

**DESCRIPTION OF THAI TYPE OF BIGFIN REEF SQUID, *SEPIOTEUTHIS LESSONIANA*,
HATCHLING WITH NOTE ON COMPARISON TO JAPANESE TYPES**

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ABSTRACT: Morphological characters of hatchlings of the Thai type of bigfin reef squid, *Sepioteuthis lessoniana*, are described. Hatchlings of the Thai type of bigfin reef squid have a muscular and cylindrical mantle, of an elongate bell-shape with a round blunt end. Fins are broad, round, almost circular in outline and subterminal. The head is squarish in outline, flattened dorso-ventrally. The chromatophores are scattered on the dorsal and ventral side of the mantle. Morphological characters of three Japanese types of *Sepioteuthis lessoniana*, the quacking type, red type and white type are compared. Notable differences are the numbers of chromatophores on mantle and fins as well as the numbers of series of chromatophores on the arms and tentacles. Numbers of chromatophores of the quacking type are larger than the other types (at the same size). Besides, the quacking type has 2 rows on Arm IV while the others have only 1 row.

INTRODUCTION

The bigfin reef squid, *Sepioteuthis lessoniana*, is one of the most commercially important squid in Indo-Pacific waters. This squid occurs both in the Gulf of Thailand and Andaman Sea in Thai waters (Nateewathana, 1997). In Japan this squid occurs along both Pacific and Japan Sea coasts from southern Hokkaido to Okinawa, and is especially abundant in inshore waters along the coast of southwestern Japan (Okutani, 1984). In Thailand, Nabhitabhata (1978) studied spawning behaviour, developmental stages, and rearing using plastic baskets floating in seawater contained in concrete tanks that were continuously aerated to simulate water circulation. The squid hatchlings at 28 °C developed to adult stage within 60 days after hatching. In Japan, Yamamoto (1943) was the first to described the hatchling morphology of *Sepioteuthis lessoniana*. Further studies of spawning behaviour, embryonic development and hatchlings were carried out by Choe and Oshima

(1961), Oshima and Choe (1961) and Segawa (1987). Segawa (1987) divided the developmental process of the oval squid from hatchling to mature squid into seven growth stages based on the morphological changes, namely, hatchling (6–10 mm in ML), juvenile 1 (10–25 mm ML), juvenile 2 (25–40 mm ML), young 1 (40–60 mm ML), young 2 (60–about 100 mm ML), subadult (over about 100 mm ML) and adult (over about 150 mm ML).

This paper describes the hatchling stages of Thai types of *Sepioteuthis lessoniana*, with note on comparison with Japanese types.

MATERIALS AND METHODS

Spawners of Thai type of bigfin reef squid, *Sepioteuthis lessoniana*, were collected from Rayong Province, Thailand during May–June 2002. The living specimens were carried to Rayong Coastal Aquaculture Station and maintained in a glass aquarium with a sub-gravel filter. Ten pairs of squid were separated and each pair was

maintained in a grass aquarium for individual observation. Twenty specimens were collected from 2 batches, each batch contained 10 hatchlings. Seven hatchlings of *Sepioteuthis* from Japanese waters (Ishigaki Island, Okinawa, Southern Japan) were obtained consisting of 2 quacking type, 3 red type and 2 white type, respectively for comparison.

All specimens of *Sepioteuthis lessoniana* were fixed in 70 % alcohol. A binocular microscope with a micrometer was used for measurement. The specimens were observed under the stereoscopic microscope at the magnification of 15–60. The length and width of dorsal mantle, dorsal head, ventral mantle, ventral head, fins and arms I-IV were measured under the stereoscopic microscope (Figure 1). The chromatophores on each body region were counted. All specimens were sketched with the aid of a drawing apparatus.

TERMINOLOGY

Hatchling- the specimens smaller than 10 mm (Segawa, 1987)

Chromatophore row- longitudinal series of chromatophores

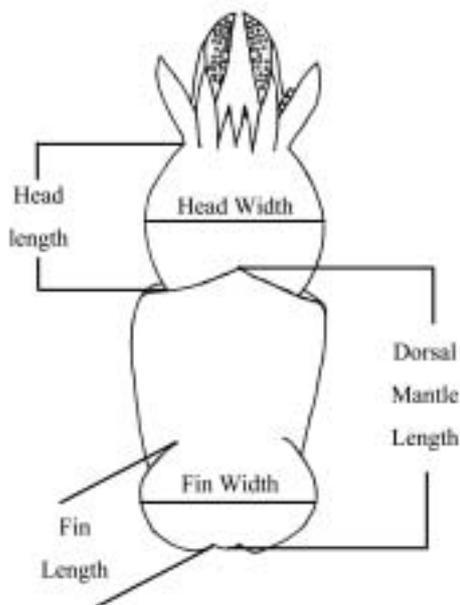


Figure 1. Measurements of hatchling *S. lessoniana* (dorsal view).

Chromatophore zones:

Dorsal mantle- band of chromatophores lying on the dorsal mantle surface (include area of dorsal fin)

Dorsal head- band of chromatophores on the dorsal surface of the head from the collar to the arms

Ventral mantle- band of chromatophores lying on the opposite site of dorsal mantle

Ventral head- band of chromatophores lying on the opposite site of dorsal head

Arms and tentacles- chromatophores on the surface of the dorsal arms and tentacles. The number of chromatophores on each row counted from dorsal to ventral side.

RESULTS

Species Description of Hatchlings:

Sepioteuthis lessoniana Thai type

(Figure 2. a, e, Figure 3. a, e)

Material examined: Twenty specimens ranging from 4.5–6.3 mm ML

Mantle: Size ranging 4.5–6.3 mm ML, mantle is muscular, cylindrical, elongate bell-shape with round blunt end. Mantle length is about 1.5–2 times the mantle width. The dorsal margin has a pointed triangular lobe in the middle. The ventral margin has small and sharply pointed lateroventral projections at the locations of both funnel cartilages.

Fins: Size ranging 4.5–6.3 mm ML, fins are broad, round, almost circular in outline, sub-terminal, separate and attached to the posterior mantle. From the base, the length of fin is about 26–42 % of dorsal mantle length. The width across the fin is approximately 2 times the fin length.

Head: Size ranging 4.5–6.3 mm ML, the head is squarish in outline, flattened dorso-ventrally, about 40–50 % of the mantle length. The width of the head is slightly less than that of the mantle. The eyes are large, not protruding and situated anterior on the head. The funnel is broad and short.

Arms: Size ranging 4.5–6.3 mm ML, arms are stout and muscular with biserial suckers (in longitudinal rows). There are 13 transverse rows of suckers on Arms II (Figure 3. a and e). Arm formula is III. II. IV. I.

Tentacle: Size ranging 4.5–6.3 mm ML, the tentacles are longer than arms. The suckers are arranged in four rows (in longitudinal rows). There

Description of Thai type of bigfin reef squid, *Sepioteuthis lessoniana*

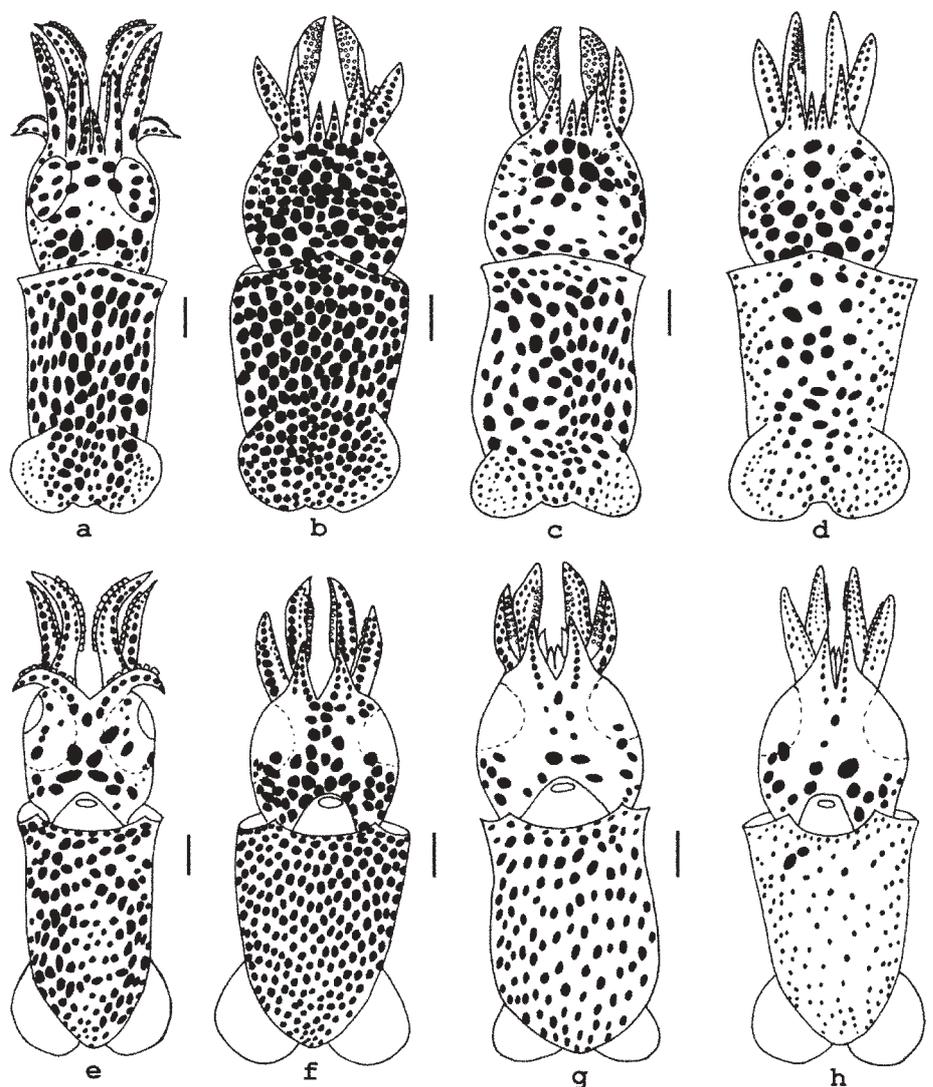


Figure 2. (a)–(h). *Sepioteuthis lessoniana*. (a). dorsal view of a 5.5 mm DML Thai type. (b). dorsal view of a 6.2 mm DML quaking type. (c). dorsal view of a 6.2 mm DML red type. (d). dorsal view of a 6.5 mm DML white type. (e). ventral view of a 5.5 mm DML Thai type. (f). ventral view of a 6.2 mm DML quaking type. (g). ventral view of a 6.2 mm DML red type. (h). ventral view of a 6.5 mm DML white type. Scale bar: 1 mm.

are 15 transverse rows of suckers on the tentacles (Figure 3. a and e).

Chromatophores:

Size 4.5 mm ML, the dorsal mantle has 141 chromatophores while ventral mantle has 104 chromatophores. On the dorsal head, there are about 37 chromatophores. On the ventral head, 21 chromatophores are arranged asymmetrically.

Dorsal fins have 42 chromatophores, but none on ventral side. Arm I has 3 chromatophores in one row. Arm II has one row of chromatophores. Arm III has 4 rows of chromatophores, 7, 10, 4 and 9 chromatophores, respectively. Arm IV has 7 chromatophores in one row. Tentacle has 5 rows of chromatophores, 7, 6, 15, 10 and 10 chromatophores, respectively.

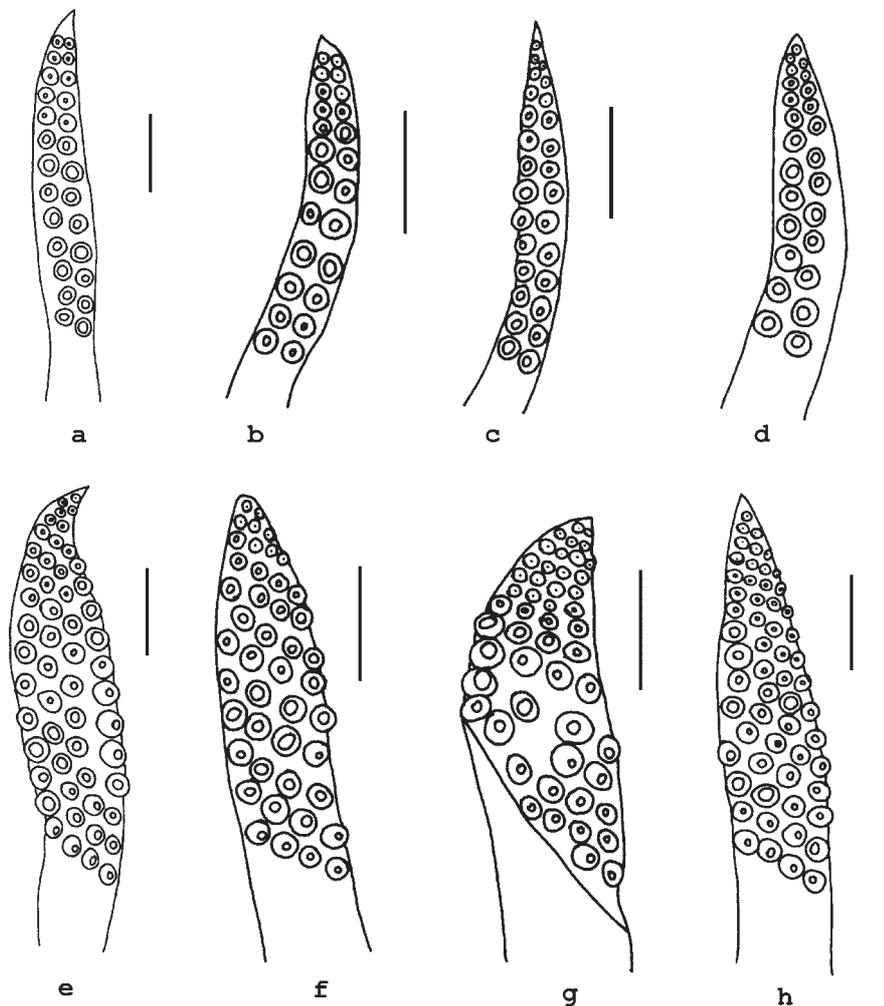


Figure 3. (a–h). *Sepioteuthis lessoniana*. (a): left Arm II of a 5.5 DML Thai type. (b). left Arm II of a 6.2 DML quacking type. (c). left Arm II of a 6.2 DML red type. (d). left Arm II of a 6.5 DML white type. (e). tentacle of a 5.5 DML Thai type. (f). tentacle of a 6.2 DML quacking type. (g). tentacle of a 6.2 DML red type. (h). tentacle of a 6.5 DML white type. Scale bar: 0.5 mm.

Size 4.6–4.9 mm ML, the chromatophore pattern on each part are increasing in number (Table 2 and 3).

Size 5.0–6.3 mm ML, the chromatophore pattern on each part quite similar in number with size 4.6–4.9 mm ML (Table 2 and 3).

Sepioteuthis lessoniana, the quacking type (Figure 2. b, f, Figure 3. b, f)

Material examined: Two specimens measuring 6.0 and 6.2 mm ML.

Mantle: Size 6.0 and 6.2 mm ML, mantle is broad, firm, cylindrical, bell-shape with a blunt end, mantle length about 1.5–1.6 times the mantle width. The dorsal margin has a pointed triangular lobe in the middle. The ventral margin has small and sharply pointed lateroventral projections at the locations of both funnel cartilages (Figure 2. b and f).

Fins: Size 6.0 and 6.2 mm ML, fins are round, almost circular in outline and situated slightly anterior to the mantle end. From the base, the length of fin is about 35–42 % of dorsal mantle

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length. The width across the fin is approximately 1.5–2 times the fin length.

Head: Size 6.0 and 6.2 mm ML, head is almost squarish, flattened dorso-ventrally, about half the mantle length. The width of the head is less than that of the mantle. The eyes are large, not protruding and situated anterior on the head. The funnel is broad and short.

Arms: Size 6.0 and 6.2 mm ML, arms are stout and muscular with biserial suckers (longitudinal rows). There are 12 transverse rows on Arm II (Figure 3. b and f). Arm formula is III. II. IV. I.

Tentacle: Size 6.0 and 6.2 mm ML, the tentacles are longer than arms. The suckers are arranged in four longitudinal rows with 12 transverse rows (Figure 3. b and f).

Chromatophores: Size 6.0 mm ML, there are 255 chromatophores on dorsal mantle and 209 chromatophores on ventral mantle. On the dorsal head, 98 chromatophores are presented. On the ventral head, 59 chromatophores are arranged asymmetrically. Dorsal fins have 80 chromatophores, but none on ventral side. Arm I has 4 chromatophores on one row. Arm II has two rows of chromatophores, 6 and 8 chromatophores on each row. Arm III has 7 rows of chromatophores, 10, 2, 9, 2, 3, 11 and 9 chromatophores, respectively. Arm IV has two rows, 9 and 4 chromatophores. Tentacle has 6 rows of chromatophores, 10, 4, 6, 14, 13 and 11 chromatophores, respectively.

Size 6.2 mm ML, there is increasing in number of dorsal mantle and dorsal head but lower on ventral mantle and ventral head than the small one. The pattern of chromatophores on arms and tentacles are similar to the small one (Table 2 and 3).

Sepioteuthis lessoniana, the red type
(Figure 2. c, g, Figure 3. c, g)

Material examined: Three specimens ranging from 5.0–6.2 mm ML.

Mantle: Size 5.0–6.2 mm ML, mantle is muscular, cylindrical, elongate bell-shape with round blunt end. Mantle length is about 1.6–1.7 times the mantle width. The dorsal margin has a pointed triangular lobe in the middle. The ventral margin has small and sharply pointed lateroventral projections at the locations of both funnel cartilages (Figure 2. c and g).

Fins: Size 5.0–6.2 mm ML, fins are broad, round, almost circular in outline, sub-terminal, separate and attached to the posterior mantle. From the base, the length of fin is about 30 % of dorsal mantle length. The width across the fin is approximately 2 times the fin length.

Head: Size 5.0–6.2 mm ML, the head is squarish in outline, flattened dorso-ventrally, about 30–50 % of the mantle length. The width of the head is slightly less than that of the mantle. The eyes are large, not protruding and situated anterior on the head. The funnel is broad and short.

Arms: Size 5.0–6.2 mm ML, arms are stout and muscular with biserial suckers (in longitudinal rows). There are 14 transverse rows on Arm II (Figure 3. c and g). Arm formula is III. II. IV. I.

Tentacle: Size 5.0–6.2 mm ML, the tentacles are longer than arms. The suckers are arranged in four longitudinal rows with 13 transverse rows (Figure 3. c and g).

Chromatophores: Size 5.0 mm ML, there are 159 chromatophores on dorsal mantle and 120 chromatophores on ventral mantle. On the dorsal head, 49 chromatophores are presented. On the ventral head, 27 chromatophores are arranged asymmetrically.

Dorsal fins have 48 chromatophores, but none on ventral side. Arm I has 3 chromatophores on one row. Arm II has one row of chromatophores. Arm III has 4 rows of chromatophores, 3, 10, 9 and 4 chromatophores, respectively. Arm IV and tentacle could not be counted.

Size 5.9 mm ML, there is increasing in number of Dorsal mantle, dorsal head and ventral mantle than the smaller one. The pattern of chromatophores on arms are similar ML (Table 2 and 3).

Size 6.2 mm ML, the chromatophore pattern is similar to size 5.9 ML (Table 2 and 3).

Sepioteuthis lessoniana, the white type
(Figure 2. d, h, Figure 3. d, h)

Material examined: Two specimens measuring 6.3 and 6.5 mm ML.

Mantle: Size 6.3 and 6.5 mm ML, mantle is muscular, cylindrical, elongate bell-shape with round blunt end. Mantle length is about 1.5–2 times the mantle width. The dorsal margin has a pointed triangular lobe in the middle. The ventral margin

has small and sharply pointed lateroventral projections at the locations of both funnel cartilages (Figure 2. d and h).

Fins: Size 6.3 and 6.5 mm ML, fins are broad, round, almost circular in outline, sub-terminal, separate and attached to the posterior mantle. From the base, the length of fin is about 26–42 % of dorsal mantle length. The width across the fin is approximately 2 times the fin length.

Head: Size 6.3 and 6.5 mm ML, head is almost squarish, flattened dorso-ventrally, about half the mantle length. The width of the head is less than that of the mantle. The eyes are large, not protruding and situated anterior on the head. The funnel is broad and short.

Arms: Size 6.3 and 6.5 mm ML, arms are stout and muscular with biserial suckers (in longitudinal rows). There are 13 transverse rows on Arm II (Figure 3. d and h). Arm formula is III. II. IV. I.

Tentacle: Size 6.3 and 6.5 mm ML, the tentacles are longer than arms. The suckers are arranged in four longitudinal rows with 15 transverse rows (Figure 3. d and h).

Chromatophores: Size 6.3 mm ML, there are 178 chromatophores on dorsal mantle and 132 chromatophores on ventral mantle. On the dorsal head, 51 chromatophores are presented. On the ventral head, 25 chromatophores are arranged asymmetrically. Dorsal fins have 84 chromatophores, but none on ventral side. Arm I has 4 chromatophores on one row. Arm II has one row of chromatophores. Arm III has 5 rows of chromatophores, 9, 8, 2, 10 and 10 chromatophores, respectively. Arm IV has 8 chromatophores in one row. Tentacle has 5 rows of chromatophores, 10, 5, 15, 14 and 10 chromatophores, respectively.

Size 6.5 mm ML, the pattern of chromatophores is similar to the 6.3 mm ML (Table 2 and 3).

The comparisons of some characteristics of the four types of *Sepioteuthis lessoniana* are shown in Table 1 – 3, Figure 4 and 5.

The characteristics of newly hatched larvae of *Sepioteuthis lessoniana* in this study had loliginid paralarvae characteristic such as the presence of corneal membranes, the precocious development of ventral and ventro-lateral arms, biserial arm suckers, chromatophores very dense over entire

body, and well developed, rounded, sub-terminal fins (Hanlon *et al.*, 1992; Vecchione and Lipiński, 1995). However, the chromatophore pattern of *Sepioteuthis lessoniana* was different from other loliginid hatchlings. *Loligo forbesi*, *Loligo vulgaris reynaudii* and *Lolliguncula mercatoris* have more numerous chromatophores on ventral side than dorsal side (Segawa *et al.*, 1988 and Vecchione and Lipiński, 1995) while *Sepioteuthis lessoniana* of 4 types in this study shows the opposite way.

DISCUSSION

The comparison of morphometrics of newly hatched larvae for 4 types of *Sepioteuthis lessoniana* (Table 1) showed a difference in size range. Thai type seems to have a wide size range, maybe because the hatchlings were collected from two different batches. Nabhitabhata (1978) found that *Sepioteuthis lessoniana* hatchlings at 28 °C developed to adult stage within 60 days after hatching. The mantle length of the hatchling was 4.4–5.8 mm for the same batch. After 10 days the mantle length increased to 7.4–8.2 mm. Omar (2003) studied the embryonic development of Bigfin Reef squid in Indonesia, the size of newly hatched larvae he measured was between 5.3–6.2 mm ML.

The distribution of chromatophores also varies considerably from type to type. Obvious differences are the numbers of chromatophores on mantle and fin as well as the numbers of series of chromatophores on arms and tentacles. Total numbers of chromatophores of the quacking type are larger than the other types at the same size. Also, numbers of series of chromatophore on arms III and IV of the quacking type are also higher than the other types (Table 2 and 3).

According to Segawa *et al.* (1993), they assumed that *Sepioteuthis lessoniana* in Japanese waters is actually a complex of at least 3 species. The differences of the morphometrics and the number of chromatophores of these 4 types in this study appear to support that view. In Japan, local populations of *Sepioteuthis lessoniana* around the coast of Okinawa are classified by the fishermen into three groups based on meat quality and appearance, and thus market prices (Okutani, 1984). By the result of an isozyme analysis, the

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Table 1. The comparison of the length (in mm) of *Sepioteuthis lessoniana*, Thai type, the quacking type, the red type and the white type.

| | Thai type Average \pm SD (range) n=20 | The quacking type n=2 | The red type n=3 | The white type n=2 |
|-----------------------|---|-----------------------------|---------------------|-----------------------|
| Dorsal Mantle Length | 5.32 \pm 0.51 (4.5–6.3) | 5.9, 6.2 | (5.0– 6.2) | 6.3, 6.5 |
| Dorsal Mantle Width | 3.10 \pm 0.37 (2.3–3.8) | 3.6, 4.1 | (3.1–3.9) | 3.9, 4.6 |
| Ventral Mantle Length | 4.55 \pm 0.35 (3.9–5.0) | 5.0, 5.2 | (4.8–5.8) | 5.0, 5.4 |
| Ventral Mantle Width | 3.11 \pm 0.34 (2.5–3.8) | 3.6, 4.2 | (3.1–3.9) | 3.8, 4.5 |
| Head Length | 2.07 \pm 0.44 (1.3–2.6) | 2.7, 2.8 | (1.3–2.5) | 1.7, 2.6 |
| Head Width | 2.76 \pm 0.23 (2.3–3.1) | 3.1, 3.6 | (3.2–3.5) | 3.6, 3.9 |
| Fin Length | 1.80 \pm 0.45 (0.9–2.7) | 2.2, 2.5 | (1.6–2.0) | 2.2, 2.5 |
| Fin Width | 2.96 \pm 0.39 (2.2–3.8) | 3.7, 4.2 | (2.8–4.0) | 3.8, 4.5 |
| Arm I | 0.87 \pm 0.18 (0.5–1.1) | 0.8, 0.9 | (0.5–0.9) | 0.5, 1.0 |
| Arm II | 1.31 \pm 0.40 (0.8–2.0) | 1.6 | (1.2–2.0) | 1.1, 2.0 |
| Arm III | 1.8 \pm 0.5 (1.1–2.4) | 2.1 | (1.8–2.7) | 1.9, 2.5 |
| Arm IV | 1.21 \pm 0.24 (1.0–1.7) | 1.3, 1.4 | (1.2–1.7) | 1.1, 1.7 |
| Tentacle | 2.14 \pm 0.36 (1.5 – 2.7) | 2.8, 3.1 | (2.1 – 3.0) | 2.2 , 2.8 |

Table 2. Mantle and head chromatophores of four types of *Sepioteuthis lessoniana*.

| | Dorsal Mantle Length(mm) | n | Dorsal Mantle + Dorsal Fins | Dorsal Head | Ventral Mantle | Ventral Head |
|-----------|--------------------------|----|-----------------------------|-------------|----------------|--------------|
| Thai Type | 4.5 | 1 | 141 | 37 | 104 | 21 |
| Thai Type | 4.6–4.9 | 4 | 150–159 | 33–59 | 114–135 | 23–32 |
| Thai Type | 5.0–5.9 | 12 | 167–198 | 46–52 | 130–143 | 27–34 |
| R Type | 5.0, 5.9 | 2 | 159, 161 | 49, 60 | 120, 145 | 27, 17 |
| Thai Type | 6.0–6.3 | 3 | 161–181 | 41–48 | 122–137 | 20–31 |
| Q Type | 6.0, 6.2 | 2 | 255, 287 | 98, 104 | 209, 198 | 59, 58 |
| R Type | 6.2 | 1 | 172 | 52 | 132 | 18 |
| W Type | 6.3, 6.5 | 2 | 178, 180 | 51, 58 | 132, 133 | 25, 24 |

Table 3. Arms and tentacles chromatophores of four types of *Sepioteuthis lessoniana*.

| | ML (mm) | N | Arm I no. of rows | Arm II no. of rows | Arm III no. of rows | Tentacle no. of rows | Arm IV no. of rows | | | | | |
|-----------|---------|----|-------------------|--------------------|---------------------|----------------------|--------------------|---|-----------------|---|-----------|---|
| Thai Type | 4.5 | 1 | 3 | 1 | 6 | 1 | 7,10,4,9 | 4 | 7,6,15,10,10 | 5 | 7 | 1 |
| Thai Type | 4.6–4.9 | 4 | 3 | 1 | 7 | 1 | 8,10,5,9 | 4 | 9,6,15,11,8 | 5 | 7 | 1 |
| Thai Type | 5.0–5.9 | 12 | 3-4 | 1 | 2,7 | 2 | 9,10,10,9 | 4 | 9,4,13,12,7 | 5 | 7–8 | 1 |
| R Type | 5 | 1 | 3 | 1 | 5 | 1 | 3,10,9,4 | 4 | not clear | | not clear | |
| R Type | 5.9 | 1 | 2 | 1 | 7 | 1 | 11,10,13,12 | 4 | 11,3,3,11,15,6 | 6 | 9 | 1 |
| Thai Type | 6.0–6.3 | 3 | 4 | 1 | 4,7 | 2 | 9,10,10,9 | 4 | 10,4,13,14,7 | 5 | 7 | 1 |
| Q Type | 6 | 1 | 4 | 1 | 6,8 | 2 | 10,2,9,2,3,11,9 | 7 | 10,4,6,14,13,11 | 6 | 9,4 | 2 |
| Q Type | 6.2 | 1 | 4 | 1 | 5,6 | 2 | 10,1,10,3,3,12,10 | 7 | 10,5,6,14,13,11 | 6 | 9,4 | 2 |
| R Type | 6.2 | 1 | 4 | 1 | 7 | 1 | 9,11,13,12 | 4 | 11,2,8,12,14,6 | 6 | 9 | 1 |
| W Type | 6.3 | 1 | 4 | 1 | 7 | 1 | 9,9,2,10,10 | 5 | 9,4,15,13,10 | 5 | 8 | 1 |
| W Type | 6.5 | 1 | 4 | 1 | 7 | 1 | 9,8,2,10,10 | 5 | 10,5,15,14,10 | 5 | 8 | 1 |

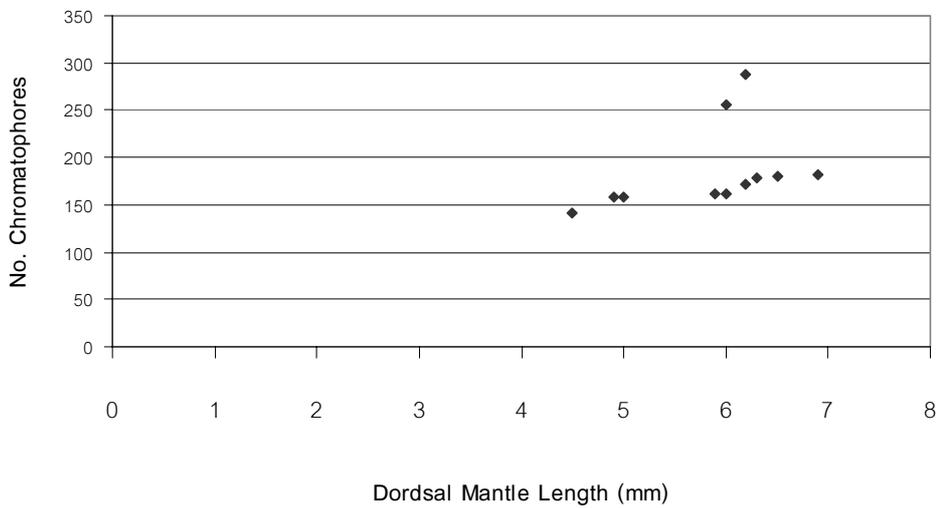


Figure 4. Number of Dorsal mantle chromatophores. T, Thai Type; R, Red Type; Q, Quacking Type; W, White Type.

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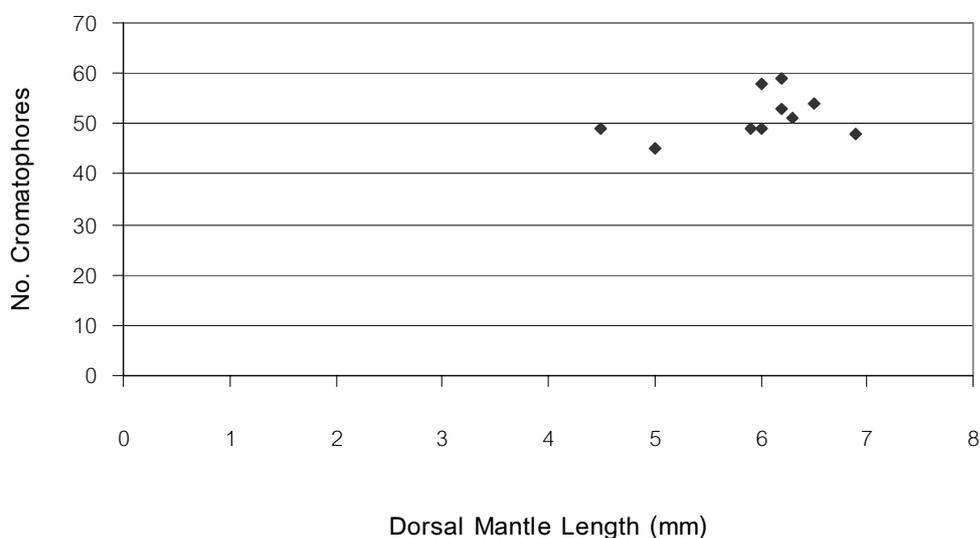


Figure 5. Number of total chromatophores on each tentacle. T, Thai Type; R, Red Type; Q, Quacking Type; W, White Type.

species was classified into three different groups: Akaika, Shiroika and Kuaika, which respectively mean red squid, white squid and quacking squid (Izuka *et al.*, 1994). The chromatophore arrangement on the funnel was also used to identify these three groups (Izuka *et al.*, 1996). In this study, there were no chromatophores on the funnel on the size range 4.5–6.5 mm ML. However, Thai type seems more similar to red type than the other types. When considering the egg capsules of each type, Izuka *et al.* (1994) found that Akaika (red squid) spawns egg capsules containing 5–13 eggs, Kuaika (white squid) lays 2-egg capsules and Shiroika (quacking squid) spawns egg capsules containing 5–6 eggs. Thai type spawns egg

capsules containing 2–7 eggs (Nabhitabhata, 1978). This result shows the similarity in egg capsules pattern between Thai type and Akaika (red squid) and Shiroika (quacking squid). However, the chromatophore pattern of the Shiroika (quacking squid) was higher than Thai type. Anyhow, isozyme analysis is needed between Thai type and Japanese type for the conclusion.

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