Two New Fossil Crabs of the Tymolidae from the Miocene Mizunami Group, Central Japan

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岐阜県中新統瑞浪層群産マメヘイケガニ類化石2新種

武田　正倫*・冨田　進**

(要　旨)

岐阜県瑞浪市とその周辺には新生代第三紀中新世前～中期（約18～14Ma）の瑞浪層群が露出し，豊富な軟体動物化石に伴って十脚甲殻類化石を産出する．筆者らはこの十脚甲殻類群集の研究を進めているうち，興味ある2新種を認めたので記載する．これら新種の発見はマメヘイケガニ類の系統を考える上で重要であり，この論文ではその点についても論述した．

Tymolus ingens sp. nov. ミズナミマメヘイケガニ（新種，新称）

甲殻は亜円形で，甲長41.5mm，甲幅46mmに達し，この属としては大型である．背甲は全体にゆるやかに隆起し，各域は線状溝によって深く彫刻される．各域は微細な大小様々の顆粒で覆われる．顆粒は甲殻後半域では比較的によく密集し，各域の顆粒のうち1～2個が他より大きい．甲殻の前側縁は半円状で細かな顆粒がある．前側縁と後側縁の境には鋭い疣を供える．額は狭く，基部でくびれ，弱く背方に突き出す．額歯は鋭い2つの歯に分かれ，それぞれ横に小さな眼前歯を伴う．眼窩上縁の切れ込みは直線的で深い．

Tymolus itoigawai sp. nov. イトイガワマメヘイケガニ（新種，新称）

甲殻はこの属に典型的な大きさと基本的構成をもつ．甲殻は1cm内外の亜円形で，全体にゆるく膨らむ．背甲は深い溝で各域に分けられ，微細な顆粒で密に覆われる．腸域と亜肝域および胃域と鰓域の各亜域はそれぞれ1個の疣状突起を備え，全部で背甲上に14個ある．甲殻の前側域の前半に2～3個，後半に1個の疣があり，前側縁と後側縁が接するところには1個の強い疣状突起がある．眼前歯はがっしりとして，額歯の位置まで達しない．眼窩上縁は深く切れ込む．

T. ingens は瑞浪市明世町の明世累層山之内層の *Saccella-Cyclocardia* 群集や *Patinopecten-Macoma* 群集に伴って産出し，また狭間層からも産出し *Macoma-Ennucula* 群集を伴う．*T. itoigawai* は同市釜戸町荻の島の宿洞相から産出したもので，*Glycymeris-Chlamys* 群集に伴い，いまのところ両種が相伴う例は知られていない．軟体動物群集や地質の検討から *ingens* を産出した地層の堆積環境は水深50mあたりの温帯の砂泥底が推定され，*itoigawai* を産出した地層は熱帯地方の水深5mまでの岩礁海岸に近い砂底に堆積したものである．

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T. ingens は大型であり，深い溝で各域が隔てられるなどによって，一方 *itoigawai* は背甲の各域に1個づつの強い疣状突起を供えることで現生9種のいずれとも区別できる．また，福島県の中新統沼の内層から記載された化石種 *T. kamadai* は小型であり，中胃域と後胃域の後部で鋭い三角形を呈するので，2新種のいずれとも異なる．既知の現生9種のうち，日本の海域からは *T. japonicus* と *T. uncifer* の2種が知られるが，*japonicus* は日本特産の浅海種であり，*uncifer* はインド・西太平洋に広く分布し，より深いところに棲息する．これら2種は熱帯系とはいえず，*japonicus* 以外の既知種はいずれも大陸斜面に棲んでいる．*Tymolus* 属はおそらく系統の異なる種を含み，Balss (1922) によって異名とされた *Cyclodorippe* 属を復活させるべきであろう．その場合は *japonicus, uncifer, similis* の3種が *Tymolus* に属し，ここに記載した化石2新種のうち少なくとも *itoigawai* も含められる．

マメヘイケガニ科 Tymolidae は最初ヘイケガニ科の亜科として Alcock (1896) によって設定され，その後 Gordon (1963) によって科として区別され，最近の研究者もこれに従っている．ところが Ortmann (1892) は Alcock に先立って Cyclodorippidae を設け，正しく科の定義を与えている．すでに述べたように，もし *Cyclodorippe* 属を復活するとなれば，先取権の法則に従って科名は Tymolidae に代えて Cyclodorippidae を使用しなければならない．

Introduction

The lower to the middle Miocene Mizunami group in the environs of Mizunami City, Gifu Prefecture is well known to the Japanese palaeontologists by the rich molluscan fauna. The decapod crustacean fossils are also frequently found together with the mollusucs, but *Callianassa titaensis* of the Callianassidae was only described from the adjoining and coeval Iwamura group by Nagao (1941), and otherwise the occurrence of a portunid crab referable to *Ovalipes* was reported by Imaizumi (1956) from the Togari member of the Mizunami group.

In Japan the Miocene fossils of the decapod crustaceans are plentifully known from the districts such as Kintaichi in Iwate Prefecture and Chichibu in Saitama Prefecture, but the studies on them are still now quite fragmentary. The results of our examination of the decapod crustacean fossils from the Mizunami group will be published serially and may contribute to the systematics of the decapod crustaceans and the knowledge of palaeoenvironmental condition of the Mizunami basin as well as the Miocene other districts.

In the present first report two new crabs of the Tymolidae are to be described in the following lines. The type specimens are deposited in the Mizunami Fossil Museum (MFM) and the National Science Museum (NSM).

We must express our hearty thanks to Dr. Junji Itoigawa of Nagoya University for his kind and useful information on the geology, and also to Messrs. Hiroaki Karasawa and Tatsuya Kaede who kindly placed the valuable specimens at our disposal for study. One of the new species was dedicated to Dr. Itoigawa.

Geological Note

According to Itoigawa (1974), the Mizunami group is divided into four formations; Toki lignite-bearing formation, Hongô formation, Akeyo formation and Oidawara forma-

Table 1. Stratigraphical correlation of the Mizunami group (cited from Itoigawa. 1974).

Period	Group	Formation	Toki area	Mizunami area	Tymolid fossil
Middle Miocene	Mizunami Group	Oidawara for.	Oidawara mudstone	Nataki conglomerate	
Early Miocene		Akeyo for.	Hida facies	Shukunohora facies ⊗	⊗ *T. itoigawai*
				Hazama m. ×	
			Kujiri facies	Yamanouchi m. × ×	× *T. ingens*
				Togari member	
			Asano facies	Tsukiyoshi m.	
			Hongô formation		
		Toki lignite-bearing formation			
Mesozoic | Paleozoic	Basement Rocks		Nôhi Rhyolite, Ryôke Granite Ryôke metamorphic rocks		

tion (Table 1). The Tsukiyoshi member occupying the lower part of the Akeyo formation contains the *Vicarya* assemblage, and it was confirmed that the palaeoenvironment in this area was the subtropical and littoral in the latest period of the early Miocene (Itoigawa, 1978). The uppermost part of the Togari member of the Akeyo formation consists of the *Felaniella* bed which is considered that the cold current had temporarily flowed in this area. The nodule including the holotype specimen of one of two new species, *Tymolus ingens* (Pl. 13, Fig. 2) accompanied with the *Saccella-Cyclocardia* assemblage of Hesoyama, and the other nodule including the paratype specimen (Pl. 13, Fig. 1) accompanied with the *Patinopecten-Macoma* assemblage of Matsugase, were obtained from the gray tufacerous sandy mudstone which corresponds to the Yamanouchi member of about 35 m thick of the middle Akeyo formation. The referred specimen (Pl. 13, Fig. 4) from Matsugase-shimo was found from the pumice bed which corresponds to the Hazama member of the upper part of the Akeyo formation. According to Itoigawa (1974), the *Macoma-Ennucula* assemblage is contained in the Hazama member, showing that the sea had gradually become deeper.

The holotype specimen of another new species, *Tymolus itoigawai* (Pl. 13, Fig. 5) was

obtained from the gray sandstone of the Shukunohora facies in Oginoshima, which is overlied by the Oidawara formation consisted of the basal conglomerate and mainly of the mudstone. Judging from the molluscan assemblage and lithofacies, it is considered that the palaeoenvironment of the Shukunohora facies in Oginoshima was a bay with sandy bottom of the tidal line to about 5 m deep, where was not so distant from rocky shore being characterized by the matrices of fine sandstone with a few pebbles and by yielding of many fossils of the rocky shore inhabitants. Predominant occurrence of the *Glycymeris-Chlamys* assemblage with some corals at the type locality, and of the *Ostrea-Suchium* assemblage

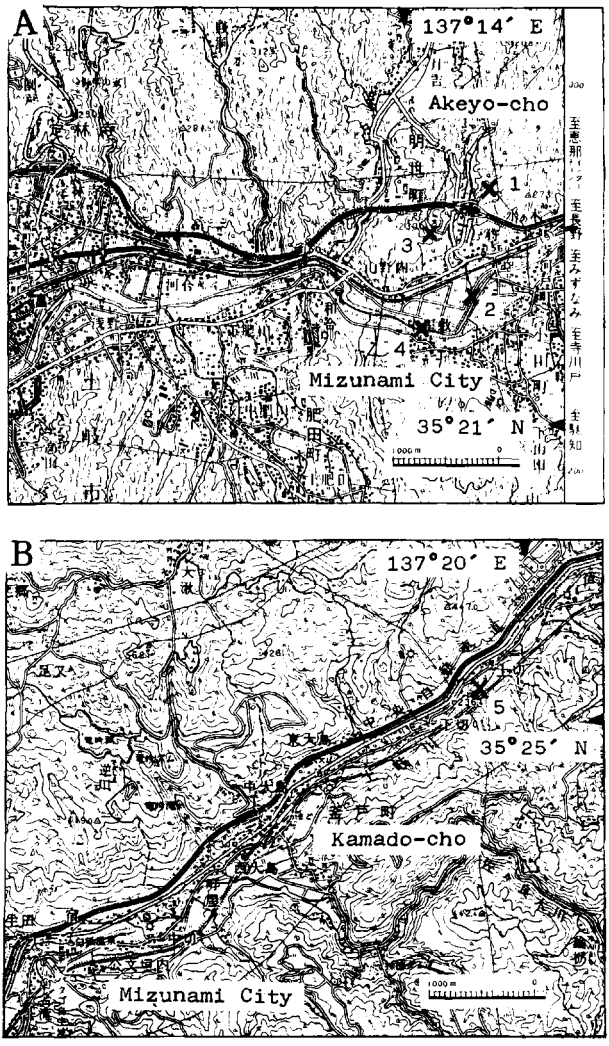

Fig. 1. Map showing the localities.
1. Hesoyama, 2. Matsugase, 3. Bōgahora, 4. Matsugase-shimo, 5. Oginoshima
(Cited from the 1/50,000 Quaddrangle Minokamo (A)and Ena (B))

with *Vicarya yokoyamai* and *Geloina yamanei* at Kamigiri near this locality, indicates the accordance with tropical condition predominated at that time.

Systematic Description

Family T y m o l i d a e Alcock, 1896

Genus *Tymolus* Stimpson, 1858

Tymolus ingens sp. nov.

(Pl. 13, figs. 1-4)

Diagnosis : Carapace subcircular in outline and large for the genus ; dorsal surface gently convex in both directions and deeply sculptured into regions by linear furrows ; each region covered with minute, more or less tuberculate granules of variable sizes ; granules rather dense on posterior half of carapace, and one or two on each region slightly larger than the others. Anterolateral border of carapace well arched and minutely granulated ; lateral angle between antero- and posterolateral borders armed with a sharp tubercle. Frontal region narrow and weakly projected dorsally, being constricted basally ; free margin may be divided into two sharp teeth, with a much smaller preorbital tooth at each side ; supraorbital notch deep and rather linear.

Type specimens : Hesoyama (Loc. no. 46 of Mizunami Fossil Museum), Togari, Akeyo-cho, Mizunami City, Gifu Pref. ; holotype (ca. 26.5 and 27.0 mm in length and breadth of carapace, respectively), MFM 09001 ; H. Karasawa leg. Matsugase (Loc. no. 54 of Mizunami Fossil Museum), Togari, Akeyo-cho, Mizunami City ; paratype (ca. 41.5 and 46. 0 mm in length and breadth of carapace), NSM-PA 12247 ; T. Kaede leg.

H o l o t y p e. Carapace well preserved, except for right marginal part and frontorbital region. Carapace subcircular in outline, gently convex in both directions, being deeply sculptured into regions by linear furrows ; each region covered with minute, more or less tuberculate granules of variable size ; granules rather sparse on anterior half of carapace, rather dense on posterior half, and one or two, or some on each region more prominent than the others ; mesogastric region longitudinally triangular, without formation of metagastric region, almost reaching postfrontal transverse depression ; protogastric region completely subdivided into two by an oblique furrow ; hepatic region large, being shallowly isolated from protogastric and epibranchial regions ; epi-, meso- and metabranchial regions distinct, except for outer halves ; a furrow between epi- and mesobranchial regions transverse, and an oblique furrow between meso- and metabranchial regions directed to outer end of the above furrow originated from a longitudinal furrow outside of cardiac and intestinal regions ; cardiac region transverse and weakly ridged, being separated deeply from gastric region and shallowly from intestinal region. Anterolateral border of carapace convex outward and fringed with minute granules, its anterior part slightly directed dorsally to external orbital angle as usual, and thus subhepatic and suborbital regions partly visible from above ; a sharp tubercle may be observable at angle between antero- and posterolateral borders of right side, being largely embedded in matrix ; left angle is shown by a scar.

Parts of cheliped and two ambulatory legs left in the same piece of matrix with carapace.

P a r a t y p e. Much larger than the holotype, depressed and worn out along margins. Regions of dorsal surface granulated and well divided; gastric regions nearly scraped for their most parts. Frontorbital region imperfect, but supplementary to the holotype, being basally constricted and weakly directed dorsally; frontal margin with two sharp teeth; each supraorbital tooth much smaller than frontal teeth; supraorbital border with a linear incision.

Referred specimens : Bôgahora (Loc. no. 50 of Mizunami Fossil Museum), Togari, Akeyo-cho, Mizunami City; 1 ex. (ca. 6.6 and 7.0 mm in length and breadth of carapace). Matsugase-shimo (Loc. no. 53 of Mizunami Fossil Museum), Yamanouchi, Mizunami City; 1 ex. (ca. 15.0 and 15 + mm in length and breadth of carapace).

These specimens are much smaller than the type specimens and in all probability juvenile or young. The state of preservation is not always good, but the shape and sculpture of the carapace are generally agreeable with those of the larger specimens. Fragments of such small specimens are often unearthed from the upper part of the Yamanouchi member of the Mizunami group at Bôgahora, but most of them are depressed and heavily crushed.

Horizon : Yamanouchi member, Akeyo formation, Mizunami group (MFM 09001, and NSM-PA 12247). Hazama member, Akeyo formation, Mizunami group.

Associated forms : Decapod crustaceans—*Leucosia* sp., *Cancer* sp., *Scylla* sp., *Charybdis* sp., *Macrophthalmus* sp. and *Carcinoplax* aff. *antiqua* (Ristori); Gastropods—*Protorotella depressa* Makiyama, *Lunella kurodai* Itoigawa, *Turritella sagai* Kotaka, *Proclava otukai* (Nomura), *Crepidula jimboana* Yokoyama, *Euspira meisensis* Makiyama, *Cymatiella variegata* Itoigawa et Shibata, *Ancistrolepis togariensis* Naruse, *Neptunea modesta* (Kuroda), *Buccinum mitsuganoensis* Shibata, *Phos minoensis* Itoigawa, *Siphonalia minoensis* Itoigawa, *Musashia yanagidaniensis* (Araki) and *Eoscaphander corpulenta* (Yokoyama); Scaphopods—*Fissidentalium* sp. and *Laevidentalium* sp.; Pelecypods—*Acila submirabilis* Makiyama, *Glycymeris ikebei* Itoigawa et Shibata, *Modiolus nakamurai* Itoigawa et Shibata, *Chlamys iwamurensis* Itoigawa, *Gloripallium izurensis* Masuda, *Kotorapecten egregius* (Itoigawa), *Cyclocardia siogamensis* (Nomura), *Lucinoma acutilineatum* (Conrad), *Wallucina habei* Itoigawa, *Phacosoma nomurai* (Otuka), *Siratoria siratoriensis* (Yokoyama), *Macoma optiva* (Yokoyama), *M. izurensis* (Yokoyama), *Cultellus izumoensis* Yokoyama, and *Thracia watanabei* Itoigawa et Shibata; Cephalopods—*Aturia minoensis* Kobayashi; Shark teeth; Plant fossils; etc.

Remarks : The present new species has the general similarity to the known *Tymolus* species in the subcircular contour of the carapace, with the narrow frontorbital region, and the sculpture of the dorsal surface, but readily distinguished from them by the large size and the deep interregional linear furrows.

Until now, the fossil tymolid crab is known only by *Tymolus kamadai* Imaizumi from the Miocene Numanouchi formation of Fukushima Prefecture. According to the original description (1952 a), *T. kamadai* is a small species, and meso- and metagastric regions are acutely triangular in the posterior part. *Tymolus* sp. from the Miocene Tomikusa group

illustrated by Shikama (1970) closely resembles to the smaller referred specimens of the present new species.

Tymolus itoigawai sp. nov.
(Pl. 13, figs. 5, 6)

Diagnosis : General formation and size of carapace typical for the genus. Carapace subcircular in its contour and gently convex in both directions; its dorsal surface deeply separated into regions and thickly covered with minute granules so as to be frosted; intestinal and subhepatic regions and subregions of gastric and branchial regions armed each with a prominent tubercle; thus, dorsal surface of carapace with 14 tubercles in all. Anterolateral margin of carapace with two or three tubercles on anterior half and one on posterior half; a strong tubercle at junction between antero- and posterolateral margins. Frontorbital region projected forward; frontal margin composed of two sharp teeth; supraorbital angle stout and strong, failing to reach the level of frontal teeth; supraorbital border deeply incised by a narrow furrow.

Type specimens : Oginoshima (Loc. no. 07 of Mizunami Fossil Museum), Kamadocho, Mizunami City, Gifu Pref.; holotype (8.5 and 9.4 mm in length and breadth of carapace, respectively), MFM 09002; T. Kaede leg. Same locality; paratype (8.4 and 9.1 mm in length and breadth of carapace), NSM-PA 11248; S. Tomida leg.

H o l o t y p e and P a r a t y p e. Carapaces in an excellent state of preservation. Their description as in diagnosis mentioned above.

Horizon : Shukunohora facies, Mizunami group.

Associated forms : Decapod crustaceans—*Leucosia* sp., *Cancer* sp., and Majidae gen. et sp. indet.; Cirriped crustaceans—*Balanus* spp.; Gastrpods—*Miohaliotis amabilis* Itoigawa et Tomida, *Diodora minoensis* Itoigawa, *Cellana depressa* Itoigawa et Shibata, *Tristichotrochus takeharai* Itoigawa et Shibata, *Marmorostoma minoensis* Itoigawa, *Suchium jyoganjiense* Fujii, *Terebralia* sp., *Bostrycaplus minoensis* (Itoigawa), *Naticarius minoensis* Itoigawa, *Neverita coticazae* Makiyama, and *Siphonaria* sp.; Scaphopods—*Antalis* sp.; Pelecypods—*Savignyarca minoensis* Itoigawa, *Scapharca abdita* Makiyama, *Glycymeris cisshuensis* Makiyama, *Pteria* cf. *loveni* (Dunker), *Isognomon minoensis* Itoigawa, *Phacosoma suketoensis* (Otuka), and *Siliqua minoensis* Itoigawa; Corals—*Cynaria* sp. and *Dendrophyllia fistula* (Alcock); Echinoid—*Kewia minoensis* (Morishita); Shark teeth; etc.

Remarks : The new species is based on the two carapaces which are almost complete, but many fragmental specimens are commonly unearthed from the gray sandstone of the type locality.

The general appearance is surely close to the known recent species of the genus *Tymolus* which is represented by six Indo-Pacific and three west Atlantic species—*japonicus* Stimpson, 1858, *antennarius* (A. Milne Edwards, 1880), *agassizii* (A. Milne Edwards, 1880), *uncifer* (Ortmann, 1892), *similis* (Grant, 1905), *depressus* (Ihle, 1916), *rostratus* (Ihle, 1916), *bouvieri* (Rathbun, 1934) and *spinosa* (Zarenkov, 1970). The present new fossil species referred to *Tymolus* is readily distinguished from the species enumerated above by having

a strong tubercle on each region of the carapace. Due to the characteristic arrangement of the tubercles, the general appearance of this species may be unexpectedly close to those of some species of *Necrocarcinus* of the Calappidae known from the Upper Aptian to the Eocene.

Discussion

One of two new species just described, *Tymolus ingens*, was unearthed from the upper part of the Yamanouchi member at Hesoyama, Bôgahora and Matsugase, and also from the Hazama member at Matsugase-shimo, in Mizunami City, while another new species, *Tymolus itoigawai*, is now found only from the Shukunohora facies at Oginoshima, Kamado-cho, Mizunami City. Thus, the co-occurrence of the two species is unknown for the present. As already mentioned in the geological note, and judging from the molluscan assemblage, the geological horizon which yielded *T. ingens* contains the fauna of the shallow water inhabitants down to about 50 m deep or more in the Temperate Zone, while another geological horizon which yielded *T. itoigawai* contains the fauna of the intertidal or subtidal inhabitants in the Tropics. It is quite possible that these two fossil species had been geographically and bathymetrically isolated from each other.

Of nine recent species enumerated elsewhere, *T. japonicus* and *T. uncifer* are known from Japanese waters (Sakai, 1976); the former is a shallow water inhabitant endemic to Japanese waters, while the latter is a deeper water inhabitant widely distributed in the Indo-West Pacific. Two Japanese species are not the tropical inhabitants, and the other known species are the inhabitants of the continental slope like *T. uncifer*. It is highly probable that the genus *Tymolus* is heterogenous, with the species having the different origin, and that the genus *Cyclodorippe* A. Milne Edwards decidedly synonymized by Balss (1922) under the suspection of Ortmann (1892) and Alcock (1896) must be resurrected. The subgenus *Cyclortmannia* erected by Ihle (1916) in the genus *Cyclodorippe* is without doubt equivalent to *Tymolus*, and thus *japonicus, uncifer* and *similis* are referred to the genus *Tymolus*. It is not sure at present, without examination of the specimens, whether the species *antennaria, agassizii, depressa, rostrata, bouvieri* and *spinosa* referable to the genus *Cyclodorippe* are generically distinct from the genus *Tymolus*. At least, of two new fossil species just described, *itoigawai* belongs to *Tymolus s. s.*, having the close similarity to *japonicus*.

The systematic status of the Tymolidae distinguished from the Dorippidae of the Oxystomata was extensively discussed by Gordon (1963), Števčić (1971), and Wright and Collins (1972), being nearly in the Dromiidea. Even if one of the new species is really close to *T. japonicus* and may possibly be the ancestral form, the discussion about the higher taxon is beyond this paper's scope. In this place only the nomenclatural problem about family name is shortly remarked following the subject derived from the validity or invalidity of *Cyclodorippe*. The family Tymolidae was originally proposed by Alcock (1896) as one of the subfamily of the Dorippidae and afterward distinguished as a distinct family by Gordon (1963) and followed by the recent authorities, while the family Cyclodorippidae was

erected by Ortmann (1892). If the genus *Cyclodorippe* is resurrected as distinct from the genus *Tymolus*, the family name "Cyclodorippidae" must be adopted on the basis of priority instead of the well-known "Tymolidae".

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Plate 13

Tymolus ingens sp. nov.

Fig. 1. Holotype, MFM09001. a: dorsal view, b: whole view a ×2, b × 1.3

Fig. 2. Paratype, NSM-PA12247. a: dorsal view, b: ventral view ×1.3

Fig. 3. Dorsal view of the referred specimen from Bogahora. ×3.5

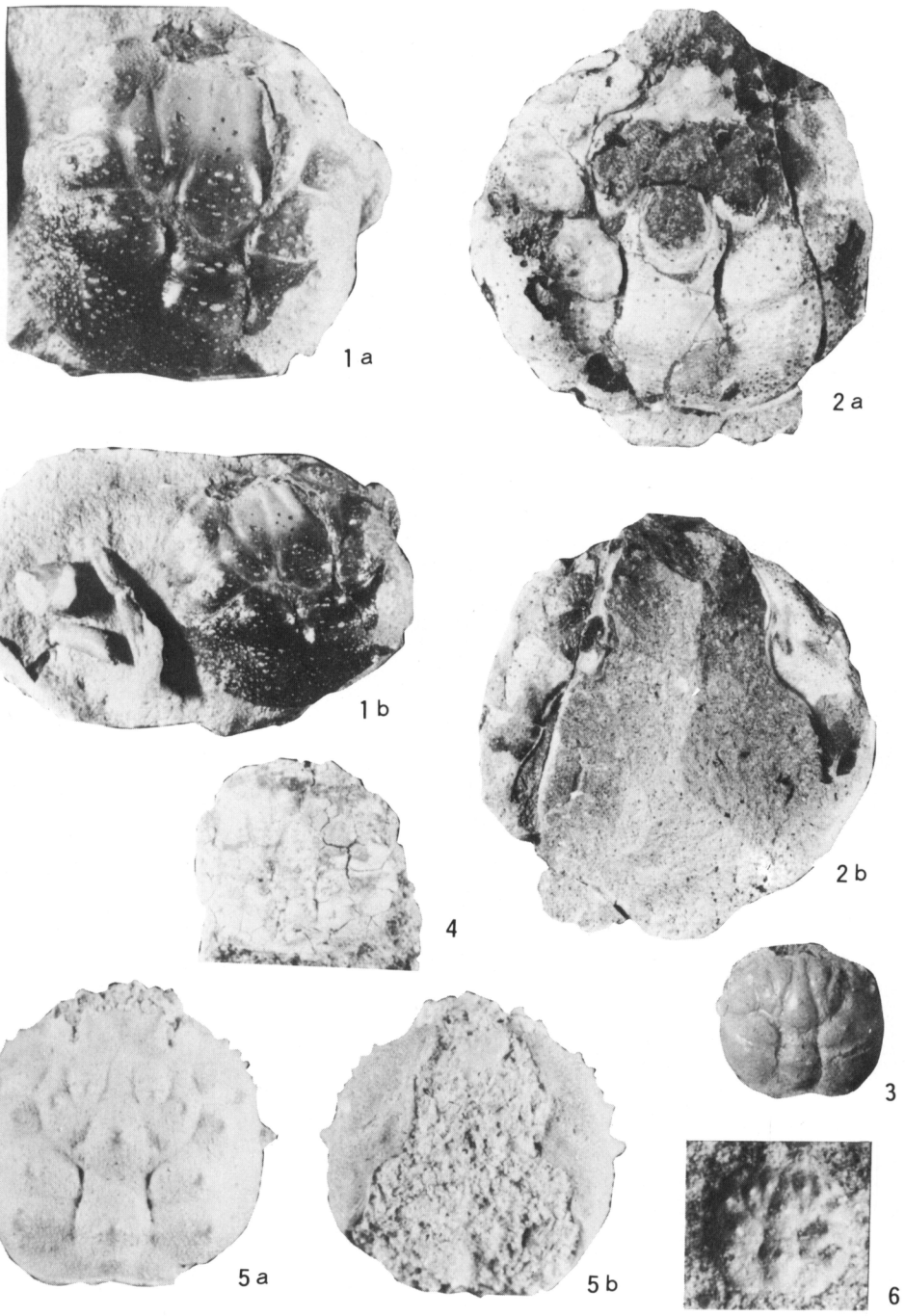
Fig. 4. Dorsal view of the referred specimen in matrix from the Hazama member at Matsugase-shimo. ×2

Tymolus itoigawai sp. nov.

Fig. 5. Holotype, MFM09002. a: dorsal view, b: ventral view ×5

Fig. 6. Paratype, NSM-PA11248. Dorsal view. ×2.3

Explanation of Plate


1 a
2 a
1 b
2 b
4
3
5 a
5 b
6