

## Two new species of Decapoda (Crustacea) from the Upper Cretaceous Izumi Group, Japan

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**Abstract.** Two new species of decapod crustacean, *Hoploparia miyamotoi* (Astacidea: Nephropidae) and *Callianassa masanorii* (Thalassinidea: Callianassidae), are described from the Upper Cretaceous Izumi Group of Osaka and Hyogo Prefectures, Japan. *H. miyamotoi* represents the first record for the genus from Cretaceous deposits of Japan and *C. masanorii* is the second of a callianassid known from the Japanese Cretaceous. The occurrence of *H. miyamotoi* extends the known geographic range of *Hoploparia* to the west side of the North Pacific.

**Key words:** Astacidea, Crustacea, Decapoda, Izumi Group, Japan, Thalassinidea, Upper Cretaceous

### Introduction

The Upper Cretaceous (Campanian-Maastrichtian) Izumi Group is distributed for about 300 km from western Shikoku eastward to the Izumi mountains along the north side of the Median Tectonic Line, SW Honshu, Japan. It is a thick, submarine deposit mainly composed of alternating beds of conglomerate, sandstone and mudstone of a turbidite facies. This group contains a rich marine molluscan fauna which has been the subject of several paleontological studies, such as on pelecypods (Ichikawa and Maeda, 1958a, b, 1963 etc.), gastropods (Kase, 1990) and cephalopods (Matsumoto and Morozumi, 1980; Morozumi, 1985 etc.). Besides these, well-preserved decapod crustaceans occur from several places.

Imaizumi (1978) first recorded, but did not figure, three species of decapod crustacean, *Callianassa ezoensis* Nagao, 1932 (Callianassidae), *Linuparus japonicus* Nagao, 1931 (Palinuridae) and *Plagiolophus ezoensis* Nagao, 1941 (Goneplacidae), from the Izumi Group (Upper Cretaceous) of Osaka and Hyogo Prefectures, Japan. Miyamoto (1992) figured *P. ezoensis* from Osaka Prefecture. Collins, Kanie and Karasawa (1993) redescribed *P. ezoensis* from Osaka and Hyogo Prefectures, and moved it from *Plagiolophus* Bell, 1857 to *Archaeopus* Rathbun, 1908 (Retropiumidae). The purpose of this paper is to describe two new species, *Hoploparia miyamotoi* (Nephropidae) and *Callianassa masanorii* (Callianassidae) from two new localities of the Izumi Group in Osaka and Hyogo Prefectures.

The specimens are housed in the Museum of Nature and Human Activities, Hyogo (D1-), 6 Yayoigaoka, Mita, Hyogo 669-1546, Japan, and the Mizunami Fossil Museum (MFM), Yamanouchi, Akeyo, Mizunami, Gifu 509-6132, Japan.

### Systematic descriptions

Infraorder Astacidea Latreille, 1802  
Superfamily Nephropoidea Dana, 1852  
Family Nephropidae Dana, 1852  
Subfamily Homarinae Huxley, 1879  
Genus *Hoploparia* McCoy, 1849

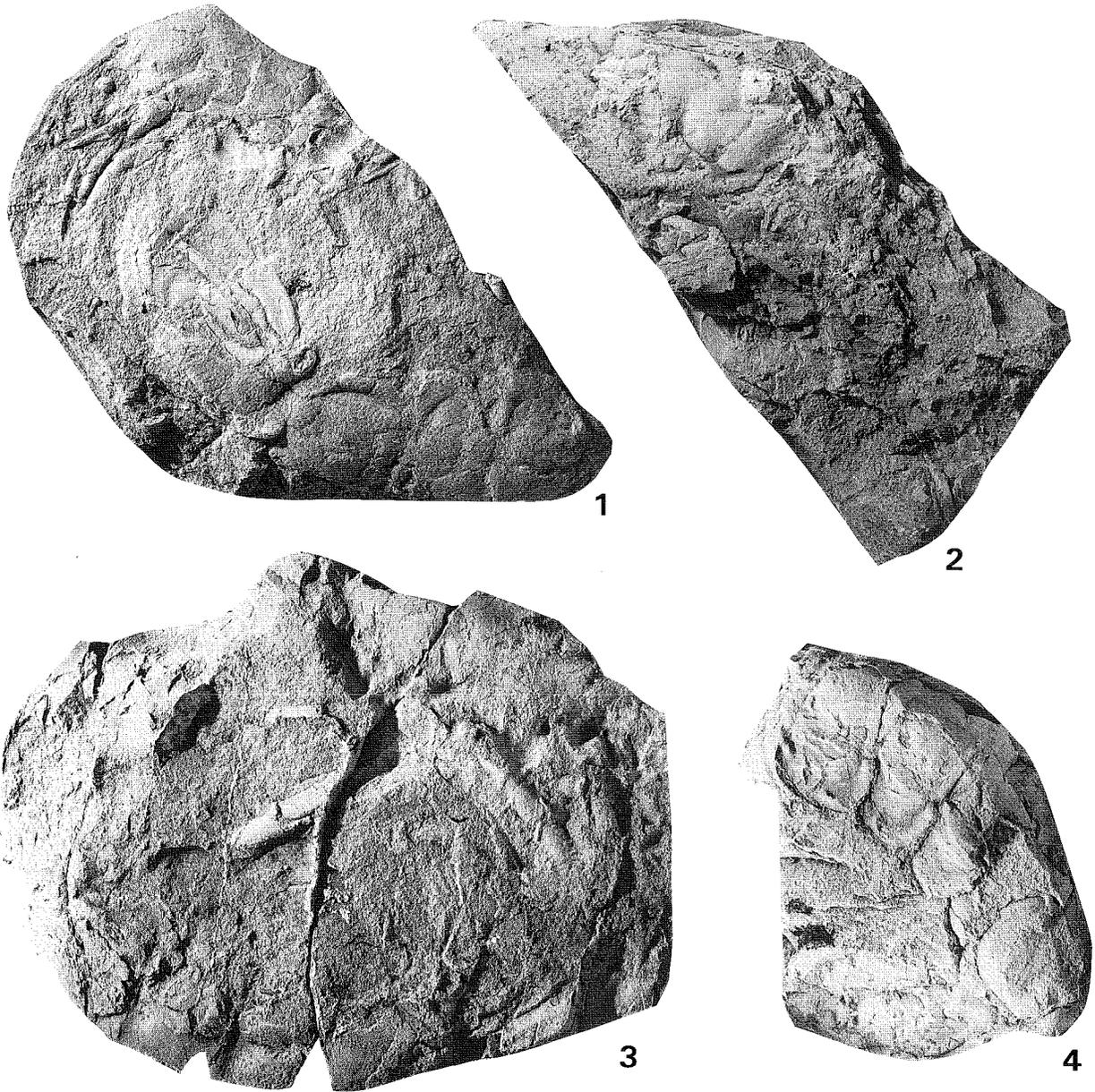
*Type species.*—*Astacus longimanus* Sowerby, 1826 by subsequent designation of Rathbun, 1926.

*Hoploparia miyamotoi* sp. nov.

Figures 1, 2

*Diagnosis.*—Rostrum with small dorsolateral spines on distal half; one supraorbital, one metaorbital and one post-antennal spine present, all small; abdominal somites with well developed lateral ridge, somites 3-5 bearing two marginal spines on pleura.

*Description.*—Carapace laterally compressed by deformation. Anterior half of carapace well preserved. Surface finely granulated and punctuated. Rostrum short, slender, slightly downturned proximally and slightly upturned over distal fourth, with four small, forwardly directed dorsolateral spines on distal half (Figures 1-1, 2-1). Orbit small, rounded, bordered by narrow, rounded ridge (Figure 1-1). Postcervical groove well defined, deep, broad, becoming shallower at junction with hepatic groove (Figures 1-2, 2-3). Cervical groove well defined, narrow, slightly arcuate, extending ventrally to join antennal groove (Figures 1-2, 2-3). Hepatic groove shallow, curving to join antennal and cervical grooves (Figures 1-2, 2-3). Antennal groove deep, arcuate, extending to anterior margin (Figures 1-2, 2-3). Gastro-orbital groove shallow (Figures 1-2, 2-3). One small, forwardly

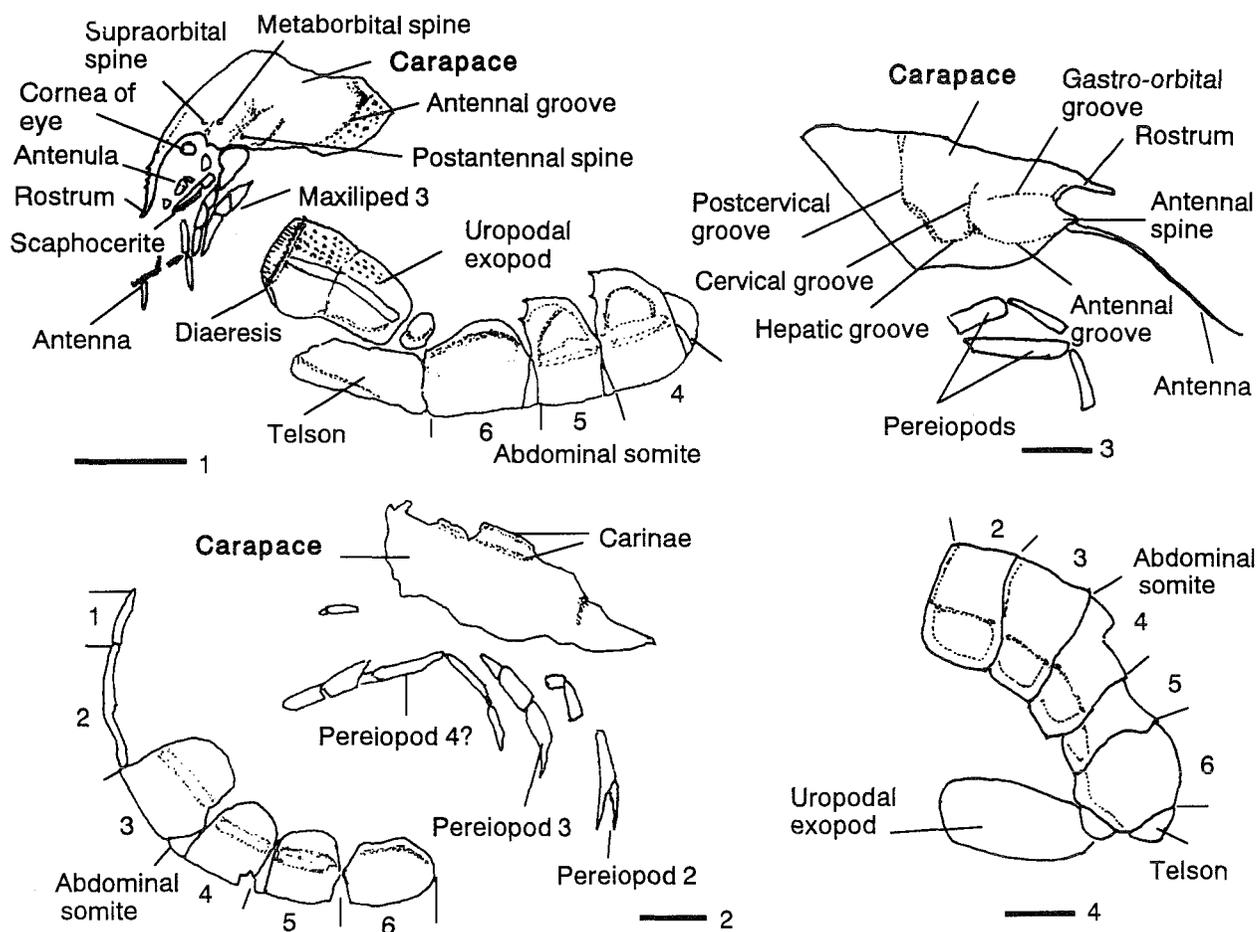


**Figure 1.** *Hoploparia miyamotoi* sp. nov. **1**, D1- 015001 (holotype), carapace, abdomen, telson and uropod, lateral view,  $\times 1.8$ ; **2**, MFM247,004 (paratype), carapace, pereopods, lateral view,  $\times 1.2$ ; **3**, MFM247,006 (paratype), carapace, abdomen and pereopods, lateral view,  $\times 1.5$ ; **4**, MFM247,005 (paratype), abdomen and uropod, lateral view,  $\times 1.5$ .

directed supraorbital spine present (Figures 1-1, 2-1). Metaorbital spine small, forwardly directed, situated behind deepest part of orbit (Figures 1-1, 2-1). Antennal spine large, directed forward (Figures 1-2, 2-3); postantennal spine small (Figures 1-1, 2-1). Cornea of eye small (Figures 1-1, 2-3). Scaphocerite long, but shorter than rostrum (Figures 1-1, 2-1). Antennula, antenna, and maxilliped 3 preserved (Figures 1-1, 1-2, 2-1, 2-3).

All terga of abdominal somites finely punctuate; somite 1 short; somite 2 largest of all terga; somites 3-5 decreasing

in size. Terga and pleura of somites 2-5 separated from one another by well developed ridge (Figures 1-4, 2-4). Anterior margins of pleura of somites 2-5, nearly straight, ventral margins gently convex, anteroventral angles rounded, posterolateral angles with a small, posteroventrally directed spine, posterior margins of pleura of somites 3-5 gently convex with small, posteriorly directed spine on ventral third (Figures 1-1, 1-4, 2-1, 2-4). Pleuron of somite 6 reduced, convex anteriorly and ventrally, but concave posteriorly (Figures 1-1, 1-4, 2-1, 2-4). Surfaces of pleura finely punctate



**Figure 2.** *Hoploparia miyamotoi* sp. nov. **1**, D1-015001 (holotype), carapace, abdomen, telson and uropod, lateral view; **2**, MFM247,006 (paratype), carapace, abdomen and pereiopods, lateral view; **3**, MFM247,004 (paratype), carapace, pereiopods, lateral view; **4**, MFM247,005 (paratype), abdomen and uropod, lateral view. Scale bar=1 cm.

with marginal furrow.

Telson longer than wide, narrowing posteriorly, surface punctuated with a median groove and a longitudinal groove diverging from mid-line posteriorly (Figures 1-1, 2-1). Uropodal exopod triangular in outline, bearing median ridge on dorsal surface, with weakly convex lateral margin (Figures 1-1, 2-1). Surface covered with small granules on outer half, diaeresis with 11 small spines on anterior margin and with fine radial ornament on posterior dorsal surface (Figures 1-1, 2-1).

Pereiopods preserved, slender; pereiopod 2 chelate (Figures 1-3, 2-2).

**Discussion.**—The present species is the first record of *Hoploparia* from Cretaceous deposits of Japan. *H. miyamotoi* resembles *Hoploparia bearpawensis* Feldmann in Feldmann, Bishop and Kammer, 1977 from the Bearpaw Shale (Campanian) of Montana, but differs by the presence of two marginal spines on the pleura of somites 3-5 and in the absence of the postcervical spine of the cardiac region and the median abdominal ridge. The species also resembles *Hoploparia buntingi* (Feldmann and Holland, 1971) from

the Cannonball Formation (Paleocene) of North Dakota (Aguirre Urreta *et al.*, 1991), but differs in having a short rostrum, having short abdominal pleura and lacking a pit on pleura of somites 2-5. In *H. miyamotoi* only one postantennal spine is present, while *H. buntingi* has three spines.

Previously known species of *Hoploparia* have been recorded from Cretaceous-Palaeogene deposits in Europe, North America, Argentina, Australia, Antarctica and Madagascar (Aguirre Urreta, 1989), and New Zealand (Feldmann and Keyes, 1992). The discovery of *H. miyamotoi* shows that the genus had reached Japan—the west side of the North Pacific—by Maastrichtian time.

**Etymology.**—The name is dedicated to Junichi Miyamoto, who is now studying the paleontology of the Izumi Group.

**Material examined.**—Holotype (D1-015001), Mitsukawa, Sumoto City, Hyogo Prefecture, mudstone of the Kita-ama Formation of the Izumi Group (Lower Maastrichtian; *Nos-toceras hetonaiense* Zone of Morozumi, 1985); 3 Paratypes, MFM247,004, Sobura, Kaizuka City, Osaka Prefecture, mudstone of the Shindachi Formation of Izumi Group (prob-

ably Lower Maastrichtian of Matsumoto and Morozumi, 1980); MFM247,005, MFM247,006, Mitsukawa, Sumoto City, Hyogo Prefecture, mudstone of the Kita-ama Formation of the Izumi Group (Lower Maastrichtian).

Infraorder Thalassinidea Latreille, 1831  
 Superfamily Callianassoidea Dana, 1852  
 Family Callianassidae Dana, 1852  
 Genus *Callianassa* Leach, 1814

*Type species.*—*Cancer (Astacus) subterraneus* Montagu, 1808 by monotypy.

*“Callianassa”* (s.l.) *masanorii* sp. nov.

Figure 3

*Diagnosis.*—Large-sized callianassid. *Linea thalassinica* present. Carapace with rostral spine; dorsal oval well defined, occupying about half length of dorsal carapace. Pereiopods 1 chelate, subequal, minor slightly smaller than major, dissimilar without meral hook.

*Description.*—Carapace well preserved, laterally compressed, height about half of length excluding rostral spine. Frontal margin with short, broadly triangular, downturned rostral spine and without lateral spines (Figure 3–5). *Linea thalassinica* well defined (Figure 3–5). Dorsal oval convex, about half of dorsal length (Figure 3–5). Cervical groove deep, joining *linea thalassinica* at posterior third of oval (Figure 3–5). Posterior margin evenly curved without lateral lobe (Figure 3–5).

Abdomen large; somite 1 short, trapezoidal in dorsal view, bearing dorsal transverse groove at anterior fourth, with divergent lateral margins (Figure 3–6). Somite 2 about 1.5 times as long as 1, lateral margin divergent posteriorly (Figure 3–6). Somites 3–5 diminishing in size posteriorly (Figure 3–6). Somites 2–5 with small setal pits posterolaterally (Figure 3–6). Telson and uropod unknown.

Pereiopods 1 chelate, subequal, dissimilar. Length of propodus of major cheliped about twice the height; fingers about 1/3 of propodus length, with smooth opposing margin; carpus short, about half as long as propodus, slightly shorter than high, dorsal margin nearly straight, ventral margin strongly curved; merus about equal to carpus length, rhomboidal in lateral view, dorsal and ventral margins strongly convex without ventral spine, lateral surface strongly vaulted with median ridge (Figures 3–1a, 2, 3, 7). Propodus of minor cheliped slightly smaller than major propodus, rather slender in outline; fingers about 2/5 of propodus length with smooth opposing margin; carpus short, about 1/3 of propodus length, convergent proximally, dorsal margin gently convex, ventral margin strongly curved; merus slightly longer than carpus, slightly convergent proximally without ventral spine, dorsal and ventral margins slightly convex, lateral surface gently vaulted (Figures 3–1b, 3).

Pereiopod 2 with fingers not gaping, cutting edges straight; dactylus slender, but fixed finger wide; palm about as long as high; merus narrowing distally (Figure 3–4).

Carpi and meri of pereiopods 3–4 preserved (Figures 3–1a, b, 2, 7).

*Discussion.*—“*C.*” *masanorii* differs from another Japanese Cretaceous callianassid, *Callianassa ezoensis* Nagao, 1932 from the “Hakobuchi Sandstone” (Campanian to Maastrichtian) of Hokkaido in that pereiopods 1 have dissimilar chelipeds, smooth ventral margins of propodi, and a rhomboidal merus of the major cheliped.

It is noteworthy that the carapace, abdomen, and pereiopods 1–4 are preserved, although the fossil record of callianassids is usually confined to pereiopods 1.

Manning and Felder (1991) recognized two families, seven subfamilies and 21 genera for taxa previously assigned to the extant Callianassidae. Since then, four genera, *Gilvossius* Manning and Felder, 1992, *Corallichirus* Manning, 1992, *Poti* Rodrigues and Manning, 1992, and *Sergio* Manning and Lemaitre, 1993, have been described.

The present species is characterized by the carapace with a rostral spine, with a dorsal oval region, and without a cardiac prominence, also by the major cheliped without a meral hook. With these features it may be assigned to *Neocallichirus* Sakai, 1988 and *Sergio* Manning and Lemaitre, 1993 in the Callichirinae or *Cheramus* Bate, 1888 in the Cheraminae. It also has an affinity *Anacalliax* de Saint Laurent, 1973, which Poore (1994) moved to the Callianassidae from the Ctenochelidae, although it lacks a rostral carina and cardiac prominence of the carapace. The generic placement of the present species is obscure because of absence both of maxilliped 3 and the telson, until knowledge of these characters is at hand, it is considered best to place the species in *Callianassa* (s.l.).

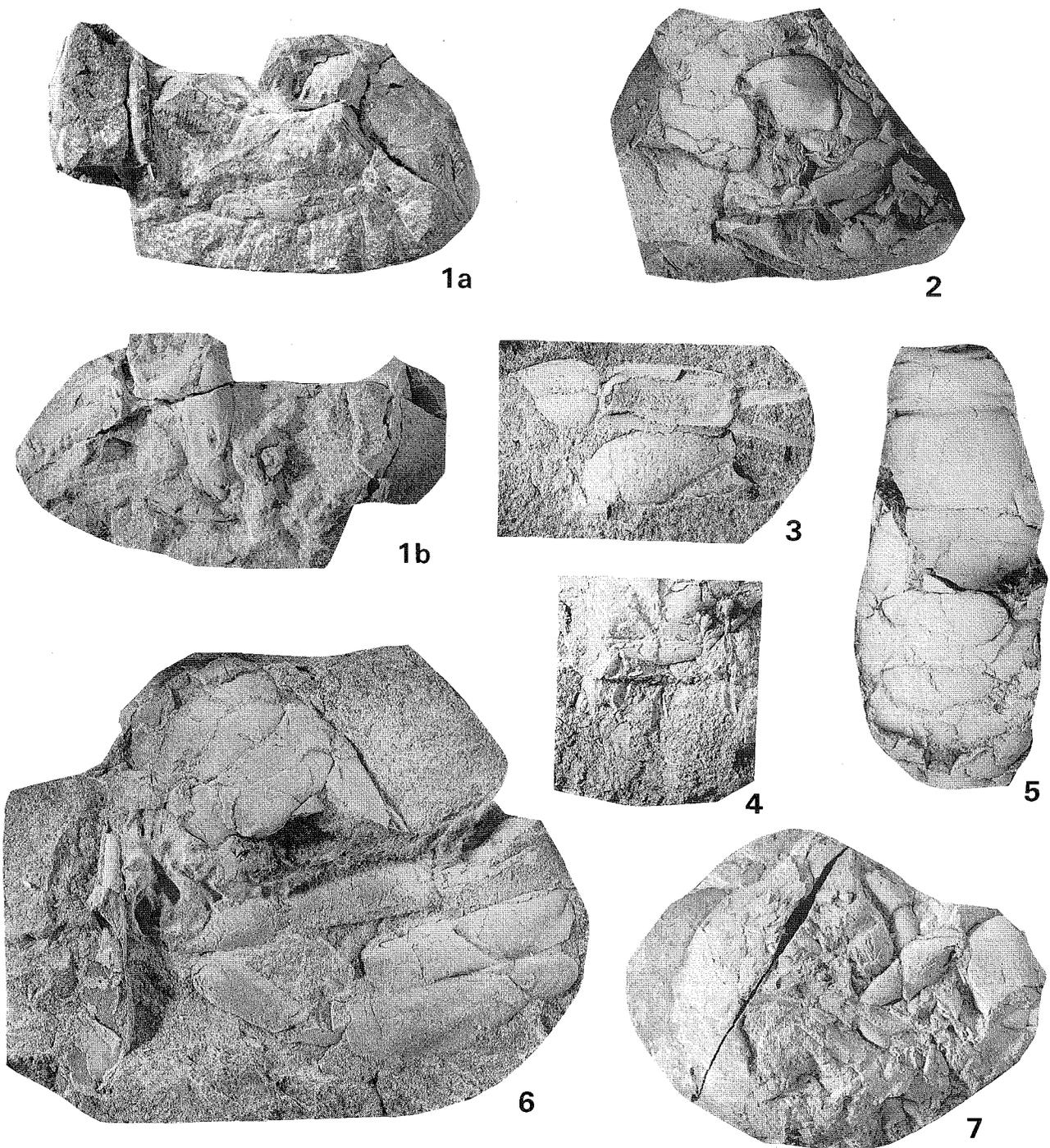
“*C.*” *masanorii* differs from all known species of *Protocallianassa* Beurlen, 1930 in the extinct subfamily Protocallianassinae Beurlen, 1930, in that the articulation between the carpus and propodus of the major cheliped lies at an angle of nearly 90° to the long axis of the propodus. In *Protocallianassa* the carpus-propodus joint of the major cheliped is inclined at about 120° to the long axis (Mertin, 1941, Vega *et al.*, 1995, Feldmann *et al.*, 1995). Nevertheless, in the carapace character, the species has a close affinity with the type *Protocallianassa archiaci* (A. Milne Edwards, 1860) from the Upper Senonian of England. Although in many extant callianassids the cervical groove of the carapace extends far back medially (Glaessner, 1969: R477), in species, “*C.*” *masanorii* and *P. archiaci*, it is situated at the mid-length of the carapace. This character is also observed in the callianassid subfamily Eucallinae and the members of the Ctenochelidae.

*Etymology.*—The name is dedicated to Masanorii Tani, who collected the paratype specimen.

*Material examined.*—Holotype (D1-000495), 5 paratypes (D1-000506, D1-000507, MFM247,007–247,009), Mitsukawa, Sumoto City, Hyogo Prefecture, Mudstone of the Kita-ama Formation of the Izumi Group (Lower Maastrichtian; *Nostoceras hetonaiense* Zone of Morozumi, 1985).

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**Figure 3.** *Callianassa* *masanorii* sp. nov. **1a, b**, MFM247,007 (paratype), pereiopods, lateral view,  $\times 1.5$ ; **2**, D1-000507 (paratype), pereiopods, lateral view,  $\times 1.5$ ; **3**, D1-00506 (paratype), pereiopods 1, lateral view of right cheliped, mesial view of left cheliped,  $\times 1.5$ ; **4**, MFM247,008 (paratype), pereiopod 2, lateral view,  $\times 1.5$ ; **5**, D1-000495 (holotype), lateral view of carapace, mesial view of pereiopods 1,  $\times 1.5$ ; **6**, D1-000495 (holotype), abdomen, dorsal view,  $\times 1.5$ ; **7**, MFM247,009 (paratype), abdomen and pereiopods, lateral view,  $\times 1.5$ .

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#### Reference cited

- Aguirre Urreta, M.B., 1989 : The Cretaceous decapod Crustacea of Argentina and the Antarctic Peninsula. *Palaeontology*, vol. 32, p. 499-552.
- Aguirre Urreta, M.B., Olivero, E.B. and Medina, C.S., 1991 : A redescription of a Maastrichtian lobster *Hoploparia antarctica* Wilckens, 1907 (Crustacea : Decapoda), from Chubut, Argentina. *Journal of Paleontology*, vol. 65, p. 795-800.
- Bate, C.S., 1888 : Report on the Crustacea Macrura collected by H.M.S. Challenger during the years 1873-76. *Report on the Scientific Results of the Voyage of H.M.S. Challenger during the years 1873-76, Zoology*, vol. 24, xc+942 p.
- Bell, T., 1857 : A monograph of the fossil malacostracous Crustacea of Great Britain. Part 1. Crustacea of London Clay. Palaeontological Society Monograph, 44 p. London.
- Beurten, K., 1930 : Vergleichende Stammesgeschichte Grundlagen, Methoden, Probleme unter besonderer Berücksichtigung der höheren Krebse. *Fortschritte der Geologie und Paläontologie*, vol. 8, p. 317-586.
- Collins, J.S.H., Kanie, Y. and Karasawa, H., 1993 : Late Cretaceous crabs from Japan. *Transactions and Proceedings of the Palaeontological Society of Japan, New Series*, no. 172, p. 292-310.
- Dana, J.D. 1852. Crustacea. In, *United States Exploring Expedition during the Years 1838, 1839, 1840, 1841, 1842 Under the Command of Charles Wilkes, U.S.N.*, vol. 13, 1620 p.
- De Saint Laurent, M., 1973 : Sur la systématique et la phylogénie des Thalassinidea : définition des familles des Callianassidae et des Upogebiidae et diagnose de cinq genres nouveaux (Crustacea Decapoda). *Comptes Rendus Hebdomadaires de l'Académie des Sciences, Paris, series D*, vol. 277, p. 513-516.
- Feldmann, R.M., Bishop, G.A. and Kammer, 1977 : Macrurous decapods from the Bearpaw Shale (Cretaceous : Campanian) of northeastern Montana. *Journal of Paleontology*, vol. 51, p. 1161-1180.
- Feldmann, R.M., Casadio, S., Chirino-Gálvez, L. and Aguirre Urreta, M., 1995 : Fossil decapod crustaceans from the Jaguel and Roca Formations (Maastrichtian-Danian) of the Neuquén Basin, Argentina. *The Paleontological Society Memoir*, no. 43, p. 1-22.
- Feldmann, R.M. and Holland, F.D. Jr., 1971 : A new species of lobster from the Cannonball Formation (Paleocene) of North Dakota. *Journal of Paleontology*, vol. 45, p. 838-843.
- Feldmann, R.M. and Keyes, I.W., 1992 : Systematic and stratigraphic review with catalogue and locality index of the Mesozoic and Cenozoic decapod Crustacea of New Zealand. *New Zealand Geological Survey Record*, vol. 45, p. 1-78.
- Glaessner, M.F., 1969 : Decapoda. In, Moore, R.C. ed., *Treatise on Invertebrate Paleontology, Part R, Arthropoda 4*, p. R399-651, Geological Society of America and University of Kansas Press.
- Huxley, T.H., 1879 [1878] : On the classification and the distribution of the crayfishes. *Proceedings of the Scientific Meetings of the Zoological Society of London*, vol. 1878, p. 752-788.
- Ichikawa, K. and Maeda, Y., 1958a : Late Cretaceous pelecypods from the Izumi Group, Part I. Cuculaeidae (*Pleurogrammatodon*, nov., *Nanonavis* and *Indogrammatodon*). *Journal of the Institute of Polytechnics, Osaka City University*, vol. 3, p. 61-74.
- Ichikawa, K. and Maeda, Y., 1958b : Late Cretaceous pelecypods from the Izumi Group, Part II. Orders Taxodontida, Prionodontida, Dysodontida, Desmodontida, and Adapodontida. *Journal of the Institute of Polytechnics, Osaka City University*, vol. 4, p. 71-112.
- Ichikawa, K. and Maeda, Y., 1963 : Late Cretaceous pelecypods from the Izumi Group, Part III. Order Heterodontida (1). *Journal of Geoscience, Osaka City University*, vol. 7, p. 113-145.
- Imaizumi, R., 1978 : Fossil decapod crustaceans from Japan, with special reference to the classifications of Conchostracans and Malacostracans. *Contributions to the Institute of Paleontology and Geology, Tohoku University*, no. 1978, 49 p.
- Kase, T., 1990 : Late Cretaceous gastropods from the Izumi Group of southwest Japan. *Journal of Paleontology*, vol. 64, p. 563-578.
- Latreille, P.A., 1802-1803 : *Histoire naturelle, générale et particulière, des crustacés et des insectes*. volume 3, 468 p. F. Dufart, Paris.
- Latreille, P.A., 1831 : *Cours d'Entomologie, ou de l'histoire naturelle des Crustacés, des Arachnides, des Myriapodes et des Insectes, etc.* Annales I. Atlas, 26 p. Roret, Paris.
- Leach, W.E., 1814 : Crustaceology. In, Brewster, D., *Edinburgh Encyclopedia*, vol. 7, p. 385-437.
- Manning, L.B., 1992 : A new genus for *Corallianassa xutha* Manning (Crustacea : Decapoda : Callianassidae). *Proceedings of the Biological Society of Washington*, vol. 105, 571-574.
- Manning, L.B. and Felder, D.L., 1991 : Revision of the American Callianassidae (Crustacea : Decapoda : Thalassinidea). *Proceedings of the Biological Society of Washington*, vol. 104, p. 764-792.
- Manning, L.B. and Felder, D.L., 1992 : *Gilvossius*, a new genus of callianassid shrimp from the eastern United States (Crustacea : Decapoda : Thalassinidea). *Bulletin of Marine Science*, vol. 49, p. 558-561.
- Manning, L.B. and Lemaitre, R., 1993 : *Sergio*, a new genus of ghost shrimp from the Americas (Crustacea : Decapoda : Thalassinidea). *Nauplius*, vol. 1, p. 39-43.
- Matsumoto, T. and Morozumi, Y., 1980 : Late Cretaceous ammonites from the Izumi Mountains, southwest Japan. *Bulletin of the Osaka City Museum of Natural History*, no. 33, p. 1-31.
- McCoy, F., 1849 : On the classification of some British fossil Crustacea with notices of new forms in the University Collection at Cambridge. *Annals and Magazine of Natural History, Series 2*, vol. 4, p. 161-179, 330-335.
- Mertin, H., 1941 : Decapode Krebse aus dem subhercynen

- und Braunschweiger Emscher und Untersenen sowie Bemerkungen über einige verwandte Formen in der Oberkreide. *Nova Acta Leopoldina*, vol. 10, p. 149-264.
- Milne Edwards, A., 1860: Monographie des decapodes macrures fossils de la famille des thalassiniens. *Annales des Sciences Naturelles, Zoologie, série 4*, vol. 14, p. 294-357.
- Miyamoto, J., 1992: Fossils from the Hakozukuri Formation, Izumi Group. In, *Hyoseki*, p. 93-97. Manabe Mineral Institute, Osaka. (in Japanese)
- Montagu, G., 1808: Description of several marine animals found on the South coast of Devonshire. *Transactions of the Linnean Society of London*, vol. 9, p. 18-114.
- Morozumi, Y., 1985: Late Cretaceous (Campanian and Maastrichtian) ammonites from Awaji Island, Japan. *Bulletin of the Osaka City Museum of Natural History*, vol. 39, p. 1-58.
- Nagao, T., 1931: Two new decapod species from the Upper Cretaceous deposits of Hokkaido, Japan. *Journal of the Faculty of Science, Hokkaido Imperial University, series 4*, vol. 1, p. 207-214.
- Nagao, T., 1932: Two Tertiary and one Cretaceous Crustacea from Hokkaidô, Japan. *Journal of the Faculty of Science, Hokkaido Imperial University, series 4*, vol. 2, p. 15-22.
- Nagao, T., 1941: On some fossil Crustacea from Japan. *Journal of the Faculty of Science, Hokkaido Imperial University, series 4*, vol. 6, p. 86-100.
- Poore, G.C.B., 1994: A phylogeny of the families of Thalassinidea (Crustacea: Decapoda) with keys to families and genera. *Memoirs of the Museum of Victoria*, vol. 54, p. 79-120.
- Rathbun, M.J., 1908: Descriptions of fossil crabs of California. *Proceedings of the U. S. National Museum*, no. 35, p. 341-349.
- Rodrigues, S. de A. and Manning, R.B., 1992: *Poti gaucho*, a new genus and species of ghost shrimp from southern Brazil (Crustacea: Decapoda: Thalassinidea). *Bulletin of Marine Science*, vol. 51, p. 9-13.
- Sakai, K., 1988: A new genus and five new species of Callianassidae (Crustacea: Decapoda: Thalassinidea) from northern Australia. *The Beagle, Records of the Northern Territory Museum of Arts and Sciences*, vol. 5, p. 51-69.
- Sowerby, J., 1826: Description of a new species of *Astacus*, found in a fossil state at Lyme Regis. *Zoological Journal*, vol. 2, p. 493-494.
- Vega, F.J., Feldmann, R.M. and Sour-Tovar, F., 1995: Fossil crabs (Crustacea: Decapoda) from the Late Cretaceous Cárdenas Formation, east-central Mexico. *Journal of Paleontology*, vol. 69, p. 340-350.

