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Title Page

Title: The cavernicolous swimming crab *Atoportunus dolichopus* Takeda, 2003 reported for the first time in the Western Indian Ocean during technical dives in the mesophotic zone (Crustacea, Decapoda, Portunidae)

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Abstract

The rare cavernicolous crab *Atoportunus dolichopus* Takeda, 2003, described from Kume-Jima Island, Ryukyu archipelago, is recorded for the first time since its description. Two specimens were observed in a marine cave off Mayotte Island, Western Indian Ocean, during technical dives in the mesophotic zone. The crabs were observed at a depth of 75 m in total darkness, 120 m far from the entrance of the cave. No specimens were collected but morphological traits recognized on close-up photographs agree with those of *A. dolichopus*. This rare species is illustrated with comments on its remarkable disjunct geographical distribution and ecology.

Keywords

Cavernicolous crab, *Atoportunus*, Mayotte Island, Mesophotic zone

Text

The marine mesophotic, or twilight zone, situated approximately in depths of 50-150 m in the tropics, is still poorly known because beyond usual depths of recreational dives. Exploring these depths necessitates technical dives with re-breather and trimix gas that are still mastered

by only a few divers. The first two authors of this note are experienced technical divers. In 2018 they have initiated a collaborative research program to study the mesophotic zone around Mayotte (Barathieu, 2019). This program brings together several experts of the marine fauna and flora around Mayotte and completes another mesophotic research program currently conducted around Mayotte (MesoMay funded by DEAL Mayotte).

During a dive by the first two authors the entrance of a cave was discovered at a depth of 50 m in the southwest of Mayotte Island near 'Passe Bateau'. The entrance of the cave was very large, approximately 3-4 m high by 15 m long, opening to two separate galleries sinking gently into the basement of the island (Figure 1). At the end of the longest gallery, about 120 m far from the entrance at a depth of 75 m, in total darkness, a remarkable crab was observed during three successive dives with photographs taken on 28/11/2018 and 23/02/2019 showing two distinct specimens. A photograph of the first specimen was transmitted for determination to JP by Professor Bernard Thomassin of the collaborative research program. Additional photographs of the second specimen, including close-up frontal views, were later examined (Figure 2).

Based on these photographs the genus *Atoportunus* Ng & Takeda (2003) is recognized for the first time around Mayotte. This genus was established to accommodate two unusual swimming crabs living in marine caves, respectively *A. gustavi* Ng & Takeda, 2003 and *A. pluto* Ng & Takeda, 2003. These two species are superficially similar but differ by a series of subtle morphological characters. *Atoportunus pluto* is still unrecorded outside Hawaii where it is probably endemic. *Atoportunus gustavi* has a much wider distribution being present in the western Pacific (Guam, Marianas; and Yonaguni Is., Ryukyus) and in the eastern Indian ocean (Christmas Is.). It is probably common in marine caves as suggested by at least three more reports in the Ryukyus since its description: in Shimojijima Is. (Fujita *et al.*, 2013) and in Okinawa-jima Is. and Ie-jima Is. (Fujita & Mizuyama, 2016). *Atoportunus gustavi* and *A. pluto* have been reported in depths of 2-30 m in coral rubbles near or in caves, normally in dark places hence the qualification of 'chalicophilous and cavernicolous' crabs by Ng & Takeda (2003). These authors have also indicated that *Atoportunus* is classified in the Portunidae Rafinesque, 1815 despite an unusual morphology and without appropriate comparison with other portunid genera. More recently Mantelatto *et al.* (2018, Fig. 1, Tab. 1) have sequenced a specimen of *Atoportunus gustavi*. It groups to *Carupa tenuipes* Dana, 1852 suggesting a potential affinity of *Atoportunus* with the Carupinae Paul'son, 1875.

A third species of the genus, *Atoportunus dolichopus* Takeda, 2003, has been recognized in Japan based on two specimens collected off Kume-jima Is., Ryukyus. They were found in a cave in total darkness at a depth of 38 m, approximately 60 m far from the entrance. The new species differed from the two previous *Atoportunus* species by at least six morphological characters: a) hemispheric carapace (vs. more flattened carapace); b) narrower carapace, carapace breadth CB (including lateral spine) on carapace length CL being 1.22-1.44 (vs. 1.67-1.83); c) last anterolateral tooth directed obliquely forward (vs. more laterally); d) longer legs and chelipeds, the cheliped being ca. 3 times CB (vs. 1.80-2.00); e) armature of merus of cheliped with mesial margin having more than 10 spines on proximal half and 3 equidistant spines on distal half (vs. 6 spines distributed over the entire length); f) cutting edges of movable and immovable fingers of chela with, respectively, 2 and 3 long spines of similar size directed obliquely (vs. 2 and 5 spines, of various sizes on immovable finger).

Morphological characters recognized on the photographs of the two *Atoportunus* specimens from Mayotte overall agree with those of *A. dolichopus*: a) carapace hemispherical (Figs 2B-C); b) last anterolateral spine directed obliquely forward (Figs 2A, 3A); c) CB/CL ca. 1.45-1.55 (Fig. 3A); d) long legs with chelipeds more than 3 times CB (Fig. 2A); e) cutting edges of movable and immovable fingers of chela with, respectively, 2 and 3 long spines of equal sizes directed obliquely (Figs 2B, 3D). The armature of the mesial margin of the merus of the cheliped is intermediate between *A. dolichopus* and *A. gustavi/pluto* having 6-8 spines on proximal half and 3-4 spines on distal half disposed as illustrated in Figure 3C. It seems, however, that this armature may have variation in *A. dolichopus* as illustrated in Takeda (2003) between male holotype (Fig. 1A, 2E) and female allotype (Fig. 1B-C). Despite this minor difference it seems reasonable, for the time being, to attribute the specimens from Mayotte to *A. dolichopus*. A new species closely affiliated to *A. dolichopus* cannot be totally excluded at this stage for Mayotte but more specimens and observations are necessary to confirm that hypothesis.

With this discovery, the geographical distribution of *A. dolichopus* appears remarkably disjunct with ca. 10 000 km between Kume-jima and Mayotte Islands. Such a disjunct distribution has been, however, already observed for *A. gustavi* occurring in the Ryukyus, Marianas and Christmas Island, the latter being ca. 5000 km far from the two former archipelagoes. *Atoportunus dolichopus* is probably widespread in the indo-west Pacific (IWP)

though rarely seen because living in deep caves not easily accessible to recreational dives but necessitating technical dives with complex and risky navigation in caves networks.

The eyes of *Atoportunus* crabs are reduced which is indicative of obligate cavernicolous species (Guinot, 1988; Ng & Takeda, 2003). In some cavernicolous crabs of the Potamidae, the reduction is so pronounced that the cornea is no more visible (Guinot, 1988, figs. 7-8). In the crabs examined from Mayotte, the cornea is still present but it is distinctly narrower than the ocular peduncle (Fig. 2C). Such a reduction is common in cavernicolous crabs. It has been documented recently by Wowor & Ng (2018) for three cavernicolous sesarmid of the genus *Karstarma*.

Because of its hemispherical body (Fig. 2B-C), long legs (Fig. 2A) and reduced natatory P5 (Fig. 3E) this crab is probably not a good swimmer (Ng & Takeda, 2003; Takeda, 2003). The crab movement in the cave was very slow and it could have been picked easily by hand which confirms Takeda's (2003) similar observation for Japanese specimens. The defensive posture of the crab illustrated on figure 2A suggests that it probably hunts from a hide in total darkness. It must be able to quickly project forward its long chelipeds when it feels a prey within reach and harpoon it with the spear-like spines of its claws (Fig. 3D). No potential preys were observed during the dives in the immediate surroundings of crab but small shrimps and fishes were seen in the first tens of meters after the entrance of the tunnel where the crab possibly move for hunting. Three other macro-decapods were observed in the cave during the dives: a swimming crab, probably *Gonioinfradens paucidentatus* (A. Milne-Edwards, 1861) hidden in a hole near the entrance; the hermit crab *Aniculus maximus* Edmonson, 1952 observed in total darkness, 60 m far from the entrance; and the shrimp *Parhippolyte misticia* (J. Clark, 1989) with solitary individuals observed in several places of the tunnel one of them in total darkness 100 m far from the entrance. *Parhippolyte misticia* is also a true cavernicolous shrimp originally described from a cave in Palau (Clark, 1989) and now reported from several IWP places (Debelius, 2001). The two other species, *G. paucidentatus*, and *A. maximus*, are not cavernicolous but occasional visitors in the cave.

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DRAFT

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Figures

Original HD figures prepared for WIOJMS (135 mm wide, 300 ppp) can be downloaded at <https://www.dropbox.com/sh/goxbnl9xllggm66/AADIZ22JTefcnBfiSRJI8X2Va?dl=0>

Figure 1. The *Atoportunus dolichopus* cave in Mayotte. A) Diver at the entrance of the cave, 50 m deep; B) Exploring the 120 m long tunnel with security line to avoid getting lost in the cave; C) End of the tunnel where the crab was observed with aspect of the bottom made of rubbles and calcareous muddy sand. Photographs G. Barathieu.

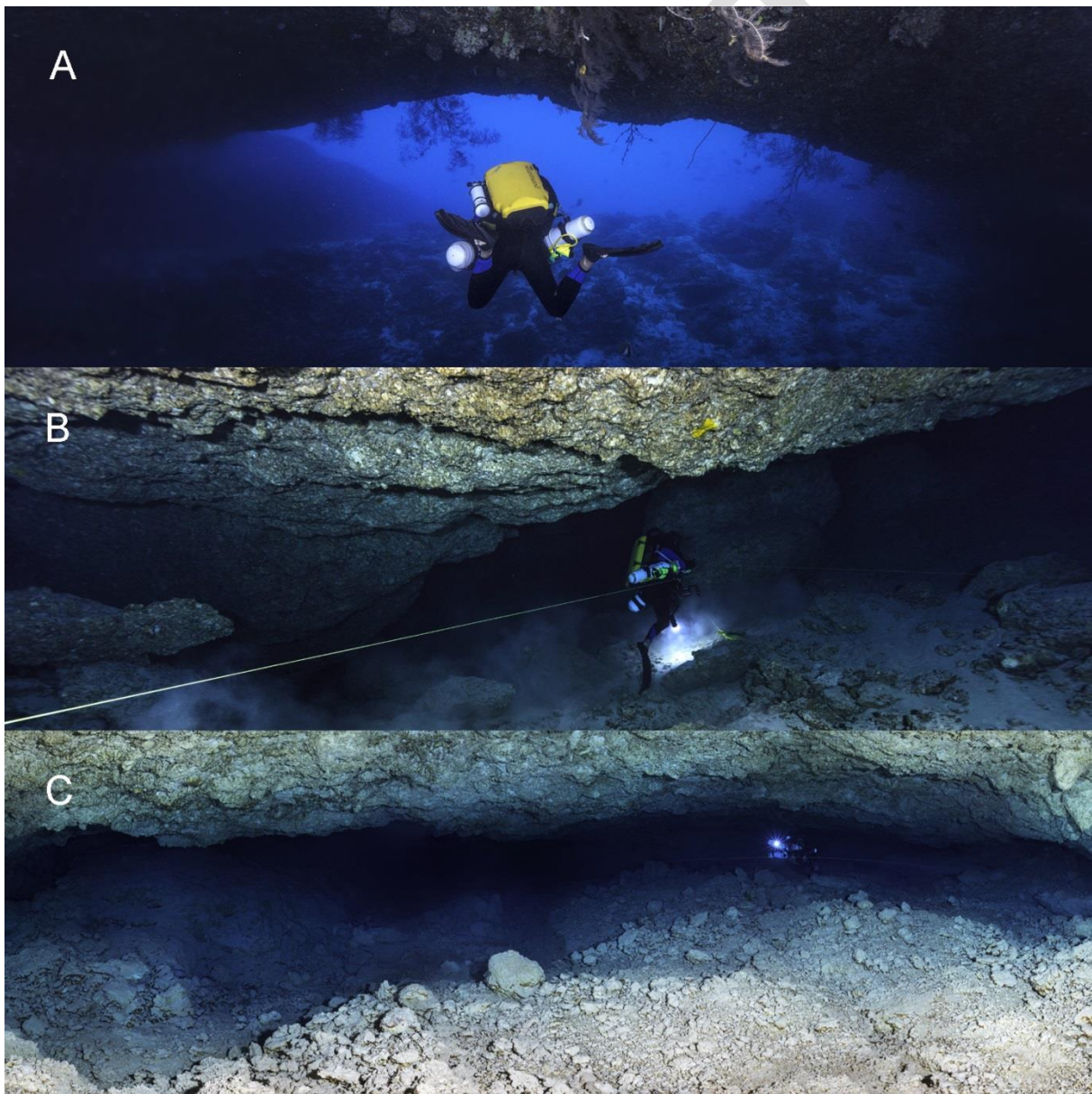


Figure 2 - *Atoportunus dolichopus* in cave 75 m depth in Mayotte Island, 23/02/2019. A) Defensive posture on hard substrate. B) Frontal view of carapace and aspect of right chela. C) Close-up frontal view showing orbits, epistome and buccal cavern. Estimated CB 28 mm. Scales bars 10 mm. Photographs G. Barathieu.

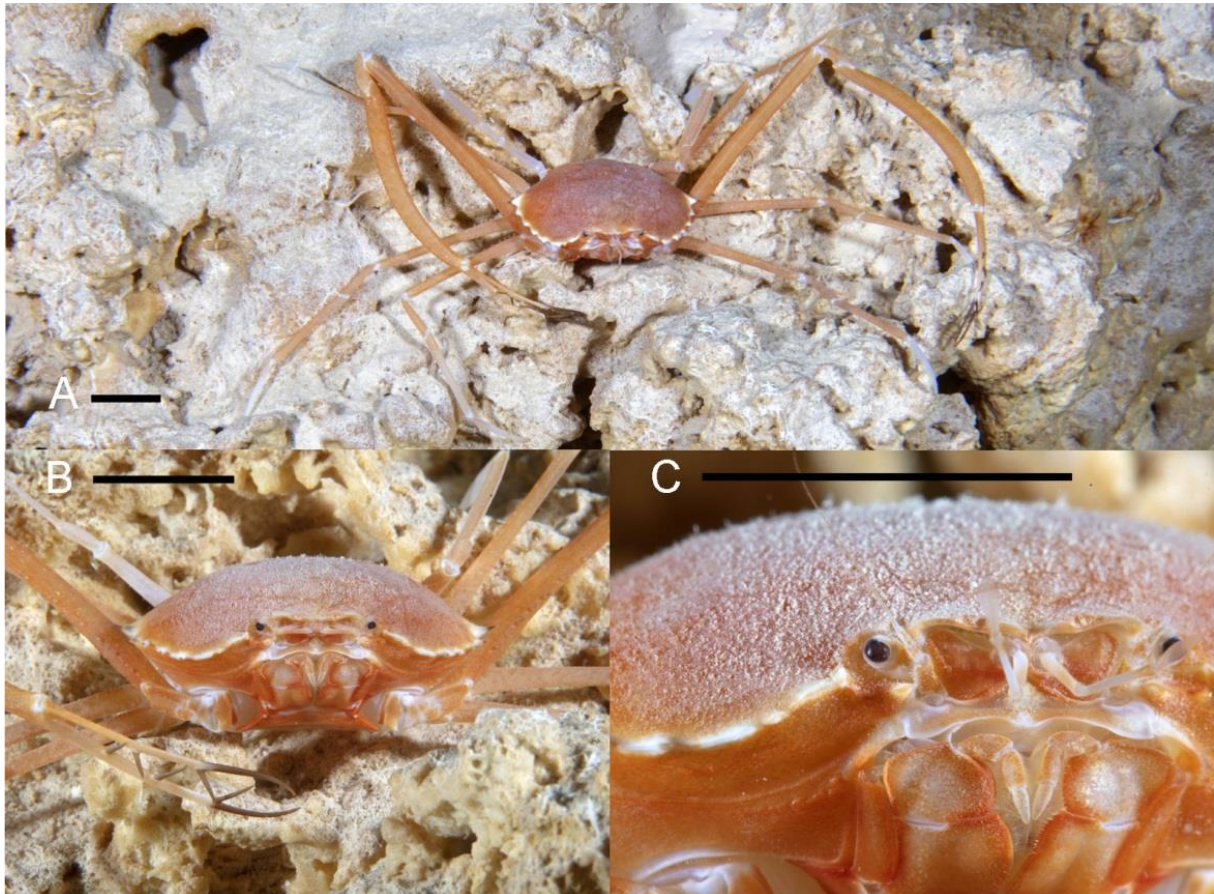


Figure 3 – *Atoportunus dolichopus*, line drawings made from photographs. A, E, specimen photographed 28/11/2018; B, C-D, specimen photographed 23/02/2019; estimated CB 28 mm for both specimens. A) Carapace, dorsal view with aspect of anterolateral armature; B) buccal cavern with MxP3 (setae omitted) and epistome (length of ischium is reduced because of oblique view); C) right cheliped showing mesial armature of merus; D) right chela, lateral view; E) right P5, dorsal view. Scale bars A-B, 5 mm, C-E, 10 mm.

