原　　著　Original articles

Cenozoic Decapod Crustacea from Southwest Japan

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西南日本の新生代十脚甲殻類**

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(要　　旨)

西南日本の新生代十脚甲殻類、73属119種を報告する．次の4新属36新種を含む：*Laurentiella imaizumii*（ハサミシャコエビ科）；*Callianassa nishikawai, C. yatsuoensis, Eucalliax miyazakiensis, Trypaea mizunamiensis, Calliax okamotoi*（スナモグリ科）；*Petrolisthes miocaenicus*（カニダマシ科）；*Galathe keijii, Munida nishioi*（コシオリエビ科）；*Dynomene shinobui*（トゲカイカムリ科）；*Ethusa chibai*（ヘイケガニ科）；*Mursia minuta*（カラッパ科）；*Padocatactes ujiharai*（ヒゲガニ科）；*Imaizumila sexdentata* gen. nov., *Itoigawaia umemotoi, Lupocyclus tuberculosus*（ガザミ科）；*Medaeops megamiensis, Leptodius crosnieri, L. morrisi, Paraxanthias fujiyamai, Palaeoxanthops minutus* gen. nov., *P. okumurai* gen. nov., *Megamia anaglypta* gen. nov., *Pilodius parvus*（オウギガニ科）；*Trapezia brevispinosa*（サンゴガニ科）；*Euryozius angustus, E. bidentatus*（イソオウギガニ科）；*Collinsius simplex* gen. nov., *Typhlocarcinus obtusus*（エンコウガニ科）；*Ebalia kakegawaensis, Randallia saitoensis, Pariphiculus inconditus, Philyra tanakai, P. tridentata, Leucosia takamii*（コブシガニ科）；*Varuna angustifrons*（イワガニ科）．

西南日本の新生界層より27の十脚甲殻類群集を認め，それらの古生態を議論する．

西南日本の新生代十脚甲殻類ファウナは，下位より順に，中期始新世（Bartonian），前期漸新世（Ruppelian），後期漸新世，前期中新世（18-16 Ma），中期中新世初頭（16-15 Ma），中期中新世中期（14-13 Ma），中期中新世後期（12-10 Ma），後期中新世—前期鮮新世（6-4 Ma），後期鮮新世（3-2 Ma），更新世のファウナに区分できる．新生代を通じた十脚甲殻類ファウナの古生物地理的変遷は次のように示される．中期始新世のファウナは，西部・中部テーチス地域のファウナと関連が深い．テーチス海要素は，漸新世までに消失すると思われる．前期漸新世のファウナは，固有化が進み，前期漸新世の固有要素は後期漸新世までに消失する．前期中新世以降のファウナでは現在のインド—西太平洋要素が卓越する．前期中新世以降で認められる中新世の固有要素は中期中新世中頃までに消失し，中期中新世末以降，現在型の属構成を示す．後期鮮新世以降に，現生種との交替が起こり，更新世に現在型のファウナが確立される．新第三紀以降の十脚甲殻類ファウナには4回の顕著な変化が認められる．その時期は，およそ1500—1600万年前，約1200万年前，約700万年前，約300万年前で，新第三紀に

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知られている3回の“Climatic optima”，“Warm episode”と呼ばれる古気候イベントに良く対応する．新第三紀以降のファウナの変化は，気候の温暖化にともなう十脚甲殻類の南方からの移入，寒冷期におけるその絶滅により引き起こされた可能性が大きい．

(Abstract)

One hundred and nineteen species belonging to seventy-three genera of decapod crustaceans are recorderd from the Cenozoic of southwest Japan. The following four genera and thirty-six species are new : *Laurentiella imaizumii* (Laomediidae) ; *Callianassa nishikawai*, *C. yatsuoensis*, *Eucalliax miyazakiensis*, *Trypaea mizunamiensis*, *Calliax okamotoi* (Callianassidae) ; *Petrolisthes miocaenicus* (Porcellanidae) ; *Galathea keijii*, *Munida nishioi* (Galatheidae) ; *Dynomene shinobui* (Dynomenidae) ; *Ethusa chibai* (Dorippidae) ; *Mursia minuta* (Calappidae) ; *Padocatactes ujiharai* (Corystidae) ; *Imaizumila sexdentata* gen. nov., *Itoigawaia umemotoi*, *Lupocyclus tuberculosus* (Portunidae) ; *Medaeops megamiensis*, *Leptodius crosnieri*, *L. morrisi*, *Paraxanthias fujiyamai*, *Palaeoxanthops minutus* gen. nov., *P. okumurai* gen. nov., *Megamia anaglypta* gen. nov., *Pilodius parvus* (Xanthidae) ; *Trapezia brevispinosa* (Trapeziidae) ; *Euryozius angustus*, *E. bidentatus* (Menippidae) ; *Collinsius simplex* gen. nov., *Typhlocarcinus obtusus* (Goneplacidae) ; *Ebalia kakegawaensis*, *Randallia saitoensis*, *Pariphiculus inconditus*, *Philyra tanakai*, *P. tridentata*, *Leucosia takamii* (Leucosiidae) ; *Varuna angustifrons* (Grapsidae).

Twenty-seven decapod assemblages are recognized from the Cenozoic of southwest Japan and the palaeoecology is discussed. The Cenozoic decapod fauna from southwest Japan is stratigraphically divided into ten, the Middle Eocene (Bartonian), Early Oligocene (Ruppelian), Late Oligocene, Early Miocene (18-16 Ma), early Middle Miocene (16-15 Ma), middle Middle Miocene (14-13 Ma), late Middle Miocene (12-10 Ma), latest Miocene to Early Pliocene (6-4 Ma), Late Pliocene (3-2 Ma) and Pleistocene faunas in ascending order. The Middle Eocene fauna is closely related to the western and central Tethyan faunas. The Early Oligocene fauna appears to become endemic. The faunas contain the Indo-West Pacific genera in high density after the Early Miocene. After the Neogene, the major change on the decapod faunas can be recognized four times in connection with climatic events. It seems that decapod species migrated from the south to Japan in warming events and extinction of them was caused by cooling events.

Introduction

Decapod crustacea is one of common macrobenthos at the present oceans. Since de Haan (1835) first described *Arges parallelus* as a new species from Japan, there have been several studies on the Japanese fossil decapods by Ristori (1889), Yokoyama (1911), Glaessner (1933) and Inagaki (1938) *etc*. After that, most of the Japanese fossil decapods have been studied by the late Drs. T. Nagao and R. Imaizumi. They have mainly described decapod species from northeast Japan.

During the course of the Cenozoic decapod survey of southwest Japan, I found 119 species which were determined on the species level. Karasawa (1989, 1990b, 1991, 1992a, b), Karasawa & Nishikawa (1991), Karasawa & Inoue (1992), Karasawa & Nakagawa

(1992) and Sakumoto *et al.* (1992) have already described some species from the Miocene formations of southwest Japan. In this paper, I describe and figure 83 species belonging to 73 genera of decapods from the Cenozoic of southwest Japan besides 36 new species. Thereafter, I discuss the palaeoecology of the decapod assemblages and the geochronological change of the Cenozoic decapod faunas in relation to the palaeobiogeography and climatic changes.

Specimens prefixed MFM are in the Mizunami Fossil Museum (Yamanouchi, Mizunami, 509-61) and, unless otherwise stated ; KMNH IvP, Kitakyushu Museum of Natural History (Nishimoto-cho, Yahatahigashi, Kitakyushu, 805) ; T., Department of Geology, Faculty of Science, Shimane University (Matsue, 609) ; ESN, Department of Earth and Planetary Sciences, School of Science, Nagoya University (Chikusa, Nagoya, 464-01).

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Localities, decapod species and assemblages in each Groups

The materials described and figured herein were obtained from southwest Honshu, Kyushu, Tanegashima, Okinawa-jima and Kume-jima (Fig. 1). The stratigraphic classification about the decapod-bearing formations are shown in Tables 1 - 3. The details of localities and decapod assemblages are as follows:

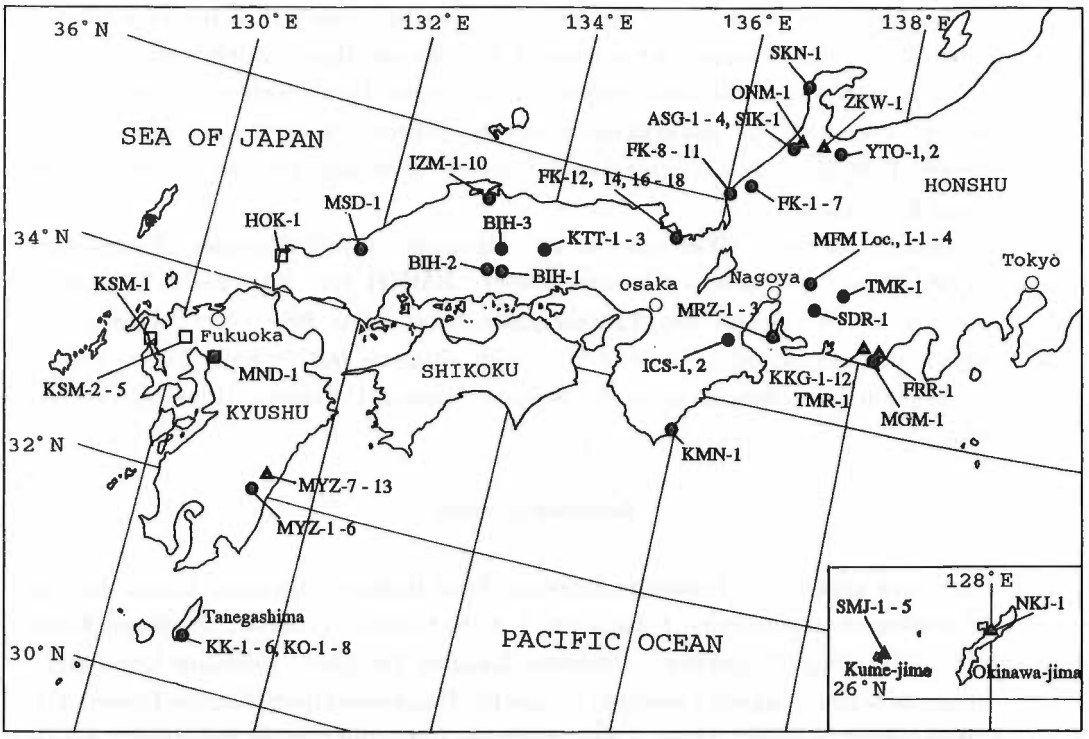


Fig. 1. Map showing the decapod-bearing localities from southwest Japan. ■, Eocene; □, Oligocene; ●, Miocene; ▲, Plio-Pleistocene.

Table 1. Stratigraphic correlation table 1 (Palaeogene). compiled by Ozaki & Hamasaki (1991).

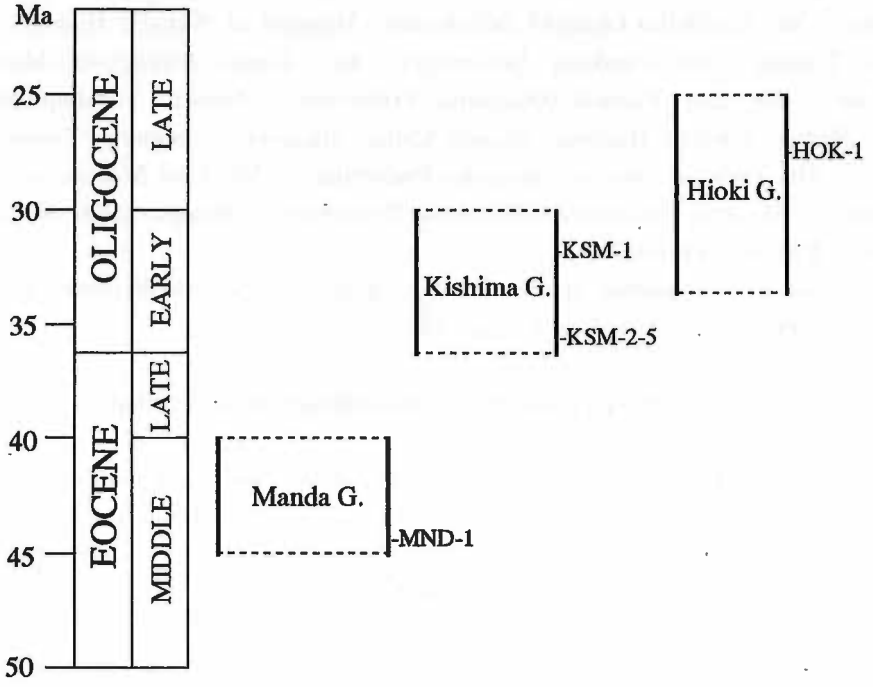


Table 2. Stratigraphic correlation table 2 (Early to Middle Miocene). compiled by Chiji *et al.* (1989), Takayasu *et al.* (1992) and Fujii *et al.* (1992).

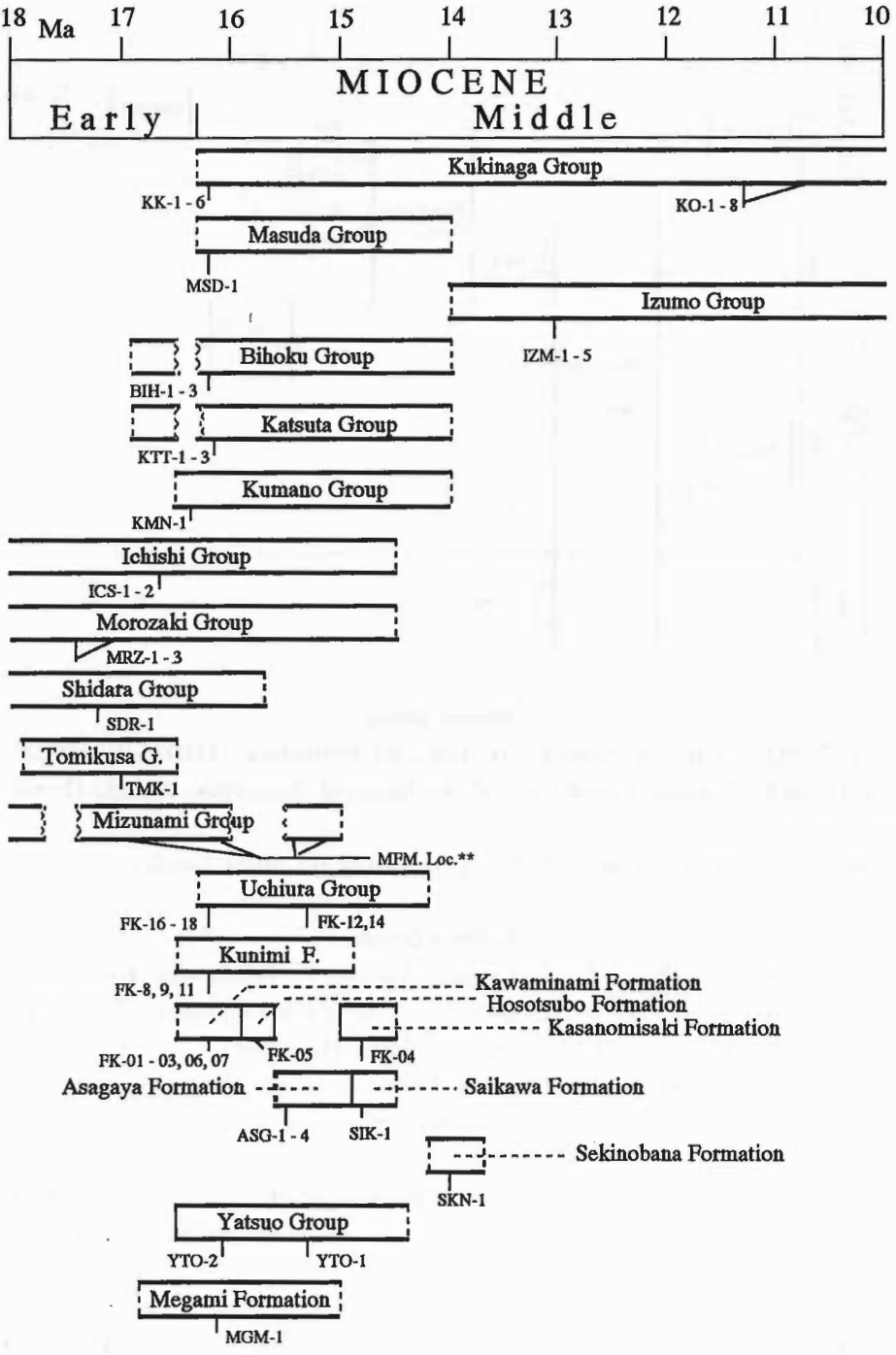
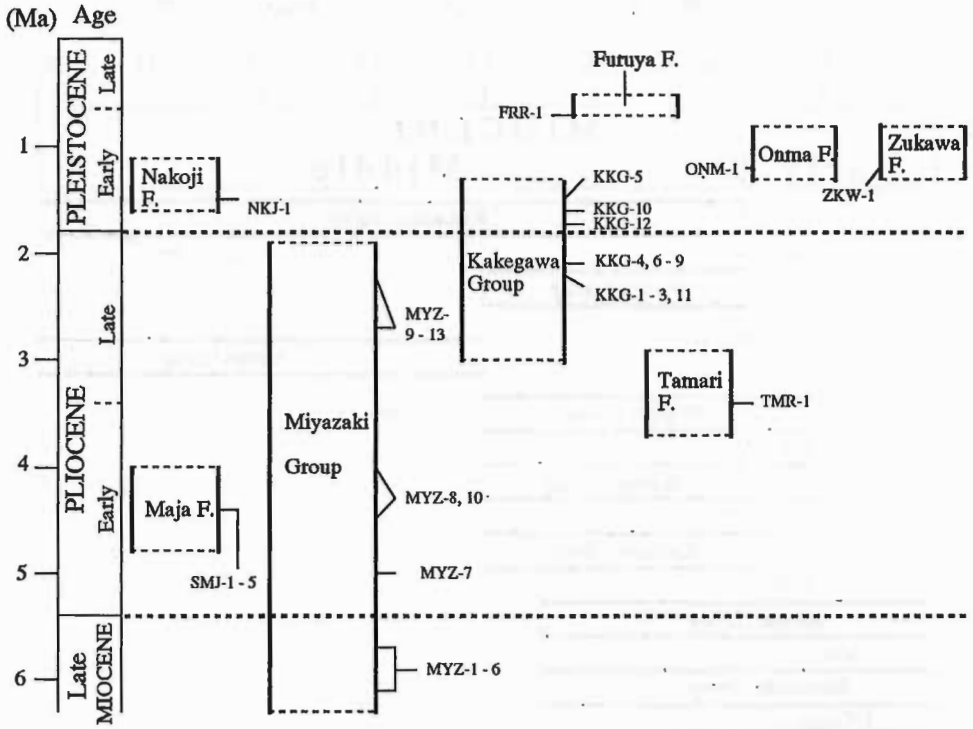


Table 3. Stratigraphic correlation table 3 (Late Miocene to Pleistocene). compiled by Endo & Suzuki (1986), Ibaragi (1986), Fujii *et al.* (1982), Nireii *et al.* (1988) and Nakagawa & Murakami (1975).



Manda Group

Loc. MND-1: Kattachi, Omuta City, Fukuoka Prefecture (33°00'45"N, 130°28'52"E). Coarse to medium-grained sandstone of the Kattachi Formation, Manda Group (Late Middle Eocene).

Karasawa (1992b) recongnized five species from the above locality.

Kishima Group

Loc. KSM-1: Beach of Takasakiyama, Usunoura, Kosasa-cho, Kitamatsura-gun, Nagasaki Prefecture (33°12'8"N, 129°35'40"E). Fine-grained sandstone of the Nagashima Sandstone, Haiki Formation, Kishima Group (Early Oligocene).

Loc. KSM-2: Cliff of Hatada, Ohmachi, Ohmachi-cho, Kishima-gun, Saga Prefecture (33°13'N, 130°8'15"E). Sandy mudstone of the Kishima Formation, Kishima Group (Early Oligocene).

Loc. KSM-3: Cliff of Umagami, Osaki, Kitakata-cho, Kishima-gun, Saga Prefecture (33°13'54"N, 130°4'18"E). Sandy mudstone of the Kishima Formation, Kishima Group (Early Oligocene).

Loc. KSM-4: Cliff of Umagami, Osaki, Kitakata-cho, Kishima-gun, Saga Prefecture (33°13'50"N, 130°4'17"E). Sandy mudstone of the Kishima Formation, Kishima Group (Early Oligocene).

Loc. KSM-5: Cliff of Tachikawa, Okawa-cho, Imari City, Saga Prefecture (33°19'N, 129°59'57"E). Sandy mudstone of the Kishima Formation, Kishima Group (Early Oligocene).

Decapod crustacean species: see Table 4. In addition, Imaizumi (1958) described *Ctenocheles sujakui* Imaizumi, 1958 from the Kishima Group of Taku City, Saga Prefecture.

Table 4. List of decapods from the Lower Oligocene Kishima Group. R, rare; F, frequent; C, common.

Species \ Formation / Loc.	Kishima Group KSM- 1	2	3	4	5
Callianassa sp.	R	R		R	
Imaizumila sexdentata gen. et sp. nov.	R				
Collinsius simplex gen. et sp. nov.		C	C	C	C
Varuna angustifrons sp. nov.		R			

Decapod assemblage: *Collinsius simplex* gen. *et* sp. nov. assemblage; Loc. KSM-2-5.

Hioki Group

Loc. HOK-1: Nabe-jima, Hosoi, Houhoku-cho, Toyoura-gun, Yamaguchi Prefecture (33°20'N, 130°60'10"E). Sandstone of the Taoyama Formation, Hioki Group (Late Oligocene).

Decapod crustacean species: *Calliax okamotoi* sp. nov.

Decapod assemblage: *Calliax okamotoi* sp. nov. assemblage.

This is characterized by a single species, *Calliax okamotoi* sp. nov., associated with Thalassinoides. The living Japanese form, *Calliax sakaii* de Saint Laurent, 1979, is an

Table 5. List of decapods from the Middle Miocene Kukinaga Group (after Karasawa & Inoue, 1992). R, rare; F, frequent; C, common.

Species \ Formation / Loc.	Kukinaga Group: Kawachi Formation KK- 1	2	3	4	5	6	Osaki Formation KO- 1	2	3	4	5	6	7	8
Thalassina anomala (Herbst)	R	R	F	C		C								
Upogebia tanegashimenis Karasawa & Inoue					C									
Callianassa yatsuoensis sp. nov.													R	
"Dardanus" muelleri Karasawa & Inoue											R			
Cancer sanbonsugi Imaizumi											R			
Mursia sp. 1										R				
Parthenope sp. 2											R			
Scylla ozawai Glaessner	R		R	F	R					R				R
Carcinoplax granulimanus Karasawa & Inoue							F	R	F	C	R	R	F	
C. imperfecta Karasawa & Inoue												R		
Actumnus guinotae Karasawa & Inoue												R		
Philyra hayasakai Karasawa & Inoue	F				R									
Macropthalmus viai Karasawa & Inoue	C	R												R
Halice sp.					R									

intertidal burrower of sandy and muddy bottoms (Sakai, 1966) and the other members of this genus inhabit shallow seas (Manning & Felder, 1991). This assemblage seems to indicate an intertidal to a shallow water of sandy and muddy bottoms.

Kukinaga Group

Karasawa & Inoue (1992) have described 14 species of 13 genera from 14 localities (Table 5). They have found four decapod assemblages as follows:

Thalassina anomala assemblage; Loc. KO-3, 4, 6.

Macrophthalmus (*Mareotis*) *viai* assemblage; Loc. KO-1, 2, KK-8.

Upogebia tanegashimensis assemblage; Loc. KO-5.

Carcinoplax granulimanus assemblage; Loc. KK-1-7.

They thought that the *T. anomala* assemblage seemed to have lived in the high spring tidal zone in mangrove swamps, the *M. viai* and *U. tanegashimensis* assemblages occupied the seaward side of mangrove swamps from the mean tidal level to below the extreme low water spring, and the *C. granulimanus* assemblage indicated a lower sublittoral zone of muddy to sandy bottom.

Miyazaki Group

Loc. MYZ-1: Cliff of Somese, Uranona, Takaoka-cho, Higashimorogata-gun, Miyazaki Prefecture (31°57'N, 131°15'30"E). Sandy siltstone of the Tano Formation, Miyazaki Group (Late Miocene).

Loc. MYZ-2: Cliff of Kawaguchi, Uranona, Takaoka-cho, Higashimorogata-gun, Miyazaki Prefecture (31°56'40"N, 131°15'35"E). Sandy siltstone of the Tano Formation, Miyazaki Group (Late Miocene).

Loc. MYZ-3: Cliff of Akatani, Uranona, Takaoka-cho, Higashimorogata-gun, Miyazaki Prefecture (31°56'48"N, 131°16'13"E). Siltstone of the Aya Formation, Miyazaki Group (Late Miocene).

Loc. MYZ-4: Cliff of Akatani, Uranona, Takaoka-cho, Higashimorogata-gun, Miyazaki Prefecture (31°56'48"N, 131°16'46"E). Siltstone of the Aya Formation, Miyazaki Group (Late Miocene).

Loc. MYZ-5: Cliff of Kawaharada, Uranona, Takaoka-cho, Higashimorogata-gun, Miyazaki Prefecture (31°56'15"N, 131°17'4"E). Sandy siltstone of the Tano Formation, Miyazaki Group (Late Miocene).

Loc. MYZ-6: Cliff of Kawaharada, Uranona, Takaoka-cho, Higashimorogata-gun, Miyazaki Prefecture (31°56'32"N, 131°17'23"E). Siltstone of the Aya Formation, Miyazaki Group (Late Miocene).

Loc. MYZ-7: Road cut of Kamiyamaji, Saito City, Miyazaki Prefecture (32°7'25"N, 131°22'20"E). Sandy siltstone of the Kawabara Formation, Miyazaki Group (Earliest Pliocene).

Loc. MYZ-8: Cliff of Ichinotomari, Saito City, Miyazaki Prefecture (32°7'58"N, 131° 25"E). Siltstone of the Tsuma Formation, Miyazaki Group (Early to early Late Pliocene).

Loc. MYZ-9: Cliff of Hirata, Shintomi-cho, Koyu-gun, Miyazaki Prefecture (32°4'N,

131°29'24"E). Mudstone of the Takanabe Formation, Miyazaki Group (Late Pliocene).

Loc. MYZ-10: Cliff of Shirodaia, Saito City, Miyazaki Prefecture (32°6'35"N, 131°25'40"E). Siltstone of the Tsuma Formation, Miyazaki Group (Early to early Late Pliocene).

Loc. MYZ-11: Cliff of Mouke, Takanabe-cho, Koyu-gun, Miyazaki Prefecture (32°6'45"N, 131°29'30"E). Fine-grained sandstone of the Takanabe Formation, Miyazaki Group (Late Pliocene).

Loc. MYZ-12: Dry river-bed of Makinouchi, Takanabe-cho, Koyu-gun, Miyazaki Prefecture (32°7'55"N, 131°27'45"E). Fine-grained sandstone of the Takanabe Formation, Miyazaki Group (Late Pliocene).

Loc. MYZ-13: Dry river-bed of Nakao, Takanabe-cho, Koyu-gun, Miyazaki Prefecture (32°40'N, 131°28'10"E). Fine-grained sandstone of the Takanabe Formation, Miyazaki Group (Late Pliocene).

Decapod crustacean species: see Table 6.

Table 6. List of decapods from the Miyazaki Group (Miocene- Pleistocene). R, rare; F, frequent; C, common.

Age	Miocene				Pliocene						
Formation	Tano F.				Aya F.		Sadohara F.	Tsuma F.	Takanabe F.		
Loc-MYZ- / Species	1	2	5	6	3	4	7	8	10	9	11	12	13
Eucalliax miyazakiensis sp. nov.								F		F	F		
Linuparus puncticulosus sp. nov						R							
Lyreidus sp.							R						
Tymolus sp.							R						
Calappa sp. 3		R											
Mursia minuta sp. nov.							C						
Padocatactes ujiharai sp. nov.											R	R	
Scylla serrata (Forskål)								R					
Lupocyclus tuberculosus sp. nov.							F						
Carcinoplax prisca Imaizumi	C		C	C	C	C	C						
Macrocheira sp,													R
Randallia saitoensis sp. nov.							R						
Pariphiculus inconditus sp. nov.							R						

Decapod assemblage: *Carcinoplax prisca* assemblage; Loc. MYZ-1, MYZ-3-6.

Carcinoplax prisca Imaizumi occurs in very high density at all the localities. In addition to *C. prisca*, *Linuparus* aff. *trigonus* (von Sievold, 1824) occurs rarely at loc. MYZ-4. Most species of the *Carcinoplax* inhabit a lower sublittoral zone of muddy and sandy bottoms at the present day (Sakai, 1976). Therefore, it seems to reflect a lower sublittoral zone of muddy to sandy bottom.

Carcinoplax prisca-Mursia minuta sp. nov. assemblage; Loc. MYZ-7.

This assemblage is characterized by the predominance of *Carcinoplax prisca* Imaizumi, 1961 and *Mursia minuta* sp. nov. This is accompanied with *Lyreidus* sp., *Tymolus* sp.,

Padocatactes ujiharai sp. nov., *Lupocyclus tuberculosus* sp. nov., *Randallia saitoensis* sp. nov. and *Pariphiculus inconditus* sp. nov. Most species of the genus *Mursia*, *Lyreidus*, *Tymolus*, *Randallia*, *Pariphiculus*, *Padocatactes*, *Lupocyclus* and *Carcinoplax* are found on bottoms of sand or sandy mud in the lower sublittoral waters (Sakai, 1976). This is thought to have lived in a lower sublittoral zone of the bottoms of sandy or sandy mud.

Eucalliax miyazakiensis sp. nov. assemblage; Loc. MYZ-9-11.

Eucalliax miyazakiensis sp. nov. occurs in high density at loc. MYZ-9-11. *Padocatactes ujiharai* sp. nov. occurs at loc. MYZ-11. This assemblage seems to reflect a lower sublittoral zone of sandy to muddy bottom.

Masuda Group

Loc. MSD-1: Okuda, Masuda City, Shimane Prefecture (34°43'N, 131°49'45"E). Shale of the Toyoda Formation, Masuda Group (early Middle Miocene).

Decapod crustacean species: *Callianassa nishikawai* sp. nov., *Laurentiella imaizumii* sp. nov., *Miosesarma japonicum* Karasawa, 1989.

Decapod assemblage: *Callianassa nishikawai* sp. nov. assemblage.

This is defined by the predominance of *Callianassa nishikawai* sp. nov. *Laurentiella imaizumii* sp. nov. is a subdominant species. Karasawa (1990a) thought that this assemblage (= *Callianassa* sp. 3 assemblage; Karasawa, 1990a) indicated palaeoenvironments in mud flats on the seaward side of mangrove swamps from the mean tidal level to below the extreme low water spring.

Bihoku Group

Loc. BIH-1: Imobara, Kawakami-cho, Kawakami-gun, Okayama Prefecture (34°44'56"N, 133°27'E). Sandy siltstone of the Lower Bihoku Group (early Middle Miocene).

Loc. BIH-2: Munekane, Yuki-cho, Jinseki-gun, Hiroshima Prefecture (34°46'21"N, 133°17'57"E). Siltstone of the Jinseki Formation, Bihoku Group (early Middle Miocene).

Loc. BIH-3: Nishikata, Niimi City, Okayama Prefecture (34°59'30"N, 133°26'10"E). Sandy siltstone of the Lower Bihoku Group (early Middle Miocene).

Table 7. List of decapods from the Middle Miocene Bihoku and Katsuta Groups. R, rare; F, frequent; C, common.

Formation / Loc. / Species	Bihoku Group			Katsuta Group		
	BIH-			KTT-		
	1	2	3	1	2	3
Thalassina anomala (Herbst)		C				
Laurentiella imaizumii sp. nov.	R				F	F
Upogebia mizunamiensis Karasawa						R
Callianassa nishikawai sp. nov.	C		C	C	C	C
Ozius collinsi Karasawa						R
Philyra plana Karasawa	R					
Miosesarma japonicum Karasawa	R				R	F
"Sesarma" sp.		R				

Decapod crustacean species: see Table 7.

Decapod assemblage: *Callianassa nishikawai* assemblage; Loc. BIH-1, 3.

The assemblage from Loc. BIH-1, 3, is referred to the *Callianassa nishikawai* assemblage on the basis of species content to the *C. nishikawai* assemblage from the Masuda Group.

Thalassina anomala assemblage; Loc. BIH-2.

Karasawa & Nishikawa (1991) showed that it indicated a mangrove swampy palaeoenvironments at the high tide level.

Katsuta Group

Loc. KTT-1: Cliff of Mino, Shouou-cho, Katsuta-gun, Okayama Prefecture (35°4'32" N, 134°9'24"E). Sandy siltstone of the Yoshino Formation, Katsuta Group (early Middle Miocene).

Loc. KTT-2: Cliff of Kaki, Nagi-cho, Katsuta-gun, Okayama Prefecture (35°6'4"N, 134°11'32"E). Mudstone of the Yoshino Formation, Katsuta Group (early Middle Miocene).

Loc. KTT-3: Niida, Tsuyama City, Okayama Prefecture (35°3'5"N, 134°4'1"E). Mudstone of the Yoshino Formation, Katsuta Group (early Middle Miocene).

Decapod crustacean species: see Table 7.

Decapod assemblage: *Callianassa nishikawai* assemblage; Loc. KTT-1-3.

The present assemblage from the above localities is referred to the *C. nishikawai* assemblage from the Masuda and Bihoku Groups on the basis of the predominance of *C. nishikawai* sp. nov.

Izumo Group

Sakumoto *et al.* (1992) found eleven species from the middle Middle Miocene Izumo Group of Shimane Prefecture (Table 8). They recognized the *Carcinoplax antiqua* and *Mursia takahashii* assemblages from the Group.

Kumano Group

Loc. KMN-1: Beach of Nassa, Yukawa, Nachikatsuura-cho, Higashimuro-gun, Wakayama Prefecture (33°36'20"N, 136°56'E). Siltstone of the Koguchi Formation, Kumano Group (Early Miocene).

Decapod crustacean species: *Carcinoplax antiqua* (Ristori, 1889), *Trachycarcinus huziokai* Imaizumi, 1951.

Decapod assemblage: *Carcinoplax antiqua-Trachycarcinus huziokai* assemblage.

Carcinoplax antiqua and *Trachycarcinus huziokai* are predominated at the locality. The living forms of the *Carcinoplax* and *Trachycarcinus* live in a lower sublittoral zone of sandy to muddy bottom (Sakai, 1976). This assemblage is thought to indicate a lower sublittoral zone of sandy to muddy bottom.

Table 8. List of decapods from the Middle Miocene Izumo Group (after Sakumoto *et al.*, 1992). R, rare; F, frequent; C, common.

Species \ Formation	Izumo Group									
	Kimachi F.	Fujina Formation								
	5	1	2	3	4	6	7	8	9
Callianassa sp.					R				
Platepistoma kaedei (Karasawa)		R							
Cancer (Metacarcinus) izumoensis Sakumoto et al.									R
C. (Cancer) fujinaensis Sakumoto et al.						R			
C. (C.) tomowoi Karasawa									R
Mursia takahashii Imaizumi	R								
Itoigawaia minoensis (Karasawa)						R			
Scylla ozawai Glaessner						R			
S. sp.								R	
Carcinoplax antiqua (Ristori)			C	F	F	F	F		C
Tritodynamia globosa Karasawa									F

Ichishi Group

Loc. ICS-1: River side of the Nagano-gawa of Ashisaka, Iono, Misato-mura, Yasuge-gun, Mie Prefecture (34°43'50"N, 136°23'45"E). Mudstone of the Oi Formation, Ichishi Group (Early Miocene).

Loc. ICS-2: River side of the Nagano-gawa of Chaya, Inaba-cho, Hisai City, Mie Prefecture (34°43'25"N, 136°44'17"E). Mudstone of the Oi Formation, Ichishi Group (Early Miocene).

Decapod crustacean species: *Trachycarcinus huziokai* Imaizumi, 1951.

Decapod assemblage: *Trachycarcinus huziokai* assemblage.

Trachycarcinus huziokai Imaizumi, 1951 occurs in high density at the above localities. The present assemblage seems to reflect palaeoenvironments in a lower sublittoral zone of bottoms of mud and sand.

Mizunami Group

Karasawa (1991) found 51 species in 24 genera of decapod crustaceans from the Early to Middle Miocene Mizunami Group at 35 localities in the Mizunami and Iwamura basins, Gifu Prefecture. He has described seven assemblages from the Group and discussed their palaeoecology.

Occurrences for each of them as follows:

Upogebia mizunamiensis assemblage; MFM. Loc. 32, 36 and Loc. I-1.

Calliax bona-Philyra nishimotoi assemblage (= *Callianassa bona-Philyra nishimotoi* assemblage of Karasawa, 1991) ; MFM. Loc. 19-22, 27, 40, 46, 79.

Tymolus itoigawai-Philyra plana assemblage; MFM. Loc. 07.

Xanthid-Grapsid assemblage; MFM. Loc. 11-13, 58.

Miosesarma japonicum-Philyra nishimotoi assemblage; Loc. I-2.

Miosesarma japonicum-Carcinoplax antiqua assemblage; MFM. Loc. 25, 45, 49, 50, 54.

Callianopsis titaensis assemblage (= *Callianassa titaensis* assemblage of Karasawa, 1991) ; MFM. Loc. 49, I-3.

Morozaki Group

Loc. MRZ-1: Cliff of Arai, Toyohama, Minamichita-cho, Chita-gun, Aichi Prefecture (34°42'40"N, 137°57'E). Tuffaceous mudstone of the Toyohama Formation, Morozaki Group (Early Miocene).

Loc. MRZ-2: Cliff of Oza, Toyohama, Minamichita-cho, Chita-gun, Aichi Prefecture (34°41'48"N, 136°57'18"E). Tuffaceous mudstone of the Toyohama Formation, Morozaki Group (Early Miocene).

Loc. MRZ-3: Cliff of Okatta, Toyooka, Minamichita-cho, Chita-gun, Aichi Prefecture (43°15'N, 136°57'12"E). Tuffaceous mudstone of the Toyohama Formation, Morozaki Group (Early Miocene).

Decapod crustacean species: *Callianopsis titaensis* (Nagao, 1941). In addition, Takeda, Mizuno & Yamaoka (1986) and Mizuno & Takeda (1993) described eight species, *Munida* sp., *Munidopsis* sp., *Trachycarcinus huziokai* Imaizumi, 1951, *Dicranodramia* sp., *Paralomis* sp., *Achaeus* sp., *Pisoides* sp., and *Hexapinus* sp. from the Morozaki Group.

Decapod assemblage: *Callianopsis titaensis* assemblage.

Callianopsis titaensis is extremely predominated at all the localities. Karasawa (1991) thought that the assemblage (= *Callianassa titaensis* assemblage of Karasawa, 1991) indicated the upper bathyal palaeoenvironments based on associated decapods, *Munida* sp., *Munidiopsis* sp., *Paralomis* sp. and *Dicranodramia* sp. by Takeda, Mizuno & Yamaoka (1986). In addition, living species, *Callianopsis goniophthalma* (Rathbun, 1902) is known from slope depths (480-650m) (Manning & Felder, 1991).

Shidara Group

Loc. SDR-1: Road cut of Komatsu, Shitara-cho, Shitara-gun, Aichi Prefecture (35°6' 20"N, 137°35'18"E). Mudstone of the Tsubosawa Formation, Shidara Group (Early Miocene).

Decapod crustacean species: *Callianopsis titaensis* (Nagao, 1941).

Decapod assemblage: *Callianopsis titaensis* assemblage.

The assemblage is referred to the *Callianopsis titaensis* assemblage from the Morozaki Group on the basis of the predominance of *C. titaensis*.

Tomikusa Group

Loc. TMK-1: Awano, Anan-cho, Shimoina-gun, Nagano Prefecture (35°21'40"N, 137° 43E). Fine-grained sandstone of the Awano Formation, Tomikusa Group (Early Miocene).

Decapod crustacean species: *Tymolus ingens* Takeda & Tomida, 1984.

Kawaminami, Kunimi, Hosotsubo and Kasanomisaki Formations, and Uchiura Group

Karasawa & Nakagawa (1992) has recognized six species from 18 localities (Table 9) and found the following three decapod assemblages:

Callianassa nishikawai assemblage (= *Callianassa* sp. assemblage of Karasawa & Nakagawa, 1992) ; Loc. FK-1, 2, 3, 8, 9, 17, 18.

Callianopsis titaensis assemblage; Loc. FK-5, 14.

Carcinoplax antiqua assemblage; Loc. FK-6, 7, 11, 12, 16.

Table 9. List of decapods from the Middle Miocene Kawaminami, Kunimi, Hosotsubo, Kasanomisaki and Shimo Formations (after Karasawa & Nakagawa, 1992). R, rare; F, frequent; C, common.

Formation / Loc. / Species	Kawaminami F.	Kasanomisaki F.	Hosotsubo F.	Kunimi F.	Shimo F.
	FK-				
	1 2 3 6 7	4	5	8 9 10 11	12 14 16 17 18
Thalassina anomala (Herbst)				R	
Laurentiella imaizumii sp. nov.				R R R	
Callianassa nishikawai sp. nov.	C C C			C C C	C C
Callianopsis titaensis sp. nov.			F		C
Trachycarcinus huziokai Imaizumi			F		
Carcinoplax antiqua (Ristori)	R R F	R			C C

Asagaya Formation

Loc. ASG-1: Dry river bed of Tatsumi-cho, Kanazawa City, Ishikawa Prefecture (36° 30'21"N, 136°42'2"E). Mudstone of the Asagaya Formation (Middle Miocene).

Loc. ASG-2: Road cut of Ohara-cho, Kanazawa City, Ishikawa Prefecture (36°29'14" N, 136°40'30"E). Mudstone of the Asagaya Formation (Middle Miocene).

Loc. ASG-3: Road cut of Bessho-cho, Kanazawa City, Ishikawa Prefecture (36°30'20" N, 136°40'15"E). Mudstone of the Asagaya Formation (Middle Miocene).

Loc. ASG-4: Road cut of Mitsukouji-cho, Kanazawa City, Ishikawa Prefecture (36°31' N, 136°40'E). Mudstone of the Asagaya Formation (Middle Miocene).

Decapod crustacean species: *Platepistoma kaedei* (Karasawa, 1990b) (at all the localities), *Munida nishioi* sp. nov. (at Loc. ASG-1).

Decapod assemblage: *Platepistoma kaedei* assemblage; Loc. ASG-1-4.

Platepistoma kaedei is extremely predominated at all the localities. Associated with *P.*

kaedei, *Munida nishioi* sp. nov. rarely occurs at Loc. ASG-1. The Japanese living form, *Platepistoma anaglyptum* Balss, 1922, inhabits a lower sublittoral zone (Sakai, 1976), while the others are known from an upper bathyal zone (Daive, 1991). Most *Munida* species is found in a lower sublittoral to an upper bathyal zone (Miyake, 1982). This assemblage seems to indicate a lower sublittoral to an upper sublittoral zone.

Saikawa Formation

Loc. SIK-1: River-bed of the Asano-gawa of Choushi-cho, Kanazawa City, Ishikawa Prefecture (36°31'3"N, 136°42'13"E). Tuffaceous fine-grained sandstone of the Saikawa Formation (Middle Miocene).

Decapod crustacean species: *Carcinoplax antiqua* (Ristori, 1889).

Sekinobana Formation

Loc. SKN-1: Beach of Sekinobana, Togi-machi, Hakui-gun, Ishikawa Prefecture (37° 12'40"N, 136°41'30"E). Coquina and fine to medium-grained sandstone of the Sekinobana Formation.

Decapod crustacean species: *Scylla* sp., *Charybdis* sp. 1.

Yatsuo Group

Loc. YTO-1: Dry river bed of Murasugi, Yatsuo-cho, Nei-gun, Toyama Prefecture (36°44'15"N, 137°9'30"E). Mudstone of the Joyama Member, Higashibessho Formation, Yatsuo Group (Middle Miocene).

Decapod crustacean species: *Munida nishioi* sp. nov., *Trachycarcinus huziokai* Imaizumi, 1951, *Platepistoma kaedei* (Karasawa, 1990b), *Cancer sanbonsugii* Imaizumi, 1962, *Carcinoplax antiqua* (Ristori, 1889), *Miosesarma japonicum* Karasawa, 1989, *Tritodynamia globosa* Karasawa, 1990b.

Decapod assemblage: *Carcinoplax antiqua-Trachycarcinus huziokai* assemblage.

Carcinoplax antiqua and *Trachycarcinus huziokai* occur in high density. It is associated with *Munida nishioi* sp. nov., *Platepistoma kaedei*, *Cancer sanbonsugii*, *Miosesarma japonicum* and *Tritodynamia globosa*. The present assemblage is referred to the *Carcinoplax antiqua-Trachycarcinus huziokai* assemblage from the Kumano Group on the basis of the predominance of *C. antiqua* and *T. huziokai*. In specific composition, it has something in common with the *Miosesarma japonicum-Carcinoplax antiqua* and *Platepistoma kaedei* assemblages by having *Munida nishioi* sp. nov. *Platepistoma kaedei*, *Miosesarma japonicum* and *Tritodynamia globosa*.

Loc. YTO-2: Dry river bed of Iguridani, Yatsuo-cho, Nei-gun, Toyama Prefecture (36°34'N, 137°11'E). Pebbly conglomerate of the Kurosedani Formation, Yatsuo Group (early Middle Miocene).

Decapod crustacean species: *Callianassa yatsuoensis* sp. nov., *Carcinoplax antiqua* (Ristori, 1889), *Miosesarma japonicum* Karasawa, 1989.

Megami Formation

Loc. MGM-1: Cliff of Megami, Sagara-cho, Haibara-gun, Shizuoka Prefecture (34°42' 16"N, 138°11'E). Limestone of the Megami Limestone, Megami Formation (Early to early Middle Miocene).

Decapod crustacean species: *Galathea keijii* sp. nov., *Petrolisthes miocaenicus* sp. nov., *Dynomene shinobui* sp. nov., *Lybia* sp., *Liomera* sp., *Carpilius* sp., *Medaeops megamiensis* sp. nov., *Leptodius crosnieri* sp. nov., *L. morrisi* sp. nov., *Paraxanthias fujiyamai* sp. nov., *Palaeoxanthops minutus* sp. nov., *P. okumurai* sp. nov., *Megamia anaglypta* sp. nov., *Pilodius parvus* sp. nov., *Eriphia* sp., *Euryozius angustus* sp. nov., *E. bidentatus* sp. nov., *Trapezia brevispinosa* sp. nov., *T.* sp., *Daira perlata* (Herbst, 1790).

Decapod assemblage: *Petrolisthes miocaenicus* sp. nov.-*Medaeops megamiensis* sp. nov. -*Galathea keiji* sp. nov. assemblage.

This assemblage is defined by the extremely predominance of *Petrolisthes miocaenicus* sp. nov., *Medaeops megamiensis* sp. nov. and *Galathea keijii* sp. nov. *Paraxanthias fujiyamai* sp. nov., *Palaeoxanthops minutus* sp. nov., *Dynomene shinobui* sp. nov. and *Daira perlata* are subdominant species.

Most species of the *Petrolisthes* and *Eriphia* are found in lagoon reefs at the present day (Miyake, 1982). Living species of the *Galathea, Dynomene* and *Lybia* inhabit the low tide level to a lower sublittoral zone and on lagoon reefs (Sakai, 1976; Miyake, 1982, 1983). The *Carpilius* and *Liomera* species are inhabitants in shallow waters and lagoon reefs at the present day (Sakai, 1976; Miyake, 1982, 1983). The genera *Palaeoxanthops* and *Megamia* have no living species, and the *Euryoziis* is not found from the West Pacific Ocean. The living forms of the *Trapezia* and *Pilodius* live in coral reefs (Sakai, 1976). The living species, *Daira perlata*, inhabits coral reefs from Kagoshima southwards (Sakai, 1976). Living species of the *Medaeops* and *Paraxanthias* are found in rocky beach under stones and coral reefs (Miyake, 1982). Therefore, this assemblage indicates lagoon reef palaeoenvironments from the present Kagoshima southwards.

Shimajiri Group

Loc. SMJ-1: Maja, Nakazato-son, Shimajiri-gun, Okinawa Prefecture (26°20'51"N, 123°34'E). Sandy siltstone of the Maja Formation, Shimajiri Group (Early Pliocene).

Loc. SMJ-2: Maja, Nakazato-son, Shimajiri-gun, Okinawa Prefecture (26°20'53"N, 123°34'03"E). Sandy siltstone of the Maja Formation, Shimajiri Group (Early Pliocene).

Loc. SMJ-3: Maja, Nakazato-son, Shimajiri-gun, Okinawa Prefecture (26°20'53"N, 123°34'05"E). Sandy siltstone of the Maja Formation, Shimajiri Group (Early Pliocene).

Loc. SMJ-4: Maja, Nakazato-son, Shimajiri-gun, Okinawa Prefecture (26°20'55"N, 123°24'03"E). Sandy siltstone of the Maja Formation, Shimajiri Group (Early Pliocene).

Decapod crustacean species: *Carcinoplax prisca* Imaizumi, 1961 from all the localities, *Scylla serrata* (Forskål, 1775) and *Thalamita* sp. from the Loc. SMJ-1.

Decapod assemblage: *Carcinoplax prisca* assemblage.

Carcinoplax prisca is predominated at all the localities. *Thalamita* sp. and *Scylla serrata* occur at Loc. SMJ-1. The present assemblage is referred to the *C. prisca* assemblage from

the Late Miocene Miyazaki Group on the basis of the dominate species.

Kakegawa Group

Loc. KKG-1: Road cut of Hongohigashi, Kakegawa City, Shizuoka Prefecture (34°48' 10"N, 138°57'50"E). Shell bed of the Dainichi Sand, Kakegawa Group (Late Pliocene).

Loc. KKG-2: Road cut of Kamiiida, Mori-machi, Suchi-gun, Shizuoka Prefecture (34° 48'30"N, 137°55'15"E). Shell bed of the Dainichi Sand, Kakegawa Group (Late Pliocene).

Loc. KKG-3: Cliff of Goudaijimashita, Toyooka-mura, Iwata-gun, Shizuoka Prefecture (34°49'20"N, 137°51'20"E). Shell bed of the Dainichi Sand, Kakegawa Group (Late Pliocene).

Loc. KKG-4: Ishigami, Kurimoto, Kakegawa City, Shizuoka Prefecture (34°48'55"N, 138°3'E). Fine-grained sandstone of the Ten-no Sand, Kakegawa Group (Late Pliocene).

Loc. KKG-5: Hyugadani, Daito-cho, Ogasa-gun, Shizuoka Prefecture (34°43'25"N, 138°2'E). Fine-grained sandstone of the Soga Formation, Kakegawa Group (Early Pleistocene).

Loc. KKG-6: Umagadani, Ukari, Kakegawa City, Shizuoka Prefecture (43°47'50"N, 138°55'20"E). Fine-grained sandstone of the Ten-no Sand, Kakegawa Group (Early Pleistocene).

Loc. KKG-7: Mitsusawa, Ukari, Kakegawa City, Shizuoka Prefecture (43°47'10"N, 138°55'15"E). Fine-grained sandstone of the Ten-no Sand, Kakegawa Group (Late Pliocene).

Loc. KKG-8: Nakamura, Ukari, Kakegawa City, Shizuoka Prefecture (43°47'35"N, 138°56'25"E). Fine-grained sandstone of the Ten-no Sand, Kakegawa Group (Late Pliocene).

Loc. KKG-9: Dainichi, Ukari, Kakegawa City, Shizuoka Prefecture (43°48'N, 138°56' 30"E). Fine-grained sandstone of the Ten-no Sand, Kakegawa Group (Late Pliocene).

Loc. KKG-10: Cliff of Kamiitazawa, Kakegawa City, Shizuoka Prefecture (34°44'30" N, 138°1'12"E). Sandy siltstone of the Hijikata Silt, Kakegawa Group (Late Pliocene to Early Pleistocene).

Loc. KKG-11: Road cut of Gomyo, Kamisaigo, Kakegawa City, Shizuoka Prefecture (34°48'15"N, 138°00'13"E). Shell bed of the Dainichi Sand, Kakegawa Group (Late Pliocene).

Loc. KKG-12: Ciff of Ieshiro, Kakegawa City, Shizuoka Prefecture (34°47'14"N, 137° 58'33"E). Shilt of Hijikata silt Formation, Kakegawa Group (Late Pliocene).

Decapod crustacean species: see Table 10.

Decapod assemblage: *Philyra platychira* assemblage; Loc. KKG-1, 2, 11.

This assemblage is defined by the predominance of *Philyra platychira* in association with *P. tanakai* sp. nov., *P. tridentata* sp. nov., *Mursia* sp. 2, *Cancer amphioetus*, *Leucosia* spp. The living species, *Philyra platychira* is found on bottoms of sand in 35 to 150 m deep (Sakai, 1976) and *Cancer amphioetus* is also on soft bottoms of sand or broken shells down to 65 m deep (Sakai, 1976). Most *Leucosia* species inhabits a lower sublittoral zone (Sakai, 1976). Accordingly, the assemblage indicates a lower sublittoral zone of sandy bottom.

Table 10. List of decapods from the Kakegawa Group (Late Pliocene-Early Pleistocene). R, rare; F, frequent; C, common.

Species \ Formation / Loc. KKG-	Dainichi Sand				Tenno Sand					Hijikata Silt		Soga Formation
	1	2	3	11	4	6	7	8	9	10	12	5
Pagurus sp.					R							
Tymolus uncifer (Ortmann)												
Mursia sp. aff. *M. armata* (de Haan)					R				R			
M. sp. 2	F			F								
Padocatactes hamifer Ortmann												R
Cancer (Cancer) japonicus Ortmann						R						
C. (Glebocarcinus) amphioetus Rathbun	F			F								
Charybdis sp. 2				F								
Carcinoplax longimanus (de Haan)					F	F	R			R		C
C. sp. aff. *C. purpurea* Rathbun												R
Typhlocarcinus obtusus sp. nov.			R									
Ebalia kakegawaensis sp. nov.								R				
Philyra platychira de Haan	C	R		C								
P. tanakai sp. nov.	R			R								
P. tridentata sp. nov.		R										
Leucosia takamii sp. nov.		R										R
L. sp. 1		R										
L. sp. 2	F			F								

Carcinoplax longimanus assemblage; Loc. KKG-4-7, 10.

Carcinoplax longimanus is predominated at all the localities. Associated with *C. longimanus*, *Pagurus* sp. and *Mursia* aff. *armata* at loc. KKG-4, *Cancer japonicus* at loc. KKG-6, and *Padocatactes hamifer*, *Carcinoplax* aff. *purpurea* and *Leucosia takamii* sp. nov. occurs rarely. Considering the ecological data of the living species, *Carcinoplax longimanus*, this assemblage reflect a lower sublittoral zone of sandy to muddy bottom.

Tamari Formation

Loc. TMN-1: Kinjo, Kakegawa City, Shizuoka Prefecture (34°46'20"N, 138°2'15"E). Mudstone of the Tamari Formation (Late Pliocene).

Decapod crustacean species: *Eucalliax miyazakiensis* sp. nov., *Ethusa chibai* sp. nov.

Decapod assemblage: *Eucalliax miyazakiensis* assemblage.

This assemblage is defined by the predominance of *Eucalliax miyazakiensis* sp. nov. associated with *Ethusa chibai* sp. nov. The living form, *Ethusa indica* Alcock, 1894, being similar to the extant species is found in a lower sublittoral zone of bottoms of sand and mud. This is thought to have lived in a lower sublittoral zone of muddy to sandy bottom.

Onma Formation

Loc. ONM-1: Dry river bed of Ohkuwa-cho, Kanazawa City, Ishikawa Prefecture (36° 32'N, 136°41'E). Fine-grained sandstone of the Onma Formation (Middle Pleistocene).

Decapod crustacean species: *Cancer japonicus* Ortmann, 1893, *Leucosia* sp.

Zukawa Formation

Loc. ZKW-1: Cliff of Zukawa, Takaoka City, Toyama Prefecture (35°45'50"N, 136°58' E). Calcareous sandstone of the Zukawa Formation (Early Pleistocene).

Decapod crustacean species: *Cancer japonicus* Ortmann, 1893.

Nakoji Formation

Loc. NKJ-1: Nakoji, Nago City, Okinawa Prefecture (26°37'N, 128°5'50"E). Siltstone of the Nakoji Formation (Early Pleistocene).

Decapod crustacean species: *Macrophthalmus* (*Euplax*) *leptophthalmus* (H. Milne Edwards, 1852).

Decapod assemblage: *Macrophthalmus* (*Euplax*) *leptophthalmus* assemblage.

Macrophthalmus (*Euplax*) *leptophthalmus* occurs in high density at the locality. The ecological data of this species is poorly known in spite of the living species. Barnes (1977) mentioned that "the range of *M. leptophthalmus* now includes the brackish and saline waters of the Chilka Lake, Orissa, India". On the other side, Kesling (1958) reported *M. leptophthalmus* (= *M. guamnensis* Kesling, 1958) accompanied with the upper sublittoral dwellers, *Macrophthalmus* (*Euplax*) *latreillei* and *Padophthalmus vigil*, from the Late Pleistocene? of Guam. Perhaps, this assemblage indicates an upper sublittoral zone in tropical waters.

Furuya Formation

Loc. FRY-1: Cliff of Ebie, Sagara-cho, Haibara-gun, Shizuoka Prefecture (34°42'10" N, 128°12"E). Sandy mudstone of the Furuya Formation (Middle Pleistocene).

Decapod crustacean species: *Macrophthalmus* (*Mareotis*) *japonicus* de Haan, 1835. In addtion, Muraoka (1976) described *Scylla serrata* (Forskål, 1775).

Decapod assemblage: *Macrophthalmus* (*Mareotis*) *japonicus* assemblage.

This assemblage is characterized by the extreme dominance of *Macrophthalmus* (*Mareotis*) *japonicus*. This extant species lives in sandy flats from the mean tidal level to below the extreme low water spring (Collaborative Research Group on "Lebensspuren", 1989). Therefore, this has lived in sandy flats from the mean tidal level to below the extreme low water spring.

Palaeoecology

The palaeoecology on the decapod assemblages in each groups are summarized in Table 11.

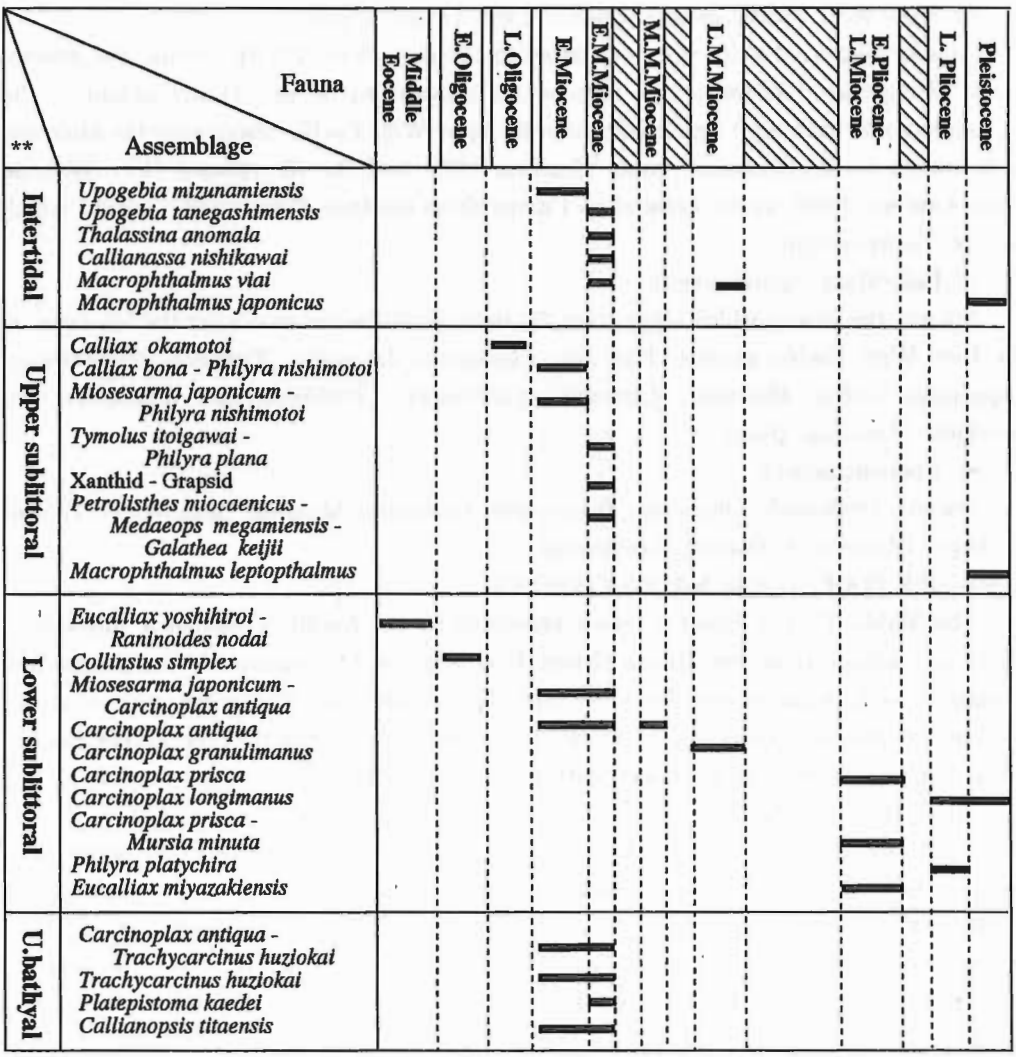
Table 11. Palaeoecology of the decapod assemblage from the Cenozoic of southwest Japan.

Assemblage	Occurrence	Climate	Water depth	Bottom	Life mode
Thalassina anomala	Kukinaga G., Bihoku G.	tropical	Intertidal	mud	endebiose > epibiose
Upogebia mizunamiensis	Mizunami G.	subtropical	Intertidal	mud	endebiose > epibiose
Upogebia tanegashimensis	Kukinaga G.	tropical	Intertidal	sand-mud	endebiose > epibiose
Callianassa nishikawai	Masuda G., Bihiku G., Katsuta G., Uchiura G., Kunimi F., Kawaminami F.	tropical	Intertidal	mud	endebiose > epibiose
Macrophthalmus viai	Kukinaga G.	tropical	Intertidal	mud	endebiose > epibiose
Macrophthalmus japonicus	Furuya F.	subtropical	Intertidal	mud	endebiose
Calliax bona - *Philyra nishimotoi*	Mizunami G.	subtropical	upper sublittoral	sand	endebiose > epibiose
Tymolus itoigawai - *Philyra plana*	Mizunami G.	tropical	upper sublittoral	sand	epibiose
Xanthid - Grapsid	Mizunami G.	tropical	upper sublittoral	sand, pebble	epibiose
Miosesarma japonicum - *Philyra nishimotoi*	Mizunami G.	subtropical	upper sublittoral	sand	endebiose > epibiose
Petrolisthes miocaenicus - *Medaeops megamiensis* - *Galathea keijii*	Megami F.	tropical	upper sublittoral	lagoon reef	epibiose
Macrophthalmus leptopthalmus	Nakoji F.	tropical	upper sublittoral	mud	endebiose > epibiose
Miosesarma japonicum - *Carcinoplax antiqua*	Mizunami G.	subtropical	lower sublittoral	mud	epibiose > endebiose
Carcinoplax antiqua	Uchiura G., Izumo G. Kawaminami F.	subtropical	lower sublittoral	mud	epibiose
Carcinoplax granulimanus	Kukinaga G.	subtropical	lower sublittoral	mud	epibiose
Carcinoplax prisca	Miyazaki G., Shimajiri G.	subtropical	lower sublittoral	mud	epibiose
Carcinoplax longimanus	Kakegawa G.	subtropical	lower sublittoral	mud	epibiose
Carcinoplax prisca - *Mursia minuta*	Miyazaki G.	subtropica	lower sublittoral	mud	epibiose
Philyra platychira	Kakegawa G.	subtropical	lower sublittoral	sand	epibiose
Eucalliax miyazakiensis	Miyazaki G., Tamari F.	subtropical	lower sublittoral	mud	endebiose
Carcinoplax antiqua - *Trachycarcinus huziokai*	Kumano G., Yatsuo G.	subtropical	l. s - upper bathyal	mud	epibiose
Trachycarcinus huziokai	Ichishi G.	?	l. s. - upper bathyal	mud	epibiose
Platepistoma kaedei	Asagaya F.	?	l. s. - upper bathyal	mud	epibiose
Callianopsis titaensis	Morozaki G., Shitara G., Uchiura G., Hosotsubo F.	?	l. s. - upper bathyal	mud	endebiose

Stratigraphic succession of the assemblages and the Cenozoic decapod faunas

Considering the change of the decapod assemblages based on the geologic age of the decapod-bearing formations from southwest Japan (Tables 1-3), the Cenozoic decapod fauna is divided into ten, Middle Eocene (Bartonian), Early Oligocene, Late Oligocene, Early Miocene (about 18-16 Ma), Early Middle Miocene (about 16-15 Ma), Middle Middle Miocene (about 14-13 Ma), Late Middle Miocene (about 12-10 Ma), Latest Miocene to Early Pliocene (7-4 Ma), Late Pliocene (about 3-2 Ma), and Pleistocene faunas in asending order (Table 12). In this paper, I use a term, "fauna" in view of the temporal change of the decapod assemblages.

Table 12. Stratigraphic distribution of the decapod assemblages from the Cenozoic of southwest Japan.



The Cenozoic decapod faunas and their palaeobiogeography

1. PALAEOBIOGEOGRAPHIC DISTRIBUTIONAL PATTERNS OF DECAPOD GENERA

Sakai (1940) divided biogeographic realms of the recent Japanese decapods into eight types at the species level. He indicated that 420 brachyuran decapod species are the Indo-West Pacific elements among 675 species around the Japanese waters. I divide the Cenozoic decapod faunas of southwest Japan to five palaeobiogeographic distributional types (Tethyan, Indo-West Pacific of Tethys origin, Indo-West Pacific, endemic and others) with respect to the genus level, taking account of the recent distributial types (Sakai, 1940; Guinot, 1966).

a) Tethyan genera.

I define the extinct genera, *Portunites* and *Branchioplax*, which occurred the Tethys realm as the Tethyan genera.

b) Indo-West Pacific genera which are the Tethys origin.

Among decapods which are distributed in the Indo-West Pacific Ocean, the genera, *Scylla, Liniparus, Charybdis* and *Varuna* are thought to be the Tethys origin in the Palaeogene and have been restricted within the Indo-West Pacific realm after the Miocene. It is known to the *Ommatocarcinus* (Jenkins, 1975) and the *Retropluma* (Via, 1980; de Saint Laurent, 1989) as the same case. I name them the Indo-West Pacific genera which are the Tethys origin.

c) Indo-West Pacific genera.

I define the genera which occur from the Indo-West Pacific area after the Miocene, as the Indo-West Pacific genera. They are *Thalassina, Laomedia, Tymolus, Parathranites, Lupocyclus, Lybia, Medaeops, Leptodius, Carcinoplax, Typhlocarcinus, Hyastenus, Pariphiculus, Leucosia, Halice.*

d) Endemic genera.

Eocene, *Prohomola*; Oligocene, *Imaizumila, Collinsius*; Miocene, *Miosesarma, Palaeoxanthops, Megamia, Itoigawaia, Paramursia.*

2. MIDDLE EOCENE FAUNA; BARTONIAN

The Middle Eocene fauna is only represented by the *Eucalliax yoshihiroi-Raninoides nodai* assemblage from the Manda Group. It consists of five species in five genera and contains two Tethyan genera, *Portunites* and *Branchioplax*, and an Eocene endemic genus, *Prohomola*. The occurrences of *Portunites* and *Branchioplax* show that the Middle Eocene fauna is related to the western and central Tethyan faunas.

3. EARLY OLIGOCENE FAUNA

The fauna from the Kishima Group is composed of four species in four genera and includes two Oligocene endemic genera, *Collinsius* and *Imaizumila*, and an Indo-West Pacific genus of the Tethys origin, *Varuna*. These decapods have nothing in common with those of the Middle Eocene fauna from the Manda Group. The Early Oligocene fauna of southwest Japan is different from the eastern Tethys fauna (Sastry & Mathur, 1970; Collins & Morris, 1978) and western Tethys fauna (Rathbun, 1926, 1928, 1935) by having the

Oligocene endemic genera. In the same way, the Oligocene fauna of New Zealand (Glaessner, 1960) is known to be characterized by the endemic genus, *Tumidocarcinus*.

The Tethyan genera seem to disappear before the Oligocene and the decapod fauna, associated with a Tethyan Indo-West Pacific genus, *Varuna*, appears to become endemic in the Early Oligocene.

4. LATE OLIGOCENE FAUNA

A single species, *Calliax okamotoi* from the Hioki Group is recognized.

5. EARLY MIOCENE FAUNA; 18-16 Ma.

The fauna is represented by the seven assemblages from the Kumano, Ichishi, Morozaki, Shidara, Tomikusa and Mizunami Groups. It consists of twenty-three species in twenty-two genera and contains five Indo-West Pacific genera (23%), *Laomedia*, *Tymolus*, *Platepistoma*, *Parathranites* and *Carcinoplax*, two Indo-West Pacific genera which are the Tethys origin (10%), *Scylla* and *Charybdis*, and two Miocene endemic genera (10%), *Itoigawaia* and *Miosesarma*.

The Indo-West Pacific genera first appear in the Early Miocene at the genus level. The fauna is characterized by having the Miocene endemic elements, *Itoigawaia* and *Miosesarma*. It is akin to the living fauna at the genus composition except for the existence of the *Laurentiella*, *Miosesarma* and *Itoigawaia*.

6. EARLY MIDDLE MIOCENE; 16-15 Ma.

The early Middle Miocene fauna comparises the twelve assemblages from the Kukinaga, Masuda, Bihoku, Katsuta, Mizunami, Uchiura and Yatsuo Groups, and the Megami, Kunimi, Kawaminami, Kasanomisaki and Asagaya Formations. The fauna, composed of fifty-six species in forty-two genera, is characterized by having twelve Indo-West Pacific genera (29%), *Thalassina*, *Tymolus*, *Platepistoma*, *Lybia*, *Medaeops*, *Leptodius*, *Pilodius*, *Glabropilumnus*, *Carcinoplax*, *Hyastenus*, *Macrophthalmus* and *Halice*, two Indo-West Pacific genera which are the Tethys origin (5%), *Charybdis* and *Scylla* and five extinct genera (12%), *Paramursia*, *Itoigawaia*. *Miosesarma*, *Palaeoxanthops*, *Megamia*. In addition to the *Tymolus*, *Platepistoma* and *Carcinoplax*, nine genera, *Thalassina*, *Lybia*, *Medaeops*, *Leptodius*, *Pilodius*, *Glabropilumnus*, *Hyastenus*, *Macrophthalmus* and *Halice*, join the Indo-West Pacific elements in the early Middle Miocene. Though one extinct endemic genus *Itoigawaia* survives in the early Miocene, four genera, *Palaeoxanthops*, *Megamia*, *Miosesarma* and *Paramursia* become extinct in the early Middle Miocene.

7. MIDDLE MIDDLE MIOCENE; 14-13 Ma

The middle Middle Miocene fauna from the Izumo Group, and Sekinobana and Saikawa Formations consists of thirteen species belonging to eight genera. It has two Indo-West Pacific genera (25%), *Platepistoma* and *Carcinoplax*, two Indo-West Pacific genera which are the Tethys origin (13%), *Scylla* and *Charybdis*, and a Miocene endemic genus (7%), *Itoigawaia*.

The fauna is represented by a single assemblage which indicates a lower sublittoral zone and contains six species such as *Platepistoma kaedei*, *Cancer* (*s.s.*) *tomowoi*, *Scylla ozawai*, *S.* sp., *Carcinoplax antiqua* and *Tritodynamia globosa*, which are common to the Early and early Middle Miocene faunas. A surviving Miocene endemic genus, *Itoigawaia*,

becomes extinct in the middle Middle Miocene.

8. LATE MIDDLE MIOCENE FAUNA; 13-10 Ma

The late Middle Miocene fauna is the representative of the Osaki Formation, Kukinaga Group. It comprises ten species in nine genera, including three Indo-West Pacific genera (33%), *Carcinoplax*, *Macrophthalmus* and *Actumnus*, and an Indo-West Pacific genus which is the Tethys origin (11%), *Scylla*. The fauna is characterized by lacking of the Miocene endemic genera and the presence of a different species of the *Carcinoplax*. The faunas are composed of the extant genera after the late Middle Miocene.

9. LATEST MIOCENE TO EARLY PLIOCENE; 6-4 Ma

Fourteen species of fourteen genera are found from the Shimajiri and Miyazaki Groups, and Tamari Formation. The fauna contains five Indo-West Pacific genera (36%), *Tymolus*, *Lupocyclus*, *Thalamita*, *Carcinoplax* and *Pariphiculus*, and two Indo-West Pacific genera which are the Tethys origin (14%), *Linuparus* and *Scylla*. It has nothing in common with the Miocene faunas at the species level.

10. LATE PLIOCENE; 3-2 Ma

The Late Pliocene fauna is the representative of eighteen species in eleven genera from the Miyazaki and Kakegawa Groups. It has three Indo-West Pacific genera (27%), *Carcinoplax*, *Typhlocarcinus* and *Leucosia*. The late Pliocene fauna is characterized by the first appearance of the living species such as *Carcinoplax longimanus*, *Philyra platychira*, *Cancer* (*Glebocarcinus*) *amphioetus* and *C.* (*s.s.*) *japonicus* though it includes many extinct species.

11. PLEISTOCENE FAUNA

Nine species belonging to six genera are found from the Kakegawa Group, and Nakoji, Onma and Furuya Formations. Although a single species, *Leucosia takamii* survives in the Early Pleistocene, the Pleistocene fauna is akin to the living fauna at the species level.

Neogene and Pleistocene decapod faunas in relation to climatic events

The stratigraphic distributions of the decapod assemblages are shown in Table 12. Before the Neogene, the change of the assemblages is referred to the major change on the palaeobiogeography. Therefore, the change of the assemblages after the Neogene is discussed in view of the change of the component species on each facies (intertidal, upper sublittoral, lower sublittoral to upper bathyal).

Although the dominant species in the assemblages change between the Early Miocene and early Middle Miocene, the assemblages in the early Middle Miocene contain the component species of the *Upogebia mizunamiensis* assemblage in the Early Miocene except for *Laomedia praeastacina* (Fig. 2). In addition to them, the assemblages in the early Middle Miocene are characterized by having *Thalassina anomala* and *Ozius collinsi*, which are inhabitants of the mangrove swamps. This phenomenon represents tropical palaeoenvironments of southwest Japan in the early Middle Miocene as Itoigawa (1989) and Karasawa (1990a; 1992a) have already suggested.

The upper sublittoral assemblages as well as the intertidal assemblages change

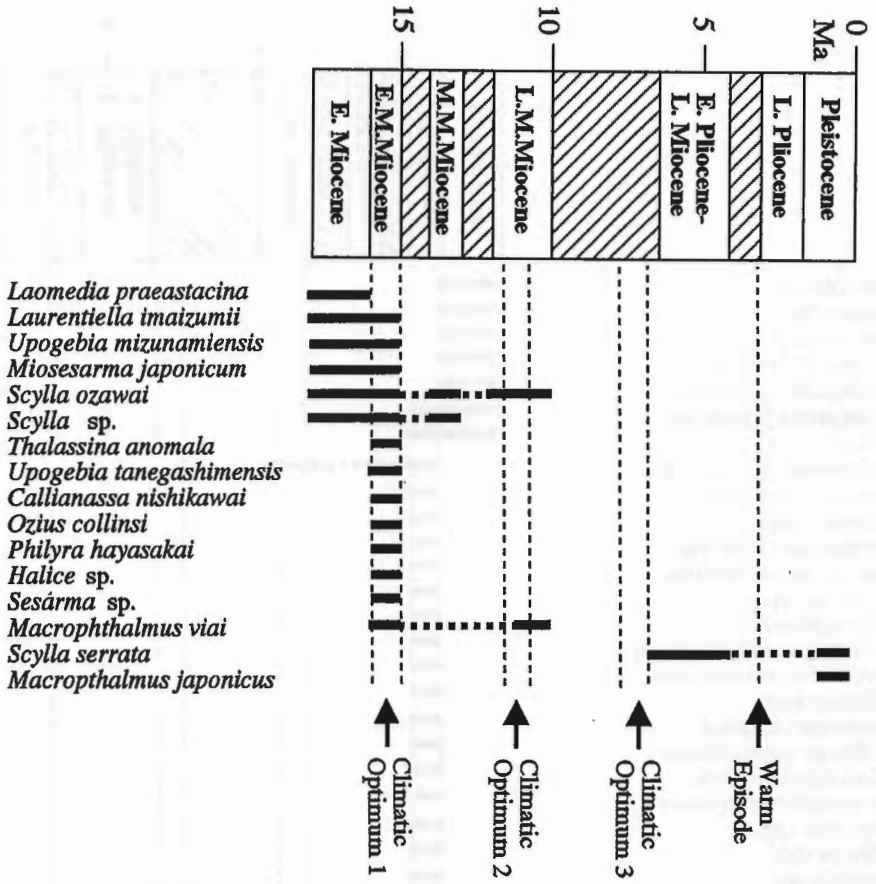


Fig. 2. Stratigraphic range of component species of the Neogene and Pleistocene decapod faunas (I-intertidal assemblage). "warm episode" (Tsuchi, 1990) and "climatic optima" (Barron & Baldauf, 1990) as warm events.

between the Early Miocene and early Middle Miocene. Difference between the Early Miocene and early Middle Miocene is represented by a low value of the common component species (Fig. 3). In the early Middle Miocene, the *Tymolus itoigawai-Philyra plana* assemblage has the tropical species, *Glabropilumnus kamiyai* which living species of the genus is distributed in Amami southwards, and the *Petrolisthes miocaenicus-Medaeops megamiensis-Galathea keijii* assemblage also has the tropical species, *Daira perlata* and *Euryozius* spp., and many species which closely relate to coral reef as habitat. Accordingly, the occurrences of these species demonstrate tropical palaeoenvironments of southwest Japan in the Early Middle Miocene.

The change on the lower sublittoral and upper bathyal assemblages contrasts well with that on the intertidal to upper sublittoral assemblages during the Early Miocene to the early Middle Miocene. The change on the assemblages is shown in Fig. 4. The component species of the Early Miocene remain in the early Middle Miocene and most of them disappear in the early Middle Miocene. The surviving species over the early Middle Miocene are extinguished in the middle Middle Miocene. Decapods in the late Middle

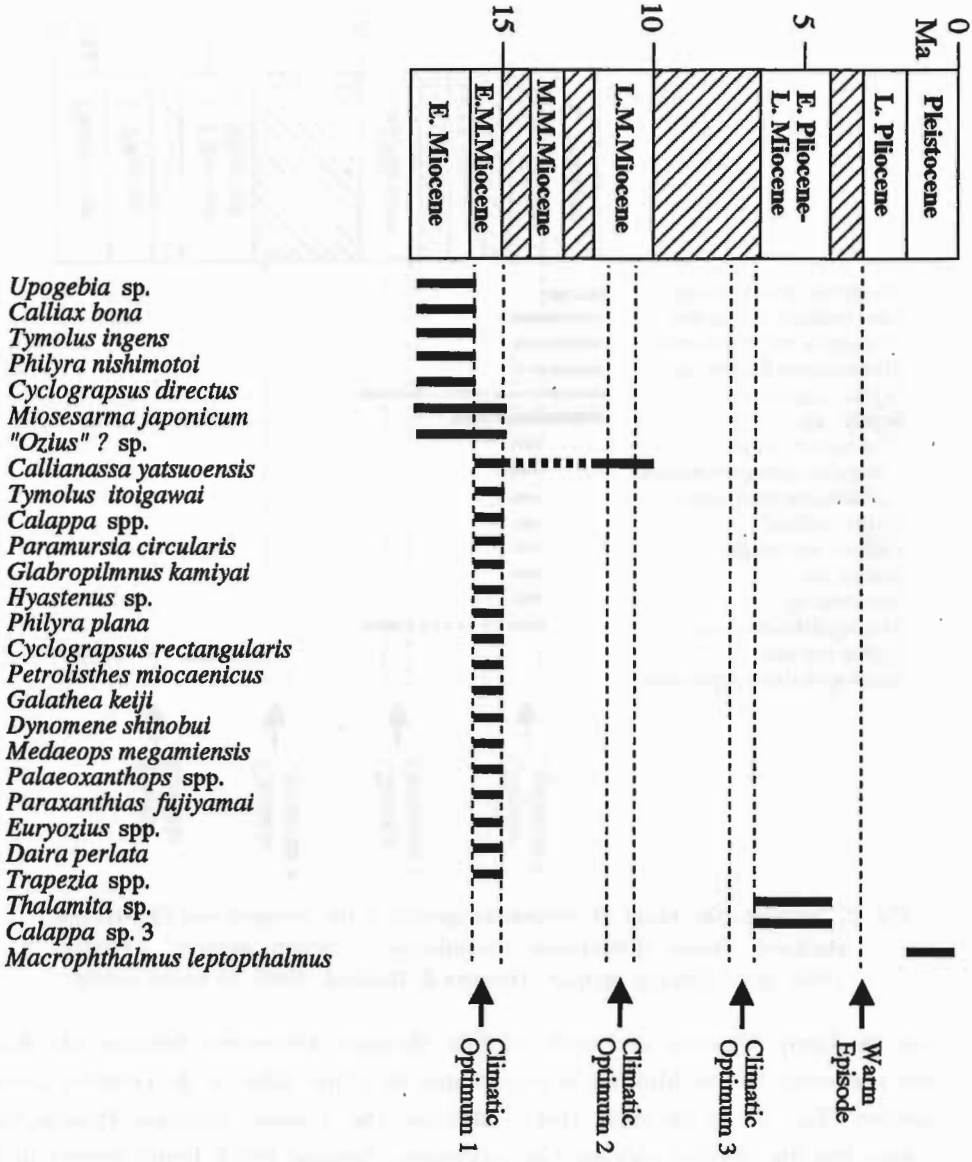


Fig. 3. Stratigraphic range of component species of the Neogene and Pleistocene decapod faunas (II-upper sublittoral assemblage). "warm episode" (Tsuchi, 1990) and "climatic optima" (Barron & Baldauf, 1990) as warm events.

Miocene have nothing common with those in the middle Middle Miocene except for *Cancer sanbonsugii*. The genus *Carcinoplax* which is the dominant element from the Early to the middle Middle Miocene, is represented by different species, *C. granulimanus* and *C. imperfecta* at that time. Difference between the late Middle Miocene and latest Miocene is recognized as the absence of the common species. Furthermore, a species of *Carcinoplax* changes to a different species, *C. prisca* after the latest Miocene. The component species after the Late Pliocene change those before the Early Pliocene. *Carcinoplax prisca* disappears in the Early Pliocene and the living species, *C. longimanus* appears in the Late

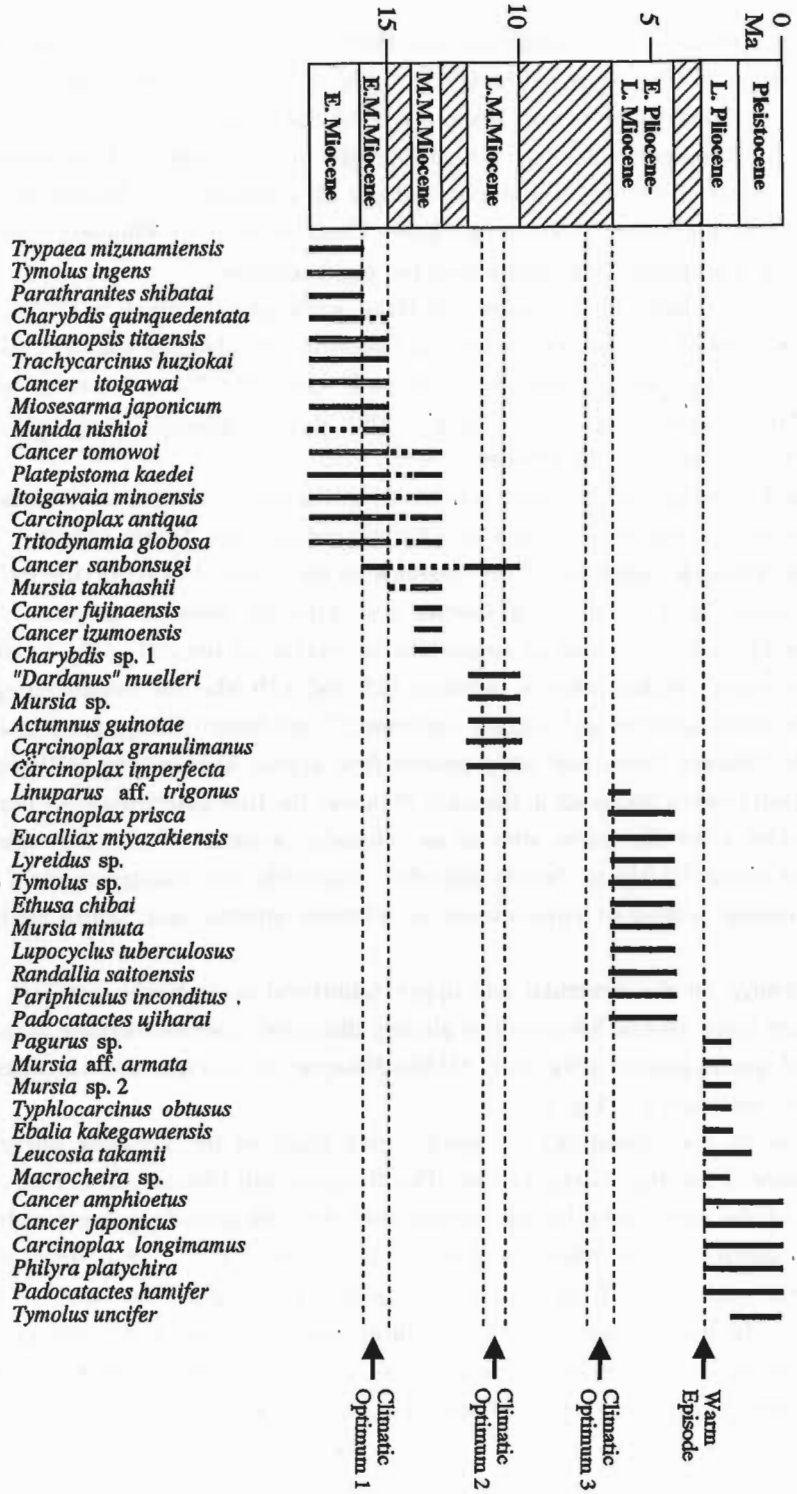


Fig. 4. Stratigraphic range of component species of the Neogene and Pleistocene decapod faunas (III-lower sublittoral and upper bathyal assemblage). "warm episode" (Tsuchi, 1990) and "climatic optima" (Barron & Baldauf, 1990) as warm events.

Pliocene. In addition, several living species, *Philyra platychira*, *Cancer amphioetus* and *C. japonicus*, occur at that time. Although *Leucosia takamii* survives in the earliest Pleistocene, the component species are characterized by the living species after the Pleistocene. As a result, the major change which is characterized by the absence of the common species, is clearly recognized between the middle Middle Miocene and late Middle Miocene, late Middle Miocene and latest Miocene, and Early Pliocene and Late Pliocene. Especially, the change of the *Carcinoplax* represents well the major change.

Barron & Baldauf (1990) recognized three warm phases which is characterized by low oxygen value, from the North Pacific Ocean in the Miocene and termed "climatic optimum 1" (16-14.9 Ma), "climatic optimum 2" (11.5-10.4 Ma), "climatic optimum 3" (7.6-6.6 Ma) in ascending order. Tsuchi (1990) also recognized "warm episode" at 3.0 Ma as a climatic event in the Pliocene.

The major change on the lower sublittoral to the upper bathyal assemblages appears to coincide with climatic events such as "climatic optima" and "warm episode". The warm interval as "climatic optimum 1" corresponds to the interval zone of the early Middle Miocene fauna. Most of decapod species and Miocene endemic genera, *Miosesarma*, *Paramurisa Palaeoxanthops* and *Megamia* become extinct at the end of the warm interval. During the major cooling interval between 14.9 and 12.9 Ma, the remaining species disappear. The warm interval as "climatic optimum 2" correlates with the interval zone of the late Middle Miocene fauna and many species first appear at that time. Although there is a wide barren zone of decapods in the Late Miocene, the first appearances of many species are recognized after the warm interval as "climatic optimum 3". Most of species occur newly after about 3.0 Ma as "warm episode". Especially, the change on the *Carcinoplax* species is closely related to warm events as "climatic optima" and "warm episode" (Fig. 5).

The change on the intertidal and upper sublittoral assemblages between the Early Miocene and early Middle Miocene has already discussed. Species increase in number and the tropical species appear in the early Middle Miocene. It coincides with the warm interval as "climatic optimum 1" (Fig. 5).

As a result, the appearance of species took place in the warming phases and the disappearance did in the cooling phases. The Neogene and Pleistocene faunas are mostly composed of the Indo-West Pacific genera and the widespread genera which have the tropical to subtropical distributions. These genera appear to be the tropical origin. For example, the well-known Indo-West Pacific genus, *Carcinoplax*, decreases in number of species from the low latitude to the high latitude areas (Guinot, 1989) and has the South China Sea as the center of disperal. Considering the presence of these genera, it seems that decapod species migrated from the south to Japan in relation to warming events and extinction of them might be caused by cooling events.

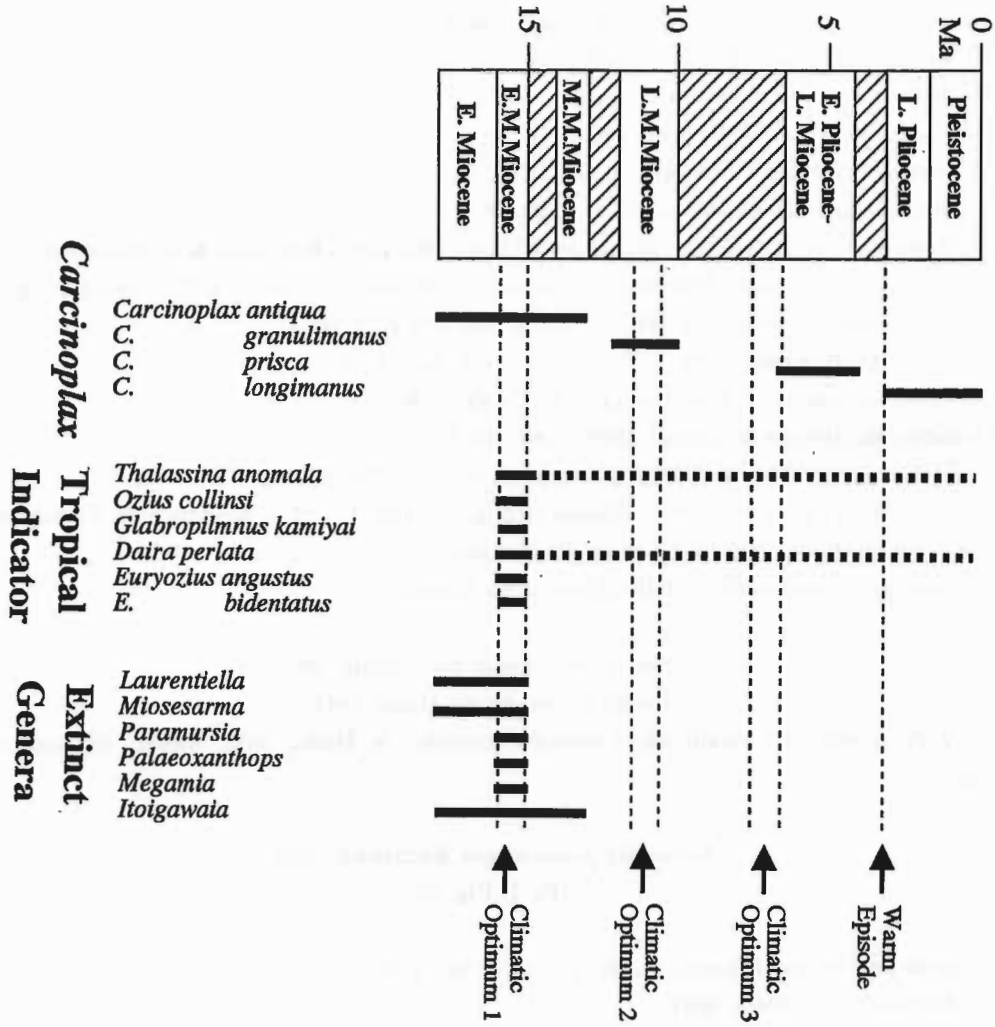


Fig. 5. The change of the *Carcinoplax* species, extinction of tropical species and Miocene endemic genera, and climatic events. "warm episode" (Tsuchi, 1990) and "climatic optima" (Barron & Baldauf, 1990) as warm events.

Systematic palaeontology

Infraorder Thalassinidea Latreille, 1831

Superfamily Thalassinoidea Latreille, 1831

Family Thalassinidae Latreille, 1831

Genus *Thalassina* Latreille, 1806

Type species: By monotypy *Thalassina scorpionoides* Latreille, 1806 = *Cancer* (*Astacus*) *anomalus* Herbst, 1804 (ICZN Opinion 434). *Range*: Miocene to Recent.

Thalassina anomala (Herbst, 1804)

(Pl. 1, Fig. 1; Pl. 2, Fig. 7)

Cancer (*Astacus*) *anomalus* Herbst, 1804, p. 45, pl. LXII.
Thalassina scorpionoides Latreille, 1806, p. 51.
Thalassina antiqua Bell, 1844, p. 455. (*nom. nud.*)
Thalassina emerii Bell, 1845, p. 93, figs. A-C.
Thalassina gracilis Dana, 1852, p. 514, pl. 32, figs. 5a-c.
Thalassina maxima Hess, 1865, p. 37, pl. 7, fig. 18.
Thalassina anomala (Herbst) ; Jacquinot & Lucas, 1853, p. 99 ; Karasawa & Nishikawa, 1991, p. 47, figs. 3-1-3, 4-1-4 (including further synonymy) ; Karasawa & Inoue, 1992, p. 76, pl. 1, figs. 7, 9-11; Karasawa & Nakagawa, 1992, p. 8, pl. 1, figs. 5, 6, pl. 2, fig. 1.
Thalassina sp., Imaizumi, 1969, N-7, figs. 8, 9. (*non.* figs 7a, b)
Thalassina squamifera de Man; Campbell & Woods, 1970, p. 41.
Thalassina sp., Förster & Barthel, 1978, p. 302, fig. 8.

Material: MFM39101-39106, 83118-83123, 83126-83166, 83230.

Occurrence: BIH-2 (Lower Bihoku Group) ; KK-1, 2, 3, 4, 6 (Kawachi Formation, Kukinaga Group) ; FK-09 (Kunimi Formation).

Geologic range: early Middle Miocene to Recent.

Family Laomediidae Borradaile, 1903

Genus *Laomedia* de Haan, 1841

Type species: By monotypy *Laomedia astacina* de Haan, 1841. *Range*: Miocene to Recent.

Laomedia praeastacina Karasawa, 1989
(Pl. 1, Fig. 5)

Laomedia praeastacina Karasawa, 1989, p. 5, pl. 1, figs. 8, 9.

Material: MFM9003, 9004.

Occurrence: MFM. 32 (Akeyo Formation, Mizunami Group).

Geologic range: Early Miocene.

Genus *Laurentiella* Le Loeuff & Intes, 1974

Type species: By monotypy *Laurentiella heterocheir* Le Loeuff & Intes, 1974. *Range*: Early Miocene to Recent.

Laurentiella imaizumii sp. nov.
(Pl. 1, Figs. 2-5; Pl. 2, Fig. 6)

Thalassinoidea fam. gen. *et* sp. indet., Karasawa, 1989, p. 4, pl. 1, figs. 1-5.
Laurentiella sp., Karasawa & Nakagawa, 1992, p. 9, pl. 1, fig. 2.

Material: MFM39003 (holotype), 39004-39006 (paratypes), 9311-9325, 9377-9384, 39112, 39113, 38117-39119, 83232.

Type locality: Loc. MSD-1 (Masuda Group, early Middle Miocene).

Etymology: In honour of the late Dr. Rikizo Imaizumi of Tohoku University.

Diagnosis: Chelipeds strongly heterochelate; left fingers strongly elongate, about 3.0 length of palm.

Description: The chelipeds are strongly heterochelate. The rounded dorsal margin of the dactylus of the left cheliped is covered with small conical granules; the occludent margin with triangular teeth near the base and at the midlength, is irregularly denticulate; the dorsolateral edge is distinctly keeled along the dorsal margin and fringed with a row of small pits below the keel; the mesial surface is convex. The fixed finger is as long as dactylus; the finely serrated occludent margin bears triangular teeth proximally and distally; the ventrolateral edge is fringed with a sharp keel reaching about one-third of the palm. The palm is slightly longer than dactylus and about 1. 2 times as long as broad; the lateral and mesial surfaces are granulate on the distal half. The short carpus with smooth dorsal and ventral margins, is 0.3 of the palm length and tapers proximally. The merus with smooth margins, is rhomboidal in lateral view, and about 1.5 of the carpus length. The right cheliped is thinner than the left cheliped. The dactylus is slender and elongate; the occludent margin is denticulate, with triangular teeth proximally and distally; the dorso- and ventrolateral edges have sharp keels; there is a row of small pits below the dorsal keel on the lateral margin. The sharp, elongate fixed finger is as long as dactylus; the occludent margin is finely dentate, with the well developed triangular teeth proximally and distally; the dorsolateral edge bears a sharp keel. The short palm is about 0.3 of the dactylus length. The merus and carpus are similar to those of left cheliped.

Discussion: The present new species is closely related to the living species, *Laurentiella heterocheir* Le Loeuff & Intes, 1974 from the tropical West Atlantic Ocean, but may be distinguished from *L. heterocheir* because in *L. imaizumii* sp. nov., there are no granules on the dorsolateral surface of the palm of the left cheliped, distally, and no keels on the ventrolateral edge of the palm of the right cheliped.

Occurrence: MFM. 32 (Akeyo Formation, Mizunami Group) ; FK-09 (Kunimi Formation) ; KTT-2, 3 (Yoshino Formation, Katsuta Group) ; BIH-1 (Bihoku Group) ; MSD-1 (Toyoda Formation, Masuda Group).

Geologic range: Early to early Middle Miocene.

Family Upogebiidae Borradaile, 1903

Genus *Upogebia* Leach, 1814

Type species: By monotypy *Cancer stellatus* Montagu, 1808 (ICZN Opinion 434). *Range*: Late Cretaceous to Recent.

Upogebia mizunamiensis Karasawa, 1989

(Pl. 2, Figs. 1, 4, 5)

Upogebia mizunamiensis Karasawa, 1989, p. 11, pl. 2, figs. 2, 4, 5.

Material: MFM9005-9007, 9351-9369.

Occurrence: MFM. 32, 36 (Akeyo Formation, Mizunami Group) ; I-1, I-2 (Toyama

Formation, Mizunami Group) ; KTT-3 (Yoshino Formation, Katsuta Group).

Geologic range: Early to early Middle Miocene.

Upogebia tanegashimensis Karasawa & Inoue, 1992
(Pl. 2, Fig. 2; Pl. 3, Fig. 1)

Upogebia tanegashimensis Karasawa & Inoue, 1992, p. 78, pl. 1, figs. 1-3, 8a, b.

Material: MFM83011-83014, 83185-83187.

Occurrence: KK-5 (Kawachi Formation, Kukinaga Group).

Geologic range: early Middle Miocene.

Upogebia sp.
(Pl. 2, Fig. 3)

Upogebia sp., Karasawa, 1989, p. 14, pl. 2, fig. 7.

Material: MFM9309, 9310.

Occurrence: I-3 (Toyama Formation, Mizunami Group).

Geologic range: Early Miocene.

Superfamily Callianassoidea Dana, 1852
Family Callianassidae Dana, 1852
Subfamily Callianassinae Dana, 1852
Genus *Callianassa* Leach, 1814

Type species: By monotypy *Cancer* (*Astacus*) *subterraneus* Montagu, 1808 (ICZN Opinion 434). *Range*: Cretaceous to Recent.

Callianassa nishikawai sp. nov.
(Pl. 3, Figs. 4-9)

Callianassa sp., Nishikawa, 1975, p. 3, fig. 16.

Callianassa sp., Karasawa & Nakagawa, 1992. p. 10, pl. 1, figs. 2-4.

Material: MFM39007 (holotype), 39008-399013 (paratypes), 39107-39111, 39115, 39116, 39120, 83231, 83233-83239.

Etymology: From Mr. Isao Nishikawa of Hiroshima Prefecture who first described the present species from Japan.

Diagnosis: Chelipeds large in size, strongly heterochelate; fingers slender, elongate; palm about 0.8 length of dactylus, with deep mesial depression; carpus slightly shorter than palm; merus with large meral hook, long, about 1.2 times as long as carpus.

Description: The chelipeds are strongly heterochelate. The slender, elongate dactylus of the major cheliped is strongly curved downward; the dorsal margin possesses five small pits; the occludent margin is denticulate, with a large tooth near base, both large and fine teeth near the tip; the dorsolateral edge bears a row of small conical tubercles in the

proximal half; there is a longitudinal ridge on the mesial surface. The fixed finger is about as long as dactylus and gently curved upward; the sharp occludent margin possesses a broadly triangular tooth at the midlength; the ventral margin with five small pits, is smooth. The palm is about 0.8 length of the dactylus, about 1. 3 to 1. 5 times as long as broad; there are seven small pits on the dorsal margin; the distal margin of the lateral and mesial surfaces is finely dentate and deeply incised at the gape. The carpus with fine serrations on the ventral margin, is slightly shorter than palm and about 1.2 times as long as broad. The long merus with the finely serrated dorsal margin and a strong ventroproximal hook, is about 1.2 times as long as the carpus and tapering distally; the lateral surface bears a longitudinal carina in the midline, and the lower half is tuberculate. The ischium is about 0.6 length of merus. The minor cheliped is about 0.3 to 0.4 the length of the major cheliped; the fingers are slender and the palm is about as long as dactylus.

Discussion: *C. nishikawai* sp. nov. resembles *Trypaea inornata* (Nagao & Huzioka, 1938) from the Miocene Kawabata Formation of Hokkaido, but differs in having a long palm and a tuberculated ventrolateral surface of the dactylus.

Occurrence: FK-01-03 (Kawaminami Formation) ; FK-08, 09 (Kunimi Formation) ; MSD-1 (Yoshino Formation, Masuda Group) ; FK-17, 18 (Shimo Formation, Uchiura Group) ; KTT-1-3 (Yoshino Formation, Katsuta Group) ; BIH-1, 3 (Bihoku Group).

Geologic range: early Middle Miocene.

Callianassa yatsuoensis sp. nov.
(Pl. 3, Figs. 2, 3)

Callianassa sp. 2., Karasawa, 1989, p. 11, pl. 2, figs. 1.
Callianassa sp., Karasawa & Inoue, 1992, p. 79, pl. 1, fig. 6.

Material: MFM83055 (holotype), 83056 (paratype), 9371, 83192.

Type locality: Loc. YTO-2 (Kurosedani Formation, Yatsuo Group; early Middle Miocene).

Etymology: From "Yatsuo", the place name of fossil occurrence.

Diagnosis: Major cheliped common in size; fingers short; propodus finely granulate on distal lateral surface; carpus short.

Description: The major cheliped is common in size. The short fixed finger is broadly triangular in lateral view. The occludent margin bears a broad tooth from the base to the middle. The palm is about 3.5-4.0 of the fixed finger length and as long as broad. The ventro- and dorsomesial edges are fringed with small pits. The distal lateral surface is finely granulated about the junction of the fixed finger. The short carpus is longer than broad and the ventral margin is curved ascending toward proximally.

Discussion: The present new species differs from all the Japanese Miocene species by having a short fixed finger, no distal depression of the palm and a finely granulated distal lateral surface. *Callianassa yatsuoensis* sp. nov. is near to *C. pugnax* Böhm, 1922 from the Miocene of Java, but differentiated by a short fixed finger with a broad tooth on the occludent margin and a shorter palm without a distal depression in *C. yatsuoensis* sp. nov.

Occurrence: MFM. 58 (Akeyo Formation, Mizunami Group) ; KO-7 (Osaki Formation, Kukinaga Group) ; YTO-1 (Kurosedani Formation, Yatsuo Group).

Geologic range: Middle Miocene.

Callianassa sp.
(Pl. 4, Fig. 3)

Callianassa sp., Nagao, 1941, p. 85, pl. 26, figs. 8-11.

Material: MFM218611.

Occurrence: KSM-1, 2, 4 (Kishima Formation, Kishima Group).

Geologic range: Early Oligocene.

Genus *Trypaea* Dana, 1852

Type species: By monotypy *Trypaea australiensis* Dana, 1852. *Range*: Miocene to Recent.

Trypaea mizunamiensis sp. nov.
(Pl. 4, Figs. 1, 2)

Callianassa sp. 1, Karasawa, 1989, p. 10, pl. 2, figs. 8, 9.

Material: MFM9301 (holotype), 9303, 9304 (paratypes), 9305-9308, 9337-9340.

Type locality: MFM. Loc. 48 (Yamanouchi Member, Mizunami Group; Early Miocene).

Etymology: From "Mizunami", the place name of fossil occurrence.

Diagnosis: Major cheliped common in size; fingers slender, elongate; palm with deep distal depression, short; carpus long; merus with a meral hook.

Description: The major cheliped is common in size. The slender dactylus is strongly curved downward. The dorsal margin is rounded, whereas the occludent margin is denticulate from the apex to the middle and possesses a blunt tooth near the base. The ventrolateral surface is fringed with two small pits. The slender fixed finger is about equal length with the dactylus. The occludent margin bears fine serrations and the ventral margin is smooth. The palm with a deep distal depression, is about 1.5 times as long as the dactylus and slightly longer than broad. The carpus is about 1.2 times as long as the palm. The dorsal margin is nearly straight, but the ventral margin is curved ascending toward proximally. The merus is about 1.2 times as long as the carpus. The dorsal margin is irregularly dentate. The ventral margin bears a proximal tooth of which posterior margin roundly protruded, while the anterior margin is rather straight. The ischium is about as long as the merus.

Discussion: The present new species is similar to the Miocene species, *Trypaea inornata* (Nagao & Huzioka, 1938). from the Kawabata Formation of Hokkaido, but it differs in having the dactylus without granules on the lateral surface, of the major cheliped.

Occurrence: MFM. 48 (Akeyo Formation, Mizunami Group).

Geologic range: Early Miocene.

Subfamily Eucalliinae Manning & Felder, 1991

Genus *Eucalliax* Manning & Felder, 1991

Type species: By original designation *Callianassa quadracuta* Biffar, 1970. *Range*: Eocene to Recent.

Eucalliax miyazakiensis sp. nov.
(Pl. 4, Fig. 12)

Material: MFM142007 (holotype).

Type locality: Loc. MYZ-10 (Tsuma Formation, Miyazaki Group; Early Pliocene).

Etymology: Referring to the occurrence of the species from "Miyazaki" Prefecture.

Diagnosis: Cheliped subequal; fixed finger short, with one conical tooth, proximally; propodus with 3 small pits longitudinally arranged on lateral surface.

Description: The chelipeds are subequal in size. The dactylus is strongly curved downward and its lateral surface bears three pits on the mid-line. The short fixed finger with the upwardly directed tip, is about 0.4 to 0.5 the length of the dactylus and armed with one conical tooth on the occludent margin, proximally; the lateral surface also bears two pits on the mid-line. The palm is slightly longer than broad, 1.7 of the dactylus length and tapers distally. The dorsal and ventral margins of the propodus are smooth and the ventrolateral margin is fringed with small pits. On the lateral surface of the propodus, there are three small pits longitudinally arranged.

Discussion: The present new species is similar to *Callianassa yatsuoensis* sp. nov. from the Miocene Yatsuo and Kukinaga Groups of southwest Japan, but differs in having the palm of which lateral surface bears three pits longitudinally.

Occurrence: MYZ-10 (Tsuma Formation, Miyazaki Group) ; MYZ-9, 11 (Takanabe Formation, Miyazaki Group) ; TMR-1 (Tamari Formation).

Geologic range: Early Pliocene.

Eucalliax yoshihiroi Karasawa, 1992b
(Pl. 4, Figs. 6, 7, 9, 11)

Eucalliax yoshihiroi Karasawa, 1992b, p. 1248, figs. 2-1-6; 3-1-4.

Material: KMNH IvP 300, 001-300, 009.

Occurrence: MND-1 (Manda Group).

Geologic range: Late Middle Eocene.

Genus *Calliax* de Saint Laurent, 1973

Type species: By monotypy *Callianassa lobata* de Gaillande & Lagardère, 1966. *Range*: Miocene to Recent.

Calliax bona (Imaizumi, 1958) comb. nov.
(Pl. 4, Figs. 4, 5)

Callianassa bona Imaizumi, 1958 p. 31, pl. 4, figs. 1-5; Karasawa, 1989, p. 7, pl. 1, figs. 6, 7; pl. 2, fig. 3.

Material: MFM9101-9292, 9326-9336.

Remarks: This species bears the merus without proximal hocks of the cheliped.

Occurrence: MFM. 19-22, 27, 40, 46, 79 (Akeyo Formation, Mizunami Group).

Geologic range: Early to Middle Miocene.

Calliax okamotoi sp. nov.
(Pl. 4, Figs. 8, 10)

Material: MFM218508 (holotype), 218509-218511 (paratypes).

Type locality: Loc. HOK-1 (Taoyama Formation, Hioki Group, Late Oligocene).

Etymology: In honour of Professor Kazuo Okamoto of Hiroshima University.

Diagnosis: Major cheliped large in size; fingers short; palm with shallow distal depression, longer than broad; merus bearing large, broad tooth without marginal denticules.

Description: The major cheliped is large in size. The dactylus is stout and gently curved ventrally. The short fixed finger is slightly shorter than the dactylus. The propodus with a shallow distal depression, is about 1.7 of the dactylus length and longer than broad. The carpus is slightly longer than the palm and longer than broad; the ventral margin is curved toward proximally. The merus is 0.7-0.8 of the carpus length and slightly longer than broad. The dorsal margin is nearly straight, but the ventral margin without denticules is strongly arched.

Discussion: The present new species closely resembles the Miocene species, *Calliax bona* (Imaizumi, 1958) from the Moniwa Formation of Miyagi Prefecture and the Mizunami Group of Gifu Prefecture, but differs in having the ventral margin without denticules of the merus.

This species, associated with many fossil burrows (Thalassinoides) occurs at the type locality.

Occurrence: HOK-1 (Taoyama Formation, Hioki Group).

Geologic range: Late Oligocene.

Family Ctenochelidae Manning & Felder, 1991
Subfamily Callianopsinae Manning & Felder, 1991
Genus *Callianopsis* de Saint Laurent, 1973

Type species: By monotypy *Callianassa goniophthalma* Rathbun, 1902. *Range*: Eocene to Recent.

Callianopsis titaensis (Nagao, 1941)
(Pl. 5, Figs. 1, 3, 4)

Callianassa titaensis Nagao, 1941, p. 93, pl.26, figs. 3-7 ; Takeda *et al.*, 1987, p. 14, pl. 1, figs. 5, 6; Karasawa, 1989, p. 8, pl. 1, fig. 10; pl. 2, fig. 6; Mizuno & Takeda, 1993, p. 82, pl. 2, figs. 5, 6.

Callianassa shikamai Imaizumi, 1957, p. 86, pl. 14, figs. 1-5.

Callianopsis titaensis (Nagao) ; Karasawa & Nakagawa, 1992, p. 10, pl. 2, fig. 5.

Material: MFM9293-9299, 39127-39140.

Remarks: This species is transferred from *Callianassa* Leach, 1814 to *Callianopsis* de Saint Laurent, 1973 by having the carapace with a low rostral carina and a short rostral spine, of which gastric region is transversely oval in outline and cardiac region bears a distinct prominence.

Occurrence: MFM. 77 (Akeyo Formation, Mizunami Group) ; I-4 (Toyama Formation, Mizunami Group) ; SDR-1 (Tsubosawa Formation, Shidara Group) ; MRZ-1-3 (Toyohama Formation, Morozaki Group) ; FK-5 (Hosotsubo Formation) ; FK-14 (Shimo Formation, Uchiura Group).

Geologic range: Early to early Middle Miocene.

Infraorder Palinura Latreille, 1803

Superfamily Palinuroidea Latreille, 1803

Family Palinuridae Latreille, 1803

Genus *Linuparus* White, 1847

Type species: By monotypy *Palinurus trigonus* von Siebold, 1824 (ICZN Opinion 519). *Range*: Cretaceous to Recent.

Linuparus sp. aff. *L. trigonus* (von Siebold, 1825)

(Pl. 5, Fig. 10)

Material: MFM83303.

Remarks: The dorsal ornamentation of the carapace of the species resembles that of the living species, *L. trigonus* (von Siebold, 1824) of the West Pacific Ocean. Because the anterior part of the carapace is lacking, a further discussion is difficult.

Occurrence: MYZ-4 (Aya Formation, Miyazaki Group).

Geologic range: Late Miocene.

Infraorder Anomala Boas, 1880

Superfamily Paguroidea Latreille, 1803

Family Diogenidae Ortmann, 1892

Genus *Dardanus* Paulson, 1875

Type species: By monotypy *Dardanus helleri* Paulson, 1875 (ICZN Opinion 472). *Range*: Eocene to Recent.

"Dardanus" muelleri Karasawa & Inoue, 1992

(Pl. 5, Figs. 2, 7)

"Dardanus" muelleri Karasawa & Inoue, 1992, p. 81, pl. 1, figs. 4a, b, 5.

Material: MFM83015, 83016.

Occurrence: KO-5 (Osaki Formation, Kukinaga Group).

Geologic range: Middle Miocene.

Genus *Pagurus* Fabricius, 1775

Type species: By subsequent designation of Latreille, 1810; *Cancer bernhardus* Linnaeus, 1758 (ICZN Opinion, 472). *Range*: Early Cretaceous to Recent.

Pagurus sp.
(Pl. 5, Fig. 8)

Material: MFM142163.

Remarks: This species is represented by coarsely granulated large chelipeds, the 1st pereiopods and the right 2nd pereiopod.

Occurrence: KKG-4 (Ten-no Sand, Kakegawa Group).

Geologic range: Late Pliocene.

Superfamily Galatheoidea Samouelle, 1819
Family Galatheidae Samouelle, 1819
Genus *Munida* Leach, 1820

Type species: By monotypy *Pagurus rugosus* Fabricius, 1775 (ICZN Opinion 712). *Range*: Miocene to Recent.

Munida nishioi sp. nov.
(Pl. 5, Figs. 5, 6, 9)

? *Eumunida* sp., Imaizumi, 1969, p. N-8, figs. 9a, b.

? *Eumunida* (?) sp., Imaizumi, 1971, p. 173 (with figure).

Material: MFM83054 (holotype), 83302.

Type locality: Loc. YTO-1 (Higashibessho Formation, Yatsuo Group; Middle Miocene).

Etymology: From Mr. Kouichi Nishio who collected the type specimen.

Diagnosis: Carapace slightly wider than long, dorsally rugose armed with 6 epigastric, 2 hepatic and 2 postcervical spines; cervical groove distinct; lateral margin with 6 spines.

Description: The carapace excluding the rostrum, is slightly wider than long. The dorsal surface is decorated with transverse ridges with fine granules. The gently convex gastric region possesses six forwardly directed spines anteriorly and a pair of spines behind supraocculars is large. The cervical groove is distinct. The postcervical spine is small but distinct on each side. The hepatic spine is well developed. The posterior transverse ridge is unarmed. The orbitofrontal margin is not preserved. The lateral margin tapering anteriorly, is armed with six spines; there are two strong spines in front of the cervical groove and other four spines behind it. The long, slender propodus of the cheliped is sparsely covered with small tubercles.

Discussion: The present new species is easily distinguished from *Munida* sp. from the

Morozaki Group (Takeda *et al.*, 1986) by having well marked lateral spines of the carapace. *Munida nishioi* sp. nov. resembles the living species, *M. japonica* Stimpson, 1858c from the Indo-West Pacific Ocean, but differs in having the lateral margin with six spines of the carapace. The gastric region in *M. nishioi* sp. nov. has six anterior spines, whilst that in *M. japonica* has six or seven anterior spines and three spines behind the anterior ones.

Occurrence: YTO-1 (Higashibessho Formation, Yatsuo Group) ; ASG-1 (Asagaya Formation) ; ICS-1 (Oi Formation, Ichishi Group).

Geologic range: Middle Miocene.

Genus *Galathea* Fabricius, 1793

Type species: By subsequent designation of Latreille, 1810: *Cancer strigosus* Linnaeus, 1761 (ICZN Opinion 434). *Range*: Cretaceous ? to Recent.

Galathea keijii sp. nov.
(Pl. 6, Figs. 1-3, 10)

Material: MFM83036 (holotype), 83037-83039 (paratypes), 83264-83267.

Type locality: Loc. MGM-1 (Megami Limestone; early Middle Miocene).

Etymology: In honour of Dr. Keiji Baba of Kumamoto University.

Diagnosis: Dorsal surface rugose, without spines; cervical groove indistinct; rostrum triangular, with 3 sharp spines.

Description: The carapace excluding the rostrum, is slightly longer than wide. The rugose dorsal surface bears no spines. The cervical groove is indistinct. The anterolateral spine is visible. Gently convex lateral margins bear three blunt spines anteriorly. The sharply triangular rostrum is wide at the base and the dorsal surface is interrupted by a shallow median groove. On the lateral margins of the rostrum, there are three forwardly directed spines; the anterior two spines are much longer than the third one.

Discussion: The present new species differs from *Galathea weinfurteri* Bachmayer, 1950 from the Badenian of Hungary (Müller, 1984) by having an indistinct cervical groove and the rostrum of which lateral margin bears three sharp spines.

Occurrence: MGM-1 (Megami Limestone).

Geologic range: early Middle Miocene.

Family Porcellanidae Haworth, 1835

Genus *Petrolisthes* Stimpson, 1858

Type species: By original designation *Porcellana violacea* Guérin-Mainville, 1829 (ICZN Opinion 701). *Range*: Late Eocene to Recent.

Petrolisthes miocaenicus sp. nov.
(Pl. 6, Figs. 5, 7-9, 13)

Material: MFM83021 (holotype), 83022-83025 (paratypes), 83255-83260.

Etymology: From the age Miocene.

Diagnosis: Dorsal surface with transverse striations; cervical groove distinct; rostrum triangular, with median shallow groove; supraorbital spine absent; epibranchial spine present; lateral margin entire, costate.

Description: The carapace is subcircular in outline and slightly longer than wide. The slightly elevated dorsal surface is decorated with transverse striations. The triangular rostrum is divided into two by a shallow median groove and the length to the transverse gastric ridge is slightly shorter than the basal width. The cervical groove is visible. The supraorbital spine is absent and the epibranchial spine is present. The lateral margins are entire and costate.

Cheliped: The lateral surface of the propodus is covered with the forwardly directed coarse granules. The mesial surface is ornamented with some oblique striations. The dorsal and ventral surfaces are finely granulate. The mesial surface of the carpus is transversely striated and the dorsal margin bears four to five forwardly directed triangular teeth.

Discussion: The present new species differs from *Petrolisthes magnus* Müller, 1984 from the Badenian of Hungary by having no supraorbital spines. It also differs from *P. haydni* Müller, 1984 from the Badenian of Hungary because in *P. miocaenicus* sp. nov., the lateral margin of the carapace is entire and there is no transverse grooves on the branchial region. The present species resembles the living species, *Petrolisthes lamarckii* (Leach, 1820) and *P. asiaticus* (Leach, 1820) from the Japanese waters (Miyake, 1982), but is distinguished from them in having the triangular rostrum with a median shallow groove.

Occurrence: MGM-1 (Megami Limestone).

Geologic range: early Middle Miocene.

Petrolisthes sp.
(Pl. 6, Fig. 11)

Material: MFM9600.

Description: The large propodus of the right cheliped shows the lateral surface. The surface is decorated with the forwardly directed tubercles which vary in size.

Remarks: A large propodus which is slightly longer than board, distinguishes this species from *Petrolisthes miocaenicus* sp. nov.

Occurrence: MFM. 07 (Akeyo Formation, Mizunami Group).

Geologic range: early Middle Miocene.

Infraorder Brachyura Latreille, 1803
Section Podotremata Guinot, 1977
Subsection Dromiacea de Haan, 1833
Superfamily Dromioidea de Haan, 1833
Family Dynomenidae Ortmann, 1892
Genus *Dynomene* Desmarest, 1823

Type species: By monotypy *Dynomene hispida* Guérin-Meneville, 1832. *Range*: Miocene

to Recent.

Dynomene shinobui sp. nov.
(Pl. 6, Figs. 12, 14-16)

Material: MFM83033 (holotype), 83034, 83035 (paratypes), 83262, 83263.

Type locality: Loc. MGM-1 (Megami Limestone; early Middle Miocene).

Etymology: In honour of Dr. Shinobu Mori of Nagoya University.

Diagnosis: *Dynomene* with poorly defined dorsal regions of carapace and anterolateral margin with 5 acute spines.

Description: The carapace is subcircular in outline and the length is about 0.7 to 0.8 times as long as the width. The gently convex dorsal surface is finely punctuate. The front is broadly triangular in outline and medially interrupted by a shallow groove. The cervical groove is distinct. The branchiocardiac groove is visible. The bilobed frontal margin is about 0.3 of the width and divided into two by a median shallow sinus. The orbital margin is inclined posteriorly. Gently arched anterolateral margins bear five small, acute spines; the first four spines are directed forwards and subequal in size; the last one is larger than others and directed laterally. Gently convex posterolateral margins are longer than the anterolateral margins.

Discussion: The present new species is closely related to the Miocene species, *Dynomene emiliae* Müller, 1979 of Hungary and the Pleistocene species, *D. acutispinis* (Rathbun, 1945) of Fiji, but it differs in having anterolateral teeth which are more smaller and obscurely defined. The present species resembles the living species, *Dynomene hispida* Guérin -Meneville, 1832 from the Indo-West Pacific Ocean, whilst in *D. hispida*, the dorsal surface of the carapace is well defined.

Occurrence: MGM-1 (Megami Limestone).

Geologic range: early Middle Miocene.

Subsection Archaeobrachyura Guinot, 1977
Superfamily Homoloidea de Haan, 1839
Family Homolidae de Haan, 1839
Genus *Prohomola* Karasawa, 1992b

Type species: By monotypy *Homolopsis japonicus* Yokoyama, 1911. Range: Late Middle Eocene.

Prohomola japonica (Yokoyama, 1911)
(Pl. 7, Figs. 3, 11)

Homolopsis japonicus Yokoyama, 1911, p. 12, pl. 3, fig. 4.
Paromola japonicus (Yokoyama) ; Jenkins, 1977, p. 4. (*non. Paromola japonica* Parisi, 1915)
Prohomola japonica (Yokoyama) ; Karasawa, 1992b, p. 1250, figs. 3-5-7.

Material: KMNH IvP 300,010.

Occurrence: MND-1 (Manda Group).
Geologic range: Late Middle Eocene.

Superfamily Raninoidea de Haan, 1841
Family Raninidae de Haan, 1841
Genus *Raninoides* H. Milne Edwards, 1837

Type species: By monotypy *Ranina laevis* Latreille, 1825. *Range*: Eocene to Recent.

Raninoides nodai Karasawa, 1992b
(Pl. 7, Figs. 1, 2, 5)

Raninoides nodai Karasawa, 1992b, p. 1252, figs. 4-2-8.

Material: KMNH IvP 300,011-300,015.
Occurrence: MND-1 (Manda Group).
Geologic range: Late Middle Eocene.

Genus *Lyreidus* de Haan, 1841

Type species: By monotypy *Lyreidus tridentatus* de Haan, 1841. *Range*: Late Cretaceous to Recent.

Lyreidus sp.
(Pl. 7, Fig. 4)

Material: MFM142150.

Description: The narrow carapace is longitudinally elliptical in outline. The dorsal surface is smooth. The slightly concave anterolateral margins are armed with a forwardly directed short spine in front of the junction of the anterolateral and posterolateral margins. The posterolateral margins are gently convex.

Discussion: In the anterolateral margin with a short spine, this species is closely related to the Japanese living species, *Lyreidus tridentatus* de Haan, 1841 and *L. brevifrons* Sakai, 1937. Because the details of the narrow orbitofrontal margin are obscured by poor preservation, I do not make sufficient comparison.

Occurrence: MYZ-7 (Sadohara Formation, Miyazaki Group).
Geologic range: Early Pliocene.

Superfamily Cyclodorippoidea Ortmann, 1892
Family Cyclodorippidae Ortmann, 1892
Genus *Tymolus* Stimpson, 1858

Type species: By monotypy *Tymolus japonicus* Stimpson, 1858a. *Range*: Miocene to Recent.

Tymolus ingens Takeda & Tomida, 1984
(Pl. 7, Figs. 7, 8)

Tymolus ingens Takeda & Tomida, 1984, p. 43, pl. 13, figs. 1-4.

Material: MFM9001, 9402-9405.

Occurrence: MFM. 19, 20, 45, 46, 49, 50, 55 (Akeyo Formation, Mizunami Group) ; TMK-1 (Awano Member, Tomikusa Group).

Geologic range: Early Miocene.

Tymolus itoigawai Takeda & Tomida, 1984
(Pl. 7, Figs. 9, 10)

Tymolus itoigawai Takeda & Tomida, 1984, p. 45, pl. 13, figs. 5, 6.

Material: MFM9002, 9406-9409.

Occurrence: MFM. 07 (Akeyo Formation, Mizunami Group).

Geologic range: early Middle Miocene.

Tymolus uncifer (Ortmann, 1892)
(Pl. 6, Fig. 4)

Cyclodorippe unifera Ortmann, 1892, p. 560.

Tymolus uncifer (Ortmann) ; Balss, 1922, p. 286; Sakai, 1976, p. 33; Tavares, 1991, p. 444, figs. 2, 4, 8A, 9B, 10B (including further synonymy).

Material: Umemoto coll.

Occurrence: KKG-12 (Hijikata silt Formation, Kakegawa Group).

Geologic range: Pliocene to Recent.

Tymolus sp.
(Pl. 6, Fig. 6)

Material: MFM142162.

Description: The carapace excluding the broken anterior portion, is small and transversely rectangular in outline. The regions are well defined. The protogastric lobes are longitudinally divided into two by a shallow, broad groove and deeply separated from the triangular mesogastric lobe. The inflated cardiac lobe is transversely hexagonal in outline. The branchiocardiac groove is deep. The epi-, meso- and metabranchial lobes are well defined by deep grooves.

Discussion: This species resembles three living species, *Tymolus uncifer* (Ortmann, 1892), *T. similis* (Grant, 1905) and *T. brucei*, Tavares, 1991 from the Indo-West Pacific Ocean, but I don't make sufficient comparison by lacking of the orbitofrontal margin.

Occurrence: MYZ-7 (Sadohara Formation, Miyazaki Group).

Geologic range: Early Pliocene.

Section Heterotremata Guinot, 1977
Superfamily Dorippoidea de Haan, 1833
Family Dorippidae de Haan, 1833
Subfamily Ethusinae Guinot, 1977
Genus *Ethusa* Roux, 1830

Type species: By subsequent designation of Fowler, 1912; *Cancer mascarone* Herbst, 1785 (ICZN Opinion 1622). *Range*: Eocene to Recent.

Ethusa chibai sp. nov.
(Pl. 8, Fig. 12)

Material: MFM142002 (holotype).

Type locality: Loc. TMR-1 (Tamari Formation; Early Pliocene).

Etymology: From Mr. Masaki Chiba who collected the type specimen.

Diagnosis: Carapace small, slightly longer than wide; frontal and inner orbital teeth sharp, spinose; outer orbital teeth sharp, long, spinose.

Description: The carapace is slightly longer than wide and narrows anteriorly. The carapace length is slightly longer than the width. The finely granulated dorsal surface is depressed. The regions are well defined. The slightly vaulted protogastric lobes are shallowly separated from the inflated mesogastric lobe. The cervical and branchial grooves are distinct. The narrow urogastric lobe is present. The gently convex cardiac region is longitudinally hexagonal in outline. The branchiocardiac groove is deep. In the inflated branchial region, the epibranchial lobes are divided into two by a shallow, oblique groove. The orbitofrontal margin occupies about half of the width. The acutely triangular frontal teeth are divided by a deep median V-shaped notch and deeply separated from the sharp inner orbital teeth by a V-shaped notch. The inner orbital teeth overreach the frontal teeth. The outer orbital tooth is spinose, long, straight and overreaches the inner orbital tooth. The anterolateral margins are smooth.

Discussion: The present new species is most similar to the living species, *Ethusa indica* Alcock, 1894 from the Indo-West Pacific Ocean. It differs from *E. indica* because in *E. chibai* sp. nov., the outer orbital tooth overreaches the inner orbital tooth and the inner orbital tooth also overreaches the frontal tooth.

Occurrence: TMR-1 (Tamari Formation).

Geologic range: Early Pliocene.

Superfamily Calappoidea de Haan, 1833
Family Calappidae de Haan, 1833
Subfamily Calappinae de Haan, 1833
Genus *Calappa* Weber, 1795

Type species: By subsequent designation of Latreille, 1810; *Cancer granulatus* Linnaeus, 1758 (ICZN Opinion 712). *Range*: Eocene ? to Recent.

Calappa sp. 1
(Pl. 8, Fig. 2)

Calappa sp. 1, Karasawa, 1989, p. 14, pl. 3, fig. 1.

Material: MFM9605.

Occurrence: MFM. 58 (Akeyo Formation, Mizunami Group).

Geologic range: early Middle Miocene.

Calappa sp. 2
(Pl. 8, Fig, 7)

Material: MFM83211.

Remarks: A single broken dactylus was obtained. This species is easily distinguished from *Calappa* sp. 1 (Karasawa, 1989) from the Miocene Mizunami Group by having the mesial surface with no striae. I have not found the carapace remains from the Cenozoic of Japan yet.

Occurrence: MYZ-2 (Tano Formation, Miyazaki Group).

Geologic range: Late Miocene.

Calappa sp. 3
(Pl. 7, Fig. 6)

Material: MFM142169.

Remarks: A small dactylus of the cheliped is not determined at the species level.

Occurrence: KKG-11 (Dainichi Sand, Kakegawa Group).

Geologic range: Late Pliocene.

Genus *Mursia* Desmarest, 1823

Type species: By subsequent designation of H. Milne Edwards, 1837; *Mursia cristata* H. Milne Edwards, 1837. *Range*: Oligocene to Recent.

Mursia minuta sp. nov.
(Pl. 8, Figs, 8, 10, 13, 14)

Material: MFM142003 (holotype), 142004 (paratype), 142149.

Type locality: Loc. MYZ-7 (Sadohara Formation, Miyazaki Group; Early Pliocene).

Etymology: From small carapace.

Diagnosis: Carapace small; dorsal surface with 7 rows of tubercles; anterolateral margin finely dentate; epibranchial spine 0.3 of carapace width.

Description: The small carapace is transversely oval in shape and the length excluding the epibranchial spine, is about 0.7 of the width. The gently convex dorsal surface is decorated with fine granules and conical tubercles which vary in size. A furrow between the

gastrocardiac and branchial regions are deep and broad. The dorsal surface is traversed by five rows of conical tubercles; a medial row is composed of five tubercles diminishing in size posteriorly, and there are two tubercles transversely arranged, in front of the row; first row bears five tubercles and there is one small tubercle between the first and median rows on the branchial region: four tubercles are arranged on the second row running from the gastric region to the epibranchial spine; the third row is composed of two tubercles and there is one small tubercle out of the row. The orbitofrontal margin occupies about half of the width excluding the epibranchial spine. The narrow frontal margin is trilobed and the median tooth is longer than the outer teeth. The strongly arched anterolateral margins are about half of the width and finely dentate. The epibranchial spine is about 0.3 times as long as the width and slightly protrudes posteriorly. The nearly straight posterolateral margins are slightly longer than the anterolateral margins and strongly convergent posteriorly. The narrow posterior margin is nearly straight.

Discussion: The present new species has resemblance to the living species, *Mursia curtispina* Miers, 1886 from the Indo-West Pacific Ocean, but it is different in having a small carapace, well defined dorsal tubercles and a long epibranchial spine. The carapace outline of *M. curtispina* is rounder than that of *M. minuta* sp. nov.

Occurrence: MYZ-7 (Sadohara Formation, Miyazaki Group).

Geologic range: Early Pliocene.

Mursia takahashii Imaizumi, 1952
(Pl. 8, Fig. 4)

Mursia takahashii Imaizumi, 1952, p. 90, figs. 1-4; Sakumoto *et al.*, 1992, p. 449, pl. 61, figs. 4, 5.

Material: T. 3124, T. 3125.

Occurrence: IZM-1, 4, 7 (Fujina Formation, Izumo Group).

Geologic range: Middle Miocene.

Mursia sp. aff. *M. armata* de Haan, 1837
(Pl. 8, Fig. 8)

Material: MFM142156, 142160.

Remarks: In the general ornamentation of the carapace, it is most similar to the living form, *Mursia armata* de Haan, 1837 from the Northwest Pacific Ocean, but differs in having a short, slender epibranchial spine.

Occurrence: KKG-4, 9 (Ten-no Sand, Kakegawa Group).

Geologic range: Late Pliocene.

Mursia sp. 1
(Pl. 8, Fig. 6)

Mursia sp., Karasawa & Inoue, 1992, p. 82, pl. 2, fig. 7.

Material: MFM83173.

Occurrence: KO-4 (Osaki Formation, Kukinaga Group).

Geologic range: Middle Miocene.

Mursia sp. 2

(Pl. 8, Fig. 1)

Material: MFM142157.

Description: The slender dactylus is gently curved downward. The dorsal margin is irregularly granulate, proximally. The occludent margin bears six blunt teeth from the base to the middle; the proximal tooth and basal two ones are larger than the others. The ventrolateral surface possesses a large tooth. There is a granulated row on the mid-line of the mesial surface.

Remarks: A further discussion is difficult to the single imperfect dactylus.

Occurrence: KKG-1 (Dainichi Sand, Kakegawa Group).

Geologic range: Late Pliocene.

Paramursia Karasawa, 1989

Type species: By monotypy *Paramursia circularis* Karasawa, 1989. *Range*: Late Oligocene to Middle Miocene.

Paramursia circularis Karasawa, 1989

(Pl. 8, Fig. 11)

Paramursia circularis Karasawa, 1989, p. 16, pl. 3, figs. 7, 8.

Material: MFM9013, 9014.

Remarks: In the dorsal ornamentation of the carapace, the present species is similar to the *Mursia* species, but differs in having a blunt, small epibranchial spine.

Occurrence: MFM. 07 (Akeyo Formation, Mizunami Group).

Geologic range: early Middle Miocene.

Superfamily Cancroidea Latreille, 1803

Family Corystidae Samouelle, 1819

Genus *Padocatactes* Ortmann, 1893

Type species: By monotypy *Padocatactes hamifer* Ortmann, 1893. *Range*: Pliocene to Recent.

Padocatactes hamifer Ortmann, 1893

(Pl. 9, Fig. 1)

Padocatactes hamifer Ortmann, 1893, p. 29, pl. 3, fig. 1; Sakai, 1976, p. 306, pl. 101, fig. 2, text-fig. 171.

Material: MFM142151.

Occurrence: KKG-5 (Soga Formation, Kakegawa Group) ; KKG-12 (Hijikata silt Formation, Kakegawa Group).

Geologic range: Pleistocene to Recent.

Padocatactes ujiharai sp. nov.
(Pl. 8, Figs. 3, 5)

Material: MFM142005 (holotype), 142006 (paratype).

Type locality: Loc. MYZ-11 (Takanabe Formation; Late Pliocene).

Etymology: In honour of Mr. Atsushi Ujihara of Nagoya University.

Diagnosis: *Padocatactes* with large protogastric lobe bearing one conical tubercle posteriorly and epibranchial margin with two spines.

Description: The carapace is longitudinally elliptical in outline. The finely granulated dorsal surface is depressed and the regions are well defined by shallow, broad grooves. The inflated protogastric lobes are shallowly separated from the narrow anterior process of the mesogastric lobe and bear a conical tubercle posteriorly. The hexagonal mesogastric lobe with a weak median hollow, is slightly swollen. The flattened urogastric lobe is broad. The vaulted cardiac lobe with two conical tubercles transversely arranged, is hexagonal in outline and divided into two by a shallow, broad median depression. The branchiocardiac groove is deep. The hepatic lobes are well defined. The inflated epigastric lobes are well separated from the hepatic, gastric and mesobranchial lobes, and subdivided into two by an oblique groove. On the mesobranchial lobes, there is a finely granulated oblique ridge from the last anterolateral spine to the middle. The details of the rostrum are obscured by ill -preservation. The supraorbital spine is broadly triangular in shape and the postorbital spine is longer than the praeorbital spine. Gently convex anterolateral margins taper anteriorly and are armed with three spines; one occurs on the hepatic margin and the others do on the epibranchial margin. Sigmoid posterolateral margins are convergent posteriorly and as long as the anterolateral margins.

Discussion: The genus *Padocatactes* is only represented by the Northwest Pacific living, *P. hamifer* Ortmann, 1893. The present new species is easily distinguished from *P. hamifer* by having large protogastric lobes with a posterior tubercle and an anterolateral margin of which epibranchial margin is armed with two distinct spines.

Occurrence: MYZ-7 (Sadohara Formation, Miyazaki Group) ; MYZ-11, 12 (Takanabe Formation, Miyazaki Group).

Geologic range: Pliocene.

Family Atelecyclidae Ortmann, 1893

Genus *Trachycarcinus* Faxon, 1893

Type species: By monotypy *Trachycarcinus corallinus* Faxon, 1893 (ICZN Opinion 73).

Range: Oligocene to Recent.

Trachycarcinus huziokai Imaizumi, 1951
(Pl. 9, Figs. 7-10)

Trachycarcinus huziokai Imaizumi, 1951, p. 34, pl. 6, figs. 1-10; Imaizumi, 1969, p. N-7, figs. 4, 5; Karasawa & Nakagawa, 1992, p. 11, pl. 2, figs. 3, 4; Mizuno & Takeda, 1993, p. 86, pl. 4, fig. 2.
A large right cheliped of the Xanthid type, Imaizumi, 1951, p. 39, pl. 6, fig. 11.

Material: MFM39123-39125, 83247-83249.

Occurrence: ICS-1 (Oi Formation, Ichishi Group) ; YTO-1 (Higashibessho Formation, Yatsuo Group) ; KMN-1 (Koguchi Formation, Kumano Group) ; FK-05 (Hosotsubo Formation).

Geologic range: Early to Middle Miocene.

Family Cancridae Latreille, 1803
Genus *Platepistoma* Rathbun, 1906

Type species: By monotypy *Platepistoma macrophthalmus* Rathbun, 1906. *Range*: Early Miocene to Recent.

Platepistoma kaedei (Karasawa, 1990)
(Pl. 9, Figs. 4-6)

Cancer cfr. *odosensis* Imaizumi; Imaizumi, 1969, p. N-7, figs. 1, 2.
? *Cancer* ? *imamurae* Imaizumi; Imaizumi, 1969, p. N-7, fig. 3.
Cancer (*Glebocarcinus*) *kaedei* Karasawa, 1990b, p. 9, pl. 1, figs. 4a-c, 7a, b, 13, 14.
Platepistoma kaedei (Karasawa) ; Sakumoto *et al.*, 1992, p. 446, pl. 60, figs. 3, 4.

Material: MFM9026-9029, 9340; 83204, 83294-83301; T. 3128, 3129.

Remarks: The other Miocene species, *Platepistoma imamurae* (Imaizumi, 1962) has been described from the Miocene Yatsuo Group. I have not been obtained specimens from southwest Japan.

Occurrence: MFM. 50, 54 (Akeyo Formation, Mizunami Group) ; YTO-1 (Higashibessho Formation, Yatsuo Group) ; ASG-1-5 (Asagaya Formation) ; IZM-1 (Fujina Formation, Izumo Group).

Geologic range: Early to Middle Miocene.

Genus *Cancer* Linnaeus, 1758

Type species: By subsequent designation of Latreille, 1810; *Cancer pagurus* Linnaeus, 1758 (ICZN Opinion 104). *Range*: Miocene to Recent.

Subgenus *Glebocarcinus* Nations, 1975

Type species: By original designation *Cancer oregonensis* Rathbun, 1898. *Range*: Early Miocene to Recent.

Cancer (*Glebocarcinus*) *amphioetus* Rathbun, 1898
(Pl. 9, Figs. 2, 3)

Trichocarcinus dentatus Miers, 1879, p. 34. (*nom. preoccup.* by *Cancer dentatus* Herbst, 1785).
Cancer pygmaeus Ortmann, 1893, p. 426, pl. 17, fig. 4. (*nom. preoccup.* by *Cancer pygmaeus* Fabricius, 1787 and *C. pygmaeus* Fabricius, 1793).
Cancer amphioetus Rathbun, 1898, p. 582 (substituted for *dentata* preoccupied in the genus *Cancer*) ; Rathbun, 1930, p. 205, pl. 91: Nations, 1975, p. 30, figs. 4, 6, 15, 16, 30-7, 30-8; Sakai, 1976, p. 219, pl. 109, figs. 1-8.
Cancer bullatus Balss, 1922, p. 95, pl. 1, figs. 2, 3.

Material: MFM142153-142155.

Occurrence: KKG-1 (Dainichi Sand, Kakegawa Group).

Geologic range: Late Pliocene to Recent.

Cancer (*Glebocarcinus*) *itoigawai* Karasawa, 1990b
(Pl. 10, Fig. 3)

Cancer (*Glebocarcinus*) *itoigawai* Karasawa, 1990b, p. 7, pl. 1, fig. 10.
Cancer (*Glebocarcinus*) sp. cfr. *C.* (*G.*) *itoigawai* Karasawa, 1990b, p. 9, pl. 1, figs. 11, 12.

Material: MFM9025, 9372-9374.

Occurrence: MFM. 07, 45 (Akeyo Formation, Mizunami Group).

Geologic range: Early to early Middle Miocene.

Subgenus *Romaleon* Gistl, 1848

Substitued for *Trichocera* de Haan, 1833 (type species; *Corystes* (*Trichocera*) *gibbosulus* de Haan, 1835). *Range*: Middle Miocene to Recent.

Cancer (*Romaleon*) *sanbonsugii* Imaizumi, 1962
(Pl. 10, Fig. 6)

Cancer sanbonsugii Imaizumi, 1962, p. 233, pl. 40, figs. 1-12, text-figs. 1-7.
Cancer sp. cfr. *C. sanbonsugii* Imaizumi; Karasawa & Inoue, 1992, p. 82, pl. 2, fig. 3.

Material: MFM83191, 83202, 83203.

Occurrence: KO-5 (Osaki Formation, Kukinaga Group) ; YTO-1 (Higashibessho Formation, Yatsuo Group).

Geologic range: Middle Miocene.

Subgenus *Metacarcinus* A. Milne Edwards, 1862

Type species: By original designation *Cancer magister* Dana, 1852. *Range*: Middle Miocene to Recent.

Cancer (*Metacarcinus*) *izumoensis* Sakumoto, Karasawa & Takayasu, 1992
(Pl. 10, Fig. 4)

Cancer (*Metacarcinus*) *izumoensis* Sakumoto *et al.*, 1992, p. 447, pl. 60, figs. 5a-c, pl. 61, fig. 1.

Material: T. 3130, 3131.

Occurrence: IZM-9 (Fujina Formation, Izumo Group).

Geologic range: Middle Miocene.

Subgenus *Cancer sensu stricto*

Cancer (*Cancer*) *fujinaensis* Sakumoto, Karasawa & Takayasu, 1992
(Pl. 10, Fig, 2)

Cancer (*Cancer*) *fujinaensis* Sakumoto *et al.*, 1992, p. 448, pl. 61, figs. 3a-c.

Material: T. 3132.

Occurrence: IZM-5 (Fujina Formation, Izumo Group).

Geologic range: Middle Miocene.

Cancer (*Cancer*) *japonicus* Ortmann, 1893
(Pl. 10, Figs. 1)

Cancer japonicus Ortmann, 1893, p. 427, pl. 17, fig. 5; Nations, 1975, p. 44, figs. 4, 41-3, 4.

Material: MFM142122, 142140.

Occurrence: ONM-1 (Onma Formation) ; KKG-6 (Ten-no Sand, Kakegawa Group) ; ZKW-1 (Zukawa Formation).

Geologic range: Late Pliocene to Recent.

Cancer (*Cancer*) *tomowoi* Karasawa, 1990b
(Pl. 10, Figs 7a, b)

Cancer (*Cancer*) *tomowoi* Karasawa, 1990b, p. 11, pl. 1, figs. 2a-d, 3a-d, 8, 16a, b; Sakumoto *et al.*, 1992, p. 448, pl. 61, figs. 2a-c.

Material: MFM9022-9024, 9341, 9342-1-10, 9343-1-4, 9344-1-12, 9345-1-20, 9346, 9347, 9348-1-15, 9349-1-5, 9493, 9495.

Occurrence: I-2 (Toyama Formation, Mizunami Group) ; MFM. 11-13, 19, 22, 27, 40, 45 (Akeyo Formation, Mizunami Group) ; MFM. 26, 62, 64 (Oidawara Formation, Mizunami Group) ; IZM-6 (Fujina Formation, Izumo Group).

Geologic range: Early to Middle Miocene.

Cancer sp.
(Pl. 10, Fig. 5)

Cancer sp., Karasawa, 1990b, p. 13, pl. 1, fig. 9.

Material: MFM9375.

Occurrence: MFM. 07 (Akeyo Formation, Mizunami Group).

Geologic range: early Middle Miocene.

Superfamily Portunoidea Rafinesque, 1815

Family Portunidae Rafinesque, 1815

Subfamily Carcininae MacLeay, 1838

Genus *Portunites* Bell, 1858

Type species: By monotypy *Portunites incerta* Bell, 1858. *Range*: Eocene to Miocene?.

Portunites kattachiensis Karasawa, 1992b

(Pl. 11, Fig. 7)

Portunites kattachiensis Karasawa, 1992b, p. 1252, figs. 5-1-3.

Material: KMNH. IvP 300,016.

Occurrence: MND-1 (Manda Group).

Geologic range: Late Middle Eocene.

Subfamily Polybiinae Ortmann, 1893

Genus *Imaizumila* gen. nov.

Type species: By monotypy *Imaizumila sexdentata* sp. nov.; gender, feminine. *Range*: Early Oligocene.

Etymology: In honour of the late Dr. Rhikizo Imaizumi of Tohoku University.

Diagnosis: Carapace transversely hexagonal, wider than long; regions well defined; frontal margin with 6 small, triangular teeth including supraorbital teeth; anterolateral margin bearing 5 well separated triangular teeth.

Discussion: In general shape of the carapace, the present new genus is similar to *Portunites* Bell, 1858, but differs in having a wider carapace, the frontal margin which bears six well separated teeth, and a thin orbital margin. This genus resembles the Miocene, *Itoigawaia* Karasawa, Sakumoto & Takayasu, 1992, but triangular frontal teeth, a well defined dorsal region of the carapace and the propodus with dorsal teeth of the cheliped readily distinguish *Imaizumila* gen. nov. from *Itoigawaia*.

Imaizumila sexdentata sp. nov.

(Pl. 11, Figs. 1-3)

Material: MFM218507 (holotype), 218508 (paratype).

Type locality: Loc. KSM-1 (Nagashima Sandstone, Kishima Group; Early Oligocene).

Etymology: From six frontal teeth.

Diagnosis: as for the genus.

Description: The carapace is transversely hexagonal in outline and the length is about 0.7 of the width. The finely granulated dorsal surface is gently convex. The regions are well

defined. The small epigastric lobes are transversely raised. A deep, narrow groove separates the gently swollen protogastric lobes from the anterior process of the mesogastric lobe. The mesogastric lobe is longitudinally inflated. The urogastric lobe is poorly defined. The flattened cardiac lobe with a shallow depression, is transversely hexagonal in outline and bears two small nodes transversely arranged. The deep cervical furrow separates the depressed hepatic lobes from the branchial regions. The epibranchial lobes are strongly raised and arched anteriorly; the ridge runs on a small boss out of the urogastric lobe to the last anterolateral tooth and subdivided into two by a broad groove near the mesogastric lobe. The other branchial region bears a rounded ridge below a epibranchial lobe. The orbitofrontal margin occupies about half of the width. The frontal margin bears six small, triangular teeth including the supraorbital teeth. The thin orbital margin is finely granulate and pierced by two deep notches, laterally. Gently arched anterolateral margins bear five well separated triangular tooth; the 1st tooth is the smallest; the forwardly directed first four teeth are acutely triangular in outline and the slender last tooth projects laterally. Gently concave posterolateral margins are as long as the anterolateral margins. The posterior margin is convex.

The broken cheliped remains. The propodus bears four coarse teeth on the dorsolateral margin and three forwardly directed sharp spines on the dorsomesial margin.

Genus *Itoigawaia* Karasawa, Sakumoto & Takayasu, 1992

Type species: By monotypy *Portunites minoensis* Karasawa, 1990. *Range*: Early to Middle Miocene.

Itoigawaia minoensis (Karasawa, 1990)
(Pl. 11, Figs. 1-3)

Portunites minoensis Karasawa, 1990b, p. 14, pl. 2, figs. 1a, b, 3-5.
Parathranites shibatai Karasawa, 1990b, p. 16, pl. 6, fig. 5. (non. fig. 6)
Itoigawaia minoensis (Karasawa) ; Karasawa *et al.*, 1992, p. 456, pl. 69, figs. 1-7; Sakumoto *et al.*, 1992, p. 450, pl. 61, figs. 6a, b.

Material: MFM9035-9037.

Occurrence: MFM. 25, 45 (Akeyo Formation, Mizunami Group) ; IZM-6 (Fujina Formation, Izumo Group).

Geologic range: Early to Middle Miocene.

Itoigawaia umemotoi sp. nov.
(Pl. 11, Fig. 6)

Material: MFM9039 (holotype).

Type locality: Loc. MFM. 46 (Yamanouchi Member, Mizunami Group; Early Miocene).

Etymology: From Mr. Masayuki Umemoto who collected the type specimen.

Diagnosis: *Itoigawaia* with large, fan-like carapace, front with 4 acute spines, and thin

anterolateral margin.

Description: The large carapace lacks the posterior half, but appears to be fan-like in outline. The finely granulated dorsal surface is slightly convex and the regions are defined by broad grooves. Deep grooves separate the more convex protogastric lobes with an anterior transverse ridge, from the narrow anterior mesogastric process. The slightly inflated mesogastric lobe is hexagonal in outline. The cervical groove is distinct. The hepatic regions are weakly convex. The branchial regions are tumid. The orbitofrontal margin occupies about one-third of the width. The frontal margin with four acute spines, is separated from the broadly triangular supraorbital tooth by a V-shaped notch. The orbital margin is pieced by a deep fissure laterally. Gently convex anterolateral margins are about one-third of the width and bear five forwardly directed acutely triangular teeth. The posterolateral margins appear to be concave and much longer than the anterolateral margins.

The palms of the chelipeds are about one-third of the carapace length and the surfaces are smooth.

Discussion: A large, fan-like carapace, the frontal margin with four acute spines, the orbital margin with a deep fissure, a thin anterolateral margin and a wide posterolateral margin readily distinguish the present new species from *Itoigawaia minoensis* (Karasawa, 1990b) from the Miocene Mizunami and Izumo Groups.

Occurrence: MFM. 46 (Akeyo Formation, Mizunami Group).

Geologic range: Early Miocene.

Genus *Parathranites* Miers, 1886

Type species: By monotypy *Lupocyclus* (*Parathranites*) *orientalis* Miers, 1886 (ICZN Opinion 73). *Range*: Miocene to Recent.

Parathranites shibatai Karasawa, 1990b
(Pl. 11, Fig. 5)

Parathranites shibatai Karasawa, 1990b, p. 16, pl. 6, fig. 6. (*non.* fig. 5)

Material: MFM9032.

Occurrence: MFM. 45 (Akeyo Formation, Mizunami Group).

Geologic range: Early Miocene.

Subfamily Portuninae Rafinesque, 1815

Genus *Scylla* de Haan, 1833

Type species: By subsequent designation of Rathbun, 1922; *Cancer serratus* Forskål, 1775 (ICZN Opinion 73). *Range*: Oligocene to Recent.

Scylla ozawai Glaessner, 1933
(Pl. 12, Figs. 1, 3)

Scylla ozawai Glaessner, 1933, p. 20, pl. 4, fig. 2; Karasawa, 1990b, p. 18, pl. 2, figs. 6, 7, pl. 3, figs. 1a, b; Karasawa & Inoue, 1992, p. 83, pl. 2, figs. 14, 17; Sakumoto *et al.*, p. 450, pl. 62, figs. 1a, b.
Scylla miocenica Inagaki, 1938, p. 1, pl. 3, figs. 1, 2.

Material: MFM9388, 9389, 83124, 83167-83172, 83188; T. 3136, 3137.

Occurrence: KK-1, 3-6 (Kawachi Formation, Kukinaga Group) ; KO-4, 8 (Osaki Formation, Kukinaga Group) ; MFM. 32 (Akeyo Formation, Mizunami Group) ; IZM-6 (Fujina Formation, Izumo Group).

Geologic range: Early to Middle Miocene.

Scylla serrata (Forskål, 1775)
(Pl. 13, Figs. 1, 2)

Cancer serratus Forskål, 1775, p. 90.
Scylla serrata (Forskål) ; de Haan, 1833, p. 44; A. Milne Edwards, 1860, p. 252, pls. 1, 2; Etheridge & McCulloch, 1916, p. 9, pl. 2, figs. 1, 2; van Straelen, 1928, p. 65, pl. 12, fig. 6; Sakai, 1976, p. 335, pl. 115, fig. 1 (including further synonymy).

Material: MFM142119-142120.

Occurrence: SMJ-2 (Maja Formation, Shimajiri Group) ; MYZ-8 (Tsuma Formation, Miyazaki Group).

Geologic range: Early Pliocene to Recent.

Scylla sp.
(Pl. 13, Fig. 10; Pl. 14, Fig. 1)

Scylla sp. 1, Karasawa, 1990b, p. 20, pl. 2, fig. 8; pl. 4, fig. 1; pl. 5, fig. 1.
Scylla sp. 2, Karasawa, 1990b, p. 21, pl. 2, figs. 2a, b.
Scylla sp., Sakumoto *et al.*, p. 451, pl. 62, figs. 2a-c.

Material: MFM9350, 9411, 9412, 83291.

Remarks: The fingers which bear large blunt teeth on the occludent margin can distinguish this species from the Miocene species, *Scylla ozawai* Glaessner, 1933. This is near to the living, *S. serrata* (Forskål, 1775) rather than the extant, *S. ozawai*.

Occurrence: MFM. 45, 54 (Akeyo Formation, Mizunami Group) ; SKN-1 (Sekinobana Formation) ; IZM-8 (Fujina Formation, Izumo Group).

Geologic range: Early to Middle Miocene.

Genus *Charybdis* de Haan, 1833

Type species: By subsequent designation of Glaessner, 1929; *Cancer feriatus* Linnaeus, 1758 (ICZN Opinion 712). *Range*: Oligocene to Recent.

Subgenus *Minohellenus* Karasawa, 1990b

Type species: By monotypy *Charybdis* (*Minohellenus*) *quinquedentata* Karasawa, 1990b. *Range*: Early Miocene.

Charybdis (*Minohellenus*) *quinquedentata* Karasawa, 1990b
(Pl. 13, Figs. 3a, b; Pl. 14, Figs. 3a-c)

Charybdis (*Minohellenus*) *quinquedentata* Karasawa, 1990b, p. 21, pl. 6, figs. 7a-c, 8a, b.

Material: MFM9030, 9031, 9459, 9460.

Occurrence: MFM. 45 (Akeyo Formation, Mizunami Group).

Geologic range: Early Miocene.

Charybdis sp. 1
(Pl. 15, Fig. 10)

Material: MFM83287-83290.

Occurrence: SKN-1 (Sekinobana Formation).

Geologic range: Middle Miocene.

Charybdis sp. 2
(Pl. 13, Fig.s. 8, 9)

Material: MFM142167, 142168.

Occurrence: KKG-11 (Dainichi Sand, Kakegawa Group).

Geologic range: Late Pliocene.

Genus *Thalamita* Latreille, 1829

Type species: By monotypy *Cancer admete* Herbst, 1803 (ICZN Opinion 73). *Range*: Miocene to Recent.

Thalamita sp.
(Pl. 12, Fig. 2)

Material: MFM142121.

Description: Three transverse ridges run on the inflated dorsal surface; there are two ridges divided by the narrow anterior mesogastric process on the protogastric region; one ridge runs from the last anterolateral tooth to the cervical groove on the branchial region and follows the mesogastric ridge. The wide orbitofrontal margin seems to occupy 0.7 of the width. The frontal teeth are missing. The anterolateral margins bear five teeth.

Discussion: This species is similar to the living species, *Thalamita sima* H. Milne Edwards, 1834 from the Indo-West Pacific Ocean. Specimens with more completely preserved frontal and anterolateral margins are necessary for comparison with the *Thalamita* species.

Occurrence: SMJ-2 (Maja Formation, Shimajiri Group).

Geologic range: Early Pliocene.

Genus *Lupocyclus* Adams & White, 1848

Type species: By monotypy *Lupocyclus rotundatus* Adams & White, 1848 (ICZN Opinion 73). *Range*: Pliocene to Recent.

Lupocyclus tuberculosus sp. nov.
(Pl. 13, Figs. 4-7)

Material: MFM142011 (holotype), 142014, 142013 (paratype), 142161.

Type locality: Loc. MYZ-7 (Sadohara Formation, Miyazaki Group).

Etymology: From tuberculated carapace.

Diagnosis: Carapace small, hexagonal, slightly wider than long; dorsal surface covered with one tubercle on protogastric lobe, one on hepatic region, three on branchial region; frontal margin with 4 lobes; anterolateral margin bearing 5 teeth.

Description: The carapace is transversely hexagonal in outline and the length is 0.8-0.85 of the width. The dorsal surface is gently vaulted. The regions are well defined. The large protogastric lobes with an anterior small tubercle, are inflated and deeply separated from the narrow anterior mesogastric process. The pentagonal mesogastric lobe is gently swollen. The inflated urogastric lobe is well defined. The cervical and branchiocardiac grooves are deep. The convex cardiac lobe is divided into two by a shallow median depression. The hepatic regions are covered with one conical tubercle. The branchial region is ornamented with three conical tubercles and the tubercle near the gastric region is larger than the others. The orbitofrontal margin occupies about 0.7-0.8 of the width. The frontal margin is composed of four lobes and shallowly separated from the supraorbital angle. The wide orbital margin is deeply concave. The thin, gently convex anterolateral margins bear five forwardly directed teeth. Concave posterolateral margins are slightly longer than the anterolateral margins.

Discussion: The present new species is easily distinguished from the living species, *Lupocyclus rotundatus* Adams & White, 1848, *L. quinquedentatus* Rathbun, 1906, *L. philipinensis* Semper, 1880 and *L. tugelae* Barnard, 1950 from the Indo-West Pacific Ocean, because in *L. tuberculosus* sp. nov., the dorsal surface of a small carapace is decorated with some tubercles and the anterolateral margin bears five teeth.

Occurrence: MYZ-1 (Sadohara Formation, Miyazaki Group).

Geologic range: Early Pliocene.

Superfamily Xanthoidea MacLeay, 1838
Family Carpilidae Ortmann, 1893
Genus *Carpilius* Desmarest, 1823

Type species: By monotypy *Cancer maculatus* Linnaeus, 1758 (ICZN Opinion 73). *Range*: Miocene to Recent.

Carpilius sp.
(Pl. 15, Fig. 6)

Material: MFM83285.

Description: The large propodus is as long as broad, and has the strongly arched dorsal and nearly straight ventral margins. The smooth lateral and mesial surfaces are gently convex.

Discussion: Two living species, *Carpilius maculatus* (Linnaeus, 1758) and *C. convexus* (Forskål, 1775) are known from the Indo-West Pacific Ocean. I don't make sufficient comparison by a single propodus of the cheliped.

Occurrence: MGM-1 (Megami Limestone).

Geologic range: early Middle Miocene.

Family Xanthidae MacLeay, 1838

Subfamily Polydectinae Dana, 1851

Genus *Lybia* H. Milne Edwards, 1834

Type species: By monotypy *Grapsus tessellatus* Latreille, 1812 (ICZN Opinion 37).

Range: Miocene to Recent.

Lybia sp.

(Pl. 15, Fig. 5)

Material: MFM83280.

Description: The carapace is rectangular in outline and the length is slightly shorter than the width. The dorsal surface is gently convex. The regions are well defined by shallow grooves. The protogastric lobes which are not separated from the epigastric lobes, are slightly convex. The mesogastric lobe is flattened. The urogastric and cardiac lobes are indistinct. The inflated hepatic lobes are well defined. The branchial regions are slightly swollen, but the details are obscured by poor preservation. The bilobed frontal margin is divided into two by a shallow sinous and shallowly separated from the supraorbital angle. The orbital and anterolateral margins are missing. Gently arched posterolateral margins are convergent posteriorly.

Discussion: The present species resembles the living species, *Lybia tessellata* (Latreille, 1812) from the Indo-West Pacific Ocean, but I don't make sufficient comparison by a broken carapace.

Occurrence: MGM-1 (Megami Limestone).

Geologic range: early Middle Miocene.

Subfamily Liomerinae Sakai, 1976

Genus *Liomera* Dana, 1851

Type species: By monotypy *Carpilius cinctimanus* White, 1847 (ICZN Opinion 36, 37).

Range: Miocene to Recent.

Liomera sp.

(Pl. 14, Fig. 2)

Material: MFM83282.

Description: The carapace seems to be transversely oval in outline. The dorsal surface is deformed by pressure. Among the regions, the large protogastric lobes are distinct. The orbitofrontal and anterolateral margins are missing. The last two anterolateral teeth are visible and rounded in outline.

Remarks: Specimens with more completely preserved carapace are needed to identify the species.

Occurrence: MGM-1 (Megami Limestone).

Geologic range: early Middle Miocene.

Subfamily Euxanthinae Alcock, 1898

Genus *Medaeops* Guinot, 1967

Type species: By original designation *Leptodius granulosus* Haswell, 1882. *Range*: Miocene to Recent.

Medaeops megamiensis sp. nov.

(Pl. 15, Figs. 1, 2, 4, 11)

Material: MFM83040 (holotype), 83041, 83043 (paratypes), 83270, 83271.

Type locality: Loc. MGM-1 (Megami Limestone; early Middle Miocene).

Etymology: Referring to the locality, "Megami" of the fossil occurrence.

Diagnosis: Carapace about 0.7 times as long as wide; dorsal surface decorated with many feeble transverse rows of small granules; frontal margin wide, finely dentate.

Description: The carapace is transversely oval in shape and the length is about 0.7 of the width. The gently convex dorsal surface is irregularly decorated with many feeble transverse rows of small granules. The regions on the anterior half are well defined by deep grooves. The depressed frontal region is interrupted by a shallow median furrow. The transversely raised epigastric lobes are shallowly separated from the gently swollen protogastric lobes which are subdivided into two by a shallow groove anteriorly, and there are a small areola above the protogastric lobes and out of the epigastric lobes. The mesogastric lobe is flattened. The urogastric lobe is narrow. The cardiac and intestinal lobes are poorly defined and depressed. The inflated hepatic lobes are well defined. The epibranchial lobes are subdivided into three areolae by shallow oblique furrows. The furrow between the meso- and metabranchial lobes is distinct. The nearly straight frontal margin with a weak median notch, is about 0.3 of the width, finely dentate and separated from the sharp, small supraorbital angle by a deep groove. The concave orbital margin is about one-seventh of the width and pierced by two shallow fissures laterally. Gently arched anterolateral margins bear five teeth including the postorbital tooth; the first two teeth are broadly triangular in outline and directed forwards; the broadly triangular third is the largest of all the teeth and the acutely triangular last two teeth are projected laterally. The posterolateral margins are convergent posteriorly and longer than the anterolateral margins.

Discussion: The present new species resembles the living species, *Medaeops granulosus* (Haswell, 1882) from the Indo-West Pacific Ocean, but *M. megamiensis* sp. nov. has a wide frontal margin which bears fine dentitions and the carapace of *M. megamiensis* sp. nov. is wider than that of *M. granulosus*.

Occurrence: MGM-1 (Megami Limestone).

Geologic range: early Middle Miocene.

Subfamily Xanthinae MacLeay, 1838

Genus *Leptodius* A. Milne Edwards, 1863

Type species: By monotypy *Chlorodius exaratus* H. Milne Edwards, 1834 (ICZN Opinion 37). *Range*: Miocene to Recent.

Leptodius crosnieri sp. nov.

(Pl. 16, Fig. 9)

Material: MFM83029 (holotype).

Type locality: Loc. MGM-1 (Megami Limestone; early Middle Miocene).

Etymology: In honour of Dr. A. Crosnier of Laboratoire de Zoologie (Arthropodes), Muséum National d'Histoire Naturelle, Paris.

Diagnosis: *Leptodius* with slightly convex dorsal surface, anterior regions well defined by deep grooves, and fused 1st and 2nd anterolateral teeth.

Description: The carapace is transversely oval in outline and the length is about three -fifths times as long as the width. The dorsal surface is slightly convex. On the anterior half of the carapace, the regions are well defined by deep grooves. The transversely raised epigastric lobes are well separated from the elevated protogastric lobes which are longitudinally subdivided into two elongated areolae. The mesogastric lobe is depressed. The narrow, flattened urogastric lobe is visible. The inflated hepatic lobes are longitudinally divided into two vaulted lobes. The epibranchial lobes are also divided into three areolae by oblique furrows. The boundary between the meso- and metabranchial lobes is distinct. There is one small tubercle between the last anterolateral tooth and the mesobranchial lobe on the dorsal surface. The ill-preserved frontal margin is about two-fifths of the width and separated from the sharp supraorbital angle by a deep notch. The concave orbital margin is about one-fifth of the width and pierced by two shallow fissures laterally. Gently convex anterolateral margins bear five teeth; the fused first and second teeth are broadly triangular in outline; the last three teeth are acutely triangular in shape and directed forwards.

Discussion: The present new species resembles the living species, *Leptodius exaratus* (H. Milne Edwards, 1834) from the Indo-West Pacific Ocean, but differs in having the fused first and second teeth and the sharply defined third to fifth teeth of the anterolateral margin.

Occurrence: MGM-1 (Megami Limestone).

Geologic range: early Middle Miocene.

Leptodius morrisi sp. nov.
(Pl. 15, Fig. 7)

Material: MFM83047 (holotype).

Type locality: Loc. MGM-1 (Megami Limestone; early Middle Miocene).

Etymology: In honour of Mr. S. F. Morris of the Natural History Museum, London.

Diagnosis: *Leptodius* with the anterior protogastric lobe divided into three areolae and 5 anterolateral teeth.

Description: The carapace is transversely oval in outline and the length is about 0.6 times as long as the width. The dorsal surface is gently convex. On the dorsal half, the regions are well defined by deep grooves. The transversely raised epigastric lobes are shallowly separated from the large, convex protogastric lobes which are divided into three by deep, longitudinal grooves anteriorly. The mesogastric lobe is flattened and the urogastric lobe is indistinct. The transversely hexagonal cardiac region is depressed. Deep, longitudinal grooves separate two areolae from the inflated hepatic lobes. The epibranchial lobes are divided into three areolae by oblique furrows. The orbitofrontal margin occupies about half of the carapace width. The nearly straight frontal margin with a shallow median notch, is finely granulate and shallowly separated from the small, triangular supraorbital angle. The orbital margins are concave. Gently convex anterolateral margins occupy about two-third of the carapace width and bear five teeth which are broadly triangular in outline and sharply directed forward. The nearly straight posterolateral margins are as long as the anterolateral margins.

Discussion: Five broadly triangular anterolateral teeth readily distinguishes the present new species from *Leptodius crosnieri* sp. nov. The protogastric lobe in the new species is divided into three areolae, anteriorly, whilst that in *L. crosnieri* sp. nov. is divided into two areolae.

Occurrence: Loc. MGM-1 (Megami Limestone).

Geologic range: early Middle Miocene.

Genus *Paraxanthias* Odhner, 1925

Type species: By original designation *Xanthodes notatus* Dana, 1852. *Range*: Miocene to Recent.

Paraxanthias fujiyamai sp. nov.
(Pl. 15, Figs. 8, 9)

Material: MFM83042 (holotype), 83043 (paratype), 83274-83279.

Type locality: Loc. MGM-1 (Megami Limestone; early Middle Miocene).

Etymology: In honour of Dr. Ienori Fujiyama of Tokyo.

Diagnosis: Carapace transversely oval, about 0.7 times as long as wide; frontal margin with deep median sinus, nearly straight, shallowly separated from supraorbital angle; anterolateral margin composed of the small 1st, the broad 2nd and 3rd, the broadly

triangular 4th and 5th teeth.

Description: The carapace is transversely oval in outline and the length is about 0.7 times as long as the width. The dorsal surface is gently swollen and the regions are well defined on the anterior half of the carapace. The epigastric lobes are not separated from the protogastric lobes which are subdivided into two by a transverse, shallow groove anteriorly. The flattened mesogastric lobe bears a shallow median depression. The narrow, depressed urogastric lobe is present. The depressed cardiac lobe with a shallow median groove, is hexagonal in outline. Gently convex hepatic lobes are well defined. The epibranchial lobes are shallowly subdivided into three areolae by oblique grooves. The furrow between the meso- and metabranchial regions is inconspicuous. The straight frontal margin is about one-fourth of the width, divided into two lobes by a deep median sinus and shallowly separated from the supraorbital angle. The orbital margin is about one-fifth of the width. Gently arched anterolateral margins bear five teeth including the postorbital tooth; the first tooth is small; the second and third are broad, and the fourth and fifth are broadly triangular in outline. The posterolateral margins are longer than the anterolateral margins.

Discussion: The present new species is allied to the living species, *Paraxanthias notatus* (Dana, 1852) from the West Pacific Ocean. It is distinguished from *P. notatus* because in *P. fujiyamai* sp. nov., the anterolateral teeth are small and obscurely defined.

Occurrence: MGM-1 (Megami Limestone).

Geologic range: early Middle Miocene.

Genus *Palaeoxanthops* gen. nov.

Type species: *Palaeoxanthops minutus* sp. nov.; gender, masculine. *Range*: early Middle Miocene.

Etymology: From the earliest member of *Xanthops*.

Diagnosis: Carapace hexagonal, 0.8 times as long as wide; dorsal surface convex on anterior half; regions well defined; frontal margin straight, with weak median notch, shallowly separated from supraorbital angle; orbital margin small, inclined posteriorly; anterolateral margin with four teeth directed laterally.

Discussion: The present new genus resembles the living genus *Neoxanthops* Guinot, 1968, but differs in having a hepatic lobe well separated from the supraorbital tooth. In *Neoxanthops lineatus* (A. Milne Edwards, 1867) from the Indo-West Pacific, the poorly defined dorsal regions of the carapace is flattened, while in the new genus, the carapace is dorsally convex with well defined regions.

The present new genus is represented by two species, *Palaeoxanthops minutus* sp. nov. and *P. okumurai* sp. nov. from the Middle Miocene Megami Limestone of Japan.

Palaeoxanthops minutus sp. nov.
(Pl. 16, Figs. 1, 4, 8)

Material: MFM83044 (holotype), 83045 (paratype), 83272.

Type locality: Loc. MGM-1 (Megami Limestone; early Middle Miocene).

Etymology: From small orbit.

Diagnosis: Carapace hexagonal in outline, four-fifths times as long as wide; dorsal surface convex on anterior half; regions well defined; frontal margin straight, with weak median notch, shallowly separated from supraorbital angle; orbital margin small, inclined posteriorly; anterolateral margin gently convex, bearing five teeth.

Description: The carapace is transversely hexagonal in shape and the length is about 0.8 times as long as the width. The dorsal surface is gently ridged and the regions are well defined by deep grooves. The protogastric lobes united with the epigastric lobes, are subdivided into two elongate areolae which are longitudinally ridged. The mesogastric lobe is flattened. The narrow urogastric lobe is present. The flattened cardiac lobe is hexagonal in outline and visible. A transverse ridge runs on the hepatic region. The epibranchial lobes are subdivided into three flat areolae by deep furrows. The boundary between the meso- and metabranchial lobes is indistinct. On the branchial region, there is a distinct ridge from the last anterolateral tooth to the cardiac lobe. The nearly straight frontal margin with a shallow median furrow, is 0.4 of the width and separated from the small supraorbital angle by a shallow sinus. The small orbital margin is inclined posteriorly. Gently arched anterolateral margins bear five teeth including the postorbital tooth; the small first tooth protrudes forwards; the second is broad; the last three teeth are broadly triangular in outline and directed laterally and the fourth is the largest of all the teeth. Gently convex posterolateral margins are as long as the anterolateral margins and strongly convergent posteriorly.

Palaeoxanthops okumurai sp. nov.
(Pl. 16, Figs. 5-7)

Material: MFM83050 (holotype), 83051 (paratype), 83284.

Type locality: Loc. MGM-1 (Megami Limestone; early Middle Miocene).

Etymology: In honour of Mr. Yoshitsugu Okumura of Mizunami Fossil Museum.

Diagnosis: *Palaeoxanthops* with sharp last three anterolateral teeth.

Description: The carapace is transversely hexagonal in outline and the length is about 0.8 of the width. The dorsal surface with the well defined regions, is gently convex. The transversely raised frontal lobe is divided into two by a deep median groove. The inflated epigastric lobes are well defined. The longitudinally elevated protogastric lobes are deeply separated from the anterior process of the mesogastric lobe and divided into two elongate areolae by a deep, broad groove. The depressed mesogastric lobe is shallowly separated from the flattened urogastric lobe. The convex hepatic lobe is well defined and subdivided into two near the anterolateral margin. The flattened epibranchial lobes are subdivided into three by deep, oblique furrows. The orbitofrontal margin occupies about 0.6 of the width. The nearly straight frontal margin with a shallow median notch, is shallowly separated from the supraorbital angle. The small orbital margin is inclined posteriorly. Gently convex anterolateral margins bear five teeth; the first tooth is blunt; the broadly

triangular second and acutely triangular last three teeth are directed laterally.

Discussion: The present new species differs from *Palaeoxanthops minutus* sp. nov. in having a more flattened dorsal surface and acutely triangular last three anterolateral teeth.

Genus *Megamia* gen. nov.

Type species: By monotypy *Megamia anaglypta* sp. nov.; gender, feminine. *Range*: early Middle Miocene.

Etymology: From "Megami", a locality of the fossil occurrence.

Diagnosis: Carapace about 0.7 times as long as wide; dorsal surface convex longitudinally and transversely; anterior regions well defined by deep grooves; frontal margin bilobed, with shallow median notch; anterolateral margin with 5 teeth.

Discussion: In general shape of the carapace, the present new genus is similar to the genus *Palaeoxanthops* gen. nov., but it is different in having a wide carapace with dorsal deep sculptures and a bilobed frontal margin.

Megamia anaglypta sp. nov.
(Pl. 15, Fig. 3)

Material: MFM83026 (holotype).

Type locality: Loc. MGM-1 (Megami Limestone; early Middle Miocene).

Etymology: Referring to dorsal deep sculptures of the carapace.

Diagnosis: as for genus.

Description: The small carapace is transversely oval in shape and the length is 0.7 times as long as the width. The dorsal surface is convex longitudinally and transversely. The regions are well defined by deep grooves. The protogastric lobes which unite the epigastric lobes, are subdivided into two longitudinally elevated areolae by a longitudinal deep groove. The slightly convex mesogastric lobe is well defined. The narrow urogastric lobe is distinct. The gently swollen cardiac lobe is transversely hexagonal in outline and divided into two by a shallow median groove. The intestinal lobe is transversely ridged. The hepatic lobes are strongly ridged along the anterolateral margin. The epibranchial lobes are separated from the hepatic and mesobranchial lobes by deep, transverse grooves; one runs from the third anterolateral tooth to the gastric region; one does from the fourth anterolateral tooth to the cardiac region; the lobes are subdivided into three by oblique furrows; the inner areola out of the meso- and urogastric lobes is triangular in shape and subdivided into two by a shallow transverse groove. The boundary between the meso- and metabranchial lobes is present. The bilobed frontal margin with a shallow median groove, is one-fourth of the width and separated from the sharp supraorbital angle by a deep groove. The concave orbital margin is small and inclined posteriorly. Convex anterolateral margins are two-fourths of the width and bear five teeth including the postorbital tooth; the forwardly directed first tooth is the smallest; the second and third are broadly triangular in outline and directed forwards; the fourth and fifth are acutely triangular in outline and directed laterally. The slightly concave posterolateral margins are strongly

convergent posteriorly.

Subfamily Chlorodiinae Alcock, 1898

Genus *Pilodius* Dana, 1852

Type species: By subsequent designation of Forest and Guinot, 1961; *Chlorodius pilumnoides* White, 1847b (= *Chlorodopsis melanochirus* A. Milne Edwards, 1873). *Range*: Miocene-Recent.

Pilodius parvus sp. nov.

(Pl. 16, Figs. 2, 13)

Material: MFM83026 (holotype).

Type locality: Loc. MGM-1 (Megami Limestone; early Middle Miocene).

Etymology: From small carapace.

Diagnosis: Carapace without granules dorsally; frontal margin with two rounded lobes; 2nd to 4th anterolateral teeth spinose.

Description: The carapace is transversely hexagonal in outline and the length is 0.6 of the width. The dorsal surface is slightly convex and the regions are well defined anteriorly. The transversely raised epigastric lobes are shallowly separated from the gently swollen protogastric lobes which are divided into two by a shallow, broad groove, anteriorly. The mesogastric lobe is flattened. The urogastric lobe is also flattened and inconspicuous. The hepatic lobes are inflated. The flattened epibranchial lobes are well separated anteriorly. On the margin of the dorsal surface, there are two small convex areolae near the second and third anterolateral teeth. The orbitofrontal margin occupies 0.6 of the width. A V -shaped sinous separates the frontal margin with two rounded lobes from the supraorbital angle. The wide orbital margin is pierced by a shallow notch laterally. Gently convex anterolateral margins bear four teeth; the first tooth (= the postorbital tooth) is broadly triangular in outline and the forwardly directed others are spinose.

Discussion: The present new species is readily distinguished from *"Pilodius" vulgaris* (Glaessner, 1928) from the Badenian of Hungary (Müller, 1984) because in *P. parvus* sp. nov., the dorsal surface of the carapace is not granulate, the frontal margin is composed of two rounded lobes and anterolateral teeth are spinose. It is similar to the living species, *P. scabriculus* Dana, 1852 from the Indo-West Pacific Ocean, but differs in having sharply defined anterolateral teeth and a narrow frontal margin.

Occurrence: MGM-1 (Megami Limestone).

Geologic range: early Middle Miocene.

Family Trapeziidae Miers, 1886

Subfamily Trapeziinae Miers, 1886

Genus *Trapezia* Latreille, 1825

Type species: By monotypy *Trapezia ferruginea* Latreille, 1825. *Range*: Eocene to Recent.

Trapezia brevispinosa sp. nov.
(Pl. 16, Fig. 10)

Material: MFM83046 (holotype).

Type locality: Loc. MGM-1 (Megami Limestone; early Middle Miocene).

Etymology: From small epibranchial spines.

Diagnosis: *Trapezia* with a straight frontal margin and a short epibranchial spine.

Description: The small carapace is pentagonal in outline and the length is slightly shorter than the width. The dorsal surface is gently convex and the regions are not defined. The wide frontal margin with sharp lateral angles, is nearly straight and occupies one-third of the width. The wide, concave orbital margin is rounded. The lateral margins have a very short epibranchial spine.

Discussion: A straight frontal margin without lobes readily distinguishes the present new species from *Trapezia glaessneri* Müller, 1976 from the Badenian of Hungary. The present new species resembles *Trapezia speciosa* Dana, 1852 from the Indo-West Pacific Ocean, but differs in having a epibranchial spine.

Occurrence: MGM-1 (Megami Limestone).

Geologic range: early Middle Miocene.

Trapezia sp.
(Pl. 18, Figs. 2, 3)

Material: MFM83261, 83273.

Description: The regions of the depressed dorsal surface are not defined. The wide frontal margin is divided into six lobes (including the supraorbital angle) by shallow notches. The orbital margin is wide and the postorbital tooth is sharp. The epibranchial spine is rather short.

Discussion: The frontal margin with six lobes easily distinguishes the present species from *T. brevispinosa* sp. nov.

Occurrence: MGM-1 (Megami Limestone).

Geologic range: early Middle Miocene.

Family Menippidae Ortmann, 1893
Subfamily Menippinae Ortmann, 1893
Genus *Ozius* H. Milne Edwards, 1834

Type species: By subsequent designation of Rathbun, 1930; *Ozius tuberculosus* H. Milne Edwards, 1834. *Range*: Miocene to Recent.

Ozius collinsi Karasawa, 1992a
(Pl. 16, Figs. 16, 17)

Ozius collinsi Karasawa, 1992a, p. 20, pl. 1, figs. a, b.

Material: MFM39001, 39002.

Occurrence: KTT-3 (Yoshino Formation, Katsuta Group).

Geologic range: early Middle Miocene.

"Ozius" ? sp.

(Pl. 16, Fig. 11)

"Ozius" ? sp., Karasawa, 1990b, p. 27, pl. 8, figs 13, 16a-d.

Material: MFM9471-1-4, 9472-1-6, 9473-1-3, 9474-1-3, 9475-1-3, 9476, 9477-1-3.

Occurrence: MFM. 07, 11, 12, 19, 40 (Akeyo Formation, Mizunami Group) ; MFM. 73 (Oidawara Formation, Mizunami Group).

Geologic range: Early to early Middle Miocene.

Genus *Euryozius* Miers, 1886

Type species: By monotypy ? *Xantho bouvieri* A. Milne Edwards, 1869. *Range*: Miocene to Recent.

Euryozius angustus sp. nov.

(Pl. 17, Figs. 5, 6)

Material: MFM83028 (holotype), 83269.

Type locality: Loc. MGM-1 (Megami Limestone; early Middle Miocene).

Etymology: From narrow frontal margin.

Diagnosis: *Euryozius* with narrow frontal margin and anterolateral margin with 2 blunt teeth posteriorly.

Description: The carapace is transversely oval in outline and the length is three-fifths times as long as the width. The smooth dorsal surface is transversely convex and the regions are not defined. The deflexed frontal margin is about one-fifth of the width and divided into two by shallow grooves. The boundary between the frontal margin and the supraorbital angle are inconspicuous. The small orbital margin with the sharp postorbital tooth, is about one-seventh of the width. The strongly arched anterolateral margins have two blunt teeth posteriorly and the last anterolateral tooth is visible. The posterolateral margins are strongly convergent posteriorly.

Discussion: The present new species differs from the Atlantic species, *Euryozius sanguinensis* (Linnaeus, 1771) (Manning & Holthuis, 1981; Manning & Chace, 1990) and the Indo-West Pacific species, *E. canorus* (Rathbun, 1911) (Crosnier, 1984 in Serêne) by having a thin frontal margin and a strongly arched anterolateral margin which bears one blunt tooth and small ones posteriorly.

Occurrence: MGM-1 (Megami Limestone).

Geologic range: early Middle Miocene.

Euryozius bidentatus sp. nov.
(Pl. 17, Figs. 1-4)

Material: MFM83030 (holotype), 83031, 83032 (paratypes), 83268.

Etymology: From two anterolateral teeth.

Type locality: Loc. MGM-1 (Megami Limestone; early Middle Miocene).

Diagnosis: Frontal margin prominent, with median furrow, separated from rounded supraorbital angle by shallow notch; anterolateral margin with two small teeth posteriorly.

Description: The carapace is transversely oval in outline and 0.6 of the width. The dorsal surface of the carapace is transversely swollen and the regions are not defined. The prominent frontal margin is 0.3 of the width, divided into two lobes by a weak median notch and shallowly separated from the rounded supraorbital angle. The smooth orbital margin with the sharp postorbital tooth, is about 0.2 of the width. The strongly arched anterolateral margins bear two forwardly directed small, triangular teeth posteriorly. The posterolateral margins are longer than the anterolateral margins and convergent posteriorly.

Discussion: The present new species is closely related to the Atlantic living form, *Euryozius sanguinensis* (Linnaeus, 1771) (Manning & Holthuis, 1981; Manning & Chace, 1990) rather than the Indo-West Pacific species, *E. canorus* (Rathbun, 1911) (Crosnier, 1984 in Serène). It is distinguished from *E. sanguinensis* by having a small carapace, a prominent frontal margin and the anterolateral margin which is shorter than the posterolateral margin. The new species also differs from *E. angustus* sp. nov. because in *E. bidentatus*, a wide frontal margin is shallowly separated from a rounded supraorbital angle and the anterolateral margin bears distinct two teeth.

Occurrence: MGM-1 (Megami Limestone).

Geologic range: early Middle Miocene.

Subfamily Eriphiinae Alcock, 1898
Genus *Eriphia* Latreille, 1817

Type species: By subsequent designation of H. Milne Edwards, 1837; *Cancer spinifrons* Herbst, 1795 (ICZN Opinion 712). *Range*: Miocene to Recent.

Eriphia sp.
(Pl. 16, Fig. 14)

Material: MFM83286.

Description: The flattened dorsal surface of the carapace is sparsely ornamented with granules and pits. The regions are poorly defined by shallow, broad grooves. The orbital margin is wide. The details of the frontal and anterolateral margins are obscured by poor preservation.

Discussion: *Eriphia* is represented by three species, *E. sebana* (Shaw & Nodder, 1803), *E. smithi* MacLeay, 1838 and *E. scabricula* Dana, 1852 from the Indo-West Pacific Ocean, but I don't make sufficient comparison by a broken carapace.

Occurrence: MGM-1 (Megami Limestone).

Geologic range: early Middle Miocene.

Family Pilumnidae Samouelle, 1819

Genus *Pilumnus* Leach, 1820

Type species: By monotypy *Cancer hirtellus* Linnaeus, 1761 (ICZN Opinion 348). *Range*: Miocene to Recent.

"Pilumnus" ? sp.

(Pl. 16, Fig. 12)

"Pilumnus" ? sp., Karasawa, 1990b, p. 28, pl. 8, figs. 6a-d.

Material: MFM9492-1, 2.

Occurrence: MFM. 58 (Akeyo Formation, Mizunami Group).

Geologic range: early Middle Miocene.

Genus *Glabropilumnus* Balss, 1932

Type species: By original designation *Pseudozius dispar* Dana, 1852. *Range*: Miocene to Recent.

Glabropilumnus kamiyai Karasawa, 1991

(Pl. 16, Fig. 3)

Glabropilumnus kamiyai Karasawa, 1991, p. 16, fig. 2-1.

Material: MFM9039.

Occurrence: MFM. 07 (Akeyo Formation, Mizunami Group).

Geologic range: early Middle Miocene.

Genus *Actumnus* Dana, 1851

Type species: By subsequent designation of Rathbun, 1922; *Actumnus tomentosus* Dana, 1852 (ICZN Opinion 73). *Range*: Miocene to Recent.

Actumnus guinotae Karasawa & Inoue, 1992

(Pl. 16, Fig. 15)

Actumnus guinotae Karasawa & Inoue, 1992, p. 84, pl. 2, figs. 2, 4, 12.

Material: MFM83017, 83018, 83019.

Occurrence: KO-5 (Osaki Formation, Kukinaga Group).

Geologic range: Middle Miocene.

Family Goneplacidae MacLeay, 1838

Subfamily Carcinoplacinae H. Milne Edwards, 1852

Genus *Branchioplax* Rathbun, 1916

Type species: By monotypy *Branchioplax washingtoniana* Rathbun, 1916. *Range*: Eocene to Oligocene.

Branchioplax pentagonalis (Yokoyama, 1911)
(Pl. 17, Figs. 7-9)

Xanthilites pentagonalis Yokoyama, 1911, p. 13, pl. 3, fig. 3.
Branchioplax pentagonalis (Yokoyama) ; Karasawa, p. 1254, figs. 4-1, 5-4-6.
Material: KMNH IvP 300,017-300,019, ESN83005.
Occurrence: MND-1 (Manda Group).
Geologic range: Late Middle Eocene.

Genus *Carcinoplax* H. Milne Edwards, 1852

Type species: By subsequent designation of Glaessner, 1929; *Cancer* (*Curtonotus*) *longimanus* de Haan, 1833. *Range*: Miocene to Recent.

Carcinoplax antiqua (Ristori, 1889)
(Pl. 18, Figs. 1, 7, 8)

Curtonotus antiquus Ristori, 1889, p. 4.
Carcinoplax antiqua (Ristori) ; Glaessner, 1933, p. 17, pl. 4, fig. 3; Imaizumi, 1961, p. 164, pls. 12-17; Karasawa, 1990b, p. 23, pl. 7, figs. 1-8 (including further synonymy) ; Sakumoto *et al.*, 1992, p. 451, pl. 63, figs. 1a, b.
Carcinoplax senecta Imaizumi, 1961, p. 172, pl. 18, figs. 1-3.
Material: MFM9550-9587, 83197-83201, 83206-83210, 83240-83242.
Occurrence: MFM. 25, 45, 46 (Akeyo Formation, Mizunami Group) ; MFM. 73 (Oidawara Formation, Mizunami Group) ; YTO-1 (Higashibessho Formation, Yatsuo Group) ; KMN-1 (Koguchi Formation, Kumano Group) ; FK-1, 6, 7 (Kawaminami Formation) ; FK-4 (Kasanomisaki Formation) ; FK-12, 16 (Shimo Formation, Uchiura Group) ; IZM-2-4, 6, 7, 9 (Fujina Formation, Izumo Group).
Geologic range: Early to Middle Miocene.

Carcinoplax granulimanus Karasawa & Inoue, 1992
(Pl. 18, Figs. 4, 5, 9)

Carcinoplax granulimanus Karasawa & Inoue, 1992, p. 85, pl. 2, figs. 10, 11, 13, 15, 16.
Material: MFM83007-83010, 83174-83184.
Occurrence: KO-1-7 (Osaki Formation, Kukinaga Group).
Geologic range: Middle Miocene.

Carcinoplax imperfecta Karasawa & Inoue, 1992
(Pl. 18, Fig. 6)

Carcinoplax imperfecta Karasawa & Inoue, 1992, p. 86, pl. 2, fig. 5

Material: MFM83020.

Occurrence: KO-5 (Osaki Formation, Kukinaga Group).

Geologic range: Middle Miocene.

Carcinoplax longimanus (de Haan, 1833)
(Pl. 19, Figs. 1, 3, 5)

Cancer (*Curtonotus*) *longimanus* de Haan, 1833 p. 6, fig. 1.

Carcinoplax longimanus (de Haan) ; H. Milne Edwards, 1858, p. 164; Guinot, 1989, p. 273, pl. 1, figs. A-D, pl. 2, figs. A-D. (including further synonyms).

Carcinoplax longimana (de Haan) ; Ortmann, 1893, p. 688; Sakai, 1976, p. 524, pl. 189; Karasawa, 1990c, p. 58, figs. 1a-c.

Material: MFM14136-14139.

Occurrence: KKG-4, 7 (Ten-no Sand, Kakegawa Group) ; KKG-5, 10 (Soga Formation, Kakegawa Group).

Geologic range: Late Pliocene to Recent.

Carcinoplax prisca Imaizumi, 1961
(Pl. 19, Figs. 4, 6, 7; Pl. 20, Figs. 3, 5-7)

Carcinoplax prisca Imaizumi, 1961, p. 171, pl. 13, figs. 12, 13; pl. 16, figs. 1-3; pl. 17, figs. 1, 12-16; pl. 18, figs. 4-14, pls. 19, 20; pl. 21, figs. 7-9.

Material: MFM83211-83220, 93223-93229, 142101-142118, 142159.

Discussion: This species has a sexual dimorphism such as *Carcinoplax longimanus* (de Haan, 1833). In male specimens, the carapace outline becomes rounder and the chelipeds become longer in proportion to growth. *C. prisca* is hardly distinguished from *C. longimanus* in the carapace characters. *C. prisca*, however, differs from *C. longimanus* by having the palm of which lateral surface bears a distinct longitudinal ridge on the mid-line and mesial surface does not have the distal spine.

Occurrence: MYZ-1-6 (Tano and Aya Formations, Miyazaki Group) ; MYZ-7 (Sadohara Formation, Miyazaki Group) ; SMJ-1-5 (Maja Formation, Shimajiri Group).

Geologic range: Latest Miocene to Early Pliocene.

Carcinoplax sp. aff. *C. purpurea* Rathbun, 1914
(Pl. 19, Fig. 2)

Material: MFM142164.

Remarks: In the general shape of the carapace, this species is most similar to the living, *Carcinoplax purpurea* Rathbun, 1914, but bears blunt anterolateral teeth.

Occurrence: KKG-5 (Soga Formation, Kakegawa Group).

Geologic range: Latest Pliocene to Early Pleistocene.

Subfamily Rhizopinae Stimpson, 1858

Genus *Typhlocarcinus* Stimpson, 1858

Type species: By original designation *Typhlocarcinus villosus* Stimpson, 1858. *Range*: Late Pliocene to Recent.

Typhlocarcinus obtusus sp. nov.

(Pl. 21, Figs. 1, 2)

Material: MFM142009 (holotype), 142010 (paratype).

Type locality: Loc. KKG-3 (Dainichi Sand, Kakegawa Group; Late Pliocene).

Etymology: From blunt notches of anterolateral margin.

Diagnosis: Carapace rectangular, 0.7-0.8 times longer than wide; anterolateral margin with 2 blunt notches.

Description: The carapace is transversely rectangular in outline and the length is 0.7-0.8 of the width. The dorsal surface is transversely convex. The regions are poorly defined. The frontal region bears a shallow median depression. The shallow cervical furrow becomes inconspicuous toward margins. The branchiocardiac grooves are distinct. The orbitofrontal margin occupies 0.4 of the carapace width. The narrow frontal margin is composed of two rounded lobes. The small orbit is subcircular in outline. The eye peduncle is short. The strongly arched anterolateral margins are pierced by two blunt notches. The straight posterolateral margins are parallel. The wide posterior margin is gently convex.

Thoracic sterna: The fused 1st to 3rd sternite is broadly triangular in outline. The 4th sternite is slightly longer than wide and separated from the 1st to 3rd sternite by a shallow groove. The well separated last three sternites are much wider than long. The last sternite is narrower and shorter than the 5th and 6th sternites.

Abdomen of male: The 4th, 5th and 6th somites are wider than long and their lateral margins taper anteriorly. The 7th somite is triangular in shape.

Discussion: The present new species is easily distinguished from the living species, *Typhlocarcinus nudus* Stimpson, 1858b from the Indo-West Pacific Ocean by having a narrow carapace and no anterolateral teeth. It is near to *T. villosus* Stimpson, 1858b from the Indo-West Pacific Ocean, but differs in having the carapace of which dorsal surface possesses distinct cervical and branchiocardiac grooves and the anterolateral margin cut into two blunt notches.

Occurrence: KKG-3 (Dainichi Sand, Kakegawa Group).

Geologic range: Late Pliocene.

Subfamily indeterminable

Genus *Collinsius* gen. nov.

Type species: By monotypy *Collinsius simplex* sp. nov.; gender; masculine. *Range*: Early Oligocene.

Etymology: In honour of Dr. J. S. H. Collins of London.

Diagnosis: Carapace rectangular, slightly wider than long, smooth dorsally; front with

weak median notch, narrow, straight, protruded anteriorly; orbital margin with sharp outer angle, bearing triangular tooth in middle; lateral margin tapering anteriorly; chelipeds heterochelate; 3rd to 5th somites of male abdomen fused.

Discussion: The South American Eocene genus *Falconoplax* van Straelen, 1933 (type species; *Falconoplax klugeri* van Straelen, 1933) was originally placed in the family Goneplacidae. Glaessner (1969) transferred the genus from the family Goneplacidae to the family Tymolidae. Tavares (1992) moved it to the family Goneplacidae on the basis of the thoracic sterna. In the general character of the carapace, male abdomen and thoracic sterna, the *Collinsius* gen. nov. is similar to the *Falconoplax*. The *Collinsius* gen. nov. has a protruded narrow front with a weak median notch, while the *Falconoplax* has a broadly triangular front. The dorsal regions of the carapace in the *Falconoplax* are well defined.

Collinsius simplex sp. nov.
(Pl. 21, Figs. 3-8)

Material: MFM218502 (holotype), 218503-218507 (paratypes), 218601-218610, 218612-218630.

Type locality: Loc. KSM-2 (Kishima Formation, Kishima Group; Early Oligocene).

Etymology: From simple carapace.

Diagnosis: as for genus.

Description: The carapace is rectangular in shape and the length is slightly shorter than the width. The finely granulated dorsal surface is transversely convex. The epigastric lobes are poorly defined. The protogastric lobes are shallowly separated from the anterior mesogastric process. The furrow between the gastric and cardiac regions is more deeper on the dorsal surface. The branchiocardiac groove is distinct. The cervical groove becomes obsolete before reaching the anterolateral margin. The branchial region is divided into two by a broad, transverse groove anteriorly and bears a distinct longitudinal ridge along the posterolateral margin. The orbitofrontal margin occupies about half of the width. The narrow, straight front protrudes anteriorly and is interrupted by a weak median notch. The orbital margin bears a broadly triangular tooth on the middle. The short anterolateral margins with a sharp postorbital tooth, are smoothly rounded. The rounded posterolateral margins are slightly divergent posteriorly. The posterior margin is wide.

Thoracic sterna: A shallow groove separates the fused 1st to 3rd sternites which are broadly triangular in outline, from the 4th sternite. The 4th to 8th sternites are wider than long. The 4th sternite is wider than others and the 8th is short.

Abdomen of male: The 3rd to 6th somites remain. The fused 3rd to 5th somites are broad and the lateral margins taper anteriorly. The 6th somite is wider than long and the lateral margins also taper anteriorly.

The chelipeds are strongly heterochelate. The major cheliped has a short dactylus and the propodus with a smooth lateral surface. The minor cheliped has slender fingers as long as the palm.

Occurrence: KSM-2-5 (Kishima Formation, Kishima Group).

Superfamily Majoidea Samouelle, 1819
Family Majidae Samouelle, 1819
Subfamily Inachinae MacLeay, 1838
Genus *Macrocheira* de Haan, 1839

Type species: By monotypy *Maja kaempferi* Temminck, 1836. *Range*: Oligocene to Recent.

Macrocheira sp.
(Pl. 20, Fig. 9)

Material: MFM142165, 142166.
Remarks: The tuberculated large imperfect fingers were obtained.
Occurrence: Loc. MYZ-13 (Takanabe Formation, Miyazaki Group).
Geologic range: Late Pliocene.

Subfamily Pisinae Alcock, 1895
Genus *Hyastenus* White, 1847

Type species: By original designation *Hyastenus sebae* White, 1847. *Range*: Miocene to Recent.

Hyastenus sp.
(Pl. 20, Fig. 4)

Tiarinia ? sp. 1, Karasawa, 1990b, p. 4, pl. 1, fig. 5.
Hyastenus sp., Karasawa, 1991, figs. 2-2, 3.
Material: MFM9463, 9469.
Occurrence: MFM. 07 (Akeyo Formation, Mizunami Group).
Geologic range: early Middle Miocene.

Superfamily Parthenopoidea MacLeay, 1838
Family Parthenopidae MacLeay, 1838
Subfamily Parthenopinae MacLeay, 1838
Genus *Parthenope* Weber, 1795

Type species: By subsequent designation of Rathbun, 1904; *Cancer longimanus* Linnaeus, 1758 (ICZN Opinion 696). *Range*: Eocene to Recent.

Parthenope sp. 1
(Pl. 20, Fig. 1)

Parthenopinae gen. *et* sp. indet., Karasawa, 1990b, p. 5, pl. 1, figs. 1a-c.
Material: MFM9470.
Remarks: This species is placed in the genus *Parthenope* herein.

Occurrence: I-3 (Toyama Formation, Mizunami Group).

Geologic range: Early Miocene.

Parthenope sp. 2

(Pl. 20, Figs. 2, 8)

Parthenope sp., Karasawa & Inoue, 1992, p. 83, pl. 2, figs. 1, 6.

Material: MFM83193, 83194.

Occurrence: KO-5 (Osaki Formation, Kukinaga Group).

Geologic range: Middle Miocene.

Genus *Daira* de Haan, 1833

Type species: By monotypy *Cancer perlatus* Herbst, 1790 (ICZN Opinion 78). *Range*: Eocene to Recent.

Daira perlata (Herbst, 1790)

(Pl. 22, Figs. 12, 13)

Cancer perlatus Herbst, 1790, p. 265, pl. 21, fig. 22.

Daira perlata (Herbst) ; de Haan, 1833, p. 18; Sakai, 1939, p. 457, pl. 89, fig. 5; Rathbun, 1945, p. 379, pl. 59, figs. E-H; Sakai, 1976, p. 521, pl. 187, fig. 4 (including further synonymy).

Material: MFM83250-83254.

Remarks: This species is characterized by having a transversely oval carapace and the dorsal surface densely decorated with coarse conical tubercles. This living species have been also found from the Pleistocene of Fiji (Rathbun, 1945). It is hardly distinguished from the European Miocene species, *Daira speciosa* (Reuss, 1871).

Occurrence: MGM-1 (Megami Limestone).

Geologic range: Miocene to Recent.

Superfamily Leucosioidea Samouelle, 1819

Family Leucosiidae Samouelle, 1819

Genus *Ebalia* Leach, 1817

Type species: By subsequent designation of Rathbun, 1922; *Cancer tuberosus* Pennant, 1777 (ICZN Opinion 73). *Range*: Eocene to Recent.

Ebalia kakegawaensis sp. nov.

(Pl. 22, Figs. 6a, b)

Material: MFM142017 (holotype).

Type locality: Loc. KKG-8 (Ten-no Sand, Kakegawa Group; Late Pliocene).

Etymology: From "Kakegawa", the place name of the fossil occurrence.

Diagnosis: Carapace rhomboidal, slightly wider than long; dorsal surface with high

cardiac and intestinal tubercles; front strongly extended forwards with median sulcus, each lobe strongly convex dorsally; margins finely granulate without tubercles.

Description: The small carapace is rhomboidal in shape and slightly wider than long. The finely granulated dorsal surface is strongly convex. The front with a shallow depression, protrudes anteriorly and is strongly directed dorsally. The groove between the gastrocardiac and branchial regions is deep. The gastrocardiac region is strongly elevated longitudinally and bears conical tubercles on the cardiac region. The strongly convex intestinal region with an upwardly erected median tubercle, is defined by deep grooves. The branchial region is inflated. The frontal margin occupies half of the width and divided into two lobes by a broadly V-shaped median notch. The orbit is small. The anterolateral margins are nearly straight. The finely granulated posterolateral margins are gently convex and slightly longer than the anterolateral margins. The straight posterior margin is finely granulate.

Discussion: The present new species resembles *Ebalia oersi* Müller, 1979 and *'E'. hungarica* Müller, 1974 from the Badenian of Hungary rather than all the living Japanese forms. This species is easily distinguished from them by having high cardiac and intestinal tubercles, and the posterior margin without tubercles.

Occurrence: KKG-8 (Ten-no Sand, Kakegawa Group).

Geologic range: Late Pliocene.

Genus *Randallia* Stimpson, 1858

Type species: By original designation *Ilia ornata* Randall, 1840 (ICZN Opinion 73). *Range*: Miocene ? to Recent.

Randallia saitoensis sp. nov.
(Pl. 22, Fig. 2)

Material: MFM142015 (holotype).

Type locality: Loc. MYZ-7 (Sadohara Formation, Miyazaki Group; Early Pliocene).

Etymology: Referring to the place name of the fossil occurrence.

Diagnosis: Carapace small, subcircular; dorsal surface finely granulate; hepatic facet distinct; small tubercle between anterolateral and posterolateral margins; posterior margin with 3 small tubercles.

Description: The small carapace is subcircular in shape. The strongly convex dorsal surface is finely granulate. The furrow between the gastrocardiac and branchial regions is broad and shallow. The intestinal region is well defined by deep grooves. The finely denticulated hepatic facet slightly protrudes laterally. The subhepatic region is visible on dorsal view. The pterygostomian margin is finely dentate. The orbitofrontal margin is narrow. There is a small tubercle at the junction between the anterolateral and posterolateral margins. The posterior margin bears three small tubercles.

Discussion: The present new species is near to the living, *Randallia eburna* Alcock, 1896 from the Indo-West Pacific Ocean, but it is different in having the well defined intestinal

region and hepatic facets, and the posterior margin with small tubercles.

Occurrence: MYZ-7 (Sadohara Formation, Miyazaki Group).

Geologic range: Early Pliocene.

Pariphiculus Alcock, 1896

Type species: By subsequent designation of Rathbun, 1922; *Randallia coronata* Alcock & Anderson, 1894 (ICZN Opinion 73). *Range*: Miocene to Recent.

Pariphiculus inconditus sp. nov.
(Pl. 3, Fig. 2)

Material: MFM142014 (holotype).

Type locality: Loc. MYZ-7 (Sadohara Formation, Miyazaki Group; Early Pliocene).

Etymology: From margins without spines.

Diagnosis: *Pariphiculus* with anterolateral and posterolateral margins without spines or tubercles.

Description: The carapace is subcircular in outline. The finely granulated dorsal surface is strongly convex. The regions are not defined except for intestinal lobe distinctly isolated by deep grooves. The narrow orbitofrontal margin occupies 0.4 of the width. The produced front is bilobed and cut into a deep V-shaped median notch. The small orbit bears two deep fissures on the upper orbital margin. The anterolateral and posterolateral margins without spines, are strongly arched.

Discussion: The present new species is allied to the Pliocene, *Pariphiculus gselli beeti* Morris & Collins, 1991, of Brunei, but it is easily distinguished from *P. gselli beeti* by having the anterolateral and posterolateral margins without spines or tubercles.

Occurrence: MYZ-7 (Sadohara Formation, Miyazaki Group).

Geologic range: Early Pliocene.

Genus *Philyra* Leach, 1817

Type species: By subsequent designation of H. Milne Edwards, 1837; *Cancer globus* Fabricius, 1775 (ICZN Opinion 712). *Range*: Miocene to Recent.

Philyra hayasakai Karasawa & Inoue, 1992
(Pl. 22, Fig. 3)

Philyra hayasakai Karasawa & Inoue, 1992, p. 86, pl. 3, figs. 3, 4.

Material: MFM83005, 83006, 83115-83117.

Occurrence: KK-1, 5 (Kawachi Formation, Kukinaga Group).

Geologic range: early Middle Miocene.

Philyra nishimotoi Karasawa, 1989
(Pl. 22, Figs. 8, 11)

Philyra nishimotoi Karasawa, 1989, p. 18, pl. 3, figs. 5, 6, 9.

Material: MFM9008-9011, 9413-9457.

Occurrence: MFM. 22, 40, 45, 79 (Akeyo Formation, Mizunami Group) ; I-2 (Toyama Formation, Mizunami Group).

Geologic range: Early Miocene.

Philyra platychira de Haan, 1841
(Pl. 22, Figs. 4, 6, 9)

Philyra platychira de Haan, 1841, p. 132, pl. 33, fig. 6.

Material: MFM142142-142147.

Occurrence: KKG-1, 2 (Dainichi Sand, Kakegawa Group).

Geologic range: Late Pliocene to Recent.

Philyra plana Karasawa, 1989
(Pl. 22, Fig. 1)

Philyra plana Karasawa, 1989, p. 20, pl. 3, figs. 2, 3.

Material: MFM9011, 9012, 9391-9399.

Occurrence: MFM. 07, 58 (Akeyo Formation, Mizunami Group) ; MFM. 62 (Oidawara Formation, Mizunami Group).

Geologic range: early Middle Miocene.

Philyra tanakai sp. nov.
(Pl. 22, Fig. 10)

Material: MFM142001 (holotype).

Type locality: KKG-1 (Dainichi Sand, Kakegawa Group; Late Pliocene).

Etymology: In honour of Dr. Toshio Tanaka of Aichi-gakuin Junior College.

Diagnosis: Carapace subcircular; dorsal surface strongly convex; subhepatic facets well marked; margins of carapace bearing 13 distinct granules.

Description: The large carapace is subcircular in outline. The anterior part is missing. The dorsal surface is strongly swollen and the regions are poorly defined. The smooth gastric and cardiac regions are more convex and shallowly separated from the branchial region. The inflated intestinal region is also shallowly separated from the cardiac region, whereas it is separated from the branchial region by a deep, broad groove. The strongly convex hepatic regions are well defined and densely decorated with fine granules. The subhepatic facets are also well defined and the margins are finely denticulate. The branchial regions are also convex and sparsely covered with fine granules. Gently arched anterolateral and posterolateral margins are finely granulate. The posterior margin is nearly straight. There are thirteen distinct granules on the margin; one on the anterolateral margin behind the hepatic region, one on the end of anterolateral margin, three on the

posterolateral margin, and three on the posterior margin.

Discussion: The present new species is similar to the living, *Philyra heterograna* Ortmann, 1892 from the Northwest Pacific Ocean, but differs in having well marked subhepatic facets, and no median tubercles on the gastrocardiac regions.

Occurrence: KKG-1 (Dainichi Sand, Kakegawa Group).

Geologic range: Late Pliocene.

Philyra tridentata sp. nov.
(Pl. 22, Fig. 7)

Material: MFM142018 (holotype).

Type locality: Loc. KKG-2 (Dainichi Sand, Kakegawa Group; Late Pliocene).

Etymology: Referring to the posterolateral margin with 3 teeth.

Diagnosis: Carapace rhomboidal, slightly longer than wide; dorsal surface with strong median carina, densely granulate; posterolateral margin with 3 small teeth.

Description: The small carapace is rhomboidal in outline and the length is slightly longer than wide. The strongly convex dorsal surface is densely decorated with granules. A deep groove separates the more convex gastrocardiac region with a strong median ridge, from the branchial region. The intestinal region with a median ridge, is longitudinally vaulted and well defined. The inflated hepatic regions are also well defined. The branchial regions become tumid surrounding the cardiac and intestinal regions. The orbitofrontal region is missing. The nearly straight anterolateral margins are finely granulate. Gently convex posterolateral margins are longer than the anterolateral margins and fringed with three small teeth.

Discussion: Deep sculptures of the dorsal surface with a strong median carina, and the posterolateral margin with three teeth readily distinguish the present new species from *Philyra granulosa* Morris & Collins, 1991 from the Pliocene of Brunei and *P. tanakai* sp. nov. from the Pliocene Kakegawa Group. *P. tridentata* sp. nov. is closely related to the living, *P. carinata* Bell, 1855 from the Northwest Pacific Ocean, but differs in having the dorsal surface with a strong median carina, well defined hepatic regions and three posterolateral teeth.

Occurrence: KKG-2 (Dainichi Sand, Kakegawa Group).

Geologic range: Late Pliocene.

Genus *Leucosia* Weber, 1795

Type species: By subsequent designation of Holthuis, 1959; *Cancer craniolaris* Linnaeus, 1758 (ICZN Opinion 712). *Range*: Miocene to Recent.

Leucosia takamii sp. nov.
(Pl. 23, Figs. 12a, b)

Material: MFM142016 (holotype).

Type locality: Loc. KKG-5 (Soga Formation, Kakegawa Group; Early Pleistocene).

Etymology: In honour of Dr. Takami Nobuhara of Nagoya University.

Diagnosis: Carapace rhomboidal, slightly longer than wide; anterior edge of thoracic sinous simple, shallowly invaginated forward; lower edge with 4 large pearly granules.

Description: The carapace is rhomboidal in outline and slightly longer than wide. The smooth dorsal surface is strongly convex. The narrow front protrudes anteriorly. The finely granulated anterolateral margins are slightly convex at the hepatic regions and the lateral angles are rounded. Gently arched posterolateral margins are also finely granulate and longer than the anterolateral margins. The finely granulated posterior margin occupies about 0.4 of the width. The simple anterior edge of the thoracic sinous is shallowly invaginated forward. The lower edge of the sinous is defined by four large pearly granules.

Discussion: The present new species resembles the Pliocene, *Leucosia longiangulata* Morris & Collins, 1991 from Brunei, but differs in having a rounded lateral corner of the posterior margin. This species is near to the living, *L. formosensis* Sakai, 1937 from Taiwan, but different in a rhomboidal carapace and the thoracic sinus of which anterior edge is shallowly invaginated forward. The lower edge of the thoracic sinus of *L. takamii* sp. nov. bears four large pearly granules, while that of *L. formosensis* does four large and two pearl-like smaller granules.

Occurrence: KKG-3 (Dainichi Sand, Kakegawa Group) ; KKG-5 (Soga Formation, Kakegawa Group).

Geologic range; Late Pliocene to Early Pleistocene.

Leucosia sp. 1
(Pl. 23, Fig. 7)

Material: Umemoto collection.

Remarks: This imperfect carapace is not determined at the species level because the details of the thoracic sinous are not preserved.

Occurrence: KKG-2 (Dainichi Sand, Kakegawa Group).

Geologic range: Late Pliocene.

Leucosia sp. 2
(Pl. 23, Fig. 10)

Material: MFM14157.

Remarks: Specimens is characterized by having the coarsely granulated margins of the merus.

Occurrence: KKG-1 (Dainichi Sand, Kakegawa Group).

Geologic range: Late Pliocene.

Section Thoracotremata Guinot, 1977
Superfamily Grapsoidea MacLeay, 1838

Family Grapsidae MacLeay, 1838

Subfamily Varuninae H. Milne Edwards, 1852

Genus *Varuna* H. Milne Edwards, 1834

Type species: By monotypy *Cancer litteratus* Fabricius, 1798. *Range*: Eocene to Recent.

Varuna angustifrons sp. nov.

(Pl. 23, Fig. 13)

Material: MFM218501 (holotype).

Type locality: Loc. KSM-2 (Kishima Formation, Kishima Group; Early Oligocene).

Etymology: Referring to a narrow frontal margin.

Diagnosis: *Varuna* with narrow frontal margin, wide orbital margin and four transverse ridges running on dorsal surface.

Description: The carapace is roundly quadrate in outline and about as long as wide. The dorsal surface is gently swollen. The furrow between the meso- and protogastric regions is indistinct. There is a weak epigastric ridge and a transverse protogastric ridge interrupted by the narrow anterior mesogastric process. The cervical groove is broad. The vaulted cardiac region is rhomboidal in outline and bears a transverse ridge which is divided into two by a shallow median groove. A strong transverse ridge runs from the last anterolateral tooth to the gastric region on the branchial region. The straight frontal margin is 0.3 of the width. The finely denticulated orbital margin is concave and 0.4 as long as the width. Gently convex anterolateral margins bear three teeth including the postorbital tooth. The posterolateral margins are convergent posteriorly.

Discussion: The present new species is easily distinguished from the living, *Varuna litterata* (Fabricius, 1798) from the Indo-West Pacific Ocean by having a small carapace, a narrow frontal margin and a wide orbital margin.

Occurrence: KSM-2 (Kishima Formation, Kishima Group).

Geologic range: Early Oligocene.

Subfamily Sesarminae Dana, 1851

Genus *Sesarma* Say, 1817

Type species: By monotypy *Ocypode reticulatus* Say, 1817. *Range*: Miocene to Recent.

Sesarma ? sp.

(Pl. 23, Fig. 6)

Material: Nishikawa coll.

Remarks: Species is only represented by a broken large carapace.

Occurrence: BIH-2 (Bihoku Group).

Geologic range: early Middle Miocene.

Genus *Cyclograpsus* H. Milne Edwards, 1837

Type species: By subsequent designation of Rathbun, 1918, *Cyclograpsus punctatus* H. Milne Edwards, 1837. *Range*: Miocene to Recent.

Cyclograpsus directus Karasawa, 1989
(Pl. 23, Fig. 1)

Cyclograpsus directus Karasawa, 1989, p. 22, pl. 3, fig. 15.

Material: MFM9021.

Occurrence: MFM. 27 (Akeyo Formation, Mizunami Group).

Geologic range: Early Miocene.

Cyclograpsus rectangularis Karasawa, 1989
(Pl. 23, Figs. 8, 11)

Cyclograpsus rectangularis Karasawa, 1989, p. 21, pl. 3, figs. 14, 16.

Material: MFM9019, 9020.

Occurrence: MFM. 07 (Akeyo Formation, Mizunami Group).

Geologic range: early Middle Miocene.

Genus *Miosesarma* Karasawa, 1989

Type species: By monotypy *Miosesarma japonica* Karasawa, 1989. *Range*: Early to early Middle Miocene.

Miosesarma japonicum Karasawa, 1989
(Pl. 23, Figs. 3, 4, 8; Pl. 24, Fig. 10)

Miosesarma japonica Karasawa, 1989, p. 24, pl. 3, figs. 10-13.

Material: MFM9015-9018, 9620-9689, 39114, 39121.

Occurrence: MFM. 25, 32, 36, 46, 49, 50 (Akeyo Formation, Mizunami Group) ; I-2 (Toyama Formation, Mizunami Group) ; YTO-1 (Higashibessho Formation, Yatsuo Group) ; YTO-2 (Kurosedani Formation, Yatsuo Group) ; BIH-1 (Bihoku Group) ; KTT-2, 3 (Yoshino Formation, Katsuta Group) ; MSD-1 (Toyoda Formation, Masuda Group).

Geologic range: Early to early Middle Miocene.

Genus *Halice* de Haan, 1835

Type species: By monotypy *Ocypode* (*Halice*) *tridens* de Haan, 1835. *Range*: Miocene to Recent.

Halice sp.
(Pl. 23, Fig. 5)

Halice sp., Karasawa & Inoue, 1992, p. 87, pl. 3, figs. 1, 2.

Material: MFM83195, 83196.

Occurrence: KK-5 (Kawachi Formation, Kukinaga Group).

Geologic range: Middle Miocene.

Superfamily Pinnotheroidea de Haan, 1833

Subfamily Asthengnacthinae Stimpson, 1858

Genus *Tritodynamia* Ortmann, 1894

Type species: By monotypy *Tritodynamia japonica* Ortmann, 1894. *Range*: Miocene to Recent.

Tritodynamia globosa Karasawa, 1990b

(Pl. 24, Figs. 3, 8)

Tritodynamia globosa Karasawa, 1990b, p. 30, pl. 8, figs. 12a-c, 15; Sakumoto *et al.*, p. 452, pl. 63, figs. 12, 15.

Material: MFM9033, 9034, 9461.

Occurrence: MFM. 45, 46 (Akeyo Formation, Mizunami Group) ; YTO-1 (Higashibessho Formation, Yatsuo Group) ; IZM-9 (Fujina Formation, Izumo Group).

Geologic range: Early to Middle Miocene.

Superfamily Ocypodoidea Rafinesque, 1815

Family Ocypodidae Rafinesque, 1815

Subfamily Macrophthalminae Dana, 1852

Genus *Macrophthalmus* Latreille, in Desmarest 1823

Type species: By subsequent designation of H. Milne Edwards, 1841; *Goneplax transversus* Latreille, 1817. *Range*: Miocene to Recent.

Subgenus *Mareotis* Barnes, 1967

Type species: By original designation *Macrophthalmus japonicus* (de Haan, 1835). *Range*: Miocene to Recent.

Macrophthalmus (*Mareotis*) *japonicus* (de Haan, 1835)

(Pl. 24, Figs. 5, 6, 11)

Ocypode japonica de Haan, 1835, p. 54, pl. 7, fig. 1; pl. 15, fig. 2.

Macrophthalmus japonicus (de Haan) ; Gray, 1847, p. 38; Barnes, 1968, p. 224, pl. 2 (D), fig. 8. (including further synonymy)

Material: MFM142125-142135.

Occurrence: FRY-1 (Furuya Formation).

Geologic range: Middle Pleistocene to Recent.

Macrophthalmus (*Mareotis*) *viai* Karasawa & Inoue, 1992
(Pl. 24, Figs. 4, 7, 11)

Macrophthalmus (*Mareotis*) *viai* Karasawa & Inoue, 1992, p. 88, pl. 3, figs. 5-10.

Material: MFM83001-83004, 83101-83114, 83190.

Occurrence: KK-1, 2 (Kawachi Formation, Kukinaga Group) ; KO-8 (Osaki Formation, Kukinaga Group).

Geologic range: Middle Miocene.

Subgenus *Euplax* H. Milne Edwards, 1852

Type species: By subsequent designation of Barnes, 1966; *Euplax leptophthalmus* H. Milne Edwards, 1852. *Range*: Miocene? to Recent.

Macrophthalmus (*Euplax*) *leptophthalmus* (H. Milne Edwards, 1852)
(Pl. 24, Figs. 1, 2, 12)

Euplax leptophthalmus H. Milne Edwards, 1852, p. 160.

Macrophthalmus guamnensis Kesling, 1958, p. 225, pl. 3, figs. 9, 10; pl. 8, fig. 3; pl. 10, figs. 10-13; pl. 11, figs. 4-8; pl. 12, fig. 18.

Macrophthalmus leptophthalmus (H. Milne Edwards) : Barnes, 1966, p. 370, pl. 14, figs. 3, 4; Barnes, 1968, p. 204; Barnes, 1977, p. 268, figs. 1a, b.

Macrophthalmus (*Euplax*) *leptophthalmus* (H. Milne Edwards) : Morris & Collins, 1991, p. 32.

Material: MFM142123, 142124.

Occurrence: NKJ-1 (Nakoji Sand).

Geologic range: Early Pleistocene to Recent.

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Explanation of Plate

Plate 1

Fig. 1. *Thalassina anomala* (Herbst). MFM83101, Loc. BIH-2, × 1.0, dorsal view of carapace.

Figs. 2-5. *Laurentiella imaizumii* sp. nov.

Fig. 2. MFM39004 (paratype), Loc. MSD-1, chelipeds, × 2.0.

Fig. 3. MFM39005 (paratype), × 2.3, mesial view of propodus and dactylus of cheliped.

Fig. 4. MFM39006 (paratype), × 3.2, lateral view of propodus of cheliped.

Fig. 5. MFM39117, Loc. KTT-2, chelipeds, × 2.0.

Fig. 6. *Laomedia praeastacina* Karasawa, MFM9003 (holotype), Loc. MFM. 32, chelipeds and pereiopods, × 1.5.


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Plate 2

Figs. 1, 4, 5. *Upogebia mizunamiensis* Karasawa, Loc. MFM. 32.
Figs. 1a, b, 4a, b. MFM9006 (paratype), × 3.4, a, lateral; b, mesial view.
Figs. 5a, b. MFM9005 (holotype), × 3.4, a, dorsal; b, lateral view.

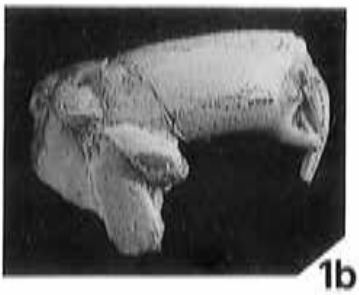
Fig. 2. *Upogebia tanegashimensis* Karasawa & Inoue, MFM83014 (paratype), Loc. KK-5, × 4.5, dorsal view of telson and uropod.

Fig. 3. *Upogebia* sp., MFM9309, Loc. I-2, 1st pereiopods, × 1.5.

Fig. 6. *Laurentiella imaizumii* sp. nov. MFM39003 (holotype), Loc. MSD-1, chelipeds, × 2.0.

Fig. 7. *Thalassina anomala* (Herbst), MFM83147, Loc. KK-4, × 1.2, lateral view of right propodus of cheliped.


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1b

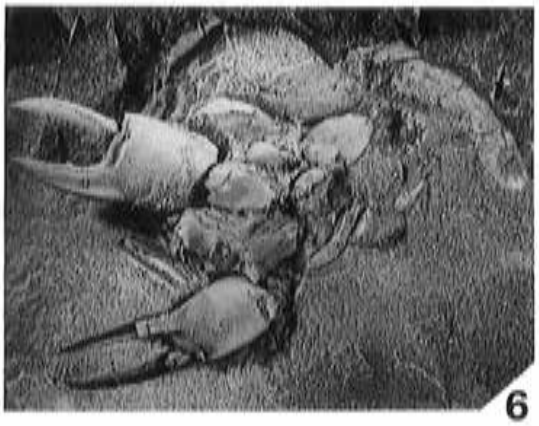

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4b


5a


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Plate 3

Fig. 1. *Upogebia tanegashimensis* Karasawa & Inoue. MFM83011 (holotype), Loc. KK-5, × 4.5, mesial view of propodus of 1st pereiopod.

Figs. 2, 3. *Callianassa yatsuoensis* sp. nov., Loc. YTO-2.

Fig. 2. MFM83055 (holotype), × 4.5, lateral view of propodus of major cheliped.

Fig. 3. MFM83057 (paratype), × 2.8, lateral view of carpus of major cheliped.

Figs. 4-9. *Callianassa nishikawai* sp. nov. Loc. MSD-1.

Figs. 4a-c. MFM83008 (paratype), dactylus of major cheliped, × 3.7, a, dorsal; b, mesial; c, ventral view.

Fig. 5. MFM83012 (paratype), × 1.5, major and minor chelipeds.

Figs. 6a, b. MFM83009 (paratype), × 1.8, propodus of major cheliped, a, lateral; b, mesial view.

Fig. 7. MFM83007 (holotype), × 1.5, mesial view of major cheliped.

Fig. 8. MFM83010 (paratype), × 1.5, lateral view of major cheliped.

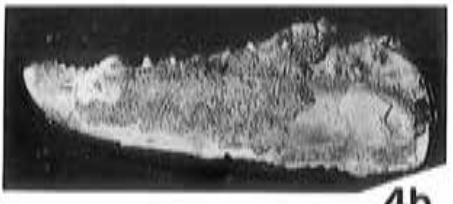
Fig. 9. MFM83011 (paratype), × 1.5, lateral view of major cheliped.


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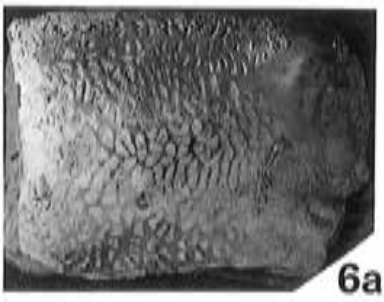

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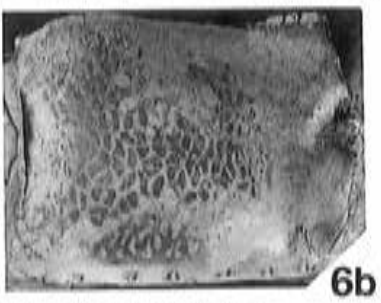

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Plate 4

Figs. 1, 2. *Trypaea mizunamiensis* sp. nov., Loc. MFM. 48, × 1.5.

Fig. 1. MFM9301 (paratype), lateral view of major cheliped.

Fig. 2. MFM9303 (holotype), lateral view of major cheliped.

Fig. 3. *Callianassa* sp., MFM218611, Loc. KSM-4, × 2.2, mesial view of major cheliped.

Figs. 4, 5. *Calliax bona* (Imaizumi), Loc. MFM. 40, × 1.2.

Fig. 4. MFM9101, lateral view of major cheliped.

Fig. 5. MFM9102, lateral view of major cheliped.

Figs. 6, 7, 9, 11. *Eucalliax yoshihiroi* Karasawa, Loc. MND-1.

Fig. 6. KMNH IvP 300,005 (paratype), × 2.3, dorsal view of six abdominal segment.

Fig. 7. KMNH IvP 300,002 (paratype), × 1.0, mesial view of right propodus of cheliped.

Fig. 9. KMNH IvP 300,007 (paratype), × 1.5, lateral view of right propodus of cheliped.

Fig. 11. KMNH IvP 300,001 (holotype), × 1.5, right and left propodus of chelipeds.

Figs. 8, 10. *Calliax okamotoi* sp. nov., Loc. HOK-1.

Fig. 8. MFM218509 (holotype), × 1.2, lateral view of major cheliped.

Fig. 10. MFM218507 (paratype), × 1.2, lateral view of major cheliped.

Fig. 12. *Eucalliax miyazakiensis* sp. nov., MFM142007 (holotype), Loc. MYZ-10, major and minor chelipeds, × 2.0.


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Plate 5

Figs. 1, 3, 4. *Callianopsis titaensis* (Nagao), Loc. MRZ-1.
Fig. 1. MFM39130, × 1.2, lateral view.
Fig. 3. MFM39127, × 1.8, lateral view of minor cheliped.
Fig. 4. MFM39128, × 2.0, dorsal view of carapace.
Figs. 2, 7. "*Dardanus*" *muelleri* Karasawa & Inoue, Loc. KO-5, × 2.2.
Fig. 2. MFM83016 (paratype), mesial view of minor cheliped.
Fig. 7. MFM83015 (holotype), lateral view of major cheliped.
Figs. 5, 6, 9. *Munida nishioi* sp. nov., Loc. YTO-1.
Fig. 5. MFM83054 (holotype), × 2.4, dorsal view of plaster cast of carapace.
Fig. 6. Nishio Coll., × 1.5, lateral view of cheliped.
Fig. 9. Nishio Coll., × 2.4, dorsal view of carapace.
Fig. 8. *Pagurus* sp., MFM142163, Loc. KKG-4, × 1.4, lateral view of cheliped.
Fig. 10. *Linuparus* sp. aff. *L. trigonus* (von Siebold), MFM83303, Loc. MYZ-4, × 0.7, dorsal view of carapace.


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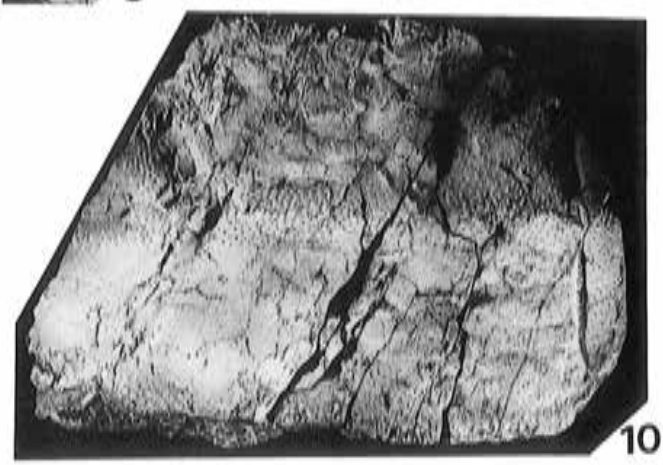

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Plate 6

Figs. 1-3, 10. *Galathea keijii* sp. nov., Loc. MGM-1, dorsal view of carapace.
Fig. 1. MFM83036 (holotype), × 6.4.
Fig. 2. MFM83039 (paratype), × 6.2.
Fig. 3. MFM83037 (paratype), × 4.2.
Fig. 10. MFM83038 (paratype), × 3.5.

Fig. 4. *Tymolus uncifer* (Ortmann), Umemoto coll., Loc. KKG-12, × 6.5, dorsal view of carapace.

Figs. 5, 7-9, 13. *Petrolisthes miocaenicus* sp. nov., Loc. MGM-1.
Fig. 5. MFM83022 (paratype), × 3.9, dorsal view of carapace.
Fig. 7. MFM83021 (holotype), × 4.0, dorsal view of carapace.
Fig. 8. MFM83024 (paratype), × 4.0, lateral view of propodus of cheliped.
Fig. 9. MFM83023 (paratype), × 3.8, mesial view of propodus and dactylus of cheliped.
Fig. 13. MFM83025 (paratype), × 3.2, lateral view of merus of cheliped.

Fig. 6. *Tymolus* sp., MFM142162, Loc. MYZ-7, × 6.5, dorsal view of carapace.

Fig. 11. *Petrolisthes* sp., MFM9600, Loc. MFM. 07, × 3.4, mesial view of propodus of cheliped.

Figs. 12, 14-16. *Dynomene shinobui* sp. nov., Loc. MGM-1, dorsal view of carapace.
Fig. 12. MFM83025 (paratype), × 9.7.
Fig. 14. MFM83263, × 4.4.
Fig. 15. MFM83033 (holotype), × 4.3.
Fig. 16. MFM83034 (paratype), × 4.8.


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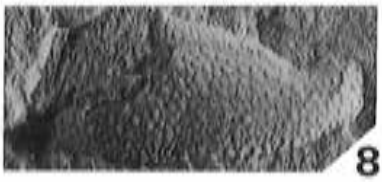

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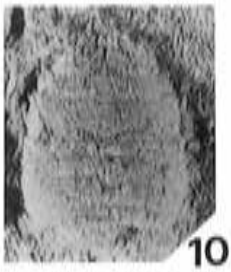

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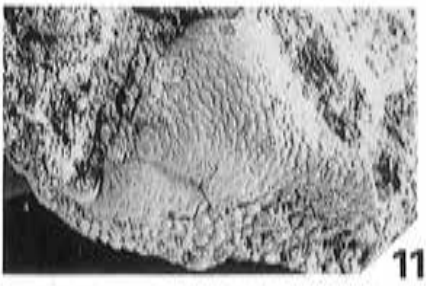

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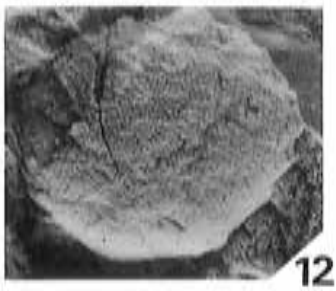

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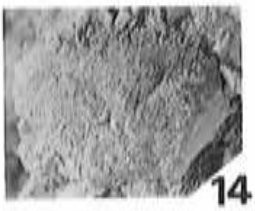

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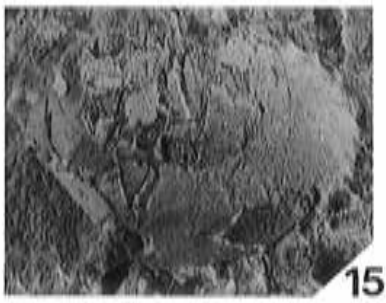

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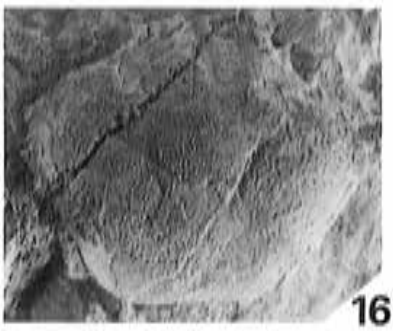

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Plate 7

Fig. 1, 2, 5. *Raninoides nodai* Karasawa, Loc. MND-1.
Fig. 1. Noda coll., × 2.0, dorsal view of carapace.
Fig. 2. KMNH IvP 300,011 (holotype), × 2.0, dorsal view of carapace.
Fig. 5. KMNH IvP 300,011 (holotype), × 2.2, lateral view of cheliped.
Figs. 3, 11. *Prohomola japonica* (Yokoyama, 1911), Loc. MND-1.
Fig. 3. Noda coll., × 2.8, dorsal view of carapace.
Fig. 11. KMNH IvP 300,010, × 3.2, dorsal view of carapace.
Figs. 7, 8. *Tymolus ingens* Takeda & Tomida, dorsal view of carapace.
Fig. 7. MFM9402, Loc. MFM. 45, × 3.7.
Fig. 8. MFM9001 (holotype), Loc. MFM. 45, × 1.4.
Figs. 9, 10. *Tymolus itoigawai* Takeda & Tomida, Loc. MFM. 07. × 2.8, dorsal view of carapace.
Fig. 9. MFM9002 (holotype).
Fig. 10. MFM9406.
Fig. 4. *Lyreidus* sp., MFM142150, Loc. MYZ-7, × 1.6, dorsal view of carapace.
Fig. 6. *Calappa* sp. 3, MFM142169, Loc. KKG-11, × 3.4, lateral view of dactylus of cheliped.


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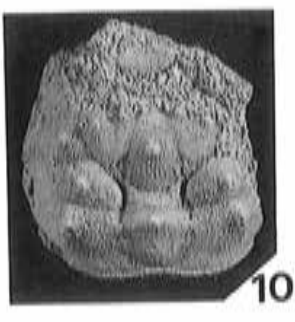

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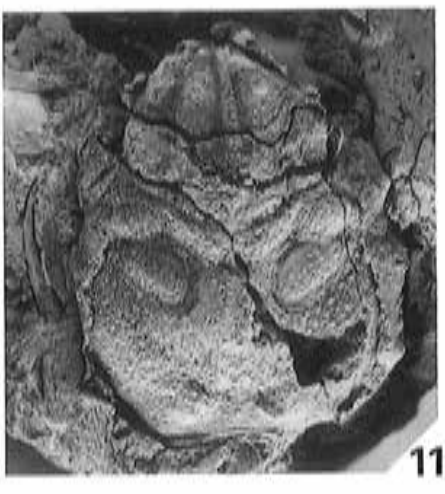

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Plate 8

Fig. 1. *Mursia* sp., MFM142157, Loc. KKG-1, × 3.5, mesial view of dactylus.

Fig. 2. *Calappa* sp. 1, MFM9605, Loc. MFM. 58, × 4.0, lateral view of dactylus of right cheliped.

Figs. 3, 5. *Padocatactes ujiharai* sp. nov., Loc. MYZ-11, dorsal view of carapace.

Fig. 3. MFM142005 (holotype), × 1.7.

Fig. 5. MFM142006 (paratype), × 3.4.

Fig. 4. *Mursia takahashii* Imaizumi. Miyamoto coll., Loc. IZM-7, × 2.8, dorsal view of carapace.

Fig. 6. *Mursia* sp. 1, MFM83173, Loc. KO-4, × 1.4, lateral view of propodus of cheliped.

Fig. 7. *Calappa* sp. 2, MFM83211, Loc. MYZ-2, × 2.0, mesial view of dactylus.

Fig. 8. *Mursia* sp. aff. *M. armata* de Haan, MFM142156, Loc. KKG-4, × 2.0, dorsal view of carapace.

Figs. 9, 10, 13, 14. *Mursia minuta* sp. nov., Loc. MYZ-7, dorsal view of carapace.

Fig. 9. MFM142149-2, × 2.8.

Fig. 10. MFM142149-1, × 2.8.

Fig. 13. MFM142004 (paratype), × 3.3.

Fig. 14. MFM142003 (holotype), × 3.4.

Fig. 11. *Paramursia circularis* Karasawa, MFM9013 (holotype), Loc. MFM. 07, × 2.8, dorsal view of carapace.

Fig. 12. *Ethusa chibai* sp. nov., MFM142002 (holotype), Loc. TMR-1, × 3.4, dorsal view of carapace.


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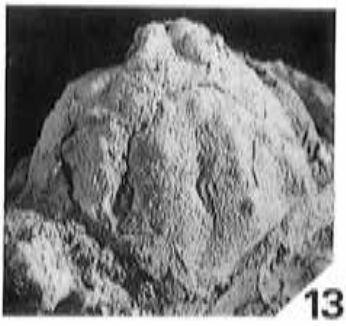

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Plate 9

Fig. 1. *Padocatactes hamifer* Ortmann, MFM142151, Loc. KKG-5, × 2.2, dorsal view of carapace.

Figs. 2, 3. *Cancer* (*Glebocarcinus*) *amphioetus* Rathbun, Loc. KKG-1.

Fig. 2. MFM142154, × 2.0, mesial view of dactylus.

Fig. 3. MFM142153, × 2.0, lateral view of fixed finger.

Figs. 4-6. *Platepistoma kaedei* (Karasawa),

Fig. 4. MFM9028 (paratype), Loc. MFM. 54, × 2.0, dorsal view of carapace.

Fig. 5. MFM83204, Loc. YTO-2, × 2.2, dorsal view of carapace.

Fig. 6. MFM9028 (paratype), Loc. MFM. 54, × 3.5, cheliped, a, lateral; b, dorsal view.

Figs. 7-10. *Trachycarcinus huziokai* Imaizumi.

Fig. 7. MFM83247, Loc. YTO-1, × 1.2, dorsal view of carapace.

Fig. 8. Mizuno coll., × 1.4, Loc. ICS-1, dorsal view of carapace.

Fig. 9. MFM39124, × 1.4, Loc. ICS-1, lateral view of cheliped.

Fig. 10. MFM39124, × 1.2, Loc. ICS-1, dorsal view of carapace.

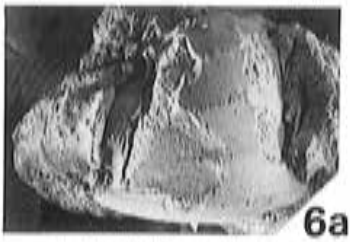

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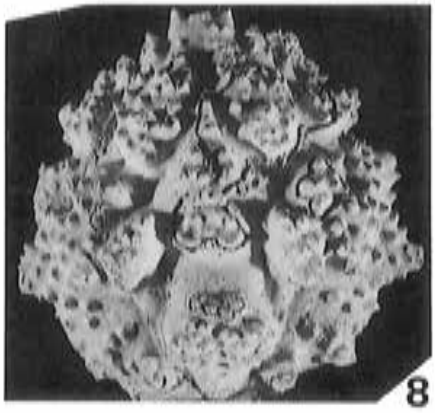

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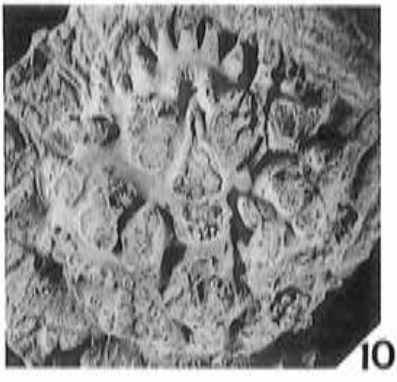

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Plate 10

Fig. 1. *Cancer* (*Cancer*) *japonicus* Ortmann, MFM142122, Loc. ONM-1, × 1.4. lateral view of cheliped.

Fig. 2. *Cancer* (*Cancer*) *fujinaensis* Sakumoto, Karasawa & Takayasu, T. 3133 (holotype), Loc. IZM-4, dorsal view of carapace.

Fig. 3. *Cancer* (*Glebocarcinus*) *itoigawai* Karasawa, MFM9025 (holotype), Loc. MFM. 45, dorsal view of carapace.

Fig. 4. *Cancer* (*Metacarcinus*) *izumoensis* Sakumoto, Karasawa & Takayasu, T. 3130 (paratype), Loc. IZM-5, × 0.7, dorsal view of carapace.

Fig. 5. *Cancer* sp., MFM9375, Loc. MFM. 07, × 1.5, lateral view of propodus of cheliped.

Fig. 6. *Cancer* (*Romaleon*) *sanbonsugii* Imaizumi, MFM83202, Loc. YTO-1, × 1.8, dorsal view of carapace.

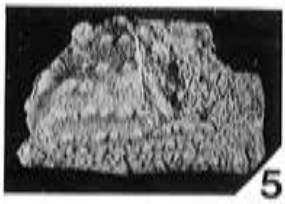
Figs 7a, b. *Cancer* (*Cancer*) *tomowoi* Karasawa, MFM9022 (holotype), Loc. I-3, × 1.5, a, lateral; b, mesial view.


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Plate 11

Figs. 1-3. *Imaizumila sexdentata* gen. *et* sp. nov. Loc. KSM-1.

Fig. 1. MFM218507 (holotype), × 3.0, orbitofrontal region of carapace.

Figs 2a, b. MFM21808 (paratype), × 2.4, a, dorsal; b, lateral view of cheliped.

Fig. 3. MFM218507 (holotype), × 1.2, dorsal view of carapace.

Figs. 4, 8. *Itoigawaia minoensis* (Karasawa).

Fig. 8. Miyamoto coll., × 2.0, Loc. IZM-4, dorsal view of carapace.

Fig. 4. Miyamoto coll., × 2.8, lateral view of right cheliped.

Fig. 5. *Parathranites shibatai* Karasawa, MFM9032 (holotype), Loc. MFM. 45, × 1.5, carapace and cheliped.

Fig. 6. *Itoigawaia umemotoi* sp. nov., MFM9039 (holotype), Loc. MFM. 46, × 1.2, dorsal view.

Fig. 7. *Portunites kattachiensis* Karasawa, Loc. MND-1, holotype (KMNH IvP 300, 016), × 2.8, dorsal view of carapace.


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Plate 12

Figs. 1, 3a, b. *Scylla ozawai* Glaessner.

Fig. 1. MFM83168, Loc. KK-4, × 1.2, lateral view of cheliped.

Figs 3a, b. MFM9388, Loc. MFM. 58, × 1.0, a, dorsal; b, ventral view.

Fig. 2. *Thalamita* sp., MFM142121, Loc. SMJ-1, × 1.4, dorsal view of carapace.


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3a


3b

Plate 13

Figs. 1, 2. *Scylla serrata* (Forskål), Loc. SMJ-1.

Fig. 1. MFM142120, × 1.4, lateral view of fixed finger.

Fig. 2. MFM142119, × 1.4, lateral view of dactylus.

Figs. 3a, b. *Charybdis* (*Minohellenus*) *quinquedentata* Karasawa, × 1.2, Loc. MFM. 45, MFM9032 (holotype), a, dorsal; b, ventral view.

Figs. 4-7. *Lupocyclus tuberculosus* sp. nov., Loc. MYZ-7, dorsal view of carapace.

Fig. 4. MFM142011 (holotype), × 6.0.

Fig. 5. MFM142012 (paratype), × 6.0.

Fig. 6. MFM142013 (paratype), × 6.0.

Fig. 7. MFM142161-1, × 6.0.

Figs. 8, 9. *Charybdis* sp. 2, Loc. KKG-11.

Fig. 8. MFM142168, dactylus, × 3.7, lateral view.

Fig. 9. MFM142167, fixed finger, × 3.7, mesial view.

Fig. 10. *Scylla* sp., MFM9350, Loc. MFM. 55. × 0.5, dorsal view of carapace.


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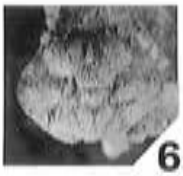

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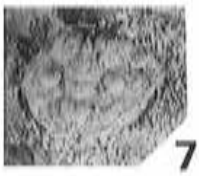

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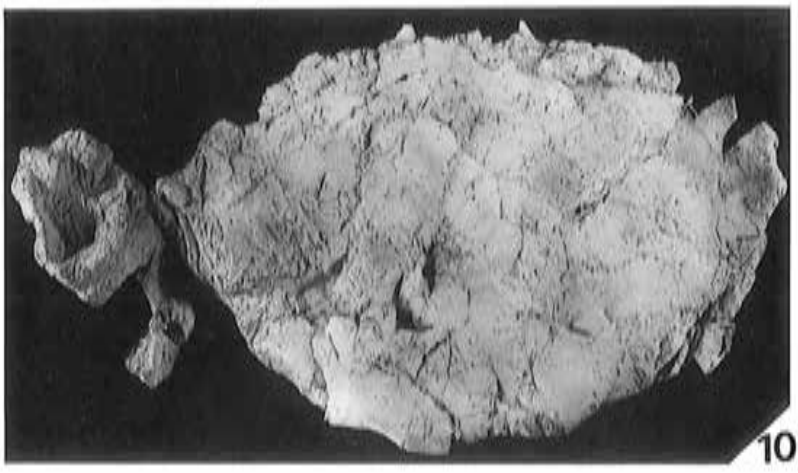

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Plate 14

Fig. 1. *Scylla* sp., MFM9350, Loc. MFM. 55, × 1.0, lateral view of cheliped.

Fig. 2. *Liomera* sp., MFM83282, Loc. MGM-1, × 1.5, dorsal view of carapace.

Figs. 3a–c. *Charybdis* (*Minohellenus*) *quinquedentata* Karasawa, × 1.2, Loc. MFM. 45, MFM9031 (paratype), a, frontal; b, dorsal; c, ventral view.


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Plate 15

Figs. 1, 2, 4, 11. *Medaeops megamiensis* sp. nov., Loc. MGM-1, dorsal view of carapace.
Fig. 1. MFM83041 (paratype), × 3.5.
Fig. 2. MFM83043 (paratype), × 3.7.
Fig. 4. MFM83040 (holotype), × 3.8.
Fig. 11. MFM83271, × 2.2.

Fig. 3. *Megamia anaglypta* gen. *et* sp. nov., MFM83026 (holotype), Loc. MGM-1, × 4.2, dorsal view of carapace.

Fig. 5. *Lybia* sp., MFM83280, Loc. MGM-1, × 2.8, dorsal view of carapace.

Fig. 6. *Carpilius* sp., MFM83285, Loc. MGM-1, × 1.5, lateral view of palm of cheliped.

Fig. 7. *Leptodius morrisi* sp. nov., MFM83047 (holotype), Loc. MGM-1, × 5.7, dorsal view of carapace.

Figs. 8, 9. *Paraxanthias fujiyamai* sp. nov., Loc. MGM-1, dorsal view of carapace.
Fig. 8. MFM83043 (holotype), × 6.5.
Fig. 9. MFM3042 (paratype), × 6.1.

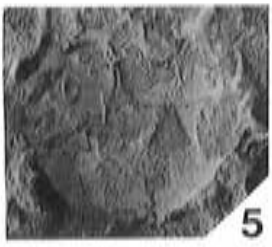
Fig. 10. *Charybdis* sp. 1, MFM83287, Loc. SKN-1, × 1.5, mesial view of fixed finger of cheliped.


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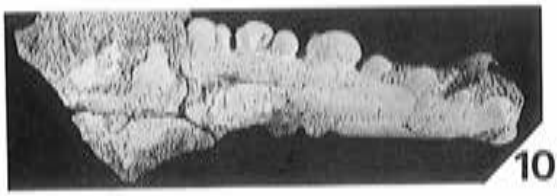

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Plate 16

Figs. 1, 4, 8. *Palaeoxanthops minutus* gen. *et* sp. nov., Loc. MGM-1, dorsal view of carapace.

Fig. 1. MFM83272, × 3.7.

Fig. 4. MFM83035 (paratype), × 3.7.

Fig. 8. MFM83044 (holotype), × 4.0.

Figs. 2, 13. *Pilodius parvus* sp. nov., Loc. MGM-1, dorsal view of carapace.

Fig. 2. MFM83027 (holotype), × 5.6.

Fig. 13. MFM83277, × 5.6.

Fig. 3. *Glabropilumnus kamiyai* Karasawa, MFM9038 (holotype), Loc. MFM. 07, × 3.0, dorsal view of carapace.

Figs. 5-7. *Palaeoxanthops okumurai* gen. *et* sp. nov., Loc. MGM-1, dorsal view of carapace.

Fig. 5. MFM83050 (holotype), × 10.0.

Fig. 6. MFM83284, × 4.2.

Fig. 7. MFM83051 (paratype), × 4.2.

Fig. 9. *Leptodius crosnieri* sp. nov., MFM83029 (holotype), Loc. MGM-1, × 5.0, dorsal view of carapace.

Fig. 10. *Trapezia brevispinosa* sp. nov., MFM83046 (holotype), Loc. MGM-1, × 5.6, dorsal view of carapace.

Fig. 11. "*Ozius*" ? sp., MFM9471, Loc. MFM. 07, × 2.8, lateral view of dactylus of cheliped.

Fig. 12. "*Pilumnus*" ? sp., MFM9492, Loc. MFM. 58, × 4.5, lateral view of fixed finger of cheliped.

Fig. 14. *Eriphia* sp., MFM83286, Loc. MGM-1, × 2.4, dorsal view of carapace.

Fig. 15. *Actumnus guinotae* Karasawa & Inoue, MFM83017 (holotype), Loc. KO-5, × 2.4, dorsal view of carapace.

Figs. 16, 17. *Ozius collinsi* Karasawa, Loc. KTT-3.

Fig. 16. MFM39002 (paratype), × 2.0, lateral view of cheliped.

Fig. 17. MFM39001 (holotype), × 1.5, dorsal view of carapace.


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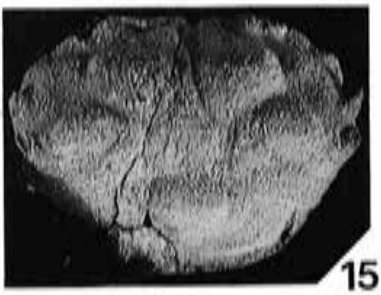

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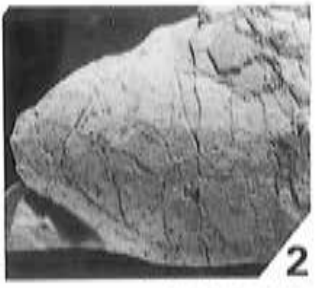
Plate 17

Fig. 1–4. *Euryozius bidentatus* sp. nov., Loc. MGM-1, dorsal view of carapace.
Fig. 1. MFM83031 (paratype), × 2.2.
Fig. 2. MFM83032 (paratype), × 2.4.
Fig. 3. MFM83268, × 1.8.
Fig. 4. MFM83030 (holotype), × 2.6.

Figs. 5, 6. *Euryozius angustus* sp. nov., Loc. MGM-1, dorsal view of carapace.
Fig. 5. MFM83028 (holotype), × 3.0.
Fig. 6. MFM83269, × 3.0.

Fig. 7–9. *Branchioplax pentagonalis* (Yokoyama, 1911), Loc. MND-1.
Fig. 7. right and left chelipeds, thoracic sterna and abdomen (plaster cast), KMNH IvP 300,019, × 1.5, ventral view.
Fig. 8. ESN80005, × 2.0, dorsal view of carapace.
Fig. 9. KMNH IvP 300,018, × 1.5, dorsal view of carapace and left cheliped.


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Plate 18

Figs. 1, 7, 8. *Carcinoplax antiqua* (Ristori).

Figs. 1a, b. MFM9557, Loc. MFM. 45, × 1.2, a, dorsal; b, ventral view.

Figs. 7a, b. MFM9558, Loc. MFM. 45, × 1.2, a, dorsal; b, ventral view.

Fig. 8. MFM83197, Loc. YTO-1, × 1.2, dorsal view of carapace.

Figs. 2, 3. *Trapezia* sp., Loc. MGM-1.

Fig. 2. MFM83261, × 3.5.

Fig. 3. MFM83273, × 4.5.

Figs, 4, 5, 9. *Carcinoplax granulimanus* Karasawa & Inoue, Loc. KO-2.

Fig. 4. MFM83010 (paratype), cheliped, × 1.2, a, lateral; b, ventral; c. dorsal view.

Fig. 5. MFM83008 (paratype), × 1.2, dorsal view of carapace.

Fig. 9. MFM83007 (holotype), × 1.0, dorsal view of carapace.

Fig. 6. *Carcinoplax imperfecta* Karasawa & Inoue, MFM83020 (holotype), Loc. KO-5, × 3.8, dorsal view of carapace.


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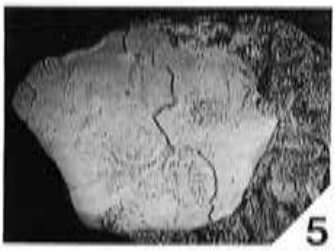

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4c


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7a


7b


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Plate 19

Figs. 1, 3, 5. *Carcinoplax longimanus* (de Haan).

Figs. 1a, b. MFM142139, Loc. KKG-4, × 1.2, a, lateral; b. dorsal view.

Fig. 3. MFM142136, Loc. KKG-7, × 1.2, lateral view of cheliped.

Fig. 5. MFM142136, Loc. KKG-7, × 1.2, dorsal view of carapace.

Fig. 2. *Carcinoplax* sp. aff. *C. purpurea* Rathbun, MFM142164, Loc. KKG-5, dorsal view of carapace.

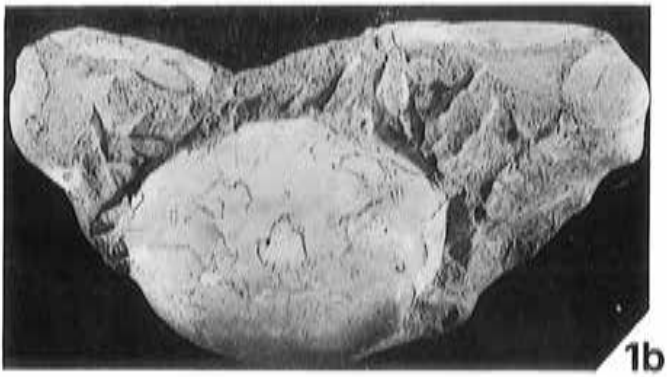
Figs. 4, 6, 7. *Carcinoplax prisca* Imaizumi.

Fig. 4. MFM83213, Loc. MYZ-1, × 1.2, dorsal view of carapace.

Fig. 6. MFM83212, Loc. MYZ-1, × 1.2, dorsal view of carapace.

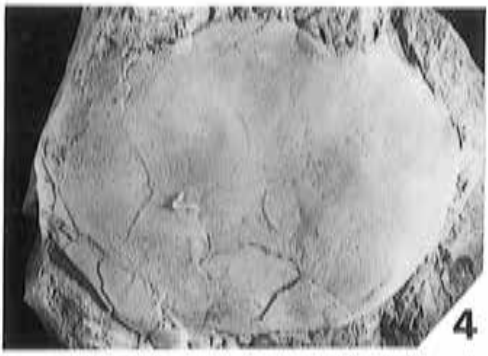
Fig. 7. MFM83226, Loc. MYZ-1, × 1.2, ventral view of carapace.

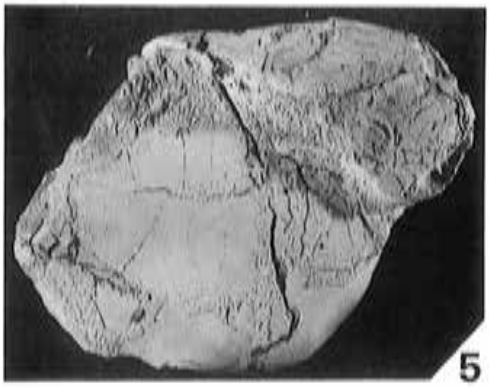

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Plate 20

Fig. 1. *Parthenope* sp. 1, MFM9470, Loc. I-2, × 2.8, lateral view of dactylus of cheliped.

Figs. 2, 8. *Parthenope* sp. 2, Loc. KO-5.

Fig. 2. MFM83193, × 2.2, mesial view of dactylus of cheliped.

Fig. 8. MFM83194, × 1.0, dorsal view of merus of cheliped.

Figs. 3, 5-7. *Carcinoplax prisca* Imaizumi.

Figs. 3a, b. MFM83223, MYZ-4, × 1.0, cheliped, a, dorsal; b, lateral view.

Fig. 5. MFM83197, MYZ-1, × 0.7, a, dorsal view.

Fig. 6. MFM83211, MYZ-1, × 1.2, dorsal view of carapace.

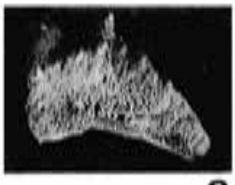
Fig. 7. MFM83229, MYZ-6, × 1.2, lateral view of cheliped.

Fig. 4. *Hyastenus* sp., MFM9468-1, Loc. MFM. 07, × 2.0, dorsal view of carapace.

Fig. 9. *Macrocheira* sp., MFM142165, Loc. MYZ-13, × 1.0, lateral view of fixed finger.


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3a

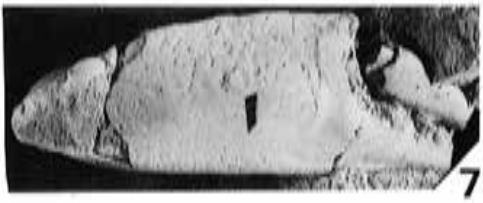

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3b


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Plate 21

Figs. 1, 2. *Typhlocarcinus obtusus* sp. nov. Loc. KKG-3.

Figs. 1a, b. MFM142009 (holotype), × 4.1. a, dorsal; b, ventral view.

Figs. 2a, b. MFM142010 (paratype), × 3.8. a, dorsal; b, ventral view.

Figs. 3–8. *Collinsius simplex* gen. *et* sp. nov., × 4.2.

Fig. 3. MFM218503 (paratype), Loc. KSM-2, lateral view of chelipeds.

Fig. 4. MFM218505 (paratype), Loc. KSM-4, dorsal view of carapace.

Fig. 5. MFM218502 (holotype), Loc. KSM-2, dorsal view of carapace and cheliped.

Fig. 6. MFM218613, Loc. KSM-4, ventral view (male).

Fig. 7. MFM218505 (paratype), Loc. KSM-4, ventral view (female).

Fig. 8. MFM218506 (paratype), Loc. KSM-4, ventral view (male).


1a

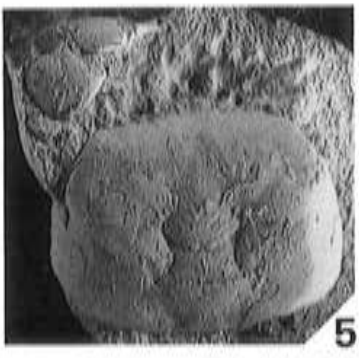

2a


1b


2b


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Plate 22

Fig. 1. *Philyra plana* Karasawa, MFM9012 (holotype), Loc. MFM. 07, × 3.2, dorsal view of carapace.

Fig. 2. *Randallia saitoensis* sp. nov., MFM142015 (holotype), Loc. MYZ-7, × 3.5, dorsal view of carapace.

Fig. 3. *Philyra hayasakai* Karasawa & Inoue, MFM83005 (holotype), Loc. KK-1, × 4.3, dorsal view of carapace.

Figs. 4, 6, 9. *Philyra platychira* de Haan.

Fig. 4. MFM142170, Loc. KKG-11, × 2.8, ventral view of carapace.

Fig. 6. MFM142142, Loc. KKG-1, × 3.4, dorsal view of merus of cheliped.

Fig. 9. MFM142170, Loc. KKG-11, × 3.0, dorsal view of carapace.

Figs. 6a, b. *Ebalia kakegawaensis* sp. nov., MFM142017 (holotype), Loc. KKG-8, × 4.3, a, dorsal; b, lateral view of carapace.

Fig. 7. *Philyra tridentata* sp. nov., MFM142018 (holotype), MFM142018 (holotype), Loc. KKG-2, × 3.2, dorsal view of carapace.

Figs 8, 11a, b. *Philyra nishimotoi* Karasawa, Loc. MFM. 22, × 2.8.

Fig. 8. MFM9008 (holotype), dorsal view of carapace.

Figs. 11a, b. MFM9009 (paratype), a, dorsal; b, ventral view of carapace.

Fig. 10. *Philyra tanakai* sp. nov., MFM142001 (holotype), Loc. KKG-1, × 3.0, dorsal view of carapace.

Figs. 12, 13. *Daira perlata* (Herbst), Loc. MGM-1, dorsal view of carapace.

Fig. 12. MFM83250, × 2.1.

Fig. 13. MFM83254, × 3.4.



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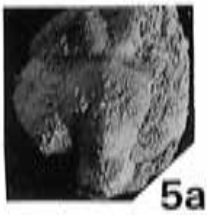
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5a



5b



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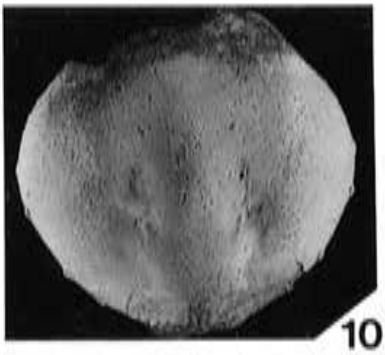
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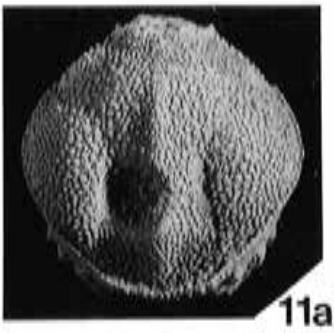
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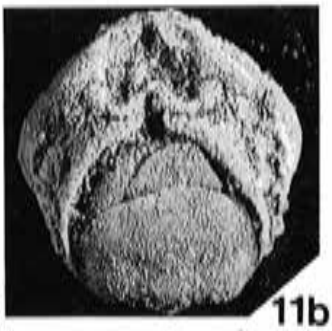
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11a



11b



12



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Plate 23

Fig. 1. *Cyclograpsus directus* Karasawa, MFM9021 (holotype), Loc. MFM. 27, × 2.8, dorsal view of carapace.

Fig. 2. *Pariphiculus inconditus* sp. nov., MFM142014 (holotype), Loc. MYZ-7, × 3.8, dorsal view of carapace.

Figs. 3, 4, 8. *Miosesarma japonicum* Karasawa.

Fig. 3. MFM9015 (holotype), Loc. MFM. 25, × 2.8, dorsal view of carapace.

Fig. 4. MFM9017 (paratype), Loc. MFM. 25, × 2.8, ventral view.

Fig. 8. MFM9635, Loc. I-2, × 2.8, mesial view of propodus of cheliped.

Fig. 6. *Sesarma* sp., Nishikawa coll., Loc. BIH-2, × 1.2, dorsal view of carapace.

Fig. 5. *Halice* sp., MFM82195, Loc. KK-5, × 2.0, dorsal view of carapace.

Fig. 7. *Leucosia* sp. 1, Umemoto coll., Loc. KKG-2, × 2.4, dorsal view of carapace.

Figs. 8, 11. *Cyclograpsus rectangularis* Karasawa, Loc. MFM. 07.

Fig. 8. MFM9020 (paratype), × 2.8, lateral view of cheliped.

Fig. 11. MFM9019 (holotype), × 2.8, dorsal view of carapace.

Fig. 10. *Leucosia* sp. 2, MFM142157, Loc. KKG-1, × 4.0, mesial view of merus of cheliped.

Figs. 12a, b. *Leucosia takamii* sp. nov., MFM142016 (holotype), Loc. KKG-5. a, × 1.4, dorsal view; b, × 2.0, lateral view of carapace.

Fig. 13. *Varuna angustifrons* sp. nov., MFM218501 (holotype), Loc. KSM-1, × 2.8, dorsal view of carapace.


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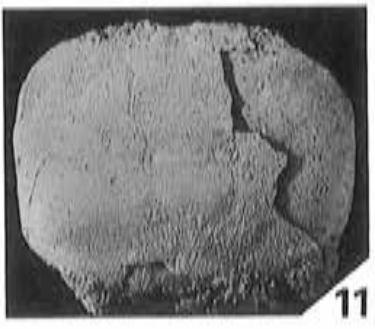

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12a


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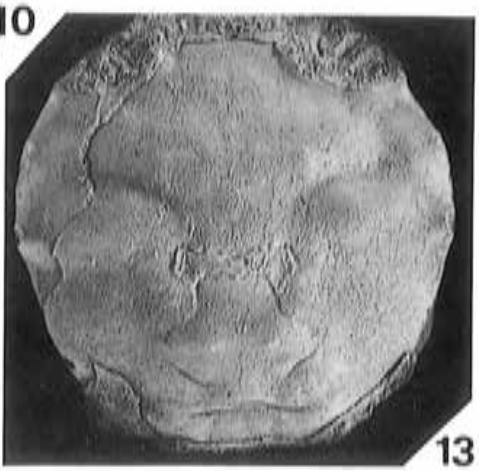

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Plate 24

Figs. 1, 2, 12. *Macrophthalmus* (*Euplax*) *leptophthalmus* (H. Milne Edwards), Loc. NKJ-1, × 2.0, dorsal view of carapace.

Fig. 1. MFM142123-1.

Fig. 2. MFM142124-2.

Fig. 12. MFM142124-3.

Figs. 3, 8. *Tritodynamia globosa* Karasawa.

Figs. 3a, b. MFM90333 (holotype), Loc. MFM. 45, × 2.8, a, frontal; b, dorsal view of carapace.

Fig. 8. MFM83205, Loc. YTO-1, × 2.8, dorsal view of carapace.

Figs. 4, 7, 11. *Macrophthalmus* (*Mareotis*) *viai* Karasawa & Inoue. Loc. KK-1.

Fig. 4. MFM83001 (holotype), × 2.0, dorsal view of carapace.

Fig. 7. MFM83004 (paratype), × 1.5, ventral view.

Fig. 11. MFM83002 (paratype), × 1.0, dorsal view.

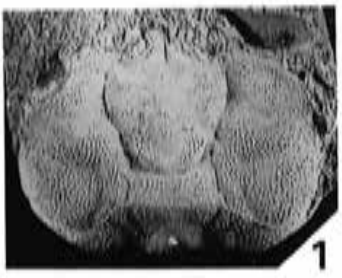
Figs. 5, 6, 12. *Macrophthalmus* (*Mareotis*) *japonicus* (de Haan), Loc. FRY-1, × 2.0, dorsal view of carapace.

Fig. 5. MFM142125.

Fig. 6. MFM142126.

Fig. 12. MFM142127.

Fig. 10. *Miosesarma japonicum* Karasawa, MFM9018 (paratype), Loc. MFM. 25, × 2.8, dorsal view of carapace.


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3a

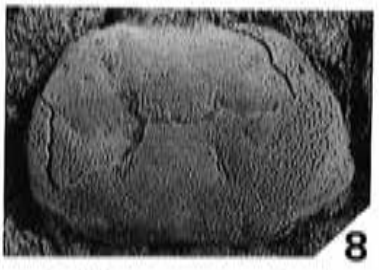

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3b


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