-0001066		6.4			
CBM-PI-0001067	4.7	6.0			
CBM-PI-0001072	8.7	11.4	2.0	4.2	8.0
SSME-13336	3.8	4.5		2.2	3.0
SSME-13337	4.0			1.8	3.5
SSME-13338	4.0+	6.0			
SSME-13339	5.4+	6.7		2.6	4.2

on anterior margin. Fifth pereiopod much smaller than second to fourth; merus subcylindrical, row of minute spinules on upper margin.

Ischium of third maxilliped subrectangular; notably, but not extremely smaller than foliate merus.

Remarks.—*Globihexapus kosekii* sp. nov. is easily distinguished from the type, *G. paxillus*, in having a narrower carapace with well developed front. *Globihexapus kosekii* also appears to be a smaller species than *G. paxillus* (Figure 3). While most of the described and examined specimens of *G. paxillus* exceed a maximum carapace width of more than 10 mm, only one specimen of *G. kosekii* attains a maximum carapace width of 10 mm (Table 1). In addition, the fifth pereiopod of *G. kosekii* is proportionally smaller than that of *G. paxillus*.

Several juvenile specimens (e.g., CBM-PI 0001052a) show a strongly vaulted, rounded carapace with deeply divided dorsal regions.

Geologic age.—Late early – early middle Miocene.

Measurements.—Carapace measurements are shown in Table 1.

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Addendum

In his unpublished Master's thesis, Nyborg (2002MS) also found the presence of fifth pereiopods in his additional specimens of *Globihexapus paxillus* Schweitzer and Feldmann, 2001, obtained from the Miocene Astoria Formation, Oregon, and moved *Globihexapus* to the Pinnotheridae.

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