

Occurrence and Living Habit of Bathyal Bobtail Squid, *Heteroteuthis hawaiiensis* (Cephalopoda: Sepiolidae) from off the Ogasawara Islands, Japan

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Abstract: A small school of the bobtail squid *Heteroteuthis hawaiiensis* was observed on the ocean floor at a depth of 912 m near the Ogasawara Islands. This is the first report of an observation on the living deep-sea bobtail squid.

Keywords: living habit, Sepiolidae, *Heteroteuthis*, bathyal, nektobenthic

Introduction

During the biological and physico-chemical investigations using the ROV *Hyper-Dolphin* around the Kaikata Seamount, near the Ogasawara Islands, a small school of a bobtail squid of the family Sepiolidae was observed on the sea floor at a depth of 912 m. The video images of this animal were taken and several specimens were then collected by the ROV. Close examination of these specimens revealed them to be *Heteroteuthis hawaiiensis*, representing a positive record of this taxon in Japanese waters.

Materials

Nine specimens were collected with a suction sampler of the ROV *Hyper-Dolphin* operated by the R/V *Natsushima*, Japan Agency for Marine-Earth Science and Technology (JAMSTEC), on June 28, 2003, on the Kaikata Seamount at 26°41.25' N, 141°02.72' E, from the bottom at a depth of 912 m (Fig. 1). This dive (HD Dive 188) was aimed at observing and collecting animals in non-chemosynthetic environments on the sea bottom of the southwestern slope of the Kaikata Seamount, between depths of 962 m and 871 m (Watanabe *et al.*, 2003).

Observations

Living habit

The observation point of the ROV *Hyper-Dolphin* was on a gentle slope of the Kaikata Seamount. The bottom texture was made up of coarse sand in general, with scattered large to small rocks, stones and pebbles, on which occasional growths of cnidarians and sessile crinoids were observed (Fig. 2F). The visible benthos was very intermittent.

More than a dozen bobtail squids were found hovering here and there very close to the bottom. All specimens under observation were oriented randomly, and seem not to have been affected by water currents in this place.

Under the light of the ROV, the dorsal surface of all specimens was fresh brownish red, and the ventral side was silvery. The dorsal eye-lid and ventral shield, which project forward, exhibit strong iridescent light-reflection (Figs. 2D & E). No special behavior, such as light emitting, inking, copulating, egg-laying, fighting or camouflaging was observed.

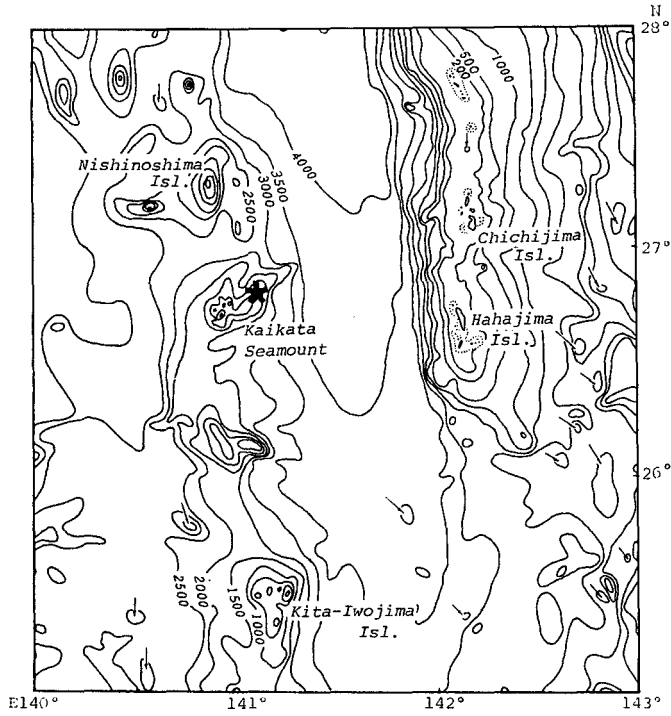


Fig. 1. Observatory station at the Kaikata Seamount (star).

Voucher Specimens

Nine female specimens (five in ethanol: JAMSTEC-053574 to 053578 and one frozen lot).

Taxonomy

Family Sepiolidae Leach, 1817

Heteroteuthis (Stephanoteuthis) hawaiiensis Berry, 1909

(Figs. 2A-C, 3)

Morphology

Animal small with plump body, large oval fins, and short arms (Fig. 2A-C).

Mantle rather muscular, ovoidal to ellipsoidal in shape with round, dome-shaped posterior end. Mantle width (MW) about three quarters of dorsal mantle length (DML). Dorsal surface convex, and densely speckled by dark reddish-purplish chromatophores. Dorsal margin of mantle bluntly projected in form of broad triangle. Ventral surface likewise convex with dense reddish-purple chromatophores. Prominent ventral shield projects forward beyond dorsal mantle projection or level of eye. Therefore, ventral mantle length (VML) about 20% longer than DML. This ventral shield marked off from ventral mantle by evident boundary, and more heavily pigmented with weakly plicate skin. Small but distinct funnel excavation in center of ventral margin. Both ventral lobes not acute, but round.

Fins oval, separated, almost non-pigmented except small patch of microscopic chromatophores along dorsal distal margin. Posterior margin of fin smoothly round, with small anterior free lobe.

Table 1. Measurements of five selected specimens in ethanol preservation (in mm)

	#1	#2	#3	#4	#5
Dorsal mantle length (DML)	23.7	22.7	22.1	23.4	23.8
Ventral mantle length (VML)	27.9	26.1	27.0	26.5	27.2
Mantle width (MW)	18.0	9.0	16.5	17.3	14.9
Fin length (FL)	17.1	17.2	16.4	17.4	15.3
Fin width (FW)	29.6	32.3	29.4	29.9	32.7
Head width (HW)	16.0	15.1	14.9	15.4	14.8
Right Arm I length (ALI)	7.5	6.0	9.0	9.8	10.8
Right Arm II length (ALII)	11.0	10.0	9.0	9.0	11.9
Right Arm III length (ALIII)	12.5	11.0	9.1	9.5	11.0
Right Arm IV length (ALIV)	7.5	9.0	9.5	9.0	11.2
Arm I sucker count* (AScI)	14	14(L)	14(L)	15	12
Arm II sucker count (AScII)	10	12	12	11	12
Arm III sucker count (AScIII)	22	22	22	22	20
Arm IV sucker count (AScIV)	18+m**	20+m	14+m	14+m	14+m
Right tentacle length (TtL)	20.5	17.0	15.5	16.0(L)	14.4
Right club length (CbL)	2.0	2.0	1.8	1.9	2.1

*All on the right arm except those denoted L (= left arm); ** “+m” denotes minute distal suckers.

Length of fin base about 40% DML.

Head subcubic, darker in color than mantle, very gradually tapering forward, with large eyes on lateral sides. Funnel moderate in size, tubular, reaching to fork of Arm IV. Dorsal element of funnel organ large, inverted V-shaped. Ventral pads indistinct.

Arms short but muscular, subequal in length (Fig. 3A). Arm I with broader aboral side than oral (sucker-bearing) side, trapezoid in cross-section. Some specimens bear short aboral keel on this arm. Aboral side of Arm I dark in color like head surface. Arm I with 7 pairs of globular suckers on proximal two-thirds. Distal one-third totally naked, with several chromatophoric speckles. Interbrachial web (A) between both Arm Is nearly half arm length.

Arm II with 5 or 6 pairs of globular suckers at about proximal half of arm length. Distal half of arm totally naked, with shallow longitudinal furrow and only a few chromatophoric speckles. Interbrachial web (B) between Arms I and II as deep as half of arm length. Arm III with 11 pairs of globular suckers at about proximal three quarters of arm length. Distal quarter naked, ornamented by only a few chromatophoric speckles. Interbrachial web (C) between Arms II and III extended to about the half of Arm II, and two-thirds of Arm III. Aboral side of Arm III less pigmented than that of other arms, but ornamented by a longitudinal row of square chromatophore patches.

Arm IV with 10-14 pairs of globular suckers on proximal two-thirds followed by more than 20 pairs of very compactly arranged, very small suckers diminishing in size towards distal tip. No naked distal portion present on this arm unlike other arms. Interbrachial web (D) between Arms III and IV reaches about halfway along Arm III, and extends almost entire length of Arm IV. In contrast, interbrachial web (E) between both Arm IVs almost vestigial. Aboral side of Arm IV as dark as head surface, but opaque patch present on wide basal portion (Fig. 2C).

No arms or arm suckers in any specimen under examination exhibit modification, such as hectocotylization and sucker enlargement (all are females). All normal globular suckers similar in

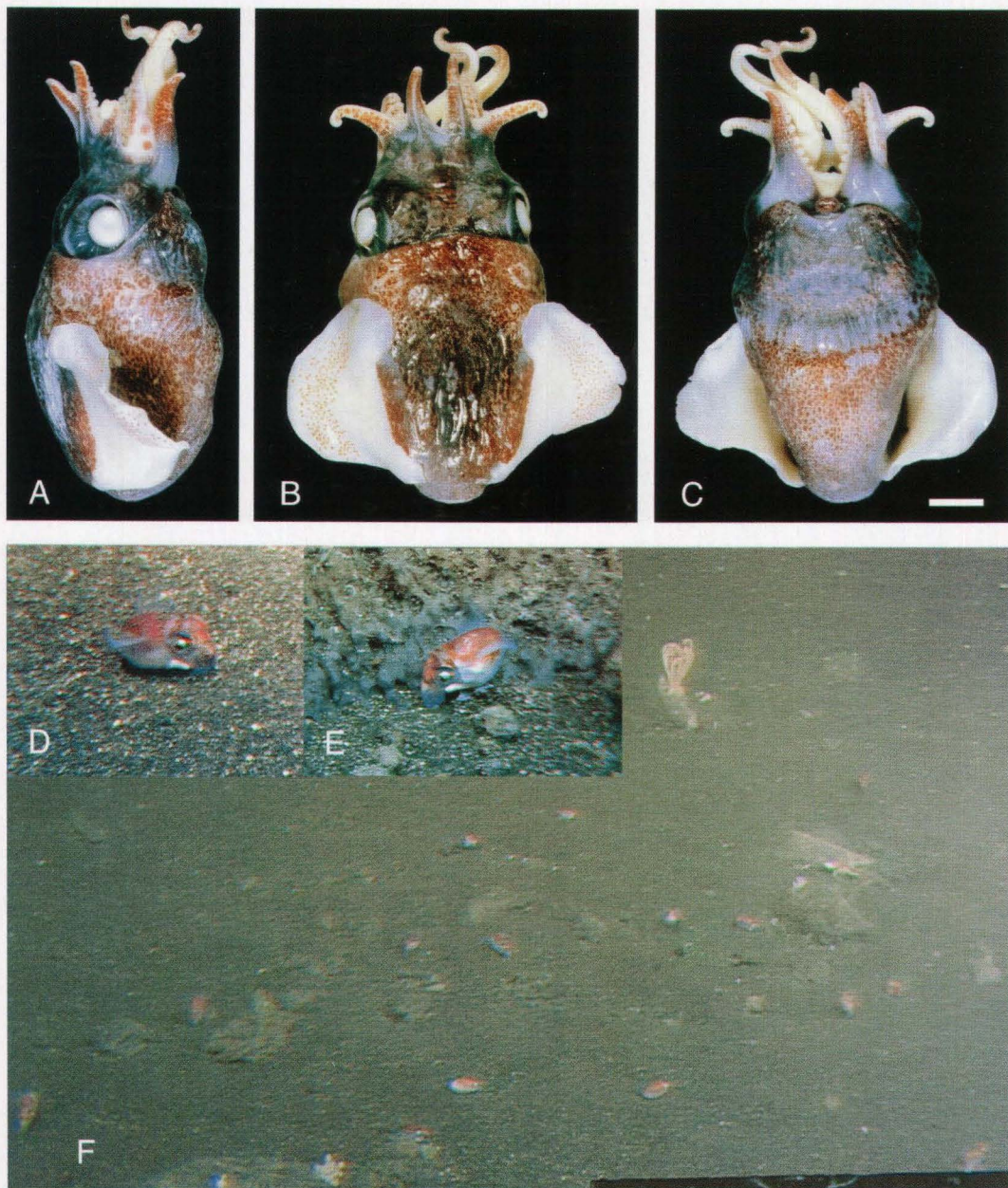


Fig. 2. A-C. Lateral (A), dorsal (B) and ventral (C) views of *Heteroteuthis hawaiiensis* (♀ : JAMSTEC-053574). D-F. Living habit of *Heteroteuthis hawaiiensis* from the video images taken by the ROV *Hyper-Dolphin*.

appearance, with very small apertures armed with minute sucker rings. Sucker rings smooth under light microscope, but revealed to be composed of two zones under the electron microscope. Inner zone simple ring consisted by a series of square, brick-like pegs, while outer zone consists of 2-4 rows of flat-topped, polygonal pegs of various sizes (Fig. 4A, B).

Tentacle weak and short, with naked stalk. Club not expanded, with multiserries of microscopic

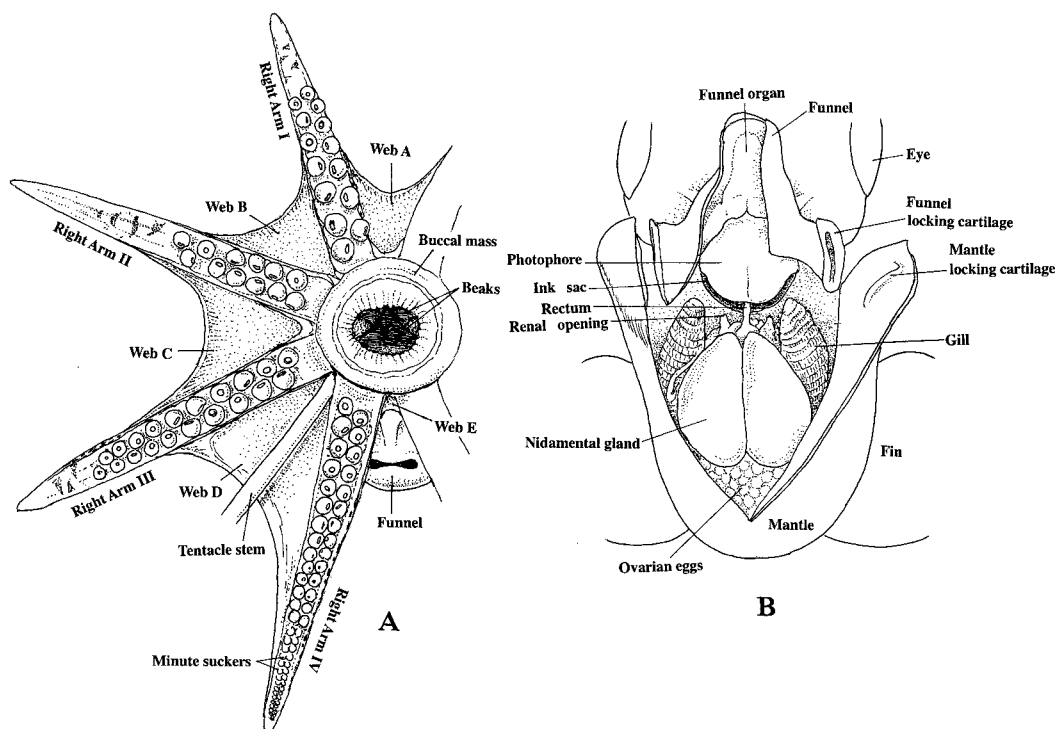


Fig. 3. *Heteroteuthis hawaiiensis*. **A.** Oral view (JAMSTEC-053574). **B.** Mantle cavity (JAMSTEC-053578).

suckers (Fig. 4C). Tentacle suckers short cylindrical with small aperture. Chitinous rings in two distinct zones; smooth inner zone surrounding aperture, and outer zone with double rows of flat-topped, polygonal pegs that are regularly spaced (Fig. 4D).

Buccal membrane not developed, and buccal connectives not apparent except dorsal attachment at Arm I. Lip papillated.

Radula ribbon short, carrying about 30 transverse rows (Fig. 4E). Radula composed of 7 teeth: tricuspid central tooth, triangular lateral teeth and sickle-shaped inner and outer marginal teeth (Fig. 4F).

Mantle locking cartilage low, but sharp ridge, well demarcated (Fig. 3B). Cartilage curves slightly, with strongly curved anterior end. Funnel locking cartilage weakly curved, with rounded posterior end and pointed anterior end. Groove also weakly curved and shallow, but slightly deepening anteriorly.

Large, round photophore present on ink sac, almost at anterior end of mantle cavity (Fig. 3B). Photophore about a quarter of ML in diameter, opaque and yellowish, with indistinct indentation on posterior margin. Gill lamellae 17 or 18 in number. Pair of large nidamental glands occupies more than half of mantle cavity. Ovary filled by ovarian eggs (Fig. 3B).

Taxonomic notes

Six nominal species of *Heteroteuthis* from world oceans were reduced to three named species and a single unresolved one by Nesis (1987): *Heteroteuthis dispar* (Rüppell, 1845) [= *H. atlantis* Voss, 1955 (Nesis, 1987)] from the tropical and subtropical Atlantic, *H. weberi* Joubin, 1902 from the Indonesian waters, *H. hawaiiensis* Berry, 1909 [?= *H. serventyi* Allan, 1945 (Nesis,

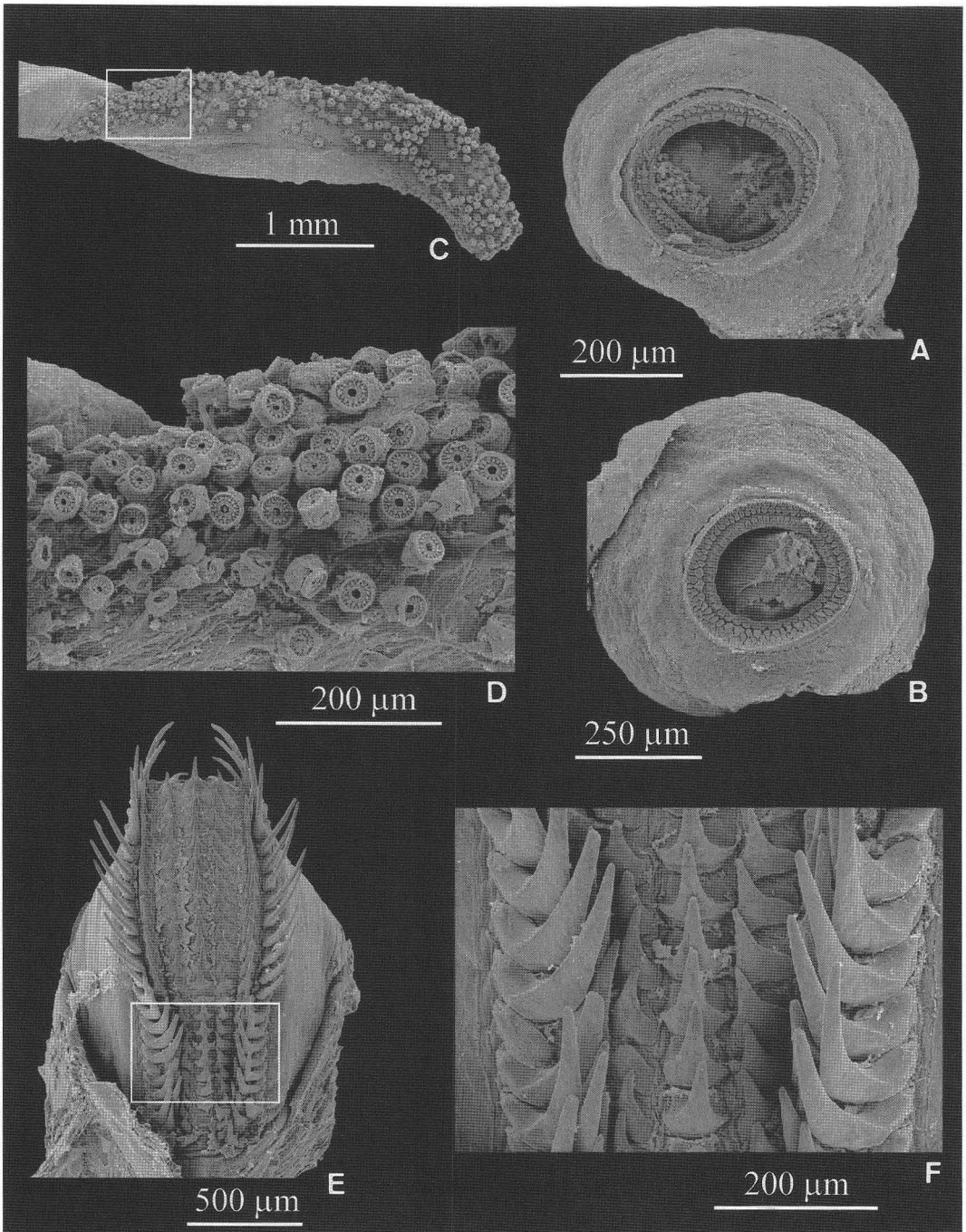


Fig. 4. *Heteroteuthis hawaiiensis*. **A, B.** Suckers of Arm III. **C, D.** Tentacle club. **E, F.** Radula (all JAMSTEC- 053578).

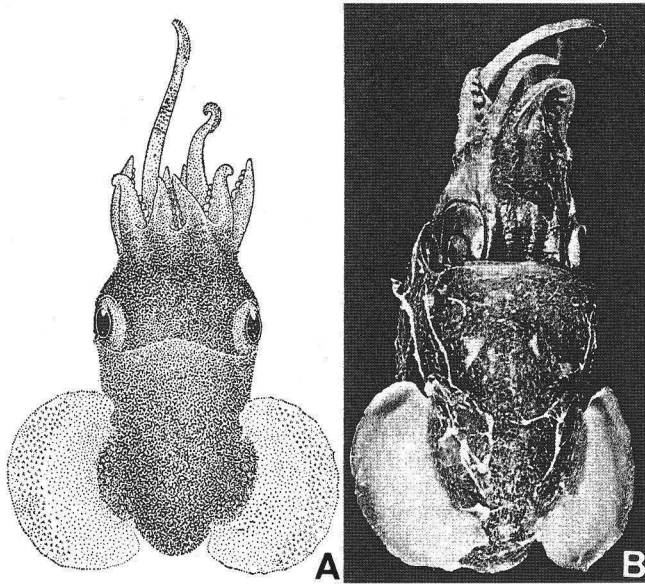


Fig. 5. *Heteroteuthis hawaiiensis*. **A.** After Berry (1914, Fig. 29).
B. After Lu & Boucher-Rodoni (2001: fig. 14 as *H. cf. hawaiiensis*).

1987)] from the tropical and subtropical West Pacific, down south to Tasmania, and an unresolved species, *H. dagamensis* Robson, 1924 from South Africa.

Nesis (1987) treated *Stephanoteuthis* Berry, 1902 (Type species: *H. hawaiiensis* Berry, 1909) as a subgenus of the genus *Heteroteuthis* Gray, 1849. The subgeneric and species differences are clearer in males than in females, but Nesis (1987) stated that female *Heteroteuthis* (s.s.) are still separable from female *Stephanoteuthis* in having a keeled and non-striated oral surface on Arm II. The naked part of Arm II of the present specimens is neither keeled nor striated. But the present specimens are closest to *H. hawaiiensis* Berry, 1912 (Fig. 5A) in many morphological characters.

Lu & Boucher-Rodoni (2001) identified a female from the Southwest Pacific as *H. cf. hawaiiensis* (Fig. 5B). Their hesitation to the final identification may be the difference of arm formula (II, III = IV, I) from that of Nesis (1987), who stated that Arms I and II are the shortest. Nesis's account may be based on Berry (1914) who gave the formula III, IV, II, I (Berry's measurements were 10 mm, 9-12 mm, 9 mm, and 8 mm, respectively). In our specimens, the arm formulae are highly variable. Those of five selected specimens are: III, II, I = IV; III, II, IV, I; IV, III, II = 1; I, III, II = IV, and II, IV, III, I. Therefore, arm formula is not a very reliable criterion to separate species.

The photophore on the ink sac is oval, and the diameter about 25% ML, agreeing with the description by Lu & Boucher-Rodoni (2001). It differs from the photophore of *H. atlantis*, which is five-lobed (Voss, 1955). Two other species (*Heteroteuthis* sp. 1 & 2) of Lu & Boucher-Rodoni have similar-shaped photophore, but they differ from our specimens, particularly in the number of arm suckers, and the shape of the locking cartilages among other characters.

The type specimen of *H. hawaiiensis* was a female, from *Albatross* St. 3989 near Kauai Island, at 733 fathoms (= 1341 m) collected with a few fragmented specimens. But all of them are no longer extant (Voss, 1955). A single specimen examined by Lu & Boucher-Rodoni from MUSORSTOM 7, St. CP554 at Banc Combe, 795-820 m, was also a female. Our specimens are again all females.

A sole male specimen of *Heteroteuthis* in the collection of the National Science Museum Tokyo (NSMT-Mo 68348: DML 21.3 mm) from off Sanriku Coast (36°50.28' N, 141°44.65' E, 0-1000 m) was examined for comparison. Although some important characters of this specimen are common to those of *H. hawaiiensis* treated here, this particular specimen was not conspecific, because it has a peculiar intestinal photophore carrying a pair of mammillary papillae.

The future acquisition of a set of male specimens is highly desirable for resolution of *Heteroteuthis* systematics.

Distribution

From the above-mentioned capture records, this species is known from the Hawaiian waters, the Southwest Pacific (north of Samoa Islands), and the Ogasawara Islands.

Nesis (1982) already gave its distributional range as “Hawaii, Bonin, Ryukyu Islands, Indonesia, Tasman Sea (?), and the Great Australian Bight”, which includes the present locality, but Nesis’s voucher specimens have not been examined.

Vertical distribution range of this species may range from about 800 m to 1400 m. However, most of the past collections were made by open tow-net or trawl. Nesis (1987) defined the habitat of this species as the “lower epipelagic and mesopelagic zone”. Roper & Young (1975) stated that “*Heteroteuthis* probably is pelagic throughout its life cycle”, but “the preponderance of specimens taken in bottom trawls compared to midwater captures suggests that these species spend considerable time on or near bottom”. The present direct observation of its habitat proved that their assumption was correct and that this squid is a bathyal nektobenthic dweller.

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小笠原諸島近海で見られたハワイヒカリダンゴイカの生態

奥谷喬司・土田真二

要 約

海洋科学研究開発機構 (JAMSTEC) の無人深海探査機ハイパードルフィンによって、小笠原諸島西方の海形海山の中腹、水深 912 m においてハワイヒカリダンゴイカの小群が発見された。いずれの個体も海底面すれすれのところでホーバリングを行っており、海底に付いているものや高い位置で遊泳しているものは見られなかった。各個体ともまちまちな方向を向いており、海流に支配されているようには見えない。

本種はこれまでもハワイ他西太平洋各地に分布していることは知られていたが、これまでの採集はおおむね開放ネットによるものであり、中層浮遊性とされていたが、今回の観察により漸深海底帯で、近底层性の生活を送っていることが判った。

この観察の時、9 標本が採集されたが、いずれも雌で、ハワイから採集されたタイプ標本も、またサモア北方のコンベ礁から採集されたものも雌で、雄の報告はない。また、Nesis は琉球や小笠原など日本近海を分布範囲にあげているが、それらの詳細についての報告は見あたらない。これらの標本と過去の形態記載と比較も行い、腕長式などかなりの種内変異があることも確かめられた。