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# Description of the first Lessepsian squid migrant, *Sepioteuthis lessoniana* (CEPHALOPODA: Loliginidae), in the Aegean Sea (Eastern Mediterranean)

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**Abstract**

*Loliginid squids of the Sepioteuthis lessoniana complex are widely spread in the Indo-Pacific Ocean, where they constitute a commercially important resource for neritic fisheries. Sepioteuthis lessoniana is the only Lessepsian squid migrant till now, recorded for the first time in the Mediterranean in 2002 along the Turkish Levantine coasts. Two maturing males, with mantle lengths 193 mm and 244 mm, have been recently caught near the coasts of Rhodes Island (SE Aegean), extending the species distribution northward, into Hellenic waters. Their identity was confirmed by comparison of the main body, beak characteristics and morphometric measurements with those available in the literature for this species. Suspected expansion of the Lessepsian loliginid into the Aegean Sea, due to the gradual warming of the sea, is discussed.*

**Keywords:** *Sepioteuthis lessoniana;* Cephalopoda; Lessepsian migration; Invasive species; Aegean Sea; Mediterranean.

## Introduction

The members of the myopsid squid genus *Sepioteuthis* (Cephalopoda: Loliginidae) show some external similarities to cuttlefish but can be easily distinguished from them by the presence of a gladius instead of the cuttlebone dorsally in the mantle cavity and the absence of pockets into which to retract the tentacles (DUNNING, 1998). Since the generic revision by ADAM (1939), the genus *Sepioteuthis* includes three more species, *S. australis, S. sepioidea* and *S. loliginiformis* (VECCHIONE *et al.,* 1998), the latter of which has been considered doubtful by NESIS (1987). *Sepioteuthis lessoniana,* Lesson 1830, is the most widely distributed species of this genus, occurring

from Japanese to Australian and New Zealand coasts, as well as from Hawaii to the East African coast, north to the Red Sea and south to Madagascar (JEREB & ROPER, 2006).

ADAM (1939), who lumped the 12 names of *Sepioteuthis* in use at that time into a single species, *Sepioteuthis lessoniana,* Lesson, 1830, described it as the single species living in the Indo-West Pacific region. However, subsequent studies based on reproductive biology (SEGAWA *et al.,* 1993), isozyme electrophoresis (IZUKA *et al.,* 1996) and chromatophore arrangements on the funnel (IZUKA *et al.,* 1994), have indicated the presence of three different taxa within the *S. lessoniana* complex in the Japanese Archipelago. Thus, despite the generic level revisions undertaken, the taxonomic status of the *S. lessoniana* complex cannot be considered yet fully clarified.

The occurrence of *S. lessoniana* in the Mediterranean Sea was reported for the first time by SALMAN (2002) based on a single individual caught by fishermen in the İskenderun Bay (northeastern Levantine Sea) in March 2002, while the second record concerned a specimen filmed off the coast of Israel in the spring of 2004 (MIENIS, 2004).

This paper deals with two specimens of this species collected in Hellenic waters, along the coasts of the island of Rhodes, in February and April 2009 respectively.

A detailed description of the main characteristics contributing to the distinction of *S. lessoniana* from the other Mediterranean loliginid species is provided. Basic morphometric measurements concerning body and beak dimensions are presented and compared with relative data reported in the literature. Finally the expansion of *S. lessoniana* in the SE Mediterranean and its probable effects are discussed.

## Material and Methods

One specimen of *Sepioteuthis lessoniana* was collected on 8th February 2009 by a recreational fisherman using a fishing line near Fanes, along the NW coast of Rhodes, at about 4 m depth. A second specimen of the same species was caught on 4th April 2009 by a professional fisherman using trammel-nets for red mullets near Lindos, along the eastern coast of the island, at 7-8 m of depth (Fig. 1). The species was identified at the laboratory following the keys in ROPER *et al.* (1984). The maturity stage was assessed according to the macroscopic scale for squids presented in JEREB & ROPER (2006).

Beaks and broader arm and tentacle suckers were removed from both specimens. Body weight (BW in g), total length (TL), dorsal mantle length (DML), mantle circumference (MC), gladius length (GL), gladius maximum width (GW), fin length (FL), fin width (FW), head length (HL), head width (HW), arm length (AL-x), hectocotylus length (HCL), tentacle length (TL-x), tentacle club length (TCL-x) (in mm), were reported for each specimen before fixing them in formalin in order to preserve and keep them in the collection of the Hydrobiological Station of the Hellenic Centre for Marine Research in Rhodes, Greece. The standard dimensions of the beaks (rostral length: RL, hood length: HL, crest length: CL, wing length: WL, distance between jaw angles: JAd on both upper: U and lower: L mandible, amplitude of the lateral wall: LWa in the upper beak and length of base line: BL in the lower beak) according to CLARKE (1962), as well as the sucker diameters, were measured to the nearest 0.01 mm using a computer-enhanced video image-analysis system interfaced with a dissecting microscope. Indices of the body and sucker dimensions were calculated as percentages of the mantle length, following the

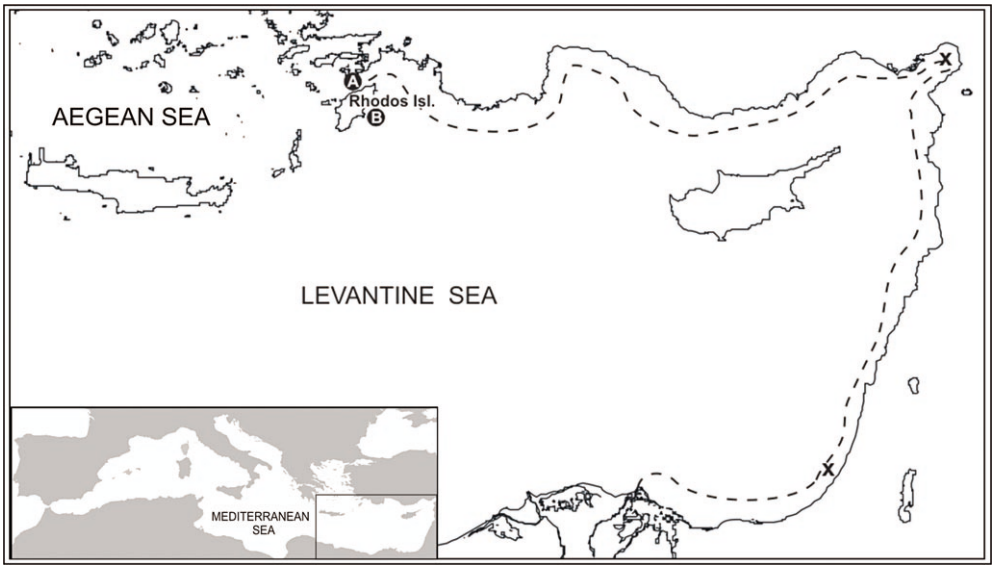


***Fig. 1:*** Map of the southeastern Mediterranean showing the locations of *Sepioteuthis lessoniana* capture off Rhodes Island (A: Fanes, B: Lindos) by circles , the approximate locations of previous records reported by SALMAN(2002) and MIENIS (2004) by X, as well as the probable pathway followed by the species after coming out of the Suez canal (by dotted line).

guidelines given by ROPER (1983) for taxonomic descriptions of cephalopod species.

## Results

Both specimens were in very good condition; with only the left tentacle missing from the specimen caught in Fanes. According to the fishermen's observations their eyes were green and their mantle dorsally had a transverse band-shading pattern. Both specimens were maturing males; their mantle lengths were 193 mm and 244 mm respectively. The body measurements and proportions are listed in Table 1.

### Description

***Mantle:*** robust, cylindrical in its anterior part, but conical in its posterior part, ended in a rounded tail (Fig. 2). It bears chromatophores on both sides, being darker violet-brown on the dorsal side.

***Fins:*** long and quite large, extending almost to the entire (88-97%) length of the mantle; their width reaching 67-70% of mantle length. They are attached to the sides of the mantle and their outline forms an oval shape. They are thick and muscular with no chromatophores on the ventral side (Fig. 2).

***Head:*** round, relatively large, with two big eyes covered by corneal membrane. The cephalic cartilage is slightly prominent at the posterior side of the head (towards the mantle opening) and forms two protruding supraorbital tectal extensions (Fig. 3A) referred thereafter as "supraorbital tectum".

***Buccal Mass:*** buccal membrane reinforced by 7 buccal connectives attached dorsally to the I and II arm pairs but ventrally to III and IV arm pairs (Fig. 3B). Buccal lappets without suckers.

**Table 1**
**Measurements and indices of two males *Sepioteuthis lessoniana* from Rhodes, Aegean Sea.**

| Parameter | Specimen 1 | | Specimen 2 | |
|---|---|---|---|---|
| | Measurement (mm) | Index (%) | Measurement (mm) | Index (%) |
| Mantle length | 196 | | 244 | |
| Total length | 510 | | 575 | |
| Mantle circumference (max.) | 155 | 79.1 | 185 | 75.8 |
| Gladius length | 201 | | 247 | |
| Gladius maximum width | 36 | | 39 | |
| Fin length | 170 | 86.7 | 238 | 97.5 |
| Fin width | 130 | 66.3 | 170 | 69.7 |
| Head length | 32 | 16.3 | 54 | 22.1 |
| Head width | 43 | 21.9 | 48 | 19.7 |
| Body weight | 356 | | 522 | |
| Arm length I-Right | 69 | 35.2 | 85 | 34.8 |
| Arm length II-Right | 82 | 41.8 | 101 | 41.4 |
| Arm length III-Right | 106 | 54.1 | 121 | 49.6 |
| Arm length IV-Right | 95 | 48.5 | 116 | 47.5 |
| Arm length I-Left | 72 | 36.7 | 85 | 34.8 |
| Arm length II-Left | 90 | 45.9 | 112 | 45.9 |
| Arm length III-Left | 110 | 56.1 | 120 | 49.2 |
| Arm length IV-Left | 103 | 52.6 | 113 | 46.3 |
| Tentacle length-Right | 270 | 137.8 | 288 | 118.0 |
| Tentacle length-Left | | | 278 | 113.9 |
| Tentacle Club length-Right | 102 | 52.0 | 98 | 40.2 |
| Tentacle Club length-Left | | | 93 | 38.1 |
| Maximum Arm Sucker Diameter | 2.85 | 1.5 | 2.83 | 1.2 |
| Maximum Tentacle Sucker Diameter | 3.35 | 1.7 | 3.33 | 1.4 |

***Funnel:*** broad, with red and brown chromatophores on both dorsal and ventral sides. Funnel-locking cartilages are long and thin.

***Gladius:*** transparent, thin, with wide vane (width ranging 16-18% of gladius length) and with a stout rachis gradually narrowing posteriorly (Fig. 3C).

***Arms:*** four pairs of unequal size, III and IV pairs longer and more robust. They have two rows of suckers. Ventral (IV) left arms of both examined males were hectocotylized with the distal one quarter of their length modified.

***Tentacles:*** long, extending the length of the mantle when folded back. Tentacular clubs are long occupying about the 1/3 of the tentacle length (Table 1). Club suckers are arranged in alternative rows of four, with those of the inner rows in the manus distinctly larger than the ones of the marginal rows (Fig. 3D).

***Fig. 2:*** Ventral view of *Sepioteuthis lessoniana* from the Aegean Sea.

***Suckers:*** horny rings of both arm and tentacular club suckers bear sharp triangular teeth around the entire margin, those in the tentacular club suckers more sparsely positioned (Fig. 4).

***Beaks:*** rostrums of both upper and lower mandibles are dark reddish-brown in colour, darkening spreads up to the middle of the hood-wings, while the other parts are transparent and yellowish, becoming colourless at the edge (Fig. 5). The rostrum is rather short and pointed, crest long and shallow and lateral walls without any folds or ridges. The posterior edge of the hood in the lower beak has a broad shallow noch. The measurements of the beak dimensions are shown in Table 2.

**Table 2**
**Upper and lower beak dimensions (mm) of the *Sepioteuthis lessoniana* specimens from Rhodes, Aegean Sea.**

| | Specimen 1 | | Specimen 2 | |
|---|---|---|---|---|
| **Parameter** | **Upper beak** | **Lower beak** | **Upper beak** | **Lower beak** |
| Rostral length | 4.49 | 3.74 | 4.17 | 3.33 |
| Hood length | 15.59 | 6.32 | 16.67 | 6.00 |
| Crest length | 21.26 | 13.77 | 22.67 | 12.17 |
| Wing length | 6.91 | 10.91 | 6.17 | 13.00 |
| Lateral Wall amplitude | 9.52 | | 10.50 | |
| Base length | | 13.65 | | 12.50 |
| Jaw Angle | 3.64 | 4.54 | 3.83 | 4.17 |


***Fig. 3:*** **(a)** Head (arrow showing the cartilaginous lamella under the eye), **(b)** Buccal mass and crown, **(c)** Gladius, **(d)** Tentacular club of *Sepioteuthis lessoniana* from the Aegean Sea.

## Discussion

### Systematics

The specimens of *Sepioteuthis lessoniana* are easily distinguished from the large Mediterranean loliginid species *Loligo vulgaris* and *Loligo forbesi* mainly by the oval shape of the fins, the longer tentacular clubs and the supraorbital tecta. This latter feature formed by the cephalic cartilage has been described for different species of the genus Sepioteuthis, as i.e. for *Sepioteuthis billineata* synonym to *Sepioteuthis australis* (KIRK, 1883), while it is also visible in the illustration of *Sepioteuthis lessoniana* by K. HOLLIS/ABRS in DUNNING (1998), constituting rather a common characteristic of this genus which can apparently also serve for its distinction from the genus *Loligo.*

The comparison of selected indices calculated for the examined specimens of *Sepioteuthis lessoniana* from the Aegean Sea with those derived from specimens of the

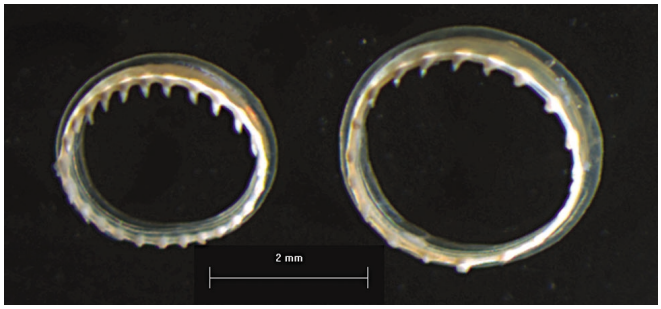


***Fig. 4:*** Horny rings in arm suckers (left) and tentacular club suckers (right) of *Sepioteuthis lessoniana* caught in the Aegean Sea.

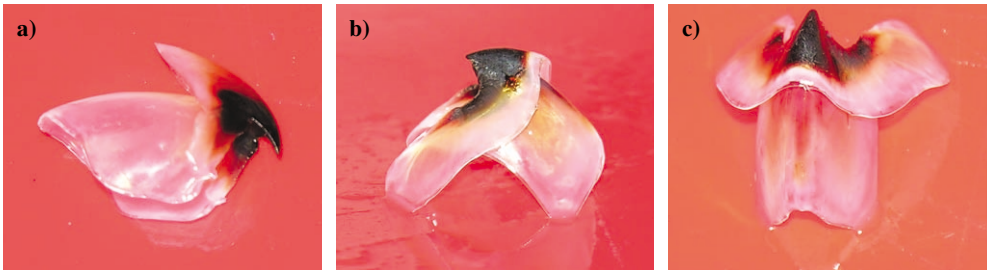


***Fig. 5:*** **(a)** Lateral view of the upper beak, **(b)** lateral and **(c)** ventral view of the lower beak of *Sepioteuthis lessoniana* from the Aegean Sea.

same species collected from various areas of the Indo-Pacific Ocean (Table 3), confirms the identification of the specimen caught near the coast of Rhodes. The other two valid species of the genus Sepioteuthis, *S. australis* and *S. sepioidea* apart from the morphological differences, the most evident of which are the relatively narrower fin and the less extended tentacular club, are distributed in faraway geographic areas (Australian waters and the central area of the Western Atlantic respectively) (ROPER *et al.,* 1984), so that any suspicion of their migration to the Mediterranean Sea can be dismissed.

Detailed characteristics of the lower beak resembled those sited in the web beak data base of KUBODERA (2005) for *S. lessoniana* from the NW Pacific Ocean. The arrangement of chromatophores on the funnel of the specimens from the Aegean Sea indicate their similarity to the 'AKAIKA' type of S. lessoniana described from the Pacific Ocean (IZUKA *et al.,* 1996), however additional comparative studies over broad geographical areas, based on morphological and isozyme analyses are required for the clarification of the *S. lessoniana* complex, as suggested in other recent studies relative to the systematics of the species (DUNNING, 1998; OKUTANI, 2005; JEREB & ROPER, 2006).

## Distribution

*Sepioteuthis lessoniana* is a neritic loliginid squid, well adapted to the high water temperatures of the tropical zone. It is listed among the alien species for the Mediterranean Sea (ZENETOS *et al.,* 2005) and con-

**Table 3**
**Selected indices calculated for *Sepioteuthis lessoniana* from different regions of the Indo-Pacific Ocean (from available literature) and from the Aegean Sea (present study).**

| Region | N | DML | MWI | FLI | FWI | TCLI | Source |
|---|---|---|---|---|---|---|---|
| Indo-Pacific Ocean | 59 | 24-365 | 22-46 | | 55-72 | 26-53 | Adam, 1939a |
| Indian Ocean | 14 | 27-335 | 25-44 | | 58-80 | 27-44 | Adam, 1939b |
| Cabo Verde | 2 | 93-149 | 39-32 | 91-94 | 64-67 | 47-51 | Adam, 1959 |
| Aqaba bay | 4 | 25-210 | 26-36 | 80-93 | 59-68 | 33-40 | Adam, 1960 |
| Philippine Islands | 20 | 54-178 | 27-40 | 91-95 | 59-84 | 32-39 | Voss, 1963 |
| Andaman Sea | 26 | 53-134 | 28-47 | 82-95 | 50-75 | 30-56 | Nateewathana, 1992 |
| Indo-Pacific Ocean | 5 | 50-111 | 27-43 | 84-92 | 59-64 | 32-50 | Jereb & Roper, 2006 |
| Aegean Sea | 2 | 196-244 | <40 | 87-97 | 66-70 | 38-52 | present study |

sidered a Lessepsian immigrant (BELLO, 2003; ÇINAR *et al.* 2005). Its occurrence in the Aegean Sea is reported for the first time, seven years after its first record for the Mediterranean Sea at Iskenderun Bay (SALMAN, 2002), indicating that this species has followed the main pathway of Lessepsian immigrants spreading within the Mediterranean (Fig. 1), favoured by the prevailing currents, along the Asiatic coasts northward and then westward toward the Aegean islands (PAPACONSTANTINOU, 1990). The appearance of *S. lessoniana,* the first Lessepsian cephalopod species entering the Aegean waters, coincides with the increasing trend of records and accelerated range expansion of Erythrean alien biota observed in the last decade, especially in the south-eastern and southern parts of this basin (PANCUCCI-PAPADOPOULOU *et al.,* 2005; PERISTERAKI *et al.,* 2006; CORSINI-FOKA & ECONOMIDIS, 2007; ZENETOS *et al.,* 2007; ELNAIS, 2009). This phenomenon is particularly intensified in the area around Rhodes, the largest island of the Dodecanese archipelago, located at the limit between the Levantine and the Aegean Sea. Its coastal zone, with a limited continental shelf, presents a sub-tropical open-sea character and is directly influenced by the neighboring Levantine Basin, since the island is hugged by the warm and salty Asia Minor Current (AMC) (PANCUCCI-PAPADOPOULOU *et al.,* 1999; BIANCHI, 2007). These hydrological characteristics create suitable conditions for thermophilous indigenous and allochthonous species. The above features, combined with the evolution of the EMT (Eastern Mediterranean Transient) (THEOCHARIS *et al.,* 2002), the increase of sea water temperature (BIANCHI & MORRI, 2000; BIANCHI & MORRI, 2003; THEOCHARIS, 2008; RAITSOS *et al.,* 2008) and other biotic and abiotic factors may enhance the introduction, establishment and spread of non-indigenous species of Indo-Pacific origin recorded in the area in the last decade.

Since the species has already received the common name «σουπιοκαλάμαρο» ('soupiocalamaro' viz. cuttlefish-like calamari) by local fishermen, an earlier occurrence of the species in the area is suspected.

*Sepioteuthis lessoniana* is one of the most commercially important squid species for inshore fisheries throughout its distributional range (JEREB & ROPER, 2006). It seems to have a similar habitat to *Loligo vulgaris,* a

squid most frequent in Hellenic waters, which composes an important resource for coastal fisheries, massively migrating to the inshore fishing grounds during late autumn when the temperature is decreasing (LEFKADITOU *et al.,* 1998). Systematic monitoring of the expansion of *S. lessoniana* in the Hellenic waters is necessary, while the study of the life history and especially the trophic spectrum and the ecology of both native and lessepsian loliginid species in the area of the Dodecanisos would contribute to understanding suspected future competition among them.

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