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The squid trap is an artisanal type of fishing gear widely used in the Gulf of Thailand and along the Andaman coast. In 1994 the total catch of cephalopods by Thailand was 144 436 tons, of which 5% was from squid traps. The trap is covered by coconut fronds and set from 4 to >40 m deep, hanging above the sea bottom with the entrance facing upwards. Egg clusters are placed in the trap to entice squid to enter. Species caught include *Sepioteuthis lessoniana* (about 80%), *Sepia pharaonis* and *Sepia aculeata*, all mature animals coming to spawn.

Squid traps are a small type of fishing gear, but they represent one of the most effective types of gear used for bigfin reef squid *Sepioteuthis lessoniana* and cuttlefish (*Sepia* spp.). Historically, *Sepioteuthis lessoniana* was taken only as a bycatch by trawlers, but the trap (modified from a fish trap already in use) was introduced to fishermen in 1977. At first, artisanal fishermen used small boats operated inshore in very shallow waters (4–5 m, Boongerd and Rachaniyom 1990). However, as the trap was modified and developed, larger boats were used to permit fishing farther offshore in deeper water (to about 25 m). From 1992, traps were used in about 14–15 m of water, some 20–200 per boat 6–14 m long (Chotiyaputta 1991). Now, they are operated up to depths of 40 m and more, and boats have increased in size to 18 m, allowing carriage of 300 traps or more.

Squid traps are now very popular and widely used both in the Gulf of Thailand and the Andaman Sea. In 1983 the total catch from squid traps was only 199 tons, but catches peaked at 7 653 tons in 1991 before declining slightly to 7 042 tons in 1994 (Table I).

The purpose of this study was to investigate the development of fishing gear and technology, the fishery itself and the impact of fishing pressure on the spawning population in Thai waters.

MATERIAL AND METHODS

Information on fishing gear operation and tech-

Table I: Marine fisheries, cephalopod and squid trap production of Thailand, 1983–1994, as given in the country's national statistics

Year	Catch by all marine fisheries (tons)	Catch (tons)					
		Cephalopods	By squid trap	Gulf of Thailand		Andaman Sea	
				Cephalopods	By squid trap	Cephalopods	By squid trap
1983	2 055 225		199		199		
1984	1 911 485		489		489		
1985	1 997 165	116 035	2 081	103 777	2 081	12 258	
1986	2 309 480	134 915	3 378	121 332	3 239	13 583	139
1987	2 576 052	132 538	6 020	120 046	5 745	12 492	275
1988	2 337 200	124 243	6 324	113 564	6 025	10 679	299
1989	2 370 500	142 923	6 668	126 540	6 436	16 383	232
1990	2 362 200	135 072	6 683	119 091	6 181	15 981	502
1991	2 478 600	154 084	7 653	119 963	7 028	34 121	625
1992	2 736 400	150 315	6 973	113 893	6 405	36 422	568
1993	2 752 500	153 237	6 993	114 004	6 551	39 233	442
1994	2 804 426	144 436	7 042	109 031	6 506	35 405	536

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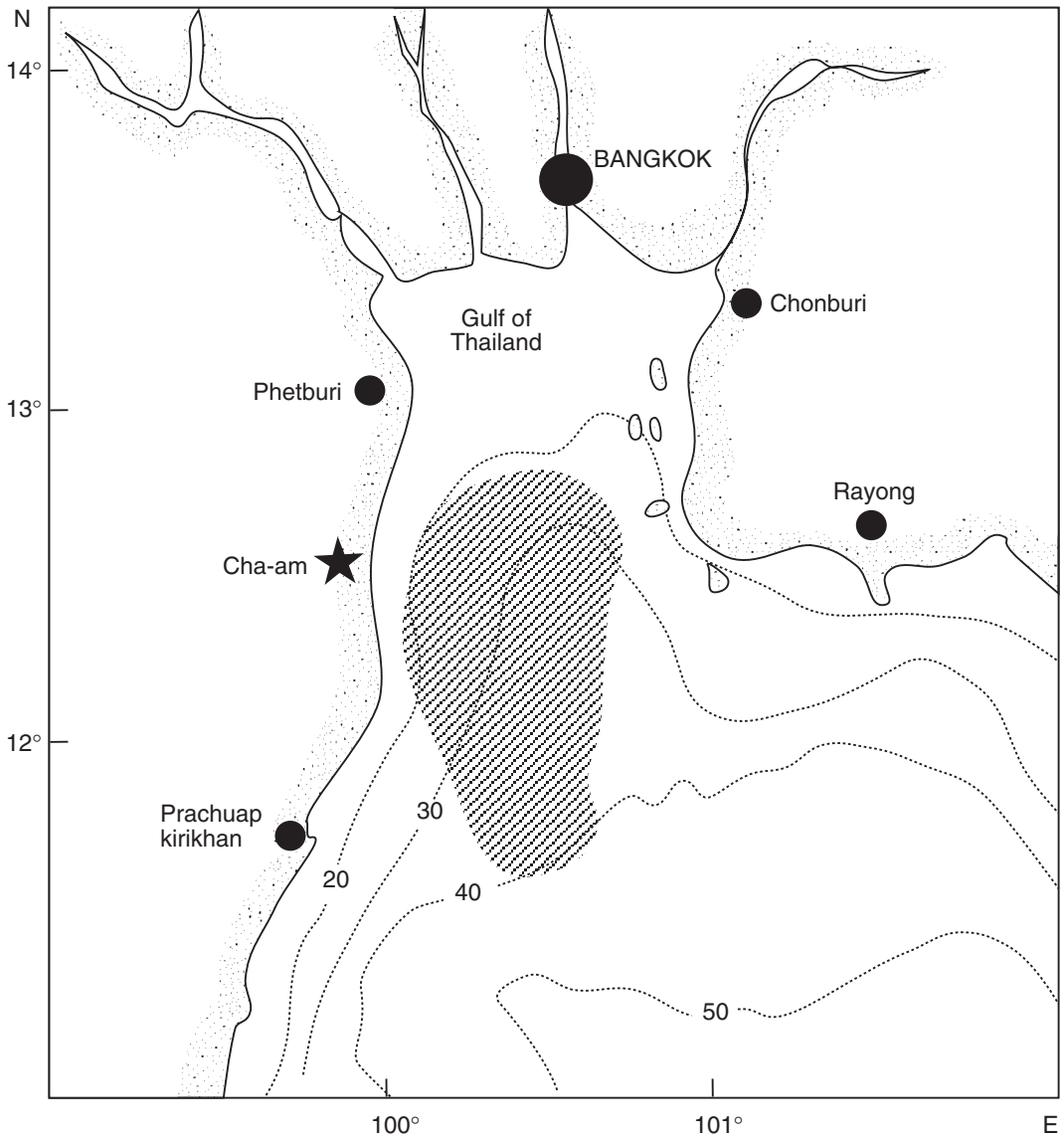

Fig. 1: The fishing and sampling area of buoyed squid traps in the Gulf of Thailand

nique was obtained from fishermen along the western coast of the Gulf of Thailand.

Monthly sampling was carried out from January to July 1997 at Cha-am, Phetburi Province (Fig. 1). Squid traps used in the study were of the buoyed type used by larger boats (defined as those that can carry more than 200 traps each and can stay out for many days on each fishing trip).

Specimens were collected to determine species composition, maturity, size composition and sex ratio. A χ^2 test was used to test whether the sex ratio differed significantly from unity. Gonad condition and maturity

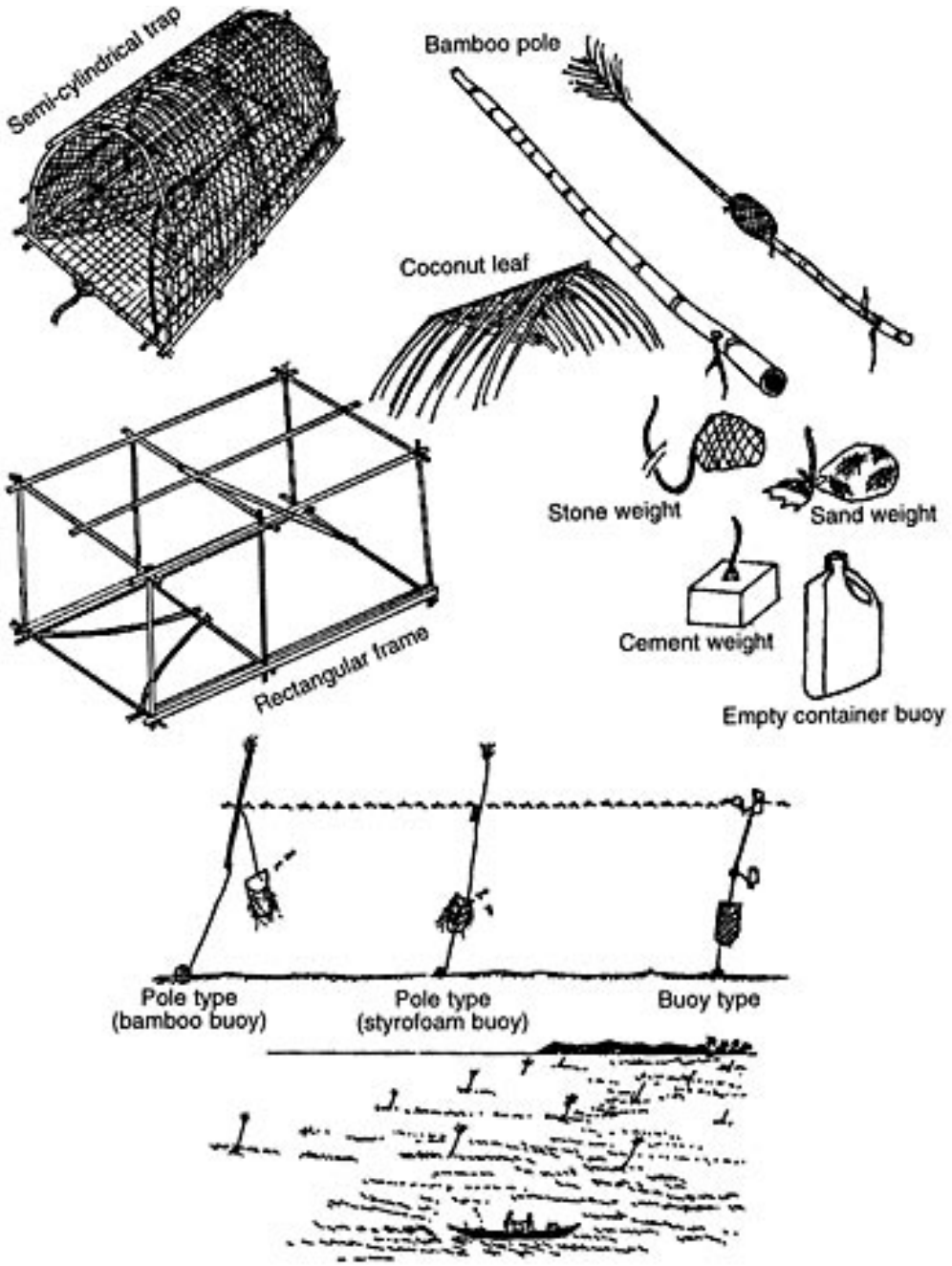

Fig. 2: Squid traps and their operation in the Gulf of Thailand

Table II: Catch and catch composition of squid traps in the western Gulf of Thailand

Month (1997)	Number of boats	Number of traps per boat		Number of days fishing	Average depth (m)	Average per trip			Average catch per trap per day (kg)			Proportion of cephalopod catch (%)		
		Start	End			Total catch (kg)	Catch rate		*Sepioteuthis lessoniana*	*Sepia pharaonis*	*Sepia aculeata*	*Sepioteuthis lessoniana*	*Sepia pharaonis*	*Sepia aculeata*
							$kg\cdot trap^{-1}$	$kg\cdot day^{-1}$						
January	3	300–320	270–290	10–18	18–50	981.53	3.57	69.67	0.154	0.032	0.040	67.70	13.80	18.50
February	3	250–300	225–270	14–20	18–34	1 404.87	5.61	83.93	0.234	0.017	0.020	83.27	7.53	9.20
March	3	200–250	180–225	14–17	15–37	993.70	4.76	65.51	0.245	0.038	0.003	80.55	17.78	1.67
April	3	290–300	265–270	10–19	20–35	1 160.60	4.32	75.22	0.250	0.023	0.001	89.02	10.73	0.25
May	5	300–330	275–295	19–21	15–35	1 641.52	5.87	82.22	0.231	0.064	0.001	76.60	23.11	0.29
June	7	280–340	220–330	9–23	16–45	1 031.86	4.07	75.51	0.223	0.061	0.007	73.98	24.71	1.68
July	4	300	220–275	12–17	20–35	1 336.38	5.46	87.91	0.230	0.098	0.000	71.11	28.89	0.00
January–July			180–330	9–23	15–50	1 221.49	4.81	77.14	0.224	0.047	0.010	77.46	18.08	4.51

stage were noted, and fecundity estimates were made by determining the total number of eggs in the oviduct and the ovary.

RESULTS

Fishing gear and operation

There are two types of squid traps in use in the Gulf of Thailand, most semi-cylindrical but some rectangular. Traps are 80–120 cm long, 50–80 cm wide and 50–65 cm high. The majority are 100 cm long, 60 cm wide and 50 cm high. They are made of a wooden frame covered with a polyethylene net of mesh size 5–6 cm or a nylon net of mesh size 2.5 cm. The entrance is about 7 cm wide and it has an intruder flap 30–35 cm long.

Boat lengths range from 4 to 18 m, with either inboard or outboard engines of 5–250 hp. The number of traps carried per boat depends on its size, small boats usually carrying 20–60 traps and larger ones as many as 300 or more.

The trap hangs 2–3 m above the sea bed, with the entrance facing upwards. It is supported by floats and a bamboo pole fixed in place with a sinker. Coconut fronds cover it and squid eggs are placed inside to entice squid to enter. Traps are set 40–60 m apart and can be categorized into two types, pole-held or buoyed.

The pole type uses a bamboo pole as buoy and marker, is operated near the shore at depths of 8–15 m, and is cleared every morning. Every 15–20 days the traps and poles are retrieved for cleaning and repair. Some of them use a bamboo pole 11–12 m long with a diameter of 6–8 cm. To such poles are tied two ropes with the trap and a bag of either stone or sand weighing some 30 kg to act as sinker. Some of the poles used are smaller, with a diameter of 3–4 cm and 6–8 m long. They are supported by a styrofoam float about 15 × 20 × 12 cm, tied one-third the way up from the base of the pole. The sinker is made of cement with a mass of some 12–18 kg. One or two ropes are used to tie the pole to the trap and sinker, but one rope is more common.

The second type of trap is buoyed by two 10-cm diameter plastic or styrofoam floats tied 1 m apart. An empty 5 l container buoys the trap underwater and is tied 2–10 m above the trap. A 12–18 kg cement sinker holds the trap in place. This type of trap is used by boats 8–18 m long and carrying 5–6 fishers; they operate offshore at depths of 15–50 m and stay at sea for 5–20 days. The traps are set each morning and recovered after noon. Traps are set in a line running

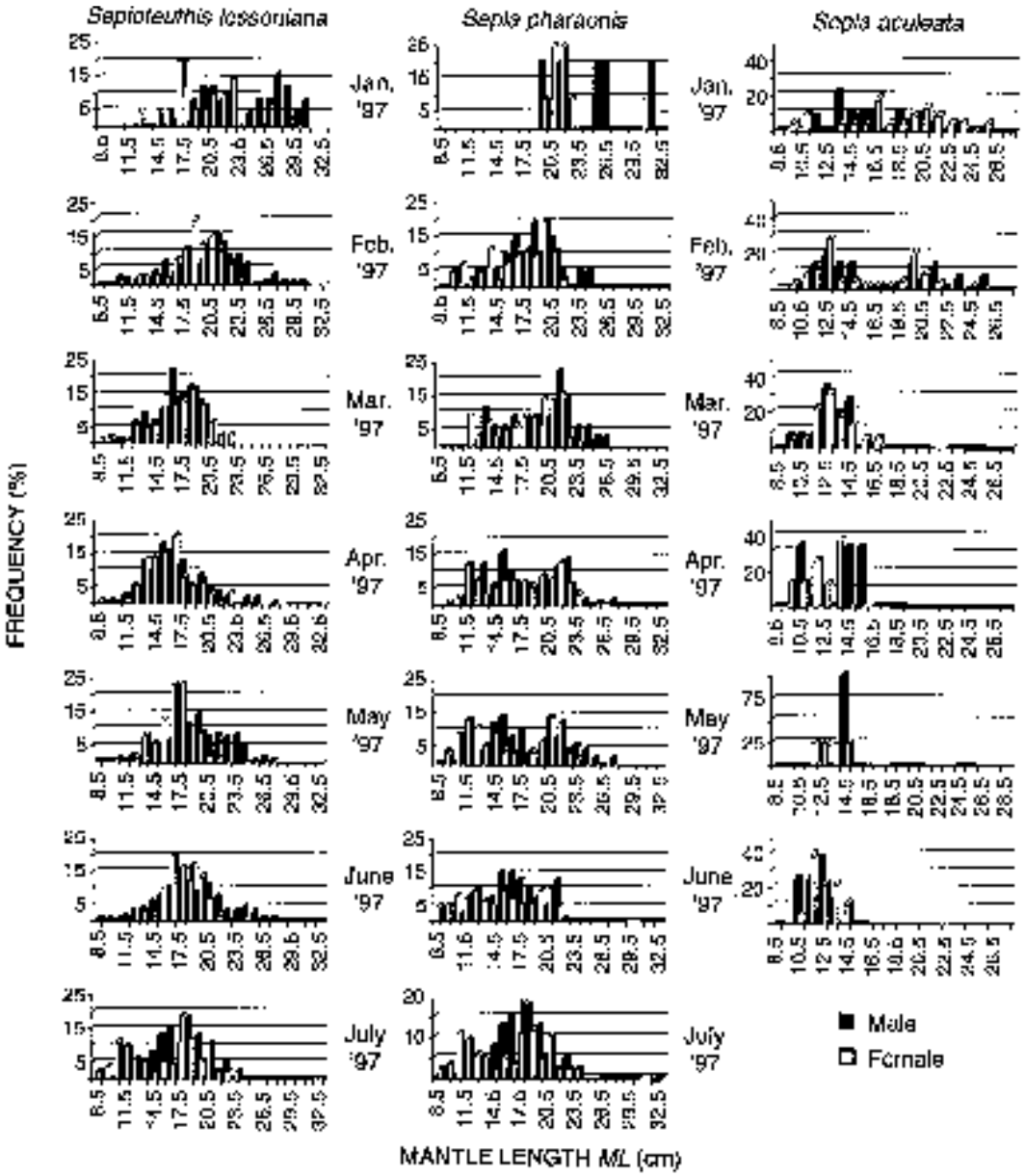

Fig. 3: Size frequency distributions of the three species caught in the squid traps in the Gulf of Thailand, January – July 1997

north to south and may be up to 5 km long. Lines are set in parallel 600–700 m apart.

The various types of squid trap and their means of operation are illustrated in Figure 2.

Catch

The squid trap is a very selective fishing technique for bigfin reef squid and cuttlefish. Species caught are

Table III: Female squid reproductive indices from animals caught by trap in the Gulf of Thailand

Species	Number	Length (cm *ML*)	Mass (g)	*GSI**	Fecundity	Proportion of individuals finished spawning (%)
Sepioteuthis lessoniana	26	15.8 – 22.9	180 – 760	0.30 – 0.83	339 – 1 680	40
Sepia pharaonis	20	14.2 – 21.2	360 – 890	0.27 – 0.66	216 – 1 609	30
Sepia aculeata	6	12.8 – 16.0	210 – 380	0.26 – 0.47	297 – 1 431	33

$$* \; GSI = \frac{\text{Ovary mass}}{\text{Body mass}} \times 1\,000$$

Sepioteuthis lessoniana (63–90%), *Sepia pharaonis* (6–33%), and *S. aculeata* (0–18%). Catch and catch composition are given in Table II. The average catch per trip was about 1 200 kg, but it varied depending on the number of traps used and the number of days fished. The average catch rate was about 4.81 kg·trap^{-1}. Fishing trips lasted 9–23 days, and 180–330 traps were deployed per boat each trip. However, as many as 10% of the traps were lost each trip to trawlers and other fishing boats, or to the adverse effects of currents or wind. Catch composition varied monthly, *Sepioteuthis lessoniana* being most abundant from February to April, *S. pharaonis* from May to July and *S. aculeata* in January and February. For *Sepioteuthis lessoniana*, the average catch rate was similar throughout, except in January when it was at its lowest of 0.154 kg·trap^{-1}·day^{-1}. The catch rate of *Sepia pharaonis* was highest in July (Table II).

Size composition

Catches were generally dominated by larger animals, males tending to be bigger than females. Monthly variations in the size frequency distributions of each of the three species are given in Figure 3. Sizes at capture for male and female *Sepioteuthis lessoniana* ranged from 11 to 30.5 cm mantle length (*ML*) for males and from 8.5 to 25.4 cm *ML* for females, *S. pharaonis* from 9.5 to 31.5 cm *ML* for males and from 8.2 to 31.5 cm *ML* for females, and *S. aculeata* from 9.4 to 25.3 cm *ML* for males and from 9.7 to 24.8 cm *ML* for females. Larger animals, especially males, were more abundant in January and February.

Reproductive condition

Most animals caught were big and fully mature. Table III shows the results of examination of the female gonads. About 30–40% of the females examined had deposited nearly all of their eggs, but the balance had spawned only partially. The gonadosomatic indices (*GSI*) were 0.30–0.83, 0.27–0.66 and 0.26–0.47 for *Sepioteuthis lessoniana*, *S. pharaonis* and *S. aculeata* respectively.

The overall sex ratio of the catch of *Sepioteuthis lessoniana* was parity, but there were some monthly variations, females being present in greater proportion than males in March and May and males dominating in June. Females were more abundant than males in the catches of *Sepia pharaonis* and *S. aculeata* (Table IV).

DISCUSSION

The average catch of the larger fishing boats was about 1 200 kg per fishing trip and the average catch rate was 0.28 kg·trap^{-1}. Not all traps caught cephalopods, but Thai fishermen seem to be satisfied with the fishing method, so squid traps are now rather popular. They have proved to be a very effective technique of capture, easy to operate with little labour, cheap, and yielding an acceptable catch of good quality that in turn provides a good return on investment. The losses during fishing activity may result in so-called "ghost-fishing", but this is not considered to be a problem because the trap is made of wood that breaks down easily and is degradable.

Production seems to have stabilized at about 7 000 tons of the three species. All three are common tropical species that are widely distributed in Thai waters, grow fast and spawn throughout the year. Chotiyaputta (1980, 1982, 1989, 1995) found that spawning peaked generally two or three times annually, during the periods known locally as the inter-monsoon (February – May), the south-west monsoon (June – October) and the north-east monsoon (November – January). Of course, seasonal variation may alter the timing of the peaks.

Most *Sepia* spp. are caught by trawlers, but the squid traps also catch these two larger cuttlefish. Nevertheless,

Table IV: Sex ratio of squid caught by trap in the Gulf of Thailand, January–July 1997

Month (1997)	*Sepioteuthis lessoniana*		*Sepia pharaonis*		*Sepia aculeata*	
	Number	♂ : ♀	Number	♂ : ♀	Number	♂ : ♀
January	90	0.8 : 1	25	2.6 : 1*	50	0.8 : 1
February	314	0.8 : 1	195	1.2 : 1	62	2.9 : 1*
March	314	1.3 : 1*	149	1.5 : 1*	40	1.5 : 1*
April	274	1.0 : 1	240	1.6 : 1*	17	2.4 : 1
May	481	1.3 : 1*	234	3.0 : 1*	13	0.9 : 1
June	464	0.8 : 1*	221	1.7 : 1*	26	2.3 : 1*
July	269	1.0 : 1	130	2.0 : 1*	0	
Total/Mean	2 206	1.0 : 1	1 194	1.8 : 1*	208	1.5 : 1*

* Significantly different from parity

the target species of the squid traps is reflected in the catch composition, namely domination by *Sepioteuthis lessoniana*. Despite the obvious pressure on the resource from trawlers and traps, the trap production seems to be relatively stable. Reasons for this could be:

- most of the animals caught are mature, so giving them opportunity to contribute to the resource's production;
- fishing activity is not possible during the monsoon season, the peak spawning period;
- some of the eggs discarded from the traps can survive and hatch;
- the fast rate of growth and maturation, the latter approximately 3–4 months (Chotiyaputta 1989, 1991, 1995).

The Thai government cannot initiate any regulatory measures at the moment. All that can be done at present is to encourage fishermen to release the eggs from the traps into the sea, hopefully enhancing production of the stock if they hatch. However, of great importance is the fact that this type of fishing gear is used only by small-scale fishermen, so enhancing their socio-economic conditions. Other practices that the Department of Fisheries has implemented are installation of artificial reefs along the coast and controlled culture of *Sepioteuthis lessoniana* and *S. pharaonis*. It is believed that both practices help sustain the resources in the wild at their present levels.

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