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Note

Insights into life-history traits of *Munidopsis* spp. (Anomura: Munidopsidae) from hydrothermal vent fields in the Okinawa Trough, in comparison with the existing data

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ABSTRACT

Squat lobsters in the genus *Munidopsis* are commonly found at, and near, hydrothermal vents. However, the reproductive traits of most *Munidopsis* spp. are unknown. This study examined the reproductive features of two *Munidopsis* species sampled from hydrothermal vent fields in the southern Okinawa Trough in February 2014. Three ovigerous females were collected: two *Munidopsis ryukyuensis* at Irabu Knoll (1661–1675 m depth) and one *M. longispinosa* at Hatoma Knoll (1482 m depth). Carapace sizes and egg volumes were measured and compared with those of other *Munidopsis* species. The ovigerous *M. ryukyuensis* specimens had postorbital carapace lengths of 10.3 and 11.8 mm, without the rostrum, and carapace widths of 8.6 and 9.7 mm. Mean egg volumes of *M. ryukyuensis* and *M. longispinosa* were ~4 mm^3. These results are consistent with early sexual maturity in *M. ryukyuensis* and lecithotrophic development in both species, as described in other species of the genus. These life-history traits may enable these vent species to maximize their reproductive and dispersive potential.

1. Introduction

Animals maximize their fitness in specific environments based on trade-offs among interconnected life traits (Stearns, 1992; Ramirez-Llodra, 2002; Reznick et al., 2002; Roff, 2002). Among such traits, age and size at maturity are important parameters because they reflect longevity and energy allocation strategies (Stearns, 1992). Early sexual maturation is advantageous for organisms living in unstable environments as it increases their probability of surviving long enough to reproduce (Stearns, 1992). Such species also tend to produce large numbers of relatively undeveloped offspring rather than investing in the care of relatively few offspring. Alternatively, they tend to have somewhat lower fecundity with multiple spawning events per year (Ramirez-Llodra, 2002). These strategies lead to high annual reproductive output, which reduces the risk of population extinction from unpredictable events.

Hydrothermal vents are inherently unstable and ephemeral, existing from several years to centuries (Macdonald, 1982; Converse et al., 1984; Grassle, 1985; Hessler et al., 1988; Lalou, 1991; Haymon et al., 1993). At fast-spreading ridges, vigorous venting activity causes abrupt changes in habitat and animal distribution (Perfit and Chadwick, 1998; Shank et al., 1998; Mullineaux et al., 2010, 2012). On the other hand, at slow-spreading ridges with greater temporal stability in vent activity (Copley et al., 2007), vent communities show some changes in species composition and abundance at the microhabitat level, reflecting changes in substrate (Gebruk et al., 2010) and temperature (Cuvelier et al., 2011). The reproductive traits of deep-sea species are believed to strongly reflect phylogenetic constraints and to exhibit the same degree of variation as those of sublittoral species (Gustafson and Lutz, 1994; Scheltema, 1994). In the case of animal species living near hydrothermal vents, variability in reproductive strategies may help to optimize their fitness in such environments (Van Dover, 2000; Young, 2003).

Among reproductive traits, early maturation is the most influential trait driving fitness (Ramirez-Llodra, 2002). Reproductive characteristics have been examined mainly for vent animals from the East Pacific Rise (EPR) and the Mid-Atlantic Ridge (MAR) (reviewed in Tyler and Young, 1999; Young, 2003; Adams et al., 2012), but little is known about reproductive traits of vent fauna in the western Pacific (Miyake et al., 2010; Nakamura et al., 2014). Evidence of early maturation has been observed in the vent shrimp *Rimicaris hybisae* (Nye et al., 2013) from the Mid-Cayman Spreading Centre and limpets in the genus *Lepetodrilus* from the EPR and MAR (Tyler et al., 2008) as well as the Okinawa Trough in the western Pacific (Nakamura et al., 2014).

Squat lobsters in the genus *Munidopsis* comprise 233 species worldwide, where they occur from shallow water to depths of

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5000 m, but mainly on continental slopes and abyssal plains (Baba et al., 2008; Schnabel et al., 2011). In addition to cold seeps (Barry et al., 1996; Macpherson and Segonzac, 2005; Cubelio et al., 2007a) and whale falls (Bennett et al., 1994; Goffredi et al., 2004; Lundsten et al., 2010), they are commonly found in hydrothermal vent ecosystems (e.g., Williams and Van Dover, 1983; Baba, 2005; Martin and Haney, 2005; Cubelio et al., 2007b, 2008), and several *Munidopsis* species have been described from vent fields around Japan (Hashimoto et al., 1995; Ohta and Kim, 2001; Cubelio et al., 2007a, 2007c; Osawa and Takeda, 2007). Despite their diversity and wide distributions, their life-history characteristics remain virtually unknown (Baba et al., 2011; Kilgour and Shirley, 2014). The data that are available concern egg size in relation to body size and ocean depth (Van Dover and Williams, 1991). For ovigerous females, there are some additional data on body and egg sizes and depth of occurrence in the catalogues by Baba et al. (2008) and by Kilgour and Shirley (2014). In the laboratory, *Munidopsis serricornis* and *M. polymorpha* showed abbreviated larval development and their larvae were lecithotrophic (Samuelsen, 1972; Wilkens et al., 1990).

Here, we examine the reproductive attributes of two *Munidopsis* spp. from the Irabu Knowll and Hatoma Knoll hydrothermal vent fields in the southern Okinawa Trough, and compare them with those of other *Munidopsis* species.

2. Materials and methods

Munidopsis specimens were sampled at the Irabu Knoll (IR) and Hatoma Knoll (HA) hydrothermal fields in the Okinawa Trough using a suction sampler mounted on the Remotely Operated Vehicle (ROV) *Hyper-Dolphin* during the KY14-02 cruise of R/V *KAIYO* in February, 2014 (Fig. 1). Sampling was conducted at 1661–1675 m depth at IR and at 1482–1510 m depth at HA. Among the 11 individuals collected (2 at IR and 8 at HA), three were ovigerous (2 at IR and 1 at HA). Based on morphology, two individuals from IR were identified as *Munidopsis ryukyuensis* (Cubelio et al., 2007a), and the specimen from HA was identified as *M. longispinosa* (Cubelio et al., 2007a) (Fig. 2, Table 1). The other 8 individuals were one male and female *M. ryukyuensis*, 4 female *M. longispinosa*, and two juveniles (Table 2). The post-orbital carapace lengths (carapace lengths without the rostrum), carapace lengths with the rostrum, and carapace widths of all specimens were measured with digital calipers to the nearest 0.1 mm. Eggs were collected from the abdomen of each ovigerous specimen. Average egg radii were measured with Image-Pro Plus (ver. 7.0) from pictures taken under a binocular dissection microscope, and egg volumes were calculated from the average radius of each egg, assuming sphericity. These data were compared with data on the reproductive traits of *Munidopsis* spp.

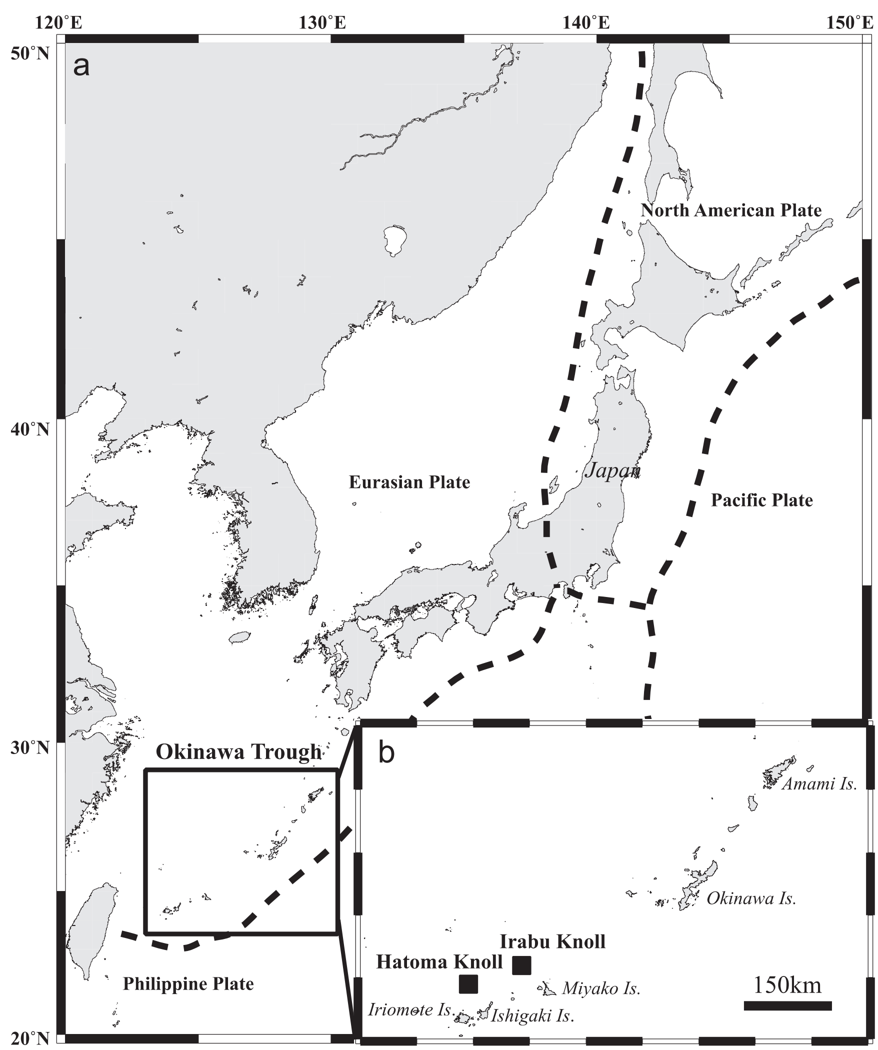

Fig. 1. Map of research sites where *Munidopsis* specimens were collected (black boxes): (a) the Okinawa Trough; (b) the two hydrothermal vent fields.