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Decapod Crustaceans from a Volcanic Hot Spring in the Marianas

MICHAEL TÜRKAY & KATSUSHI SAKAI

With 9 Text-Figures and 1 Table

Abstract

[TÜRKAY, M. & SAKAI, K. (1995): Decapod crustaceans from a volcanic hot spring in the Marianas. – Senckenbergiana marit., **26** (1/2): 25–35, 9 figs., 1 tab.; Frankfurt a. M.]

Paraglypturus calderus gen. nov., sp. nov. (Callianassidae) and *Xenograpsus novaeinsularis* TAKEDA & KURATA 1977 (Grapsidae) are recorded from Esmeralda Bank, an active submarine volcano in the Mariana Arc. The material was recovered alive in sediment from 63–114 m depth with pore water temperatures of 50°C–78.5°C. It is suggested, however, that these animals live in surface sediment layers at lower temperatures.

Kurzfassung

[TÜRKAY, M. & SAKAI, K. (1995): Dekapode Krebse aus der Umgebung einer vulkanischen Heißwasserquelle im Seegebiet der Marianen. – Senckenbergiana marit., **26** (1/2): 25-35, 9 Abb., 1 Tab.; Frankfurt a. M.]

Paraglypturus calderus gen nov., sp. nov. (Callianassidae) und *Xenograpsus novaeinsularis* TAKEDA & KURATA 1977 (Grapsidae) werden von der Esmeralda-Bank, einem aktiven submarinen Vulkan im Seegebiet der Marianen, gemeldet. Die Organismen wurden mit Sediment aus 63–114 m Wassertiefe geborgen, das eine Porenwassertemperatur von 50°C–78.5°C aufwies. Es wird vermutet, daß diese Tiere in oberflächlichen Sedimentschichten leben, die eine etwas niedrigere Temperatur aufweisen.

Introduction

During Cruise 69 of R.V. *"SONNE"* (26.VI.–8.VIII.1990) marine hydrothermalism was investigated in the Mariana back-arc area. Esmeralda Bank is the southernmost active volcano of the Mariana active arc (Fig. 1). This feature rises to 30 m below the surface (STERN et al. 1984; PUTEANUS & BLOOMER & WU 1990; STÜBEN et al. 1992; TAIBI 1992). Three sediment samples were taken with a video controlled large grab on the rims of that volcano caldera during leg 2. Two of them (stat. 28 and 29 on the more gently sloping northern rim) brought up hydrothermally influenced sediments rich in sulfide and sulfur. The sediment of stat. 28 was steaming and smelling of hydrogen sulfide. Thermometers inserted measured temperatures of more than 50°C to 78.5°C (PUTEANUS & BLOOMER & TAIBI et al. 1990). Surprisingly living decapod crustaceans were found in both samples. In the present paper we report on these. While the callianassid proved to belong to a new genus, the grapsid crab has already been known from "Nishino-shima Shintoh" an island in the Nishino-shima group that began to form by a volcanic eruption in 1973 (KIDO & NAKAMURA & KOIKE 1975; NAKAMURA & KOIKE 1975; TAKEDA & KURATA 1977). The crabs were collected there in 1975 when it was already possible to sample in the inlet between the islands without danger, but the surface water temperature

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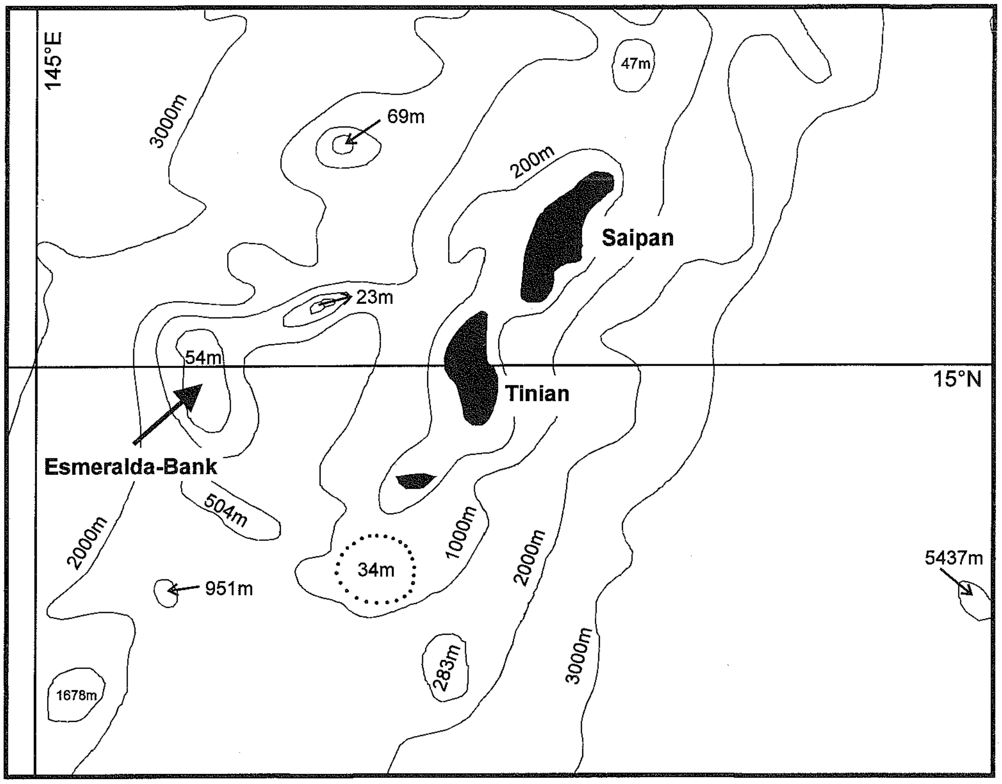

Fig. 1. Situation of Esmeralda-Bank in the Marianas.

Abb. 1. Position der Esmeralda-Bank in den Marianen.

was still higher than that of the surrounding ocean, i.e. 26°C–30.6°C in the inlet versus 20.8°C in the open ocean (Kido & Koike 1975). Since the time of the cited early studies the new island is again largely sunken, but some part of it still remains above the sea level (Maritime Safety Agency of Japan 1993). The species was rediscovered and recorded from the Tokara and Iwo Islands by Takeda et al (1993). These authors also established its connection to hydrothermal biotopes.

The material studied is deposited in the collection of the Senckenberg-Museum, Frankfurt a. M. (SMF). The following abbreviations were used throughout this paper: CB = Carapace breadth; CL = carapace length; TL = total length. All measurements are given in millimeters.

Systematic Part

Callianassidae

Paraglypturus gen. nov.

Diagnosis: Carapace unilobed anteriorly, lacking rostral carina, cardiac prominence, and dorsal ovale. Eyestalk flattened, cornea almost distal. Scaphocerite of antenna 2 small. Maxilliped 3 ischium-merus subpediform, propodus and dactylus ovate; exopod present. Chelipeds asymmetrical, without meral hook. Pleopod 1 uniramous, biarticulate, distal segment bilobed distally in male, mesially convex in female. Pleopod 2 foliaceous, biramous, endopod with appendix interna in female, and with appendix interna and masculina in male. Pleopods 3–5 similar, foliaceous, endopod with stubby appendices internae. Uropodal exopod bilobed, with lateral notch, and with dorsal plate.

Typespecies: *Paraglypturus calderus* sp. nov.

Remarks: The present new genus is closely related to *Glypturus* Stimpson 1866. As in *Glypturus* the carapace bears neither a rostral carina, nor a cardiac prominence. Common features are that the male 1st pleopod is biarticulate, the distal segment is distally bilobed, and the male 2nd pleopod is provided with the appendix interna and masculina. However, in *Glypturus* the frontal margin of the carapace is trilobed, the 3rd maxilliped is provided with an oval propodus, a slender dactylus, but not with an exopod, while in *Paraglypturus* the carapace bears no paired lateral spines on the frontal margin, the 3rd maxilliped has both an oval propodus and dactylus, and there is a distinct exopod.

Paraglypturus calderus sp. nov.

Figs. 2–6

Holotype: ♂ [TL/CL 42.0/10.0] (SMF 22947), Marianas, North rim of Esmeralda Caldera, Stat. So 69/28GTVA (14°58.30'N 145°15.14'E), 63 m depth, porewater >50°C, 21. VII. 1990, R.V. "SONNE".

Allotype: ovig. ♀ [TL/CL 34.0/8.0] (SMF 22948), same locality as holotype.

Paratypes: 1 ♂ [CL 10.0, posterior part of abdomen behind segment III lacking] (SMF 22949), 6 ♂ [TL/CL 32.0/8.0–15.0/4.0], 5 FFF includ. 3 ovig. FFF [TL/CL 28.2/7.0–20.0/5.0] (SMF 22950), same locality as holotype. – 1 ♂ [TL/CL 41.0/9.0] (SMF 22951), 1 ovig. ♀ [TL/CL 42.9/9.5] (SMF 22952), 4 ♂ [TL/CL 36.0/9.0–24.0/6.0], 9 ♀ includ. 3 ovig. ♀ [TL/CL 43.0/9.0–18.0/4.0], 16 juvs. (SMF 22953), Marianas, North rim of Esmeralda Caldera, Stat. So 69/29 GTVA (14°58.38'N 145°15.05'E), 114 m depth, porewater temperature 50–78.5°C, 21. VII. 1990. R.V. "SONNE".

Description of male holotype: Rostrum (Fig. 3a–e) indistinct, lateral projections absent. Carapace as long as abdominal somites 1 and 2 combined, flat, lacking rostral carina and dorsal oval, and with an anterolateral row of setal pores; cervical groove distinct, located slightly behind midline. Linea thalassinica complete from anterior to posterior margin, parallel on both sides of carapace. No cardiac prominence.

Eyestalk flattened dorsoventrally, indented laterally towards subacute tip, about twice as long as wide, reaching distal margin of antennular article 1; cornea hemispheric, subterminal, and brownishly pigmented. Antennular peduncle unarmed, article 3 shorter than article 2, which is slightly shorter than article 1; flagella about 1.6 times length of peduncle. Antennal peduncle overreaching antennular peduncle by distal part of antennal article 4; scaphocerite a small, rounded plate.

Relative lengths of abdominal somites 1–6 and telson (Fig. 2) are 1:1.5:1:0.9:1:1.5:0.8. Abdominal somite 1 subtriangular dorsally; pleuron extending posterolaterally to protopod of pleopod 1. Abdominal somite 2 subquadrate dorsally; pleuron produced posterolaterally, with tuft of setae near rounded posterolateral angle. Abdominal somites 3–5 quadrate dorsally, pleura produced into a rounded

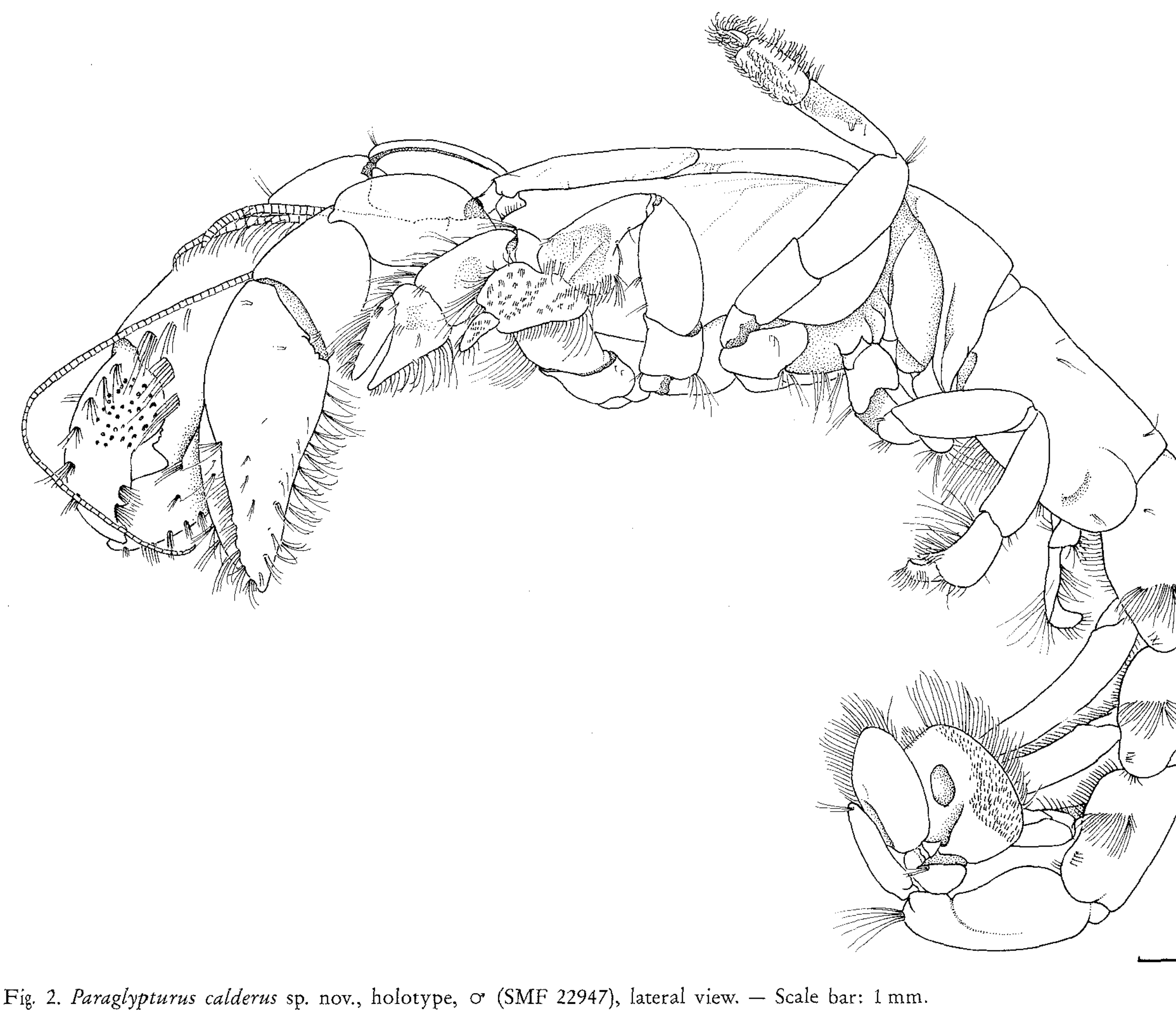

Fig. 2. *Paraglypturus calderus* sp. nov., holotype, ♂ (SMF 22947), lateral view. — Scale bar: 1 mm.

Abb. 2. *Paraglypturus calderus* sp. nov., Holotypus, ♂ (SMF 22947), lateral. — Maßstab: 1 mm.

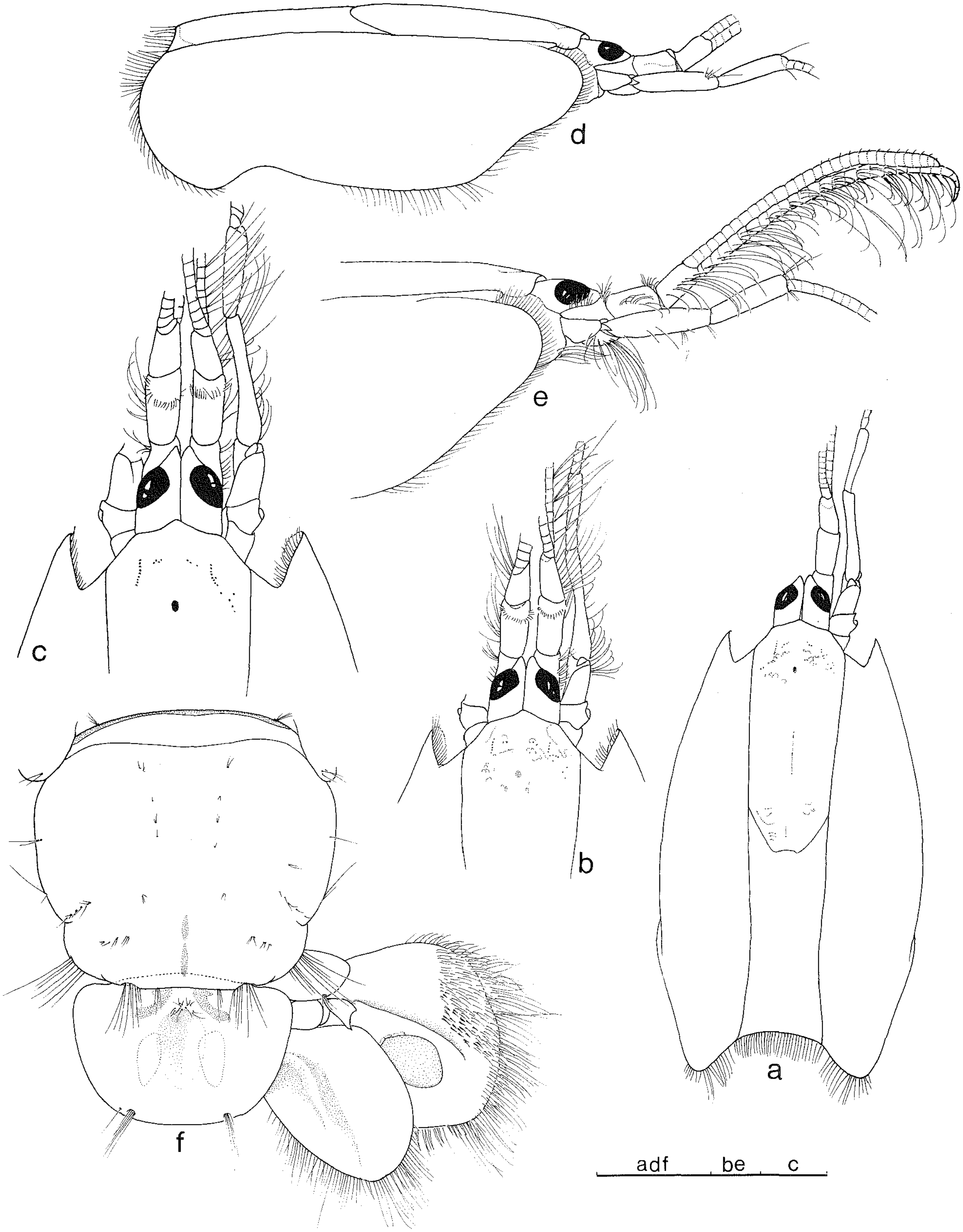

Fig. 3. *Paraglypturus calderus* sp. nov. a, b, d, e, f, holotype, ♂ (SMF 22947), c. paratype, ♂ (SMF 22949). — a. carapace, dorsal view; b. anterior part of carapace; c. same; d. carapace lateral view; e. anterior part of carapace; f. abdominal somite 6 and tail fan, dorsal view. — Scale bar: 1 mm.

Abb. 3. *Paraglypturus calderus* sp. nov. a, b, d, e, f, Holotypus, ♂ (SMF 22947), c. Paratypus, ♂ (SMF 22949). — a. Carapax, dorsal, b. vorderer Teil des Carapax; c. id.; d. Carapax, lateral, e. vorderer Teil des Carapax; f. Hinterleibssegment VI und Schwanzfächer, dorsal. — Maßstab: 1 mm.

posterolateral angle, with circular patches of fine setae in posterior third of abdominal somite 3, in midline of abdominal somites 4–5, and with tufts of setae near posterolateral angles. Abdominal somite 6 broader than long, broadened anteriorly with rounded lateral margins; mid-dorsal groove distinct in posterior fourth, and posterolateral groove visible also in posterior fourth; paired posterior transverse and paired median lines of soft setae present. Telson (Fig. 3f) 1.5 times as broad as long, tuft of setae at anterior fourth of mid-dorsal line, behind which the surface is largely impressed, and pair of setal tufts on posterolateral margin.

Mandible (Fig. 4a–b) with a three segmented palp. Maxilla 1 (Fig. 4c) with biarticulate palp, distal segment deflexed from proximal one. Maxilla 2 (Fig. 4d) with slender simple palp; scaphognathite broad. Maxilliped 1 (Fig. 4e) with slender palp; epipod large and triangular. Maxilliped 2 (Fig. 4f) with simple exopod extending beyond carpus of endopod; rudimentary epipod with rudimentary podobranch (Fig. 4g). Maxilliped 3 (Fig. 4h) subpediform, bearing an exopod; ischium 1.8 times as long as broad, proximal angle produced triangularly on mesial margin, crista dentata with a row of irregularly spaced teeth (Fig. 4i); merus slightly shorter than ischium. Carpus triangular, 0.7 times merus length. Propodus subquadrate, broader than long, and convex on mesial margin. Dactylus slightly longer than propodus and about as long as broad, rounded on its distal margin, dense setae on its distolateral part. Exopod consisting of proximal segment, and multiarticulate flagellum reaching to distal part of carpus.

Pereiopods 1 chelate, asymmetrical. In larger cheliped (Fig. 5a–b) ischium unarmed, its mesial surface with uncalcified groove submarginally along both dorsal and ventral margins. Merus slightly broader and longer than ischium, unarmed, its mesial surface with an uncalcified submarginal groove along dorsal margin, and another submarginal one in proximal half along ventral margin, turning towards ventral margin in distal half. Carpus 0.7 times as long as merus, 1.3 times as broad as long, mesial surface with broadly uncalcified proximal part ventrally below articulation with merus. Chela about three times as long as carpus. Palm about as long as broad. Fixed finger thick, cutting edge armed with square proximal tooth, smooth, with large concavity subproximally, and irregularly denticulate in its distal half. Dactylus slightly shorter than palm, thick, twice as long as broad; lateral surface with a submarginal row of five setal tufts along cutting edge reaching midline; mesial surface characteristically studded with uncalcified pits in proximal half, with row of seven setal tufts along dorsal margin and two setal tufts along cutting edge in proximal half; cutting edge sigmoid, smooth in proximal half, and straight, denticulate in distal half.

In smaller cheliped (Fig. 5c) ischium same as in larger cheliped. Merus about as long as ischium, 1.5 times as long as broad, convex on dorsal and ventral margins; mesial surface with uncalcified groove as in larger cheliped. Carpus 0.6 times as long as merus, and 0.7 times as long as broad, mesial surface with uncalcified part as in larger cheliped. Chela 3.5 times as long as carpus; fixed finger simple, lateral surface with row of setal tufts along cutting edge, cutting edge smooth, bevelled. Dactylus slender, 1.6 times as long as palm, with subproximal triangular tooth on cutting edge; lateral surface with a row of setal tufts reaching from environs of cutting edge to dorsal margin.

Pereiopod 2 (Fig. 5d) chelate. Pereiopod 3 (Fig. 5e) simple. Carpus triangular, broadest distally. Propodus about 0.5 times length of carpus, dorsal margin largely rounded, and ventral margin with rounded proximal heels, bevelled distally towards dactylus; lateral surface setose. Dactylus small, 0.5 length of propodus, lateral surface setose. Pereiopod 4 (Fig. 5f) simple. Propodus 0.7 length of carpus, 1.5 times as long as broad, setose on lateral surface. Dactylus less than 0.5 length of propodus. Pereiopod 5 (Fig. 5g) subchelate. Propodus about 0.7 length of carpus, largely convex on dorsodistal margin, and with ventrodistal projection. Dactylus 0.4 times as long as propodus; ventral margin incurved with subterminal hook.

Pleopod 1 (Fig. 6a) biarticulate; proximal segment about two times as long as broad, distal segment 0.8 times length of proximal one, 1.3 times as long as broad, distal margin broadened, bilobed with a median concavity, distal lobe rounded on distal margin and proximal one flattened, distally with a row of setae. Pleopod 2 (Fig. 6b) biramous, foliaceous; exopod elongated, about three times as long as broad; endopod 1.2 times as long as broad, shorter than exopod; appendix interna strap-shaped, distally with a row of setae, attached proximally to a small appendix masculina (Fig. 6c) posteriorly.

Pleopods 3–5 biramous, foliaceous; exopod slender, three times as long as broad. Endopod triangular, 1.8 times as long as broad, shorter than exopod, and with stubby appendix interna on mesial margin.

Uropodal endopod (Fig. 3f) 1.3 times as long as broad, oval on distal margin, extending far beyond telson, and with weak median dorsal carina; exopod about as long as broad, largely convex on distal margin, upper dorsal plate well developed, armed with dense setae distolaterally, mesial suture distinct, and lower plate with rounded yellow-transparent circular structure centrally.

Description of female: The features of females are mostly similar to those of males.

Pleopod 1 (Fig. 6d) uniramous, biarticulate; proximal half of distal segment convex mesially, distal part bending posteriorly. Pleopod 2 (Fig. 6e) biramous, foliaceous, endopod and exopod broad, appendix interna finger-like. Pleopods 3–5 (Fig. 6f) as in male.

The eggs are attached only to the 1st pleopods in most of the females (1 ovig. [SMF 22948], 3 ovig. [SMF 22950], 3 ovig. [SMF 22953]) and are small in size, 0.2 mm in diameter. In one female [SMF 22952] the eggs are attached to the pleopods 1–5, they are transparent and moderate in size, measuring 0.5 mm in diameter.

Remarks: Some remarkable individual variation is observed in the present species.

The dactylus of the cheliped in males and females bears a lateral row of 5–6 setal tufts along the cutting edge. The yellow transparent circular structure on the lower plate of the uropodal exopod is present in larger males and females, but absent in smaller specimens.

Fig. 4. *Paraglypturus calderus* sp. nov. a–i, paratype, ♂ (SMF 22949). — a. mandible, lateral view; b. same, mesial view; c. maxilla 1, lateral view; d. maxilla 2, lateral view; e. maxilliped 1, lateral view; f. maxilliped 2, lateral view; g. epipod and podobranch of maxilliped 2; h. maxilliped 3, lateral view; i. ischium of maxilliped 3, mesial view. — Scale bar: 1 mm.

Abb. 4. *Paraglypturus calderus* sp. nov. a–i, Paratypus, ♂ (SMF 22949). — a. Mandibel, lateral; b. id., mesial; c. Maxille 1, lateral; d. Maxille 2, lateral; e. Maxilliped 1, lateral; f. Maxilliped 2, lateral; g. Epipodit und Podobranchie des 2. Maxillipeden; h. Maxilliped 3, lateral; i. Ischium des 3. Maxillipeden, mesial. — Maßstab: 1 mm.

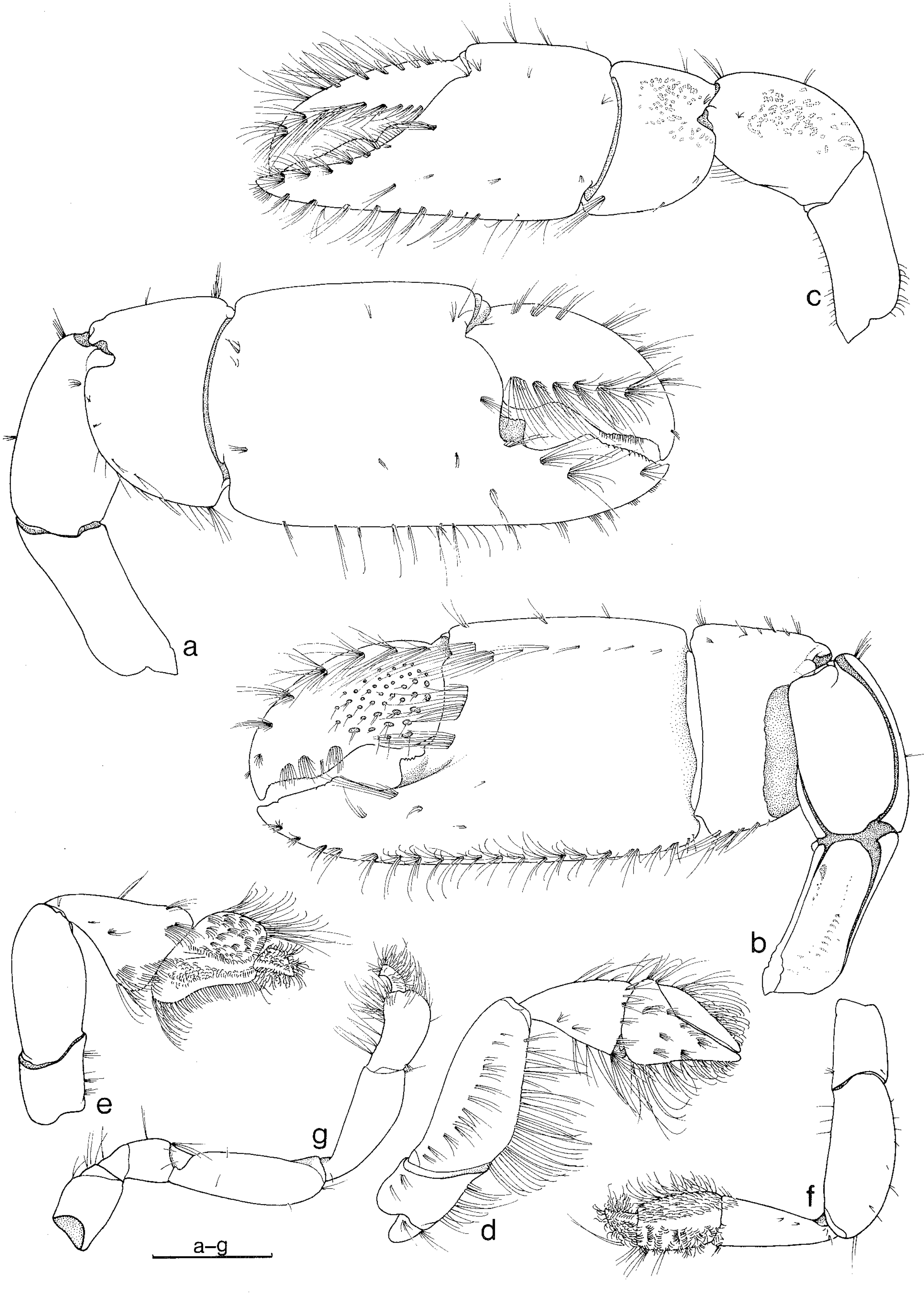

Fig. 5. *Paraglypturus calderus* sp. nov. a–g, paratype, ♂, (SMF 22949). — a. larger cheliped, lateral view; b. same, mesial view; c. smaller cheliped, lateral view; d. pereiopod 2, lateral view; e. pereiopod 3, lateral view; f. pereiopod 4, lateral view; g. pereiopod 5, lateral view. — Scale bar: 1 mm.

Abb. 5. *Paraglypturus calderus* sp. nov. a–g, Paratypus, ♂, (SMF 22949). — a. Größerer Cheliped, lateral; b. id., mesial; c. kleinerer Cheliped, lateral; d. Pereiopod 2, lateral; e. Pereiopod 3, lateral; f. Pereiopod 4, lateral; g. Pereiopod 5, lateral. — Maßstab: 1 mm.

Fig. 6. *Paraglypturus calderus* sp. nov. a–c, paratype, ♂ (SMF 22949); d–f, ovig. female, allotype (SMF 22948). — a. left pleopod 1, lateral view; b. left pleopod 2, anterior view; c. appendix interna with appendix masculina of pleopod 2, mesial view; d. left pleopod 1, lateral view; e. left pleopod 2, posterior view; f. left pleopod 3, anterior view. — Scale bar: 1 mm.

Abb. 6. *Paraglypturus calderus* sp. nov. a–c, Paratypus, ♂ (SMF 22949); d–f, Allotypus, ovig. ♀ (SMF 22948). — a. Linker Pleopod 1, lateral; b. linker Pleopod 2, frontal; c. Appendix interna und Appendix masculina des 2. Pleopoden, mesial; d. linker Pleopod 1, lateral; e. linker Pleopod 2, caudal; f. linker Pleopod 3, frontal. — Maßstab: 1 mm.

Grapsidae

Xenograpsus novaeinsularis TAKEDA & KURATA 1977

Figs. 7–9; Tab. 1

1977 *Xenograpsus novaeinsularis* TAKEDA & KURATA, Bull. natn. Sci. Mus., (A, Zool.) 3 (2): 100, Figs. 6b–c, 7, 8.

Material: 11 ♂ 7 ovig. ♀ (SMF 22945), North rim of Esmeralda Caldera, Marianas, Stat. So 69/28GTVA (14°58.30'N 145°15.14'E), 63 m depth, porewater >50°C, 21. VII. 1990, R.V. *"SONNE"*. – 1 ♂ 1 ovig. ♀ (SMF 22946), Marianas, North rim of Esmeralda Caldera, Stat. So 69/29 GTVA (14°58.38'N 145°15.05'E), 114 m depth, porewater temperature 50°–78.5°C, 21. VII. 1990. R.V. *"SONNE"*.

Measurements: See Tab. 1

Remarks: The present species was originally described from Nishino-shima Shintoh as already mentioned in the introduction. The original description does not contain any information on the depth and ambient temperature of the locality. M. TAKEDA (Tokyo) kindly informed us that the type material was collected by Y. KURATA by SCUBA-diving in less than 5 m depth. The water temperature near to the bottom was not measured, but Y. KURATA reported that it was "remarkably warm". This qualitative statement was not enough to determine whether the occurrence of the species had any relationship with the high ambient temperature. Recently TAKEDA et al. (1993) reported on the rediscovery of the species in 5 m depth at Akuseki-jima, an island of the Tokara-group and in 23–26 m depth at Kita-Iwo-jima, an island of the Iwo group. In both cases the association with shallow water hydrothermal springs was recorded. The crabs were found "under the rocks covered with sulphureous waste and washed by bubbles in shallow water thermal spring". In both cases ambient water temperatures were at about 30°C and thus well above those of the surrounding water. Our material confirms that the species is associated with active volcanic warm water areas and might have a larger distribution in the Western Pacific.

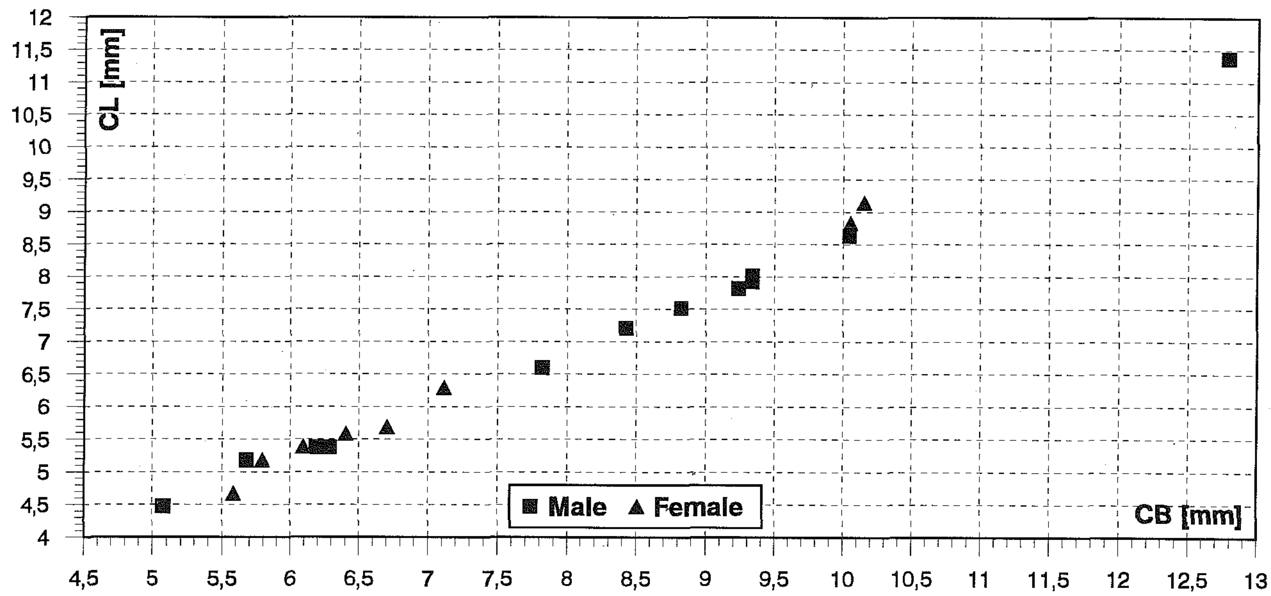

Fig. 7. *Xenograpsus novaeinsularis,* Histogram plotting carapace length (CL) against carapace breadth (CB).

Abb. 7. *Xenograpsus novaeinsularis,* graphische Darstellung der Abhängigkeit der Carapaxlänge (CL) von der Carapaxbreite (CB).

Table 1. Measurements of *Xenograpsus novaeinsularis* from Esmeralda-Bank, Marianas. — CB = carapace breadth; CL = carapace length; FFF = female; MMM = male.

Tabelle 1. Maße von *Xenograpsus novaeinsularis* von der Esmeralda-Bank, Marianen. — CB = Carapaxbreite; CL = Carapaxlänge; FFF = Weibchen; MMM = Männchen.

CB (mm)	CL (mm)	Sex	CB/CL
So-69/28-GTVA SMF 22945			
5.08	4.47	MMM	1.14
5.68	5.18	MMM	1.10
5.79	5.18	FFF	1.12
6.09	5.38	FFF	1.13
6.29	5.38	MMM	1.17
6.40	5.58	FFF	1.15
6.70	5.68	FFF	1.18
7.11	6.29	FFF	1.13
7.82	6.60	MMM	1.19
8.43	7.21	MMM	1.17
8.83	7.51	MMM	1.18
9.24	7.82	MMM	1.18
9.34	8.02	MMM	1.17
9.34	7.92	MMM	1.18
10.05	8.63	MMM	1.17
10.05	8.83	FFF	1.14
10.15	9.14	FFF	1.11
12.79	11.37	MMM	1.13
So-69/29-GTVA SMF 22946			
5.58	4.67	FFF	1.20
6.19	5.38	MMM	1.15

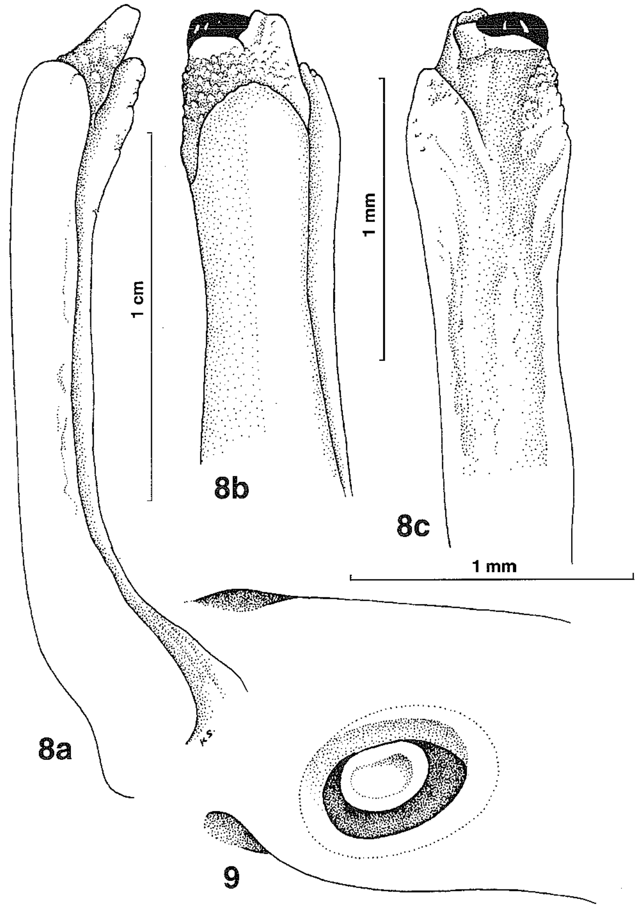

Fig. 8. *Xenograpsus novaeinsularis*, SMF 22945, first male pleopod. — a. Total, mesial aspect; b. distal part, ventral aspect; c. distal part, dorsal aspect.

Abb. 8. *Xenograpsus novaeinsularis*, SMF 22945, erster Gonopod. — a. Totalansicht, mesial; b. Distalteil, ventral; c. Distalteil, dorsal.

Fig. 9. *Xenograpsus novaeinsularis*, SMF 22945, female, left genital duct.

Abb. 9. *Xenograpsus novaeinsularis*, SMF 22945, linke weibliche Geschlechtsöffnung.

Discussion

Animals living in high temperature environments have clear upper lethal temperature boundaries. Odum (1983: 526) cites 50°C as the limit for fishes and insects, while microorganisms can tolerate much higher values. There are absolute limits determined by the denaturation temperatures of proteins beyond 70°C. Investigations in deep sea hydrothermal vents summarized by Childress & Fisher (1992) showed that all species able to tolerate high temperatures show preferences for much lower ones. In fact, alvinellid tube worms have maximal sustained body temperatures below 50°C. The temperatures of 50–78°C measured in the grab pore-water are, therefore, unlikely to equal the ambient temperatures in which the decapod species reported upon in this paper live. Probably, the surface sediment layers show a steep temperature gradient destroyed by the action of the grab. However, at least the occurrence of *Xenograpsus novaeinsularis* in two different high temperature environments shows that there are some specific faunal assemblages in such systems. This is supported by the fact that both species were still living in the grab, though they would have probably not survived the temperature stress for a longer period. Investigations into the physiology of such species are the only way to study the question of temperature adaptation and the possible attachment to other physico-chemical factors caused by the volcanic environment. If such adaptations could be shown, it would be interesting to study dispersal mechanisms which are also not fully understood in deep sea hydrothermal systems. In the grapsid crab all females, even the smallest, were ovigerous and this suggests a high fecundity and early larval production.

Shallow water marine hot springs have been studied in a number of cases (e.g. FRICKE et al. 1989). Always it was found that "normal" fauna abounded and clustered around such sources, reflecting the high production and food availability. If the species dealt with in this paper prove to be restricted to hot water environments of shallow depth, this would be the first time that a specific and adapted fauna is recorded outside the deep sea vents.

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References

CHILDRESS, J. J. & FISHER, C. R. (1992): The biology of hydrothermal vent animals: physiology, biochemistry, and autotrophic symbioses. — Oceanogr. mar. Biol. ann. Rev., **30**: 337–441, figs. 1–12.

FRICKE, H. & GIERE, O. & STETTER, K. & ALFREDSSON, G. A. & KRISTJANSSON, J. K. & STOFFERS, P. & SVAVARSSON, J. (1989): Hydrothermal vent communities at the shallow subpolar Mid-Atlantic ridge. — Mar. Biol., **102**: 125–129; Berlin.

KIDO, T. & KOIKE, Y. (1975): On the survey in the inlet of "Nisinosima-Sin To". — J. Tokyo Univ. Fisheries, **61** (1–2): 41–47, figs. 1–5; Tokyo.

KIDO, T. & NAKAMURA, Y. & KOIKE, Y. (1975): On the survey of the geographical azimuth and the topography of the coastal line on the islands of "Nisi-no-sima". — J. Tokyo Univ. Fisheries, **61** (1–2): 31–36, figs. 1–6; Tokyo.

MARITIME SAFETY AGENCY OF JAPAN (1993): Coastal Sea Bottom Map 1:50,000. — Report on investigations in Geography and Topography of Nishino-shima in May 1993. — [in Japanese.]

NAKAMURA, Y. & KOIKE, Y. (1975): On the change of the bottom topography in the surrounding area of the island "Nisi-no-sima". — J. Tokyo Univ. Fisheries, **61** (1–2): 37–40, figs. 1–3; Tokyo.

ODUM, E. P. (1983): Grundlagen der Ökologie, **1–2**: XXVI + 836 pp.; Stuttgart, New York (Thieme).

PUTEANUS, D. & BLOOMER, SH. & TAIBI, N. E. & NEUMANN, T. & BENDEL, V. & PÜSCHEL, U. & BARONE, A. & LANGE, A. (1990): Hydrothermalism of the Esmeralda Caldera. — Ber. geol.-paläontol. Inst. Univ. Kiel, **42**: 95–104, figs. 38–43, tabs. 12–13; Kiel.

PUTEANUS, D. & BLOOMER, SH. & WU, SH. (1990): Cruise Report SONNE 69 – Geochemical, hydrochemical and petrographical investigations in the Mariana back-arc area under hydrothermal aspects. Port Moresby – Saipan 26.6.–8.8.1990. — Ber. geol.-paläontol. Inst. Univ. Kiel, **42**: I–III, 1–231, figs. 1–43, tabs. 1–14; Kiel.

STERN, R. J. & BIBEE, L. D. (1984): Esmeralda Bank: Geochemistry of an active submarine volcano in the Mariana Island Arc. — Contrib. Mineral. Petrol., **86**: 159–169, figs. 1–8, tabs. 1–6; Berlin, Heidelberg, New York, Tokyo (Springer).

STIMPSON, W. (1866): Descriptions of new genera and species of macrurous Crustacea from the coasts of North America. — Proc. Chicago Acad. Sci., **1**: 46–48; Chicago.

STÜBEN, D. & BLOOMER, S. H. & TAIBI, N. E. & NEUMANN, TH. & BENDEL, V. & PÜSCHEL, U. & BARONE, A. & LANGE, A. & WU SHIYING & LI CUIZHONG & ZHANG DEYU (1992): First results of study of sulphur-rich hydrothermal activity from an island-arc environment: Esmeralda Bank in the Mariana Arc. — Mar. Geol., **103**: 521–528; Amsterdam.

TAIBI, N. E. (1992): Meeresbodenkartierung und Untersuchungen zum Hydrothermalismus im Marianen "Back-arc" Trog und im Bereich der Esmeralda Caldera, NW-Pazifik. — Ber. geol.-paläontol. Inst. Univ. Kiel, **52**: 192 pp.; Kiel.

TAKEDA, M. & KURATA, Y. (1977): Crabs of the Ogasawara Islands. IV. A collection made at the new volcanic island, Nishino-shima-shinto, in 1975. — Bull. natn. Sci. Mus., (A, Zool.) **3** (2): 91–111, figs. 1–9; Tokyo.

TAKEDA, M. & TAKEUCHI, H. & SUGANUMA, H. (1993): Occurrence of *Xenograpsus novaeinsularis* TAKEDA et KURATA (Crustacea: Decapoda: Brachyura) in the Tokara and Iwo Islands. — Natur. Envir. Sci. Res., **6**: 59–64; Kawasaki.