FIRST RECORD OF TWO PELAGIC OCTOPODS, ARGONAUTA ARGO AND TREMOCTOPUS VIOLACEUS CF. GRACILIS FROM THE ANDAMAN SEA, THAILAND

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FIRST RECORD
PELAGIC OCTOPODS
CEPHALOPODA
ANDAMAN SEA

ABSTRACT. – Two pelagic octopods, *Argonauta argo* Linnaeus, 1758 and *Tremoctopus violaceus* cf. *gracilis* (Eydoux & Souleyet, 1852) are new records from the Andaman Sea, Eastern Indian Ocean, Thai waters. Both species are known as oceanic-pelagic species. However, in 2007 the two species were collected from the coastal zone. This occurrence coincided with internal waves reported in the Andaman Sea.

INTRODUCTION

Three species of argonautid octopods have been recorded in Thai waters, *Argonauta boettgeri* Maltzen, 1881, *A. hians* Solander, 1786 and *A. argo* (Nabhitabhata 1999), but specimens of *A. argo* have not been formally deposited in any reference collections in Thailand. *A. argo* is the largest argonaut, distributed in tropical and subtropical waters of the open oceans worldwide (Roper *et al*. 1984, Norman 2000). The female dorsal arms provided with large membranous flaps that secrete a thin, calcareous, fragile secondary shell from glands on the webs (Roper *et al*. 1984). The flaps are also used to envelope and hold the secondary shell as well as for collecting plankton as feed (Young 1960, Voss & Williamson 1971, Roper *et al*. 1984). The secondary shell is used as a case for incubating, housing, protecting and transporting eggs (Young 1960, Norman 2000). Naef (1923) has suggested that the protoargonauts may have used empty shells of ammonites and nautiloids to protect themselves and their eggs, and later, enlarged these shells with their own secretions.

The blanket octopus, *Tremoctopus violaceus* Delle Chiaje, 1830 is cosmopolitan and distributed in tropical and subtropical surface waters (Norman 2000). Males and young females are reported to carry pieces of siphonophore tentacles of the Portuguese Man-of-War Jellyfish (*Physalia* sp.), by using suckers on their arms I and II. This implies that their function is for defense and catching prey (offense) (Jones 1963, Thomas 1977, Knudsen 1992, Norman *et al*. 2002). Females with mantle lengths of more than 70 mm have never been reported to function in this way (Thomas 1977). The female *Tremoctopus* have large extensive webs between their four dorsal arms. The web does not produce a secondary shell material, and may serve only for food gathering (Young 1960). The eggs (attached to paired rods) are carried in the basal region of the arm I pair (Nesis 1987). Young (1960) has suggested that the blanket octopus "… may pass through a shell-living phase (of protoargonauts, as Naef (1923) points out) and adopted the function of food-gathering and egg protection when the supply of shells failed…".

Observations on the behavior of *Tremoctopus in situ* and of *Argonauta* in captivity revealed that the immature and mature females of these pelagic octopods, frequently attached themselves to substrates (coelenterates and the aquarium wall, respectively) (Jones 1963, Voss & Williamson 1971, Suksangchan *et al*. 2008) thus indicating that they are not strong swimmers and rest by becoming attached to buoyant substrates. Both species have an extreme sexual size-dimorphism. The male is less than 10 % of the female size, with a detachable hectocotylus that has its distal part modified into a sperm reservoir (Voss & Williamson 1971, Thomas 1977, Norman *et al*. 2002).

MATERIALS AND METHODS

The material of *Argonauta argo* has been collected as by-catch of tuna purse-seining in surface water in April 2007 by T Sriploy. The total water depth at the locality was about 4000 m. The material of *Tremoctopus violaceus* cf. *gracilis* has been collected from the fish landing of purse-seining commercial fishing boats at Ratsada fishing harbour, Phuket province, Andaman Sea, Thailand in February 2007 by the second author, C Sukhsangchan. The material was fixed in 10 % neutralized formaldehyde and then transferred to 75 % ethyl alcohol (Roper & Sweeney 1983).

The definition of morphometry followed Roper & Voss (1983) and O'Shea (1999). Indices are expressed as percentage of mantle length. The described specimens are deposited in the

Princess Maha Chakri Sirindhorn Natural History Museum, Prince of Songkla University (PSUNHM) and the Reference Collection of Phuket Marine Biological Center (PMBC).

SYSTEMATIC ACCOUNT

Genus Argonauta *Linnaeus, 1758*

Mantle thin and muscular; arm suckers bi-serial; tips of female dorsal arms with broad, membranous, glandular flaps that secrete and hold the secondary shell; web shallow; water pores absent.

Argonauta argo *Linnaeus, 1758* (Fig. 1, Table I)

Argonauta argo (- Sasaki 1929: 23-25, pl. 3, figs 8-12; - Voss & Williamson 1971: 98-104, pl. 33, figs 41-44; - Roper *et al*. 1984: 225-226; - Okutani *et al*. 1987: 184-185, fig. 74; - Nesis 1987: 327-329, fig. 88A-C; - Hochberg *et al*. 1992: 232-234, figs 251-252; - O'Shea 1999: 87-90, fig. 59.)

Material examined: PMBC 21757; 1 female, ML 141.4 mm, tuna purse-seining, surface at a depth of 4000 m, East Indian Ocean, Collector T Sriploy, 17 April 2007.

Description

Mantle elongate, conical, compressed, posterior end curving upwards; attached directly to the base of arm pair I; opening very wide, extending above eyes. Orbits large, bulbous, laterally oriented; situated at the base of arm II and III; eye aperture small. Funnel long; free distal portion; attached to the base of arm IV. Arms laminar, long, sub-equal; arm formula 4.1.3.2; I, II and III distally damaged; arm I develops a wide, conspicuous, membranous extension along its ab-oral surface; arm IV length more than twice that of arms II and III. Web shallow, without extension, with A deepest and C shallowest. Arm suckers bi-serial; size gradually decreasing to arm tips; counts of up to 194 on arm III L; suckers extending to the tip of the arm. Arm I suckers 184; arm II (damaged) 82; arm III 194 (L, R damaged) arm IV 188. Secondary shell not collected. Specimen mature; possessed eggs in the distal oviducts. Detached hectocotylus not found in mantle cavity. Gill lamellae 11-12 per outer demi-branch.

Distribution

Cosmopolitan in tropical and sub-tropical open water regions (Nesis 1987).

Remarks

The secondary shell or egg case of the adult female *A. argo* in this study is not available but the longer arm IV is about twice as long as the other arms making it distinguishable from other *Argonauta* species. The size of this specimen (ML) is large compared to indications by Sasaki (1929) 82 mm, Okutani *et al*. 1987 37-45 mm, O'Shea (1999) 29.3-52.7 mm, but comparable to those of Cairns (1976) 99.0-109.5 mm and to a maximum size, up to 120 mm, as stated by Roper *et al*. 1984.

Genus Tremoctopus *Delle Chiaje, 1830*

Female large, without secondary shell. Dorsal and ventral cephalic water pores present. Arms unequal in length and shape; arms I and II greatly elongated; web sector A membranous, broad, extends along both sides of arm I.

Tremoctopus violaceus *cf.* gracilis (Eydoux & Souleyet, 1852) *Fig. 2, Table II, III, IV*

Tremoctopus violaceus (- Sasaki 1929: 29-32, pl. 8, figs 17-19; -Joubin 1937: 39-45, figs 38-48; - Voss & Wil-

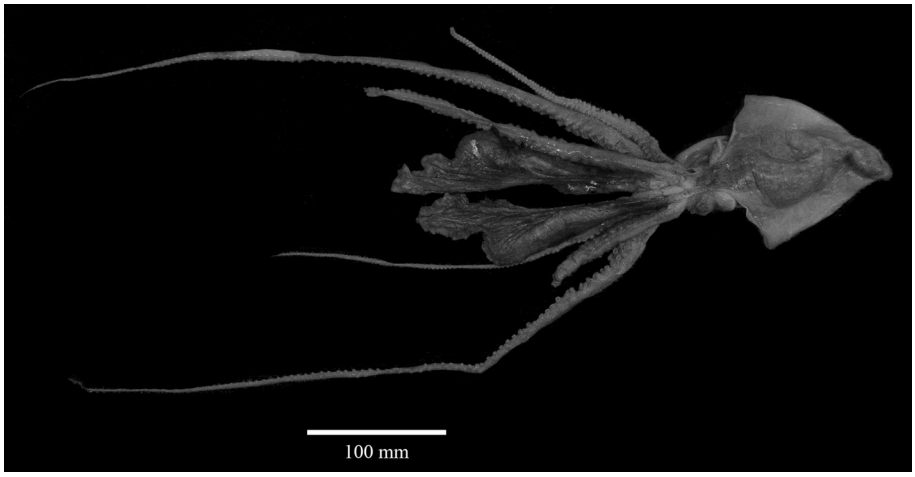

Fig. 1. – Specimen of greater argonaut, *Argonauta argo,* from the Andaman Sea, female, ML 141.4 mm (PMBC 21757).

Table I. – Measurements (mm), counts and indices (%) of female *Argonauta argo*. * = Damaged, TL = Total Length, ML = Mantle Length, MW = Mantle Width, MWI = Mantle Width Index, HW = Head Width, HWI = Head Width Index, HL = Head Length, HLI = Head Length Index, AL1 = First Arm Length, R/L = Right/Left, AL1I = First Arm Length Index, AL2 = Second Arm Length, AL2I = Second Arm Length Index, AL3 = Third Arm Length, AL3I = Third Arm Length Index, AL4 = Fourth Arm Length, AL4I = Fourth Arm Length Index, WDA = Web Depth A, WDAI = Web Depth A Index, WDB = Web Depth B, WDBI = Web Depth B Index, WDC = Web Depth C, WDCI = Web Depth C Index, WDE = Web Depth E, WDEI = Web Depth E Index, ASC1 = First Arm Sucker Count, ASC2 = Second Arm Sucker Count, ASC3 = Third Arm Sucker Count, ASC4 = Fourth Arm Sucker Count, ASD1 = First Arm Sucker Diameter, ASD1I = First Arm Sucker Diameter Index, ASD2 = Second Arm Sucker Diameter, ASD2I = Second Arm Sucker Diameter Index, ASD3 = Third Arm Sucker Diameter, ASD3I = Third Arm Sucker Diameter Index, ASD4 = Fourth Arm Sucker Diameter, ASD4I = Fourth Arm Sucker Diameter Index, FFL = Free Funnel Length, FFLI = Free Funnel Length Index, ED = Eye Diameter, EDI = Eye Diameter Index, EO = Eye Opening, EOI = Eye Opening Index, GC = Gill Lamellae Count.

Measure	PMBC 21757	Indices	PMBC 21757
TL	726.0*		
ML	141.4		
MW	87.5	MWI	61.9
HW	43.2	HWI	30.5
HL	21.5	HLI	15.2
AL1R/L	404.0*/398.0*	AL1IR/L	285.7*/281.4*
AL2R/L	255.0*/131.0*	AL2IR/L	180.3*/92.6*
AL3R/L	209.0*/346.0	AL3IR/L	147.8*/244.7
AL4R/L	554.0/540.0	AL4IR/L	391.7/381.8
WDA	34.0	WDAI	24.0
WDBR/L	23.0/24.0	WDBIR/L	16.3/17.0
WDCR/L	17.0/23.0	WDCIR/L	12.0/16.0
WDDR/L	26.0/29.0	WDDIR/L	18.4/20.5
WDE	30.0	WDEI	21.2
ASC1R/L	184*/150*		
ASC2R/L	82*/36*		
ASC3R/L	114*/194		
ASC4R/L	188/190		
ASD1R/L	6.6/6.9	ASD1IR/L	4.7/4.9
ASD2R/L	5.9/5.1	ASD2IR/L	4.2/3.6
ASD3R/L	4.7/4.1	ASD3IR/L	3.3/2.9
ASD4R/L	6.7/5.5	ASD4IR/L	4.7/3.9
FFL	55.0	FFLI	38.9
EDR/L	22.0/20.7	EDIR/L	15.6/14.6
EOR/L	40.6/31.4	EOIR/L	2.9/2.2
GCR/L	12/11		

liamson 1971: 109-112, pl. 35, figs 48-49;- Hochberg *et al*. 1992: 228-229, figs 246-248.)

Tremoctopus violaceus gracilis (-Thomas 1977: 353-392, figs 1-9; - Okutani *et al*. 1987: 182-183, fig. 73; - Nesis 1987: 324-326, fig. 87H-L.)

Material examined: PSUNHM 2197-22126-1101, 2197-22126-1102; 2 mature females, ML 144.6-181.0 mm, PMBC 23710, 21914, 21972; 3 mature females, ML 130.6-167.0 mm, 14 February 2007, PMBC 21881; 1 immature female, ML 90.4 mm, surface, purse-seining, 9°13' N, 97°15' E, Collector C Sukhsangchan, February, 2007

Description

In fresh specimens, the dorsal mantle and head is brownish purple; the ventral side is iridescent silvery. Mantle thick, muscular, blunt posterior end; mantle width index is 57.7-78.8. Head narrower than mantle; head width index is 41.2-59.4; eyes lateral; one pair of cephalic pores on dorsal head between the eyes; another smaller pair, on the ventral head adjacent to funnel opening. Funnel extends beyond eye level; free portion is 11.1-18.1. Funnel locking apparatus is formed by the folded angle of the posterior part of the funnel. The funnel organ is W-shaped with longitudinal ridges. Arms unequal in size and shape; arms I and II incomplete; arm order 1.2.4.3; suckers bi-serial, decreasing in size towards the distal portion. Web well developed, damaged in all specimens, web formula B.A.D.C.E; sector A damaged, deep, extends along both sides of the arm, V-shaped cleft. Detached hectocotylus not found in the mantle cavity. Gill lamellae 13-16 (mean 14) per outer demi-branch in mature specimens and 11 in the immature specimen.

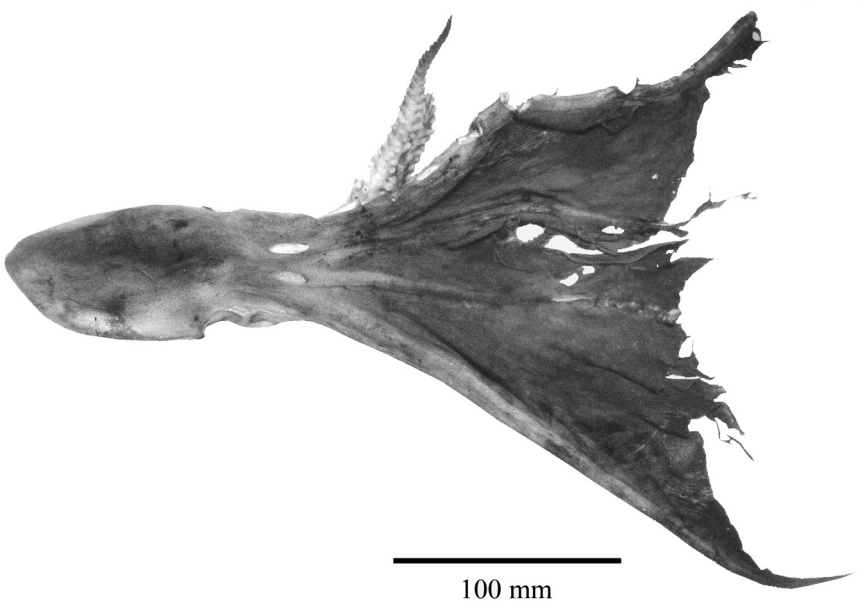

Fig. 2. – Specimen of blanket octopus, *Tremoctopus violaceus* cf. *gracilis* Eydoux & Souleyet, 1852, female, ML 144.6 mm (PMBC 21972).

Table II. – Measurements (mm) and counts of female *Tremoctopus violaceus* cf. *gracilis*. DP = Dorsal Water Pore Diameter, VP = Ventral Water Pore Diameter, other abbreviations as for Table I.

Measure	PSUNHM 2197-22126-1101	PSUNHM 2197-22126-1102	PMBC 21972	PMBC 23710	PMBC 21914	PMBC 21881
TL	781.0*	752.0*	405.8*	659.0*	473.0*	382.0*
ML	165	181.0	144.6	167	130.6	94.0
MW	116	119.0	103.4	98.0	75.3	74.1
HW	90.9	100.7	81.0	75.0	53.8	55.9
HL	35.3	43.2	46.0	44.9	38.3	22.8
AL1R/L	629/366*	357*/318*	94.6*/92.3*	273*/226*	209*/267*	138*/137*
AL2R/L	459/448	298*/438	154.4*/145.3*	410/183*	327/277*	271*/280*
AL3R/L	237/156*	222/230	107.5*/90.4*	214/206	168/161	147/113*
AL4R/L	224/237	168*/236	178*/221	216/242	163/124*	145/158
WDA	384	195	*	149	132	51.0
WDBR/L	389/387	406/401	*/*	301/101.9*	257*/241*	65/51
WDCR/L	65.0/86.0	71.0/73.0	58.0/55.0	71.0/87.4	49.0/45.0	45/38
WDDR/L	67.0/75.0	62.0/83.0	74.3/66.6	86.0/74.0	58.0/56.0	65/45*
WDE	48.0	54.0	42.2	42.0	42.0	36.0
ASC1R/L	50*/51*	45*/46*	20*/22*	46*/47*	56*/51*	46*/42*
ASC2R/L	48*/75	53*/57	32*/25*	46/32*	104/38*	106*/108*
ASC3R/L	84/33*	57*/82	18*/22*	72/63	68/65	54/58*
ASC4R/L	80/84	56*/96	44*/67	62/74	70/40*	55/57
ASD1R/L	6.7/7.4	6.1/6.9	6.5/6.2	6.7/5.8	5.6/5.3	4.0/3.9
ASD2R/L	6.8/6.2	6.6/6.2	6.1/5.7	6.4/6.8	4.8/4.6	3.4/3.4
ASD3R/L	6.5/6.6	6.0/6.1	5.2/5.8	6.2/6.4	4.0/3.9	3.7/3.1
ASD4R/L	6.5/6.3	5.4/5.7	6.4/5.3	6.2/6.9	4.2/3.9	3.4/3.3
FFL	20.0	20.2	20.3	20.7	16.6	17.0
EDR/L	40.2/-	37.4/37.8	35.4/34.4	43.4/40.9	31.8/33.2	28.2/25.3
EOR/L	19.5/-	20.8/20.7	14.6/14.7	17.8/19.3	12.1/12.7	11.7/9.2
DPR/L	22.6/26.6	22.3/22.3	23.1/28.2	16.8/21.1	28.0/21.2	13.1/10.1
VPR/L	17.8/16.1	13.7/16.1	15.1/14.1	13.9/15.3	12.0/12.7	7.2/7.3
GCR/L	15/14	16/14	14/14	14/14	14/13	11/11

Table III. – Indices (%) of female *Tremoctopus violaceus* cf. *gracilis*. DPI = Dorsal Water Pore Diameter Index, VPI = Ventral Water Pore Diameter Index, other abbreviations as for Table I.

Index	PSUNHM 2197-22126-1101	PSUNHM 2197-22126-1102	PMBC 21972	PMBC 23710	PMBC 21914	PMBC 21881
ML	165	181.0	144.6	167	130.6	94.0
MWI	70.3	65.8	71.5	58.7	57.7	78.8
HWI	55.1	55.6	56.0	44.9	41.2	59.4
HLI	21.4	23.9	31.8	26.9	29.4	24.2
AL1IR/L	381.2/221.8*	197.2*/175.7*	65.4*/63.8*	163.5*/135.3*	160.1*/204.5*	146.7*/145.7*
AL2IR/L	278.2/271.5	164.6*/242.0	106.7*/100.5*	245.5/109.6*	250.5/212.2*	288.2*/297.7*
AL3IR/L	143.6/94.5*	122.7/127.1	74.3*/62.5*	128.1/123.4	128.7/123.3	156.3/120.2*
AL4IR/L	135.8/143.6	92.8*/130.4	123.1*/152.8	129.3/144.9	124.8/95.0*	154.2/168.0
WDAI	232.7	107.7	*	89.2	101.1	54.2
WDBIR/L	235.8/234.5	224.3/221.5	*/*	180.2/61.0*	196.8*/184.6*	69.1/54.2
WDCIR/L	39.4/52.1	39.2/40.3	40.1/38.0	42.5/44.3	37.5/34.5	47.9/40.4
WDDIR/L	40.6/45.5	34.3/45.9	51.4/46.0	51.5/44.3	44.4/42.9	69.1/47.9*
WDEI	29.1	29.8	29.2	25.1	32.2	38.3
ASD1IR/L	4.0/4.5	3.3/3.8	4.5/4.3	4.0/3.5	4.3/4.1	4.2/4.2
ASD2IR/L	4.1/3.7	3.6/3.4	4.2/4.0	3.8/4.1	3.7/3.5	3.6/3.7
ASD3IR/L	4.0/4.0	3.3/3.4	3.6/4.0	3.7/3.8	3.1/3.0	3.9/3.3
ASD4IR/L	3.9/3.8	3.0/3.1	4.4/3.7	3.7/4.1	3.2/3.0	3.6/3.6
FFLI	12.1	11.1	14.0	12.4	12.7	18.1
EDIR/L	24.4/-	20.6/20.9	24.5/23.8	26.0/24.5	24.3/25.5	30.0/26.9
EOIR/L	11.8/-	11.5/11.4	10.1/10.2	10.6/11.6	9.2/9.7	12.5/9.8
DPIR/L	13.7/16.1	12.3/12.3	16.0/19.5	10.1/12.6	21.4/16.3	14.0/10.7
VPIR/L	10.8/9.7	7.6/8.9	10.4/9.7	8.3/9.2	9.2/9.7	7.7/7.8

Table IV. – Mean of indices (%) and counts of female *Tremoctopus violaceus* cf. *gracilis*. DPI = Dorsal Water Pore Diameter Index, VPI = Ventral Water Pore Diameter Index, Im = Immature included, M = Mature, other abbreviations as for Table I.

Index	n	Mean	SD	SE	Range
ML(mm)	6	147.0	31.5	12.9	94.0-181.0
MWI	6	67.1	8.1	3.3	57.7-78.8
HWI	6	52.1	7.2	2.9	41.2-59.4
HLI	6	26.3	3.8	1.6	21.4-31.8
AL1IR/L	6	185.7*/157.8*	105.4/56.7	43.0/23.2	65.4-381.2/63.8-221.8
AL2IR/L	6	222.3*/205.6	71.4/83.0	29.1/33.9	106.7-288.2/100.5-297.7
AL3IR/L	6	125.6*/108.5*	28.0/25.4	11.4/10.4	74.3-156.3/62.5-127.1
AL4IR/L	6	126.7*/139.1	20.1*/24.9	8.2/10.2	92.8-154.2/95.0-168.0
WDAI	5	117.0	67.9	30.4	54.2-232.7
WDBIR/L	5	181.3*/151.2*	66.4/87.4	29.7/39.1	69.1-235.8/54.2-234.5
WDCIR/L	6	41.1/41.6	3.7/6.1	1.5/2.6	37.5-47.9/34.5-52.1
WDDIR/L	6	48.6/45.4*	12.0/1.7	4.9/0.7	34.3-69.2/42.9-47.9
WDEI	6	30.6	4.4	1.8	25.1-38.3
ASC1R/L	6	44*/44*	12/11	5/4	20-56/22-51
ASC2R/L	6	65*/56*	32/31	13/13	32-106/25-108
ASC3R/L	6	59*/54*	23/22	9/9	18-84/22-82
ASC4R/L	6	61*/70*	13/20	5/8	44-80/40-96
ASD1IR/L	6	4.1/4.0	0.4/0.4	0.2/0.2	3.3-4.5/3.5-4.5
ASD2IR/L	6	3.9/3.7	0.3/0.3	0.1/0.1	3.6-4.2/3.4-4.1
ASD3IR/L	6	3.6/3.6	0.3/0.4	0.1/0.2	3.1-4.0/3.0-4.0
ASD4IR/L	6	3.7/3.5	0.5/0.4	0.2/0.2	3.0-4.4/3.0-4.1
FFLI	6	13.4	2.5	1.0	11.1-18.1
EDIR/L	6	25.0/24.3	3.0/2.3	1.2/1.0	20.6-30.0/20.9-26.9
EOIR/L	6	11.0/10.5	1.2/0.9	0.5/0.4	9.2-12.5/9.7-11.6
DPIR/L	6	14.6/14.6	3.9/3.3	1.6/1.3	10.1-21.4/10.7-19.5
VPIR/L	6	9.0/9.2	1.4/0.8	0.6/0.3	7.6-10.8/7.8-9.7
GCR/L Im	6	14/13	2/1	1/1	11-16/11-14
GCR/L M	5	15/14	1/1	0/0	14-16/13-14

Remarks

The present specimens can be distinguished from the gelatinous *Tremoctopus gelatus* Thomas, 1977 by their muscular mantle. Thomas (1977) reported the muscular mantle in two subspecies of *T. violaceus*, *T. violaceus violaceus* Delle Chiaje, 1830 and *T. violaceus gracilis*. The former subspecies inhabits the Atlantic Ocean and the latter the Indian Ocean. The difference between the two subspecies is the number of sucker pairs on the hectocotylized arm of the male. In *T. violaceus gracilis* there are 19-22 pairs on the distal portion and 27-29 on the proximal portion whereas in *T. violaceus violaceus* there are 15-19 pairs on the distal portion and 22-23 on the proximal portion. Another difference is the number of gill filaments as the mean of *T. violaceus gracilis* (15) is higher than that of *T. violaceus violaceus* (13), although the range is similar (13-16) (Thomas 1977). Since no male was collected in this study, the female specimens are here identified as *T. violaceus* cf. *gracilis* due to their number of gill lamellae (of mature specimens) with a mean of 15 and a range of 14-16 as well as its locality, the Andaman Sea of the Indian Ocean. The range of the numbers of gill lamellae in the females also infers that the Thai specimens are distinguishable from *T. robsoni* Kirk, 1883, another *Tremoctopus* with a muscular mantle from New Zealand waters. In this species the gill lamellae count is exactly 15 (O'Shea 1999).

DISCUSSION

Although the distribution map of *A. argo* in Roper *et al*.1984 included the Andaman Sea as a part of the Indian Ocean, no specimens have been previously recorded from Thai waters. One reason might be the oceanic habitat. The studied specimen had been collected from a deeper zone compared to *A. hians* that has been regularly collected in the neritic zone (Sukhsangchan *et al*. 2008). Another reason is that this species has no commercial importance, so specimens might be discarded as trash fish during commercial fishing. However, the commercial value of the secondary shell is high in the shell collectors market.

Notable near-shore collections of oceanic *T. violaceus* cf. *gracilis* have coincided with the occurrence of large internal waves reported during January-April 2007 in the Andaman Sea, suggesting temporary migration of the blanket octopus to the neritic zone. The above-mentioned internal waves carried a cooler water mass of < 20-25 ˚C and 33-35 ppt, < 2-4 mg/L dissolved oxygen with rich nutrients, from the continental slope (100-120 m depth) up to the continental shelf (< 30 m depth), causing plankton blooms and a mass mortality of aquatic animals (Khokiattiwong *et al*. 2008). From the authors' personal observation, large numbers of the oceanic diamond squid, *Thysanoteuthis rhombus* Troschel, 1857, were also fished from the neritic zone in the same period.

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