Plankton Benthos Res 8(4): 191–194, 2013

Plankton & Benthos Research

Note

Second record of *Eukrohnia kitoui* (Chaetognatha) with notes on morphological differences from the closely related *E. calliops*

Takuya Ohnishi[1,*], Kazunori Kuroda[2] & Hiroshi Ueda[1]

[1] *Usa Marine Biological Institute, Kochi University, 194 Inoshiri, Usa-cho, Tosa, Kochi 781–1164, Japan*
[2] *3–6–1–1009 Akitsu, Narashino, Chiba 275–0025, Japan*

Received 7 July 2013; Accepted 20 September 2013

Abstract: Nine specimens of the planktonic chaetognath *Eukrohnia kitoui*, which was originally described from Tokyo Bay 32 years ago, were collected from an underwater canyon in Tosa Bay, Japan. This is the second record of the species. We compared *E. kitoui* and the closely allied *E. calliops* based on individual data of the two species reported in the previous and the present studies. Since allometric growth was observed in morphometric characters, specimens smaller than 10 mm in body length were omitted in this comparison. The results revealed that the ratios of tail segment and eye lengths to body length and the numbers of hooks and posterior teeth on the head, which were described as distinguishable features between the species in the previous study, were significantly different between the species. However, the values of these characters overlapped between the species except for the eye/body ratio, indicating that the eye size is the most critical feature distinguishing them. The present specimens showed that the relative position of the transverse musculature to the ventral ganglion, which was another diagnostic character of *E. kitoui* in the previous study, varied greatly according to growth. Considering the characteristic sampling sites (underwater canyons) and a long absence of occurrence records, *E. kitoui* is probably a rare species restricted to waters in or near coastal underwater canyons, as observed in *E. calliops.*

Key words: allometric growth, chaetognaths, *Eukrohnia kitoui*, Tosa Bay, underwater canyon

The planktonic chaetognath *Eukrohnia kitoui* Kuroda, 1981 was originally described from the mouth of Tokyo Bay 32 years ago (Kuroda 1981). Since then, there has been no subsequent information on the species, neither from Tokyo Bay nor from other regions. In this paper, we report *E. kitoui* from Tosa Bay on the Pacific coast of Japan as the second record of the species, and we re-examined the diagnostic characters of the species. We newly advocate the Japanese name "*Kitou-yamushi*" for *E. kitoui* ("*yamushi*" means chaetognath in Japanese), since most of the other Japanese chaetognaths have Japanese names.

Sampling was done at a point with bottom depth of 369 m (32°42.6′N, 133°08.0′E; Fig. 1) in an underwater canyon near Ashizuri Point along Tosa Bay on the south coast of Shikoku, western Japan, by vertical hauls of an opening-closing bongo-type plankton net (100 μm mesh, 45 cm in diameter×2; Ueda 2013) from discrete layers of 0–50, 50–100, 100–200, and 200–356 m on 14 May 2009. A total of nine specimens of *E. kitoui* were collected from the 200–356 m layer and none from layers above 200 m depth. Specimens were fixed and preserved in about 1% buffered formalin-seawater solution immediately after sampling. Morphological examination and measurements were made under a microscope or a binocular microscope with an optic micrometer.

The body length (BL, excluding tail fin) of the *E. kitoui* specimens collected ranged from 4.0 to 16.7 mm. Ovaries were observed in eight specimens of ≥8.3 mm BL and ovary length ranged from 0.18 to 0.7 mm; the specimens without ovaries were 4.0 and 5.8 mm BL. No prey was found in any guts. Their morphologies agreed well with the original description of *E. kitoui* by Kuroda (1981), who stated that the species is easily distinguishable from any other species of *Eukrohnia* by having a remarkably prominent, bilobate glandular reservoir on the forehead (Fig. 2A), large areas of eye pigmentation (Fig. 2A, D), and lateral fins starting a little ahead of the ventral ganglion (Fig. 2B). Hooks with no serration and being sharply bent at their tips was reported as another characteristic feature of the species (Fig. 2C). Differences between the original description and the present specimens were found only in the arrangement of the eye pigments. The pigments in the original description incline like the figure "＼ ／" in dorsal view with the head at the top, while in the present specimens these were arranged almost parallel or a little like "／ ＼" (Fig. 2D).

* Corresponding author: Takuya Ohnishi; E-mail, trieste1q53@gmail.com

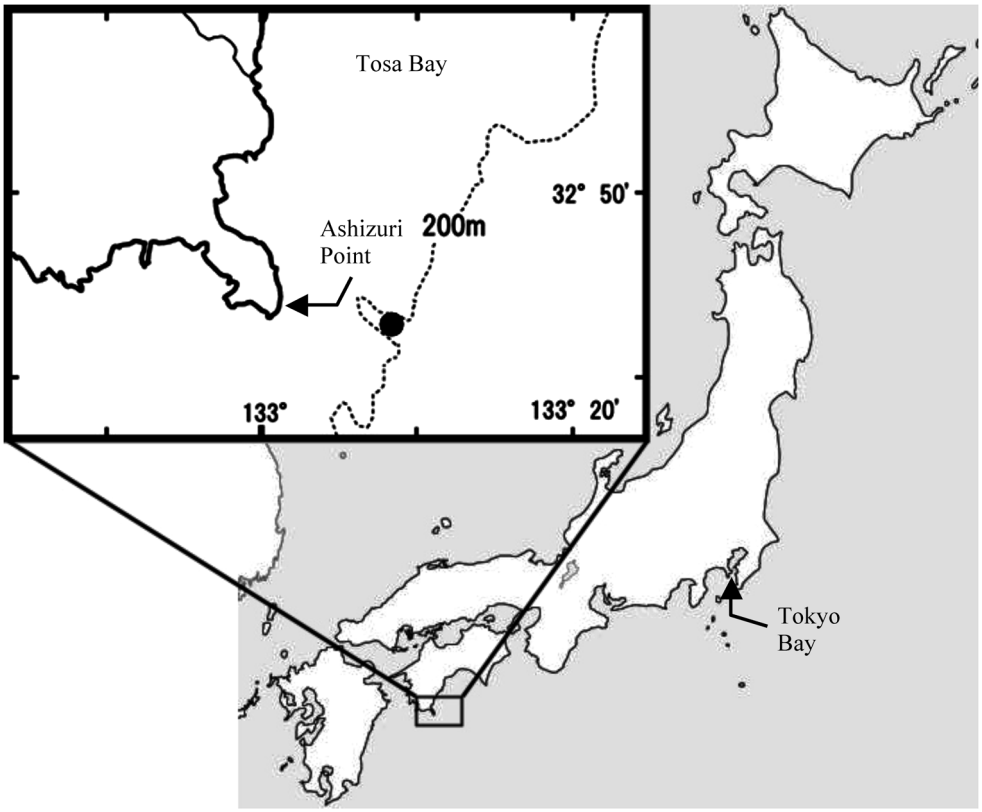

Fig. 1. Map showing the present sampling station (filled circle) near Ashizuri Point in Tosa Bay and the location of Tokyo Bay, the type locality of *Eukrohnia kitoui*. The dotted line indicates the 200-m isobaths, indicating the underwater canyon at the sampling station.

McLelland (1989) described *Eukrohnia calliops* McLelland, 1989 from near the bottom at 677 m depth in the Gulf of Mexico. Since *E. calliops* is morphologically very close to *E. kitoui*, he compared the two species based on specimens; the specimens of *E. kitoui* from Tokyo Bay being provided by one of us (KK). According to his comparison, the morphologies of *E. calliops* that made it distinguishable from *E. kitoui* were the greater numbers of posterior teeth, higher ratios of tail segment length and eye length to BL, and different shapes of the eye pigment cup, which is darker and larger in *E. calliops* in relation to the eye size. As for the morphometric characters, however, it is likely that these depend on the specimen size due to allometric growth in chaetognaths. Indeed, *Parasagitta friderici* (Ritter-Zahony, 1911) is known to exhibit allometric growth (Daponte et al. 2004). The present nine specimens of *E. kitoui* also showed allometric growth. For example, the ratios of tail segment length (TSL) to BL in the two small specimens (4.0–5.8 mm BL, TSL/BL=27.5–27.6%) were markedly higher than those in the larger ones (8.3–18.1 mm BL, TSL/BL=22.3–25.4%). McLelland (1981) presented the individual data for metric characters measured on 13 *E. calliops* specimens of 8.4–21.5 mm BL and 10 *E. kitoui* specimens of 4.7–25.4 mm BL. We reanalyzed the interspecific differences using his data and the present data by omitting young individuals smaller than 10 mm BL to reduce variations due to allometric growth. The number of data used was 12 for each species. Out of the 12 sets of data on *E. kitoui*, six are from Tokyo Bay (McLelland 1981) and six are from Tosa Bay (present study), but no characters were significantly different between the two localities (Table 1). The results revealed that the ratios of the tail segment and the eye lengths (Fig. 2D) to the BL, and the numbers of hooks and posterior teeth on the head were all significantly different between *E. kitoui* and *E. calliops* ($p<0.05$, *U*-test). Among these characters, the range of the eye to body length ratio was disjunct between the species (0.79–0.96% in *E. kitoui* and 1.21–1.83% in *E. calliops*) and the difference was highly significant ($p<0.001$), while those of the other characters examined overlapped, indicating that eye size is the most critical morphological character separating the two species.

McLelland (1989) recognized that *E. calliops* differs from *E. kitoui* also in the position of the posterior end of the transverse musculature, which extends usually to the level of the posterior edge of the ventral ganglion in *E. kitoui* but beyond the ventral ganglion by 1/4 the length of the ganglion in *E. calliops*. In the present study, however, the position of the posterior end of the transverse musculature was observed to vary greatly according to specimen size. For example, the musculature extended apparently beyond the ganglion in the specimen of 18.1 mm BL, as in *E. calliops*, while it reached only the mid length of the ganglion in young specimens of 4.0 and 5.8 mm BL (Fig. 3). This indicates that the position of the

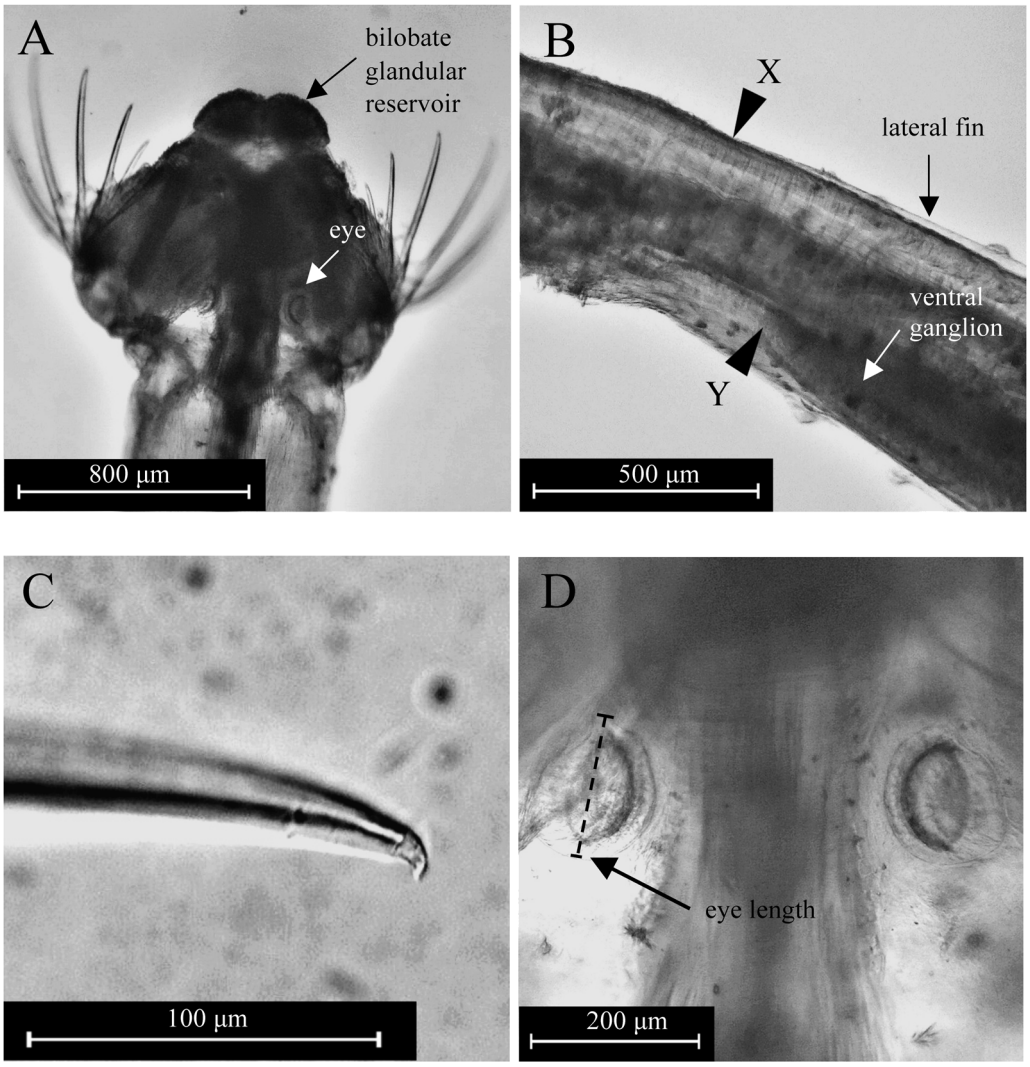

Fig. 2. Microphotographs of *Eukrohnia kitoui* from Tosa Bay. A: head, dorsal view; B: positions of anterior end of lateral fin (X) and anterior margin of ventral ganglion (Y); C: distal part of hook; D: dorsal view of eyes (upper side is anterior side). The eye length shown in D was measured as the maximum length of the major axis.

Table 1. Metric morphologies of *Eukrohnia kitoui* and *E. calliops* larger than 10 mm in body length based on McLelland's (1989) and the present data. The mean values are presented with the ranges in parentheses. The significance probabilities for differences were calculated using *U*-test.

	E. kitoui		Significance probability between two bays	*E. calliops*[1)] Gulf of Mexico (12 specimens)	Significance probability between two species
	Tokyo Bay[1)] (6 specimens)	Tosa Bay[2)] (6 specimens)			
Body length (BL) in mm	14.9 (10.4–25.4)	15.5 (12.2–18.1)	1.000	14.9 (10.4–21.5)	.347
Ratio of tail segment to BL (%)	23.5 (22.2–25.4)	23.6 (22.3–25.4)	1.000	25.7 (21.7–31.0)	.017*
Ratio of eye length to BL (%)	0.89 (0.79–0.96)	0.83 (0.74–0.90)	.065	1.54 (1.21–1.83)	.000**
No. of hooks[3)]	11.3 (10–13)	10.5 (9–12)	.310	12.2 (11.5–13)	.003**
No. of posterior teeth[3)]	12.3 (7–16.5)	9.0 (8–10)	.177	14.5 (9–21)	.028*

[1)] McLelland (1989; table 4).
[2)] present study.
[3)] When the numbers of left and right hooks/teeth were different, the mean value was used.
* significant at $p<0.05$, ** highly significant at $p<0.01$.

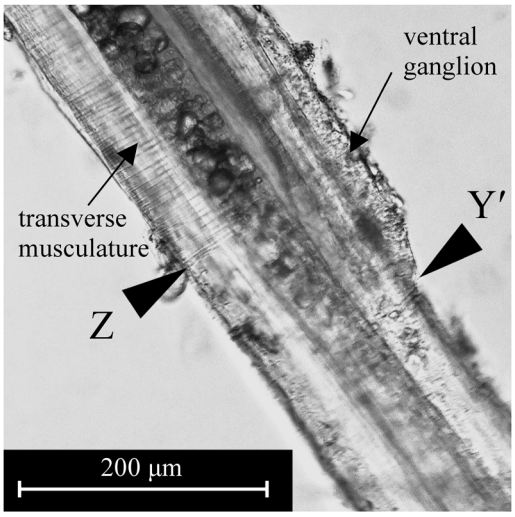

Fig. 3. Microphotograph showing positions of posterior ends of ventral ganglion (Y′) and transverse musculature (Z) in a young *Eukrohnia kitoui* specimen of 4.0 mm BL from Tosa Bay.

posterior end of the transverse musculature relative to the ventral ganglion is not a character allowing the two species to be distinguished.

According to the traditional morphological taxonomy of chaetognaths, the differences noted above are enough to distinguish *E. calliops* from *E. kitoui* at the species level. In fact, eyes have been used as an important diagnostic character for chaetognaths not only in adult specimens (e.g., Alvariño 1967) but also in immature ones (Nagasawa & Marumo 1976). However, Miyamoto et al. (2012) recently revealed that the deep-sea congeneric chaetognaths *Eukrohnia hamata* (Möbius, 1875) and *E. bathypelagica* Alvariño, 1962 genetically formed a single lineage in which they were intermixed. As for the present two species, it would also be interesting to study their genetic relationships if further specimens are collected for genetic studies.

Temperature and salinity profiles at 0.5 m intervals from the surface to the bottom were measured simultaneously with the sampling using a CTD logger (Compact-CTD, Alec Electronic Co. Ltd., Japan). The temperature decreased with depth from 23.1℃ at the surface to 9.1℃ at the bottom and the salinity ranged between 34.37 and 34.59 with high values around 34.5 or higher in the mid layer (120–220 m deep). The ranges of temperature and salinity in the 200–356 m sampling layer, from which *E. kitoui* was collected, were 9.0–15.7℃ and 34.48–34.59, respectively. These values are almost the same as the conditions at which *E. kitoui* was collected in Tokyo Bay (10–15℃, 34.42–34.57, respectively; Kuroda 1981).

Both the closely allied species *E. calliops* from the Gulf of Mexico and *E. kitoui* from the Pacific coasts of Japan have been found restrictedly in or near submarine canyons, although records are still few. McLelland (1989) stated that a large number of *E. calliops* individuals were collected when the net accidentally dragged bottom near a submarine canyon and suggested that *E. calliops* is a hypo-planktonic species. From 2009 to 2010, one of us (HU) has conducted vertical hauls of the opening/closing net monthly from 200 m depth at the shelf margin and four times from 400 m depth in the slope water in the central part of Tosa Bay, and three times from >350 m depth at the present sampling point (one for the present study). However, *E. kitoui* was found only in the single sample described in the present study. A long absence of records since the original description, very rare occurrence in Tosa Bay, and characteristic collection sites suggest that *E. kitoui* is a rare species restricted to waters near or in coastal underwater canyons as suggested by McLelland (1989) for *E. calliops*.

Acknowledgments

We thank Mr. Zenji Imoto, the captain of the research boat *Neptune* of Usa Marine Biological Institute, Kochi University, and students of HU's laboratory for their help in sampling.

References

Alvariño A (1967) The Chaetognatha of the NAGA Expedition (1959–1961) in the South China Sea and the Gulf of Thailand. Part 1—Systematics. Naga Report Vol. 2, Part 2: 1–197.

Daponte MC, Capitanio FL, Nahabedian DE, Viñas MD, Negri RM (2004) *Sagitta friderici* Ritter-Zahony (Chaetognatha) from South Atlantic waters: abundance, population structure, and life cycle. ICES J Mar Sci 61: 680–686.

Kuroda K (1981) *Eukrohnia kitoui* sp. n., from the entrance to Tokyo Bay. Publ Seto Mar Biol Lab 26: 177–185.

McLelland JA (1989) *Eukrohnia calliops*, a new species of Chaetognatha from the northern Gulf of Mexico with notes on related species. Proc Biol Soc Wash 102: 33–44.

Miyamoto H, Machida R J and Nishida S (2012) Global phylogeography of the deep-sea pelagic chaetognath *Eukrohnia hamata*. Prog Oceanogr 104: 99–109.

Nagasawa S, Marumo R (1976) Identification of young chaetognaths based on the characteristics of eyes. Bull Plankton Soc Jpn 23: 96–106. (in Japanese with English abstract)

Ueda H (2013) New messenger-operated opening/closing plankton net and new double release mechanism designed for vertical haul. Bull Plankton Soc Jpn 60: 11–17.