

# Discovery of the violet blanket octopus, *Tremoctopus violaceus* Chiaje, 1830 (Cephalopoda: Tremoctopodidae) from Korea

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## ABSTRACT

In the present study, a violet blanket octopus, *Tremoctopus violaceus* Chiaje, 1830, was collected for the first time in Korea. This species is widely distributed in tropical and subtropical oceans. To date, only a single *Tremoctopus* species, *Tremoctopus gracilis* (Souleyet, 1852) has been reported from Korean waters. In the case of *T. violaceus*, there is insufficient evidence to register it as a domestic species because the mobility and migratory characteristics of octopus have not been confirmed. Herein, we provide the morphological characteristics of *T. violaceus* with mitochondrial cytochrome c oxidase I (*cox1*) partial sequence.

**Keywords:** *Tremoctopus violaceus*, violet blanket octopus, mitochondrial *cox1*, Korea

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## INTRODUCTION

The species belonging to the family Tremoctopodidae Tryon, 1879, commonly called a blanket octopus, are widely distributed in tropical and subtropical waters of a circumtropical oceans, including the Atlantic Ocean, Indo-Pacific Ocean, Mediterranean and Caribbean seas (Arocha and Urosa, 1983; Díaz *et al.*, 2000; Haimovici and Perez, 1991; Nabhitabhata *et al.*, 2009; Norman, 2000; Relini, 2009; Roper *et al.*, 1984; Salisbury, 1953; Salman *et al.*, 2002; Thomas, 1977). This family is one of the four families under the superfamily Argonautoidea which is composed of family Argonautidae (paper nautilus), family Ocythoidae (football octopus) and family Allopsidae (seven-arm octopus). These pelagic octopods show sexual dimorphism, characterized by larger females than males because of reproductive adaptations (Norman *et al.*, 2002). The blanket octopus

exhibits two unique defense mechanisms, where the males and immature females use of stinging tentacles obtained from a siphonophore, the Portuguese Man-of-War Jellyfish (*Physalia* spp.) to defend themselves from predators (Jones, 1963; Norman *et al.*, 2002; Thomas, 1977). Another mechanism is found only in mature females, which carries a rolled up blanket web between arms I and II generally (Thomas, 1977). When the females are threatened, they unfurl their webbed blanket to increase their body size and scare the enemies.

Tremoctopodidae comprises a single genus *Tremoctopus*, and 4 species are listed in the worldwide: *T. gracilis* (Souleyet, 1852), *T. violaceus* Chiaje, 1830, *T. gelatus* Thomas, 1977 and *T. robsoni* Kirk, 1884. Among these species, only *T. gracilis* has been recorded in Korean waters (NIBR, 2019).

A single living specimen belonging to the violet blanket octopus, *T. violaceus* was collected on the eastern coast of Gangwon-do in Korea. In the present study, we newly report this species from Korean waters for the first time, with morphological description and figures. We also present the mitochondrial cytochrome c oxidase subunit I (mt COI) partial gene sequence as a molecular identification.

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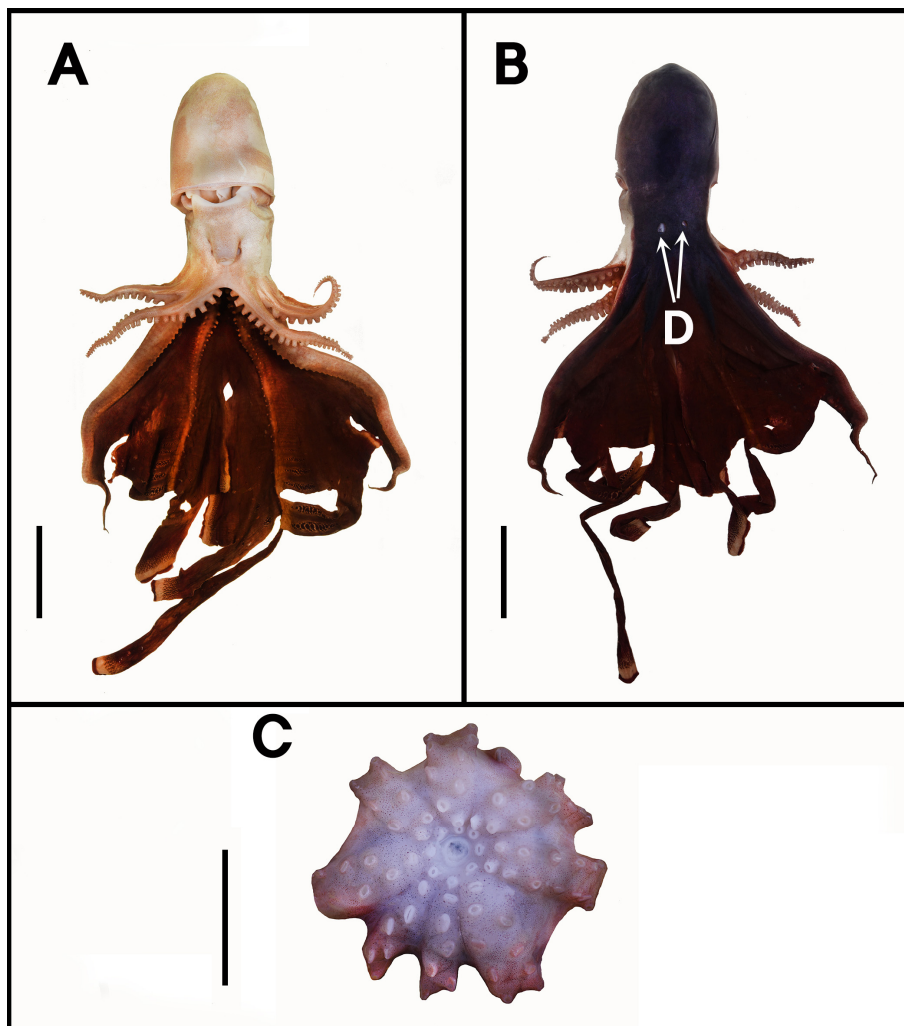


Fig. 1. *Tremoctopus violaceus*. A. dorsal view; B. ventral view; C. mouth; D. water pores. Scale bar: 50 mm.

## MATERIALS AND METHODS

**Morphological observations.** A single female specimen of *T. violaceus* was collected from the Sinnam port breakwater area, Samcheok-si, Gangwon-do by a Korea Coast Guard (KCG) officer and immediately stored in a freezer for the molecular work. After obtaining some fresh tissue from the frozen octopus, the specimen was preserved in 10% formalin for 24 hours, and then replaced with 70% ethyl alcohol. The fixed violet blanket octopus was deposited at National Marine Biodiversity Institute of Korea (MABIK), Seocheon, Republic of Korea. The morphological features of the

specimen were photographed and observed using DSLR (Nikon D800; Tokyo, Japan) and a stereo microscope (Leica MZ12.5, Germany), respectively. The specimen was identified and measured as described by Thomas (1997), Roper *et al.* (1984) and Noman *et al.* (2002).

**DNA sequencing and molecular analysis.** Total genomic DNA was extracted from the prepared part of the head tissue by using the QIAamp DNA micro Kit (Qiagen, Hilden, Germany) following the company instructions. The PCR amplification was performed using the TaKaRa Ex Taq™ polymerase (Takara Bio, Shiga, Japan) with the universal mitochondrial *cox1* primer

set [LCO1490 forward primer (5' -GGTCAACAAATCATAAAGATATTGG-3') and HCO2198 reverse primer (5' -TAAACTTCAGGGTGACCAAAAAATCA-3')] (Folmer *et al.*, 1994). The PCR product was sequenced using the ABI 3730XL DNA Analyzer (Applied Biosystems, Foster City, CA, USA) in both directions. The sequence of *T. violaceus* (GenBank accession number: MW025168) was obtained and compared with the sequences of 7 other pelagic octopuses mined from GenBank. The sequences were aligned using MAFFT alignment method in Geneious 9.1.8 (Biomatters Ltd, Auckland, New Zealand). Phylogenetic relationships were reconstructed using the neighbor-joining (NJ) method with the Kimura's two-parameter model in MEGA 7 (Kumar *et al.*, 2016).

## SYSTEMATIC ACCOUNTS

Class Cephalopoda Cuvier, 1795 두족강  
 Subclass Coleoidea Bather, 1888 초형아강  
 Order Octopoda Hasselquist, 1850 문어목  
 Superfamily Argonautoidea Cantraine, 1841 집낙지상과  
 Family Tremoctopodidae Tryon, 1879 보라문어과  
 Genus *Tremoctopus* Chiaje, 1830 보라문어속

### *Tremoctopus violaceus* Chiaje, 1830

갈색망토보라문어(신칭) (Fig. 1)

*Tremoctopus violaceus* Delle Chiaje, 1830: pls. Ixx, Ixxi, 1841: 6 (refers Thomas, 1977: 355-368, Fig. 1-9); Judkins, 2009: 701-709, Relini, 2009: 13-16; Norman *et al.*, 2002: 733-736, Fig. 1.

*Octopus velifer*: Ferussac, 1835: pls. 18, 19; Phillippi, 1844: 201.

*Octopus violaceus*: Ferussac, 1835: pl. 20; Verany, 1851: 41.

*Octopus semipalmatus*: Owen, 1836: 112.

*Octopus velatus*: Rang, 1837: 60.

*Tremoctopus microstomus*: Tryon, 1879: 130.

*Tremoctopus ocellatus*: Brock, 1882: 601.

**Type locality:** Mediterranean Sea (Chiaje, 1830).

**Habitat:** Surface waters of tropical and subtropical oceans.

**Distribution:** Atlantic Ocean, Mediterranean Sea, Gulf of Mexico, Caribbean Sea and Indo-Pacific Ocean:



**Fig. 2.** Map showing the locality where the specimen of the *Tremoctopus violaceus* was collected.

China, Japan and Korea (Gangwon-do, present study)

**Material examined:** Single individual (MO00176345), Sinnam port breakwater area, Samcheok-si, Gangwon-do, sea surface, 5 August 2019 (Fig. 2).

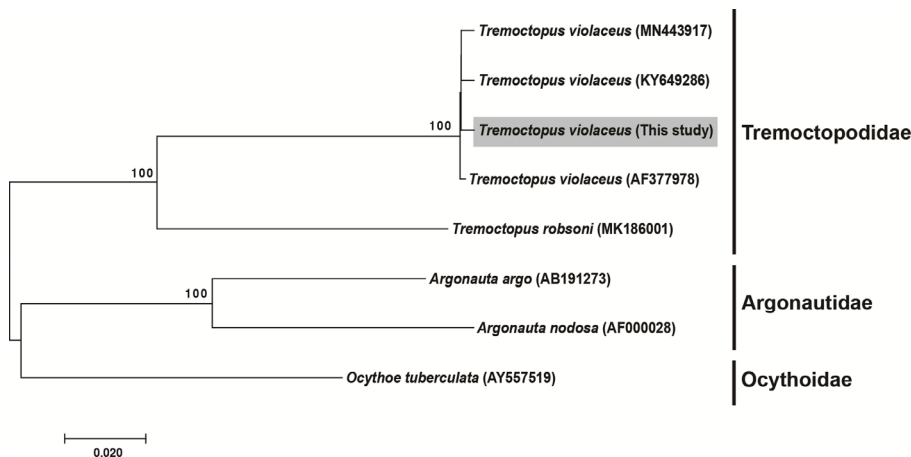
**Measurement:** See Table 1.

**Description:** Dorsal mantle and head dark bluish-purple; ventral surface iridescent silvery. Mantle smooth, thick, muscular, blunt posterior end. Head narrower than mantle; large laterally-directed eyes. Two pairs of aquiferous pores; one pair of water pores on dorsal surface of the head between the eyes; second pair on the ventral surface of the head adjacent to funnel opening. Funnel moderate in size, extends beyond the level of the eyes; funnel organ W-shaped; funnel-mantle locking apparatus. Arms unequal in size and shape; arms I and II incomplete; arm order 2.1.3.4.3. or 1.2.4.3.; suckers biserial, decreasing in size towards the end of arm; arms I truncated, degenerate in adults; arms II stout, flattened along the oral surface; arms III and IV no unusual modifications. Web deep maroon, well developed, damaged in all specimens, web formula B.A.D.C.E; sector A damaged, deep, extends to the tip of the truncated arms, V-shaped cleft.

**Remarks:** Pelagic octopuses under the genus *Tremoctopus* are morphologically similar, with features such as muscular mantle, asymmetrical arms and dorsal pairs connected by a web. They also exhibit extreme sexual dimorphism, with the male measuring less than 10% of the female in size, along with a

**Table 1.** External measurements and number of suckers of *Tremoctopus violaceus*

Characters	Measured value	No. of suckers
Total length (mm)	465	-
Head width (mm)	51	-
Head length (mm)	72	-
Mouth width (mm)	13	-
Arm length Right I (mm)	167	58
Arm length Right II (mm)	155	73
Arm length Right III (mm)	309	112
Arm length Right IV (mm)	245	76
Arm length Left I (mm)	144	64
Arm length Left II (mm)	171	45
Arm length Left III (mm)	288	101
Arm length Left IV (mm)	281	70
Weight (g)	731.4	-



**Fig. 3.** Neighbor-joining (NJ) analysis based on mitochondrial cytochrome c oxidase subunit I (mt COI) sequences of 8 pelagic octopuses.

detachable hectocotylus (Nabhitabhata *et al.*, 2009; Norman *et al.*, 2002; Thomas 1977; Voss & Williamson 1971). Among to them, *T. violaceus* and *T. gracilis* (Souleyet, 1852) are hard to distinguish in their juvenile phase because of morphological similarities. Although limited, it is possible to differentiate them based on their distribution, the number of sucker pairs on the hectocotylized arm in the male and the number of gill lamellae (Nabhitabhata *et al.* 2009; Relini 2009; Thomas 1977).

In this study, we performed molecular analysis using mtDNA *cox1* partial sequence with another NCBI sequence under the genus *Tremoctopus*. The intraspecific genetic variation in the mtDNA *cox1* gene sequences of *T. violaceus* was 0-0.5% (0 to 3 nucleotide difference). The NJ phylogenetic tree shows that our sequence was grouped with the same species (Fig. 3). As a result of the molecular analysis, it was more clearly to identified as the *T. violaceus* based on the unique morphological features.

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