Phuket mar. biol. Cent. Res. Bull. **66:** 275–282 (2005)

DISTRIBUTION AND SPAWNING GROUNDS OF CUTTLEFISH IN THE UPPER GULF OF THAILAND

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ABSTRACT: A study on the species distribution and spawning grounds of cuttlefish in the upper Gulf of Thailand was conducted in January, April, July and October 2002. Samples were collected from the research vessel Pramong 2 using an otter board trawl operated within 3, 5, 7 and more than 7 nautical miles from the shore. The most abundant cuttlefish species found in the upper Gulf of Thailand was *Sepia aculeata* followed by *S. recurvirostra* and *Sepiella inermis* while *Sepia pharaonis* and *S. brevimana* were rarely caught.

Most *Sepia aculeata* and *Sepiella inermis* were found 3–7 nautical miles offshore and *Sepia recurvirostra* was found more than 7 nautical miles offshore and at stations with bottom depths of 20–40 meters. *Sepiella inermis* tended to be abundant at 3 nautical miles offshore and at stations with bottom depths of 10–15 meters while *Sepia aculeata* was abundant over a wide range from 3–7 nautical miles and at stations with bottom depths of 10–30 meters. The spawning grounds mostly occurred 3–7 nautical miles offshore and at stations with bottom depths of 10–30 meters for *Sepia aculeata*, 5 to more than 7 nautical miles offshore and at stations with bottom depths of 20–40 meters for *S. recurvirostra* and 3 nautical miles offshore and at stations with bottom depths of 10–15 meters for *Sepiella inermis*.

INTRODUCTION

Cuttlefish are economically important marine species in the Gulf of Thailand and belong to the cephalopod Family Sepiidae. There are seven species found in the Gulf of Thailand, namely *Sepia aculeata*, *S. brevimana, S. kobiensis, S. lycidas, S. pharaonis, S. recurvirostra* and *Sepiella inermis* (Chotiyaputta *et al*., 1992 and Chaitiamvong, 1993). Cuttlefish generally occur inshore, spending much of their lives near or on the sea bed (Voss, 1973 cited after Bakhayokho, 1983), and are caught mostly by traps, push nets and otter board trawlers, that operate inshore. All seven species are widely distributed in the Gulf of Thailand except for *Sepia lycidas,* which occurs only in the southern part of the Gulf up to Chumphon province (Supongpan, 1988). The result from a resource survey in the upper Gulf of Thailand using an otter board trawl from the research vessel Pramong 2 during 1999–2000 also showed that *Sepia lycidas* and *S. kobiensis* do not occur in this area during this survey. The main species caught were *Sepia aculeata* followed in abundance by *S. recurvirostra, Sepiella inermis, Sepia pharaonis, S. brevimana* (Anugul, 2002).

Supongpan (1988) reported that the abundance of cuttlefish varies with bottom depth. *Sepiella inermis* and *Sepia lycidas* were abundant in the depth range between 10–20 meters. *Sepia aculeata* was abundant at depths of 10–30 meters. *Sepia pharaonis* and *S. recurvirostra* were abundant at stations with bottom depths of 20–30 meters. Nabhitabhata (1997) reported that *Sepiella inermis* was abundant in estuarine areas in shallow water at depths of approximately 20 meters. The amount of cuttlefish caught in the Gulf of Thailand from the small size otter board trawlers during 1976–1981 was about 40% of a total catch of cephalopods (Supongpan, 1988). Cuttlefish production in Thailand was 60.4 thousand metric tons (2,808.8 Million Bath in value) in 1993 and 71.6 thousand metric tons (4,195.2 Million Bath in value) in 1997, showing that cuttlefish catches have increased (Department of Fisheries, 1997). A cuttlefish fisheries assessment in 1995 reported an over exploitation of cuttlefish (Supongpan, 1995). Therefore, it is necessary to obtain more

information on species distribution and spawning grounds of cuttlefish as useful data for sustainable fisheries management in the future.

OBJECTIVES

1. To study the species composition and distribution of cuttlefish in the upper Gulf of Thailand;
2. To study the size distribution of cuttlefish;
3. To determine maturation stage distribution of cuttlefish in the upper Gulf of Thailand.

MATERIALS AND METHODS

Sample collection

The survey area was located between latitude 11°40′ N and 13°30′ N and longitude 99°45′ E and 101°00′ E (Fig.1). Specimens were collected at 29 stations once a month by an otter board trawl with 25 mm codend mesh size during nighttime in January, April, July and October, 2002 by the research vessel Pramong 2. An operation time was 1 hour hauling with boat speed of 2.5 knots. The hauling distance had to be in range of distance from shore 3, 5, 7 and more than 7 nautical miles from shore (± not more than 1.25 nautical miles). Bottom depths that measured in meter from sea surface to sea bottom were recorded before and after hauling. After collection, all specimens were frozen.

Laboratory procedures

The defrosted specimens were identified, the dorsal mantle length (ML) of each was measured in millimeters (±0.01 mm) by vernier calipers and weighed in grams (±0.01 g). All specimens collected in July and October and a random sample of specimens in January and April were studied for sexual maturation stage. The specimens were dissected. After dissection, the stage of sexual maturation was classified into 4 stages (adapted from Chotiyaputta, 1995) as follows:

Male

1. Immature: Testis membranous, no spermatophores present in spermatophoric sac.
2. Maturing: Testis clearly visible. Seminal vesicle and spermatophoric sac well developed.

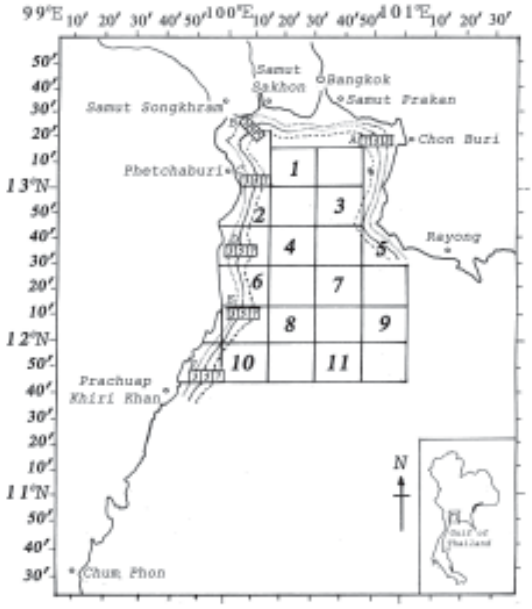

Figure 1. Cuttlefish sampling stations in the upper Gulf of Thailand.

Spermatophoric sac with few spermatophores, soft, whitish with structure less particles.
3. Mature: Testis compact and voluminous. Spermatophores developed in spermatophoric sac, but sac not full.
4. Fully mature: Testis rigid. Spermatophores densely packed in spermatophoric sac and apparent base and tip of penis.

Female

1. Immature: Ovary small, transparent, membranous, and structure not granulated. Nidamental gland visible.
2. Maturing: Eggs small, nidamental gland and accessory nidamental gland small to large, ovary with granular, whitish opaque appearance.
3. Mature: Nidamental gland and accessory nidamental gland large. Ova of two different stages present:
   - oval or polygonal, whitish opaque, and
   - round, reticulated, pale-yellowish.
4. Fully mature: Nidamental gland and accessory nidamental gland very large, accessory nidamental gland bright red. Ovary enlarged to fill dorsal portion of body cavity with reticulated pale

yellowish ova. Oviduct filled with rounded, transparent, fully mature ova.

Data analysis

The spatial distribution of cuttlefish species was assessed according to distance from the shore. Comparisons in abundance of cuttlefish species among distance from shore zones were done after dividing the study area into 4 zones as follows:

1) 3 nautical miles from shore (station : A3, B3, C3, D3, E3 and F3),
2) 5 nautical miles from shore (station : A5, B5, C5, D5, E5, F5 and 2),
3) 7 nautical miles from shore (station : A7, B7, C7, D7, E7, F7, 5 and 6) and
4) more than 7 nautical miles from shore (station : 1, 3, 4, 7, 8, 9, 10 and 11).

The bathymetric distribution of cuttlefish species was assessed according to range of bottom depths that measured from sea surface to sea bottom. Comparisons in abundance among range of bottom depths were done after dividing the study area into 6 depth ranges as follows:

1) 10–15 meters (stations : A3, B3, C3, D3 and 2)
2) 15–20 meters (stations : A5, B5, B7, C5, C7, D5, D7, F3 and 1)
3) 20–25 meters (stations : A7, E3, F5, 3, 4 and 6)
4) 25–30 meters (stations : F7 and 8)
5) 30–35 meters (stations : E5, E7, 5, 8 and 10) and
6) 35–40 meters (stations : 9 and 10)

RESULTS

1. Distribution of cuttlefish species

Five cuttlefish species were caught by an otter board trawl in this study area, namely *Sepia aculeata*, *S. brevimana, S. pharaonis, S. recurvirostra* and *Sepiella inermis.* The percentage by number of *Sepia aculeata*, *S. recurvirostra, Sepiella inermis, Sepia brevimana* and *S. pharaonis* was 48.17, 33.51, 12.21, 3.49 and 2.62, respectively (Fig. 2a). The percentage by weight of *Sepia aculeata*, *S. recurvirostra, S. pharaonis, Sepiella inermis* and *Sepia brevimana* was 60.24, 27.57, 5.93, 5.02 and 1.24, respectively (Fig. 2b).

1.1 Spatial distribution of cuttlefish species

Both *Sepia aculeata* and *Sepiella inermis* were caught in high abundance 3–7 nautical miles from shore (Fig. 3). *Sepiella inermis* tended to be most abundant at 3 nautical miles while *Sepia aculeata* was found densely in the range of 3–7 nautical miles. *Sepia aculeata* was caught from 3 to more than 7 nautical miles offshore and *Sepiella inermis* was not caught more than 7 nautical miles offshore. *Sepia recurvirostra* was most abundant more than 7 nautical miles offshore, however a few were collected 3–7 nautical miles from shore. The results show that both *Sepia aculeata* and *Sepiella inermis* were abundant inshore while *Sepia recurvirostra* were abundant offshore.

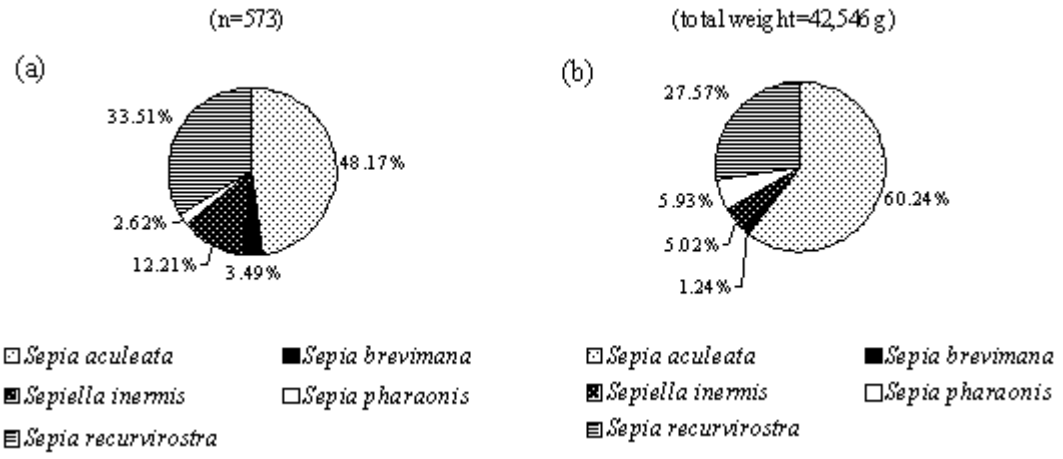

Figure 2. The percentage of cuttlefish species in the upper Gulf of Thailand (a) by number (b) by weight.

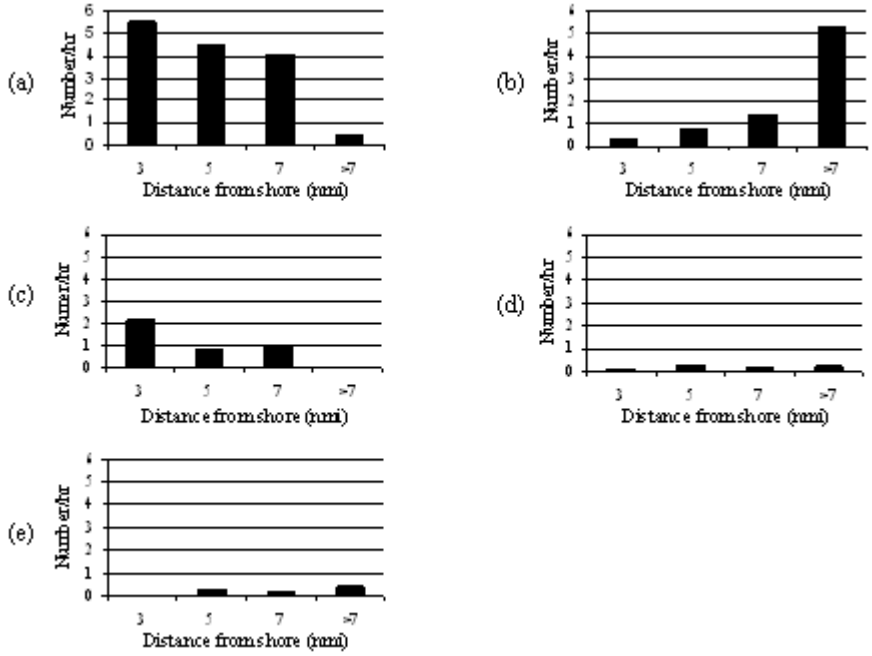

Figure 3. The abundance of cuttlefish by distance from shore (total individual=573)- (a) *Sepia aculeata*, (b) *Sepia recurvirostra*, (c) *Sepiella inermis*, (d) *Sepia pharaonis* and (e) *Sepia brevimana*

1.2 Bathymetric distribution of cuttlefish species

The abundance of cuttlefish varied with bottom depth (Fig. 4). *Sepia aculeata* was collected where bottom depths ranged from 10–35 meters and was most abundant where bottom depths, ranged from 10–30 meters. *Sepiella inermis* was caught where bottom depths ranged from 10–30 meters, and was not found at stations with bottom depths more than 30 meters. The highest abundance occurred where bottom depths were 10–15 meters and gradually decreased with increasing bottom depth. *Sepia recurvirostra* was caught where bottom depths were 20–40 meters and few specimens were collected at shallower stations. *Sepia pharaonis and S. brevimana* were rarely found in this study and appeared in some ranges of bottom depth.

1.3 Size distribution of cuttlefish species

Fig. 5 shows the sizes of cuttlefish collected. *Sepia pharaonis* was the largest species, and *Sepiella inermis* the smallest. The maturity size distribution of the various species of cuttlefish is shown in Fig. 5. For all species, females were larger than males. The smallest size of mature females of *S. aculeata* was 60 mm mantle length and most individuals larger than 110 mm mantle length were mature. The smallest male maturity size was 70 mm mantle length while most of maturity size were larger than 90 mm mantle length. For *S. recurvirostra,* the smallest size of mature females was 60 mm and most were mature at about 80 mm mantle length while one mature male was collected. The smallest maturity sizes of *Sepiella inermis* both male and female were found at 50 mm mantle length. The female maturity sizes were found mostly at 60 mm mantle length (Fig. 5). In this study, only a few *Sepia pharaonis* and *S. brevimana* were collected. Most *S. pharaonis* were small and immature.

2. Maturation stage distribution of cuttlefish species

The spawning grounds were studied only for *Sepia aculeata, S. recurvirostra* and *Sepiella inermis* since few *S. pharaonis* and *S. brevimana* were collected. The spawning grounds were defined as the areas where fully mature (stage 4) female cuttlefish were abundant. Mature females of *Sepia*

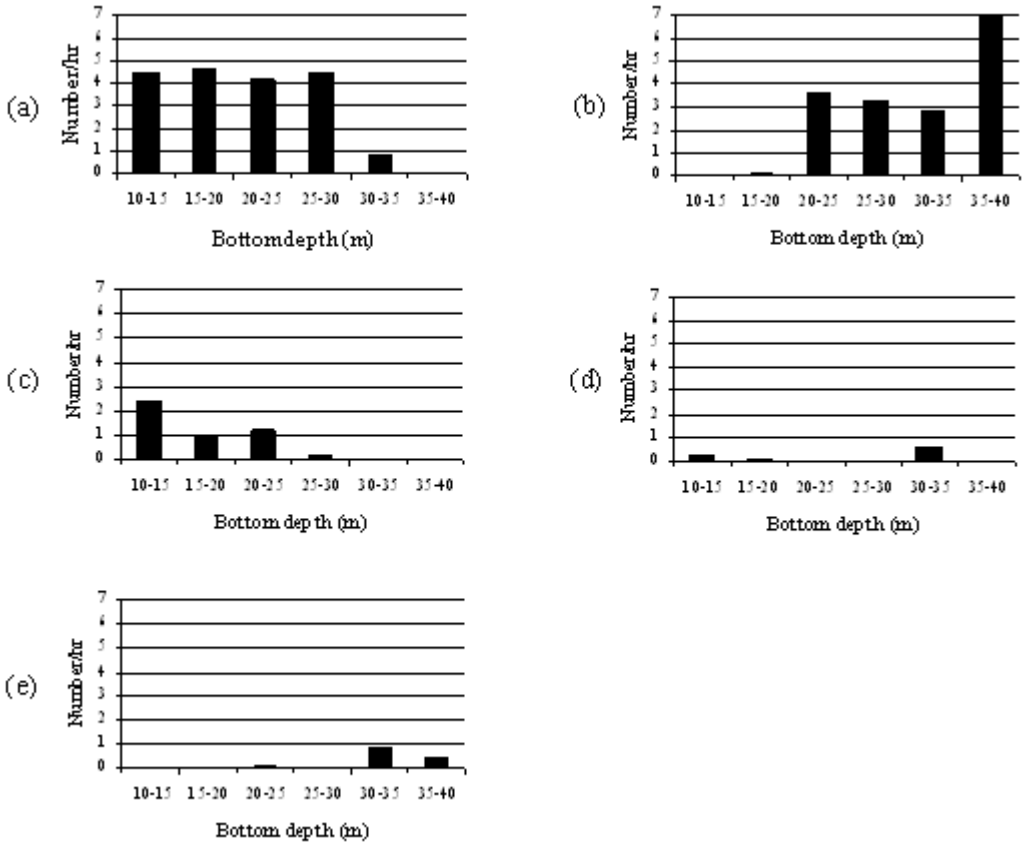

Figure 4. The abundance of cuttlefish at different bottom depths (total individual=573)- (a) *Sepia aculeata*, (b) *Sepia recurvirostra*, (c) *Sepiella inermis*, (d) *Sepia pharaonis* and (e) *Sepia brevimana*

aculeata were distributed from 3 to more than 7 nautical miles from shore and at stations with bottom depths of 10–35 meters. The abundance was observed in the area between 3 and 7 nautical miles and at stations with bottom depths of 10–30 meters indicating that the spawning occurs in this area (Fig. 6 and Fig. 7). Mature females of *Sepiella inermis* were distributed between 3 and 5 nautical miles and stations with bottom depths of 10–25 meters and were most abundant at 3 nautical miles and stations with bottom depths of 10–15 meters indicating that the spawning ground occurs in this area. Most mature female *Sepia recurvirostra* were found 5 to more than 7 nautical miles from shore and at stations with bottom depths of 20–40 meters in the same area of their habitats. Thus the spawning grounds of this species are possibly in the offshore area.

DISCUSSION

1. Distribution of cuttlefish species

Both percentage by number and weight of cuttlefish showed that the dominant species in the upper Gulf of Thailand was *Sepia aculeata* followed by *S. recurvirostra* while, *S. brevimana* and *S. pharaonis* were rarely caught in this area. Supongpan (1995) and Anugul (2002) also reported that the main species in this area was *Sepia aculeata.* Generally, *S. pharaonis* was caught by squid trap and rarely caught by small trawler. Supongpan and Boongerd (1989) reported 5.7% and 2.5–21.5% of *S. pharaonis* was caught by squid traps at Chumphon and Rayong provinces, respectively. *Sepia aculeata* was collected where bottom depths ranged from 10–35 meters and was most abundant where bottom depths, ranged from

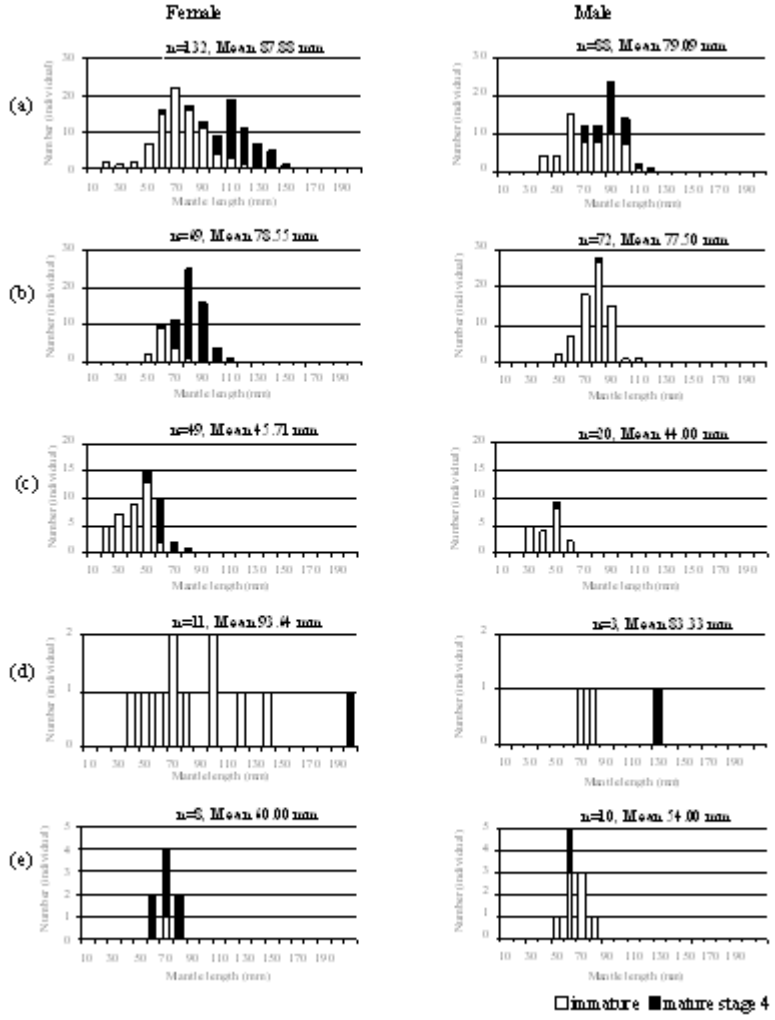

Figure 5. Size distribution of cuttlefish species.- (a) *Sepia aculeata*, (b) *Sepia recurvirostra*, (c) *Sepiella inermis*, (d) *Sepia pharaonis* and (e) *Sepia brevimana.*

10–30 meters. Similar results were reported by Supongpan (1988) who reported that *Sepia aculeata* was abundant where bottom depths ranged from 10–30 meters. *Sepiella inermis* was caught where bottom depths ranged from 10–30 meters, and was not found at stations with bottom depths more than 30 meters. The highest abundance occurred where bottom depths were 10–15 meters and gradually decreased with increasing bottom depth. Similar results were reported by Supongpan (1988), who reported that *Sepiella inermis* was abundant where bottom depths ranged from 10–20 meters. These results are also similar to those of Nabhitabhata (1997) who showed that *Sepiella inermis* distributed abundantly in estuarine areas where bottom depths are about 20 meters. *Sepia recurvirostra* was caught where bottom depths were 20–40 meters and few specimens were collected at shallower stations, while Supongpan (1988) reported that this species in the Gulf of Thailand is abundant at 20–30 meters.

From fig. 5, *Sepia pharaonis* was the biggest species, and *Sepiella inermis* the smallest. These results support the findings of Chotiyaputta (1982) and Supongpan (1988), who reported that the largest species caught was *Sepia pharaonis.* In

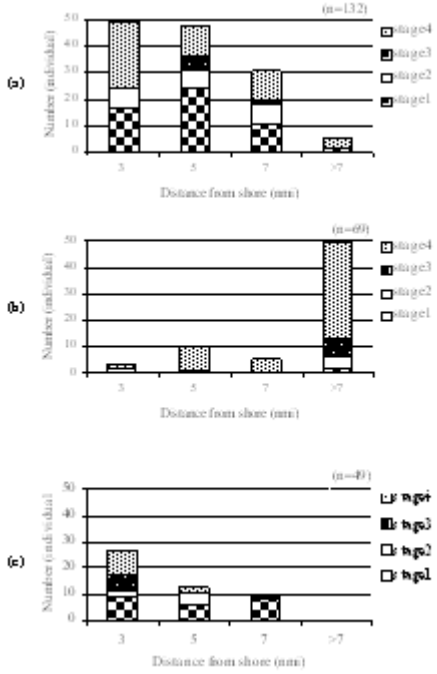

Figure 6. Maturity stage distribution of cuttlefish species by distance from shore- (a) *Sepia aculeata*, (b) *Sepia recurvirostra* and (c) *Sepiella inermis*

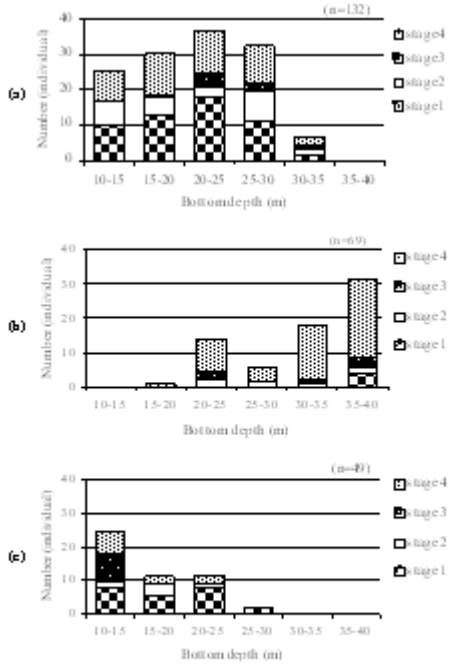

Fig. 7 Maturity stage distribution of cuttlefish species by stations with bottom depths- (a) *Sepia aculeata*, (b) *Sepia recurvirostra* and (c) *Sepiella inermis*

this study, only a few *Sepia pharaonis* and *S. brevimana* were collected. Most *S. pharaonis* were small and immature. Generally, this species is caught in squid traps and pair trawls. This corresponded with Supongpan (1995; cited in Nabhitabhata and Nilaphat (1999)) who reported that the amount of *S. pharaonis* constitues about 16% of the cephalopods landed by pair trawlers fishing offshore and about 10% of the catch by squid traps placed inshore.

2. Maturation stage distribution of cuttlefish

The spawning grounds of *Sepia aculeata* and *Sepiella inermis* in this study tended to be abundant in shallow waters. The spawning ground of *Sepiella inermis* studied by Supongpan (1988) was assumed to be at 10 meters depth along the coast of the Gulf. These concur with Bakhayokho (1983) who reported that many cuttlefish aggregate densely in shallow waters during their spawning season. The released eggs of the cuttlefish are attached to seaweed, rock, reef and various objects like branches which constituting spawning supports on the sea bottom (Bakhayokho, 1983 and Supongpan, 1988). Juveniles of *Sepia aculeata* were found at 5–10 meters of water depths and those of *Sepiella inermis* were found at water depths less than 5 meters (Chaitiamvong and Panwichien, 1993). Therefore, it could be assumed that juveniles occurred near the spawning grounds. This knowledge is needed for the Department of Fisheries to establish restricted fishing areas in future.

CONCLUSIONS

1. The cuttlefish caught in this study consisted of 5 species namely *Sepia aculeata*, *S. recurvirostra, Sepiella inermis, Sepia brevimana* and *S. pharaonis*. *Sepia aculeata* was the numerically dominant species followed by *S. recurvirostra* and *Sepiella inermis* but *Sepia pharaonis* and *S. brevimana* were rarely caught. The habitats of cuttlefish species tended to vary with distance from shore and bottom depths. *Sepia*

aculeata was abundant at 3–7 nautical miles from shore and at stations with bottom depths of 10–30 meters; *Sepia recurvirostra* was abundant more than 7 nautical miles from shore and at stations with bottom depths of 20–40 meters and *Sepiella inermis* was abundant at 3 nautical miles from shore and at stations with bottom depths of 10–15 meters.

2. The largest and smallest cuttlefish species caught were *Sepia pharaonis* and *Sepiella inermis*, respectively.

3. The spawning grounds occurred 3–7 miles offshore and at stations with bottom depths of 10–30 meters for *Sepia aculeata*, 5 to more than 7 miles offshore and at stations with bottom depths of 20–40 meters for *S. recurvirostra* and 3 miles offshore and at stations with bottom depths of 10–15 meters for *Sepiella inermis*, based on the abundance of fully mature females.

ACKNOWLEDGEMENTS

The authors thank to Dr. Chongkolnee Chamchang and Ms. Piyawan Maila-iad at Upper Gulf Marine Fisheries Research and Development Center for suggestion and critical reading the manuscript. Thank also play to captain and crew of the research vessel Pramong 2 for their help in collecting samples.

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