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New Distribution Records of the Pearlfish, *Carapus mourlani*, with Notes on Its Morphometry

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In the course of a study on pearlfishes, I had an opportunity to examine 18 specimens of *Carapus mourlani* collected from the cushion starfish, *Culcita novaeguineae*, and from the holothurian, *Bohadschia argus*, on coral reefs in sourthern Japan, Taiwan and the Marshall and Caroline Islands. I also examined four additional *C. mourlani* collected from the gut of a single specimen of the crown-of-thorns starfish, *Acanthaster planci*, on coral reefs in Iriomote Island.

In this paper, I report these 22 specimens and compare them with other reports. Though *C. mourlani* is found in the Indo-Pacific area (Trott, 1981), the Japanese and the Caroline Islands specimens represent new records of this pearlfish. Shen and Yeh (1987) reviewed the pearlfishes of Taiwan, but they did not mention the occurrence of *C. mourlani*. Thus, *C. mourlani* is added here to the ichthyofauna of Taiwan. The habitation within the crown-of-thorns starfish represents the second finding. I also found 11 proportional measurements that exhibit positive allometric growth. The result of logarithm regression is discussed in some detail.

Methods of counting and measuring follow those of Trott (1970). Soft X-ray was used for counting vertebrae and for observing the otolith.

The specimens examined are deposited in the following museums: BSKU—Department of Biology, Faculty of Science, Kochi University; IORD—Institute of Oceanic Research and Development, Tokai University; NSMT—National Science Museum, Tokyo.

Carapus mourlani (Petit, 1934)

(New Japanese name: Kazari-kakureuo)

(Figs. 1, 2)

Fierasfer Mourlani Petit, 1934: 393, fig.

Carapus pindae Smith, 1955: 412, fig. 7; Arnold, 1956: 277.

Carapus homei: Smith, 1955: 414 (in part); Arnold, 1956: 273 (in part).

Carapus mayottae Smith, 1955: 415, fig. 8.

Carapus mourlani: Schultz, 1960: 393, pl. 120E; Smith, 1964: 35; Trott, 1970: 15, pls. 6, 13, 16A; Jones and Kumaran, 1970: 192, fig. 1f; Trott and Trott, 1972: 840; Meyer-Rochow, 1977: 582, fig. 1; Cohen and Nielsen, 1978: 8; Jones and Kumaran, 1980: 543, fig. 463; Gordon et al., 1984: 314; Olney and Markle, 1986: 352, fig. 97.3.

Material examined. BSKU 45042, 97.6 mm total length (TL), male, host—*Culcita novaeguineae*, coral reefs at Aka-saki, Yoron Island (27°95′N, 128°25′E), the Amami Islands, southern Japan, 3–4 m in depth, free-diving, June 2, 1988; IORD 84–142, 4 specimens, 61.9–83.9 mm TL, sexes not determined, host—*Acanthaster planci*, coral reefs at Sakiyama Bay, Iriomote Island (24°20′N, 123°40′E), the Sakishima Islands, Japan, 3–4 m in depth, free-diving, June 12, 1984; NSMT-P 22930, 77.2 mm TL, male, host—*C. novaeguineae*, Bwokwtoonal Island, Majuro Atoll, the Marshall Islands, Aug. 6, 1982; NSMT-P 22931, 88.3 mm TL, male, host—*C. novaeguineae*, Ponape Island, the Caroline Islands, dredging, 30 m in depth, Jul. 29, 1982. Fifteen BSKU specimens from west coast of Liuchiu Island (22°20′N, 120°21′E), southwestern Taiwan, depth ranging from 15 to 20 m, diving: 45152–45155, 114.8–170.0 mm TL, 4 males, host—*C. novaeguineae*, Sep. 29, 1988; 45164–45167, 105.4–163.2 mm TL, 3 females and 1 male, host—*Bohadschia argus*, Sep. 30, 1988; 45168–45174, 96.1–177.4 mm TL, 4 females and 3 males, host—*C. novaeguineae*, Sep. 30, 1988.

Description. Counts and measurements are given in Table 1. Body slender (Fig. 1); head and body compressed. Maxillary free from suborbital posteriorly, extending backward half an eye diameter beyond posterior margin of eye. Eye circular to slightly elliptical, nearly equal to or slightly longer than snout length. Interorbital space weakly convex. Upper jaw with 2 sharp, conical tooth rows, becoming short posteriorly; anteriormost one enlarged, curved inwardly. Anterior part of dentary with 5 to 6 sharp, conical, slightly recurved teeth and 3 tooth rows behind them. The teeth in the outermost row much enlarged than those in the anterior ones, others very small and with a blunt tip. Palatine with 2 rows of short, conical teeth. Prevomer with 1 to 4 fangs. Three developed gill rakers on first arch. Two short pseudobranchiae. Tongue long, the tip pointed. Otolith large, scallop-shaped (Fig. 2). Pyloric caecum absent.

Dorsal fin very low, its origin one postorbital length of head behind posterior margin of head.

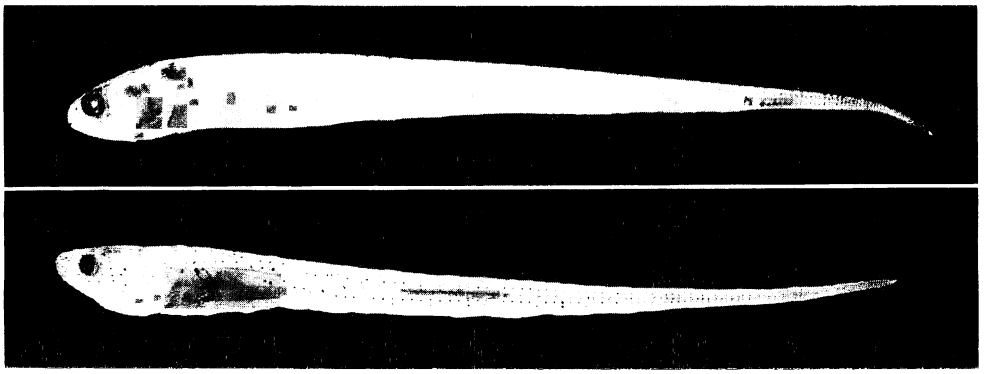

Fig. 1. *Carapus mourlani*. Top: BSKU 45042, 97.6 mm total length, found in the cushion starfish, *Culcita novaeguineae*, from Yoron Island; bottom: IORD 84–142, 83.9 mm total length, found in the crown-of-thorns starfish, *Acanthaster planci*, from Iriomote Island.

Fig. 2. X-ray photograph of *Carapus mourlani*, BSKU 45042, clearly showing a scallop-shaped otolith.

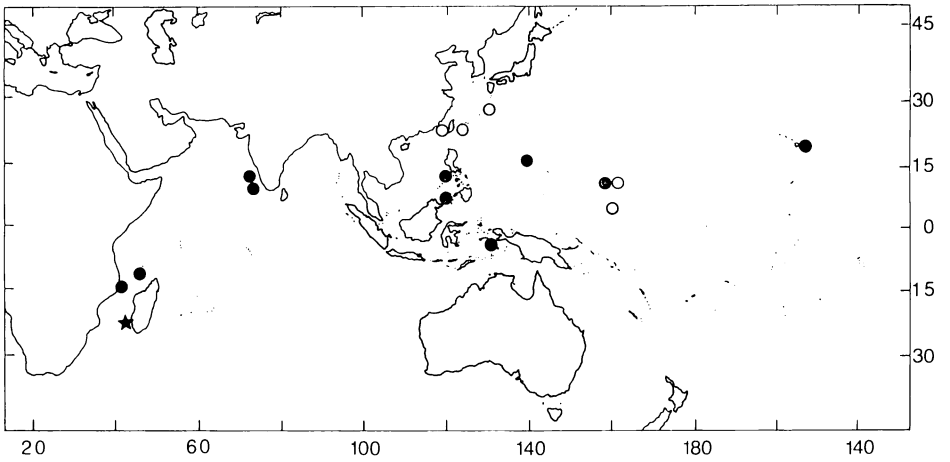

Fig. 3. Distribution of *Carapus mourlani*. ★, type locality; ●, other previous records; ○, present records.

Vent anterior to the base of pectoral fin. Anal fin origin just behind vent. Pectoral fin round, well developed.

Color in life: Head and body translucent with relatively large black melanophores; large silvery patches on body behind pectoral fin arranged in a single row. Color in alcohol: Head and body whitish, light-brown melanophores present on top and underside of head, and sides of head and body; all fins pale; mouth and gill cavities whitish; peritoneum silvery with small, dark-brown spots; intestine whitish.

Table 1. Comparison of proportional measurements and meristic counts of *Carapus mourlani* from different localities. *After Trott (1970); **after Trott and Trott (1972). *C. novae.*=*Culcita novaeguineae*; *A. planci*=*Acanthaster planci*; *B. argus*=*Bohadschia argus*. SE=standard error.

Localities Hosts	Yoron Is. *C. novae.*	Iriomote Is. *A. planci*		Liuchiu Is. *C. novae.* *B. argus*		Marshall Is. *C. novae.*	Caroline Is. *C. novae.*	Guam* *C. novae.* *B. argus*	Philippines** *C. novae.*	
Total length (mm)	97.6	61.9–83.9		83.1–177.4		88.3	77.2	65–165	74–112	
Measurements		mean	range	mean	range			mean±SE	mean	range
In % of total length										
Head length	15.2	14.4	13.4–14.9	15.7	14.3–17.6	14.6	14.9	15.7±0.2	14.1	13–16
Preanal length	13.8	12.8	12.2–13.4	14.3	12.9–16.5	13.7	13.4	14.7±0.3	13.1	12–15
In % of head length										
Body depth	56 8	54.9	52.7–57.0	64.7	51.9–78.5	57.1	55.2	63.7±3.2	60.3	55–68
Head depth	54.7	52.4	50.2–57.0	55.7	47.6–62.0	54.1	49.6	58.5±1.0	57.3	49–66
Head width	40.5	33.4	32.1–34.6	46.2	40.0–55.9	41.7	39.1	48.9±2.3	46.1	39–53
Snout length	18.6	20.7	20.5–21.2	20.4	17.4–23.0	20.1	20.9	18.8±0.2	22.1	20–26
H. orbit diam.	21.3	19.2	17.2–20.5	20.9	19.0–24.1	20.1	17.4	16.1±0.5	15.6	11–19
V. orbit diam.	21.3	18.1	16.1–20.5	20.5	19.0–22.1	17.8	14.8	16.2±0.5	15.6	12–19
Interorbital width	15.5	17.2	15.0–18.7	16.5	13.9–19.1	16.2	17.4	14.8±0.6	18.1	14–21
Maxillary length	50.0	49.3	48.7–50.0	50.1	48.3–54.4	49.4	47.4	47.2±0.7	49.0	45–56
Pectoral fin length	43.9	43.3	41.6–44.9	41.2	33.6–52.6	42.5	42.6	42.9±1.6	47.4	42–54
Counts					mode					
Branchiostegal rays	7	7		7		7	7	7		
Pseudobranchiae	2	2		2		2	2	2		
Olfactory rosettes (pairs)	15	15		15–17	15	15	15	15		
Precaudal vertebrae	17	16–17		15–17	15	15	15	15–17		
Total vertebrae	114	110–115		94–115	110	104	112	102–114		
Pectoral fin rays	19	19		18–20	19	19	19			

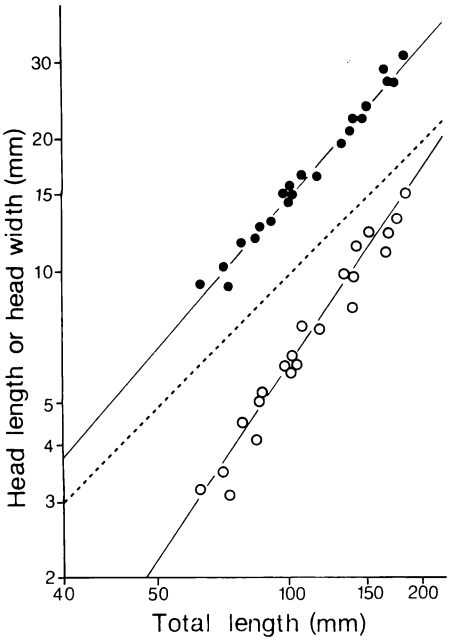

Fig. 4. Relationship of head length (●) and head width (○) to total length in *Carapus mourlani*. Broken line: *log* y=*log* x.

Distribution. This species is widely distributed in the temperate and tropical seas of the Indo-Pacific area from off Mozambique to the Hawaiian Islands (Fig. 3).

Remarks. Detailed proportional measurements and meristic counts of *Carapus mourlani* from Guam were given by Trott (1970). For nine additional specimens from the Philippines, Trott and Trott (1972) reported proportional measurements. These are shown and compared with the present materials in Table 1. Proportional dimensions of the present specimens agree well with their studies except for the head width in four specimens, IORD 84–142, which were collected from the crown-of-thorns starfish.

It should be noted that the proportional measurements given in Table 1 show rather wide intraspecific variation. Eleven proportional measurements in the present material were analysed in relation to the total length. These characters were studied by calculating the exponential function *log* y=b *log* x+a, where x is the total length in mm, y the character in question in mm, b the slope, and a the y-axis intercept. The results are shown in Table 2. Each slope of the linear regres ion is greater than 1, suggesting that all of these characters exhibit positive allometric growth. In the present specimens, the head length expressed in percent of the total length ranges from 13.4 to 17.6 (Table 1). This character apparently exhibits positive allometric growth: slope=1.152±0.027 (SE) (Table 2, Fig. 4). The largest value for the slope was obtained in the relationship between the head width and the total length. This clearly shows that the head width in percent of the head length exhibits the widest variation in the proportional measurements examined. This also means that the narrowest head width in the smallest specimens found in the crown-of-thorns starfish is related to the allometric growth of this character (Fig. 4), and not to the different host species. Morphometric characters in *C. mourlani* exhibiting positive allometric growth may suggest that

Table 2. Summary of logarithmic regression analysis of 11 proportional measurements on total length (TL) in *Carapus mourlani*. SE: standard error; R: correlation coefficient; CL: confidence limit.

Character	Slope with SE	Intercept	R with SE	Estimate at 170 mm TL with 95% CL
Head length	1.152±0.027	−1.123	0.995±0.023	27.9 (25.6–30.5)
Preanal length	1.183±0.022	−1.228	0.997±0.018	25.7 (24.0–27.6)
Body depth	1.378±0.068	−1.794	0.977±0.048	19.0 (15.3–23.6)
Head depth	1.248±0.048	−1.582	0.986±0.038	15.9 (13.6–18.5)
Head width	1.517±0.067	−2.239	0.981±0.043	14.0 (11.2–17.3)
Snout length	1.117±0.056	−1.745	0.976±0.049	5.6 (4.7– 6.7)
H. orbit diam.	1.289±0.060	−2.091	0.979±0.046	5.0 (6.1– 7.4)
V. orbit diam.	1.333±0.066	−2.200	0.976±0.048	5.9 (4.8– 7.3)
Interorbital width	1.198±0.065	−1.999	0.972±0.052	4.7 (3.8– 5.8)
Maxillary length	1.204±0.031	−1.532	0.993±0.026	14.2 (12.9–15.8)
Pectoral fin length	1.193±0.072	−1.588	0.965±0.059	11.8 (9.4–15.0)

more careful attention should be given when comparing proportional measurements in other species of the genus *Carapus*.

Dentition in the present material generally agrees with the descriptions by Petit (1934), Schultz (1960), Jones and Kumaran (1970), and Trott (1970). The scallop-shaped otolith, considered as diagnostic in this species (Trott, 1970), of the present material closely resembles the figures presented by Trott (1970), Meyer-Rochow (1977), and Meyer-Rochow and Tiang (1978). Pigmentation on the head and body of the present material is almost similar to the figures by Smith (1955: fig. 7, reported as *C. pindae*), Schultz (1960), Smith (1964), Jones and Kumaran (1970, 1980), Trott (1970), Meyer-Rochow and Tiang (1978), and Olney and Markle (1986). Moreover, the counts of the olfactory rosettes of the study material agree well with Trott's description. Total vertebral counts in the present specimens, however, have a greater range than in Trott's report.

The cushion starfish, *Culcita novaeguineae*, is a preferred host of this pearlfish (Trott, 1981): there are many findings of *C. mourlani* from this starfish (Schultz, 1960; Smith, 1964; Trott, 1970; Jones and Kumaran, 1970, 1980; Trott and Trott, 1972; Meyer-Rochow, 1977, 1979; Meyer-Rochow and Tiang, 1978). Furthermore, the holotype of *C. mourlani* was found in a *Culcita* sp. (Petit, 1934). *C. mourlani* was reported to occur in 90% of the *C. novaeguineae* sampled by Trott (1970), and in 16% of those sampled by Trott and Trott (1972). In this study, every cushion starfish collected on coral reefs in Liuchiu Island, Taiwan, contained one pearlfish, totaling to 11 *C. mourlani*. This pearlfish, however, is rarely found in the holothurians, *Stichopus variegatus* (Trott, 1970) and *Bohadschia argus* (Trott, 1970; Meyer-Rochow, 1977, 1979). Smith (1955) reported that *C. pindae* (=*C. mourlani*) was found in a large holothurian. I dissected four samples of *B. argus* taken from Linchiu Island, and obtained four individuals of *C. mourlani* from their respiratory tree: a single *B. argus* contained two *C. mourlani* and one *Encheliophis gracilis*. Cheney (1973) reported three adult specimens of *C. mourlani* taken from partly and completely dissected (n=450) and aquarium-held crown-of-thorns starfish, *A. planci*. The present finding of *C. mourlani* from *A. planci* is based on more than 500 dissected starfishes by Mr. Kohno (Kishimoto, pers. comm.). Geographical distribution of this pearlfish is apparently related to these holothurians and asteroids. The northernmost locality of *C. mourlani* previously known is Oahu Island (Schultz, 1960). Though the present finding from Yoron Island represents the northernmost record of this species at present, the actual range of *C. mourlani* may extend to much higher latitudes because its major host, *C. novaeguineae*, is distributed up to the southwestern area of Shikoku Island, and *A. planci*, a minor host, is known from the Kii Peninsula southward in Japan (Nishimura and Suzuki, 1971).

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カザリカクレウオ（新称）の新産地とその相対成長

町田吉彦

与論島，西表島，台湾の琉球島，マーシャル群島およびカロリン諸島のマンジュウヒトデ，ジャノメナマコ，オニヒトデから得られた総計 22 個体のソコカクレウオ属の標本を検討した．これらの標本は，計測形質，体節形質，歯の形状と配列，耳石の輪郭，頭部と体部の色彩が *Carapus mourlani* の従来の記載とよく一致し，全て本種と同定された．本種にその色彩的特徴に由来する新和名カザリカクレウオを与える．本報告で扱った 11 の計測計質について全長との関係で回帰式を求めた結果，全ての形質が不等成長をすることが判明し，頭幅の回帰係数が最も高い値となった．総脊椎骨数は従来の報告より明らかに変異幅が広かった．本種はマダガスカルを模式産地とし，インド・太平洋域に広く分布するが，与論島，西表島，琉球島，カロリン諸島は新産地である．本種の発見例はそのほとんどがマンジュウヒトデからであるが，ジャノメナマコ，タマナマコ，オニヒトデからの若干の報告があり，本報告はオニヒトデに関する第 2 番目の記録でもある．従来の報告ではハワイのオアフ島が本種の最北端の産地であり，与論島が確認された最も北の産地となる．しかし，本種の発見例が最も多いマンジュウヒトデが四国南西部までに，また，極めて稀な宿主ではあるがオニヒトデが紀伊半島までに分布することから，本種が与論島以北に分布している可能性は十分にある．

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編　集　後　記・Editorial notes

36 巻も，多くの皆様のご協力により，なんとか 4 号までを出すことができました．本巻掲載論文は下記の先生方のご校閲をいただきました．ここに厚く御礼申し上げます．

G. R. Allen, N. C. Aquino-Toledo, J. Carter, F. Chapleau, D. M. Cohen, B. B. Collette, 延東　真, 藤田矢郎, M. F. Gomon, 濱口　哲, 波戸岡清峰, 林　公義, 細谷和海, 池田弼生, 板沢靖男, G. D. Johnson, 木村清朗, 木村清志, 小林　博, 小林　弘, 小早川みどり, 小寺春人, 楠　豊和, 桑村哲生, E. A. Lachner, H. K. Larson, D. F. Markle, 松浦啓一, 望月賢二, 長田芳和, 仲谷一宏, 中園明信, 難波憲二, J. S. Nelson, J. G. Nielsen, 落合　明, 小川瑞穂, 小栗幹郎, 岡崎登志夫, 沖山宗雄, T. W. Pietsch, S. G. Poss, 坂本一男, 佐野光彦, 佐藤　浩, 佐原雄二, 鈴木　淳, 鈴木　亮, 高橋裕哉, 多紀保彦, 谷口順彦, 谷内　透, 富永義昭, 常木和日子, 上野輝彌, 矢部　衛, 山岡耕作, 柳沢康信, 矢野和成, 座間　彰.

なお，本誌はこれまで活版により印刷されておりましたが，37 巻からは写植・オフセット方式に切り替えることになりました．これに伴って，著者の方々にお願いする印刷準備作業・手順などにも多少の変更が生じますが，よろしくご協力のほどお願いいたします．

訂　　正・Errata

魚類学雑誌 36 巻 3 号に次の誤りがありました．お詫びして訂正いたします．

Japanese Journal of Ichthyology, 36(3), Machida: page 366, right column, 2nd paragraph 10th line, read “regression” for “regres ion.”