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SIGNIFICANT RANGE EXPANSION OF *SEPIOTEUTHIS LESSONIANA* (CEPHALOPODA: LOLIGINIDAE) IN THE AEGEAN SEA BASED ON SCUBA AND PHOTOGRAPHIC OBSERVATIONS

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ABSTRACT

The bigfin reef squid, Sepioteuthis lessoniana*, is by far the most widespread Lessepsian cephalopod in the Mediterranean Sea and has considerably expanded its range since it was first recorded almost two decades ago. In Türkiye, the species' occurrence was hitherto restricted to the northern Levantine shores, with reports from Iskenderun, Antalya, and Fethiye Bays. This study reports the presence of* S. lessoniana *from the Aegean Sea coast of Türkiye for the first time, suggesting a significant northward range of expansion. The observed individuals displayed spawning behavior, and several egg masses were deposited within inshore crevices, indicating the potential presence of a successfully breeding population in the region.*

Key words: Bigfin reef squid, Lessepsian migrant, range expansion, invasive species, first record

ESPANSIONE SIGNIFICATIVA DELL'AREALE DI *SEPIOTEUTHIS LESSONIANA* (CEFALOPODA: LOLIGINIDAE) NEL MAR EGEO BASATA SU OSSERVAZIONI SUBACQUEE E FOTOGRAFICHE

SINTESI

Il calamaro di Lesson, Sepioteuthis lessoniana*, è di gran lunga il cefalopode lessepsiano più diffuso nel Mediterraneo e ha ampliato considerevolmente il proprio areale da quando è stato segnalato per la prima volta quasi due decenni fa. In Turchia, la presenza della specie era finora limitata alle coste settentrionali del Levante, con segnalazioni dalle baie di Iskenderun, Antalya e Fethiye. Questo studio riporta per la prima volta la presenza di* S. lessoniana *lungo la costa egea della Turchia, suggerendo una significativa espansione dell'areale verso nord. Gli individui osservati mostravano comportamenti riproduttivi e diverse masse di uova sono state deposte all'interno di fessure costiere, indicando la possibile presenza di una popolazione in riproduzione con successo nella regione.*

Parole chiave: calamaro di Lesson, migrante lessepsiano, espansione dell'areale, specie invasiva, prima segnalazione

INTRODUCTION

The occurrence and establishment success of non-indigenous cephalopods in the Mediterranean Sea have long been neglected and have only become a focus of scientific interest over the past two decades (Bello *et al*., 2020). According to the most comprehensive accounts, five Lessepsian species originating from the Red Sea and Indo-Pacific are currently recognized, namely *Sepia dollfusi*, *Sepioteuthis lessoniana*, *Uroteuthis arabica*, *Octopus cyanea*, and *Amphioctopus aegina* (Marrone *et al*., 2025), while two additional species (*Acanthosepion pharaonis* and *Tremoctopus gracilis*) are either regarded as questionable or requiring further research to clarify their pathways of introduction (Bello *et al*., 2020).

Among all alien cephalopod species in the Mediterranean Sea basin, the status of the bigfin reef squid, *S. lessoniana* R.P. Lesson, 1831, is of special concern owing to its invasive potential. This neritic loliginid species is native to the Indo-Pacific region, with a broad distribution from the eastern coast of Africa and the Red Sea in the west to the Hawaiian Islands in the east, and from Japan in the north to Australia and New Zealand in the south (Jereb & Roper, 2010). The species was first recorded in the Mediterranean Sea in 2002, when a single individual was captured in Iskenderun Bay, Türkiye (Salman, 2002). Within just seven years, its range expanded to Rhodes Island, Greece, most likely along the Asiatic shores of the Mediterranean, aided by the prevailing currents (Lefkaditou *et al*., 2009). Rapidly spreading westward to the central Mediterranean, *S. lessoniana* has reached as far as Tunisia in the south and the Adriatic Sea in the north, becoming a commercial catch in several localities (Bello *et al*., 2020; Marrone *et al*., 2025).

Published information on *S. lessoniana* in Türkiye is quite scarce. Following its first record by Salman (2002), small schools of up to 15 individuals were observed in Fethiye Bay during a governmental biodiversity project (anonymous, 2009), with subsequent records reported from Kaş (Draman, 2012) and Antalya Bay (Salman *et al*., 2023). The species was included in the list of invasive marine species of Türkiye (105 species in total) by Çınar *et al*. (2021). In this paper, we report a new occurrence of *S. lessoniana* from Kuşadası Bay (Türkiye), based on photographic data obtained through SCUBA diving observations. This recent finding confirms a significant range expansion of the species in the Aegean Sea, and careful monitoring is warranted due to its potential intrusion further northward.

MATERIAL AND METHODS

On 17 August 2025, three individuals of *S. lessoniana* were observed at a depth of 5 m during a recreational SCUBA dive carried out at Kuşadası Bay (37°52′39″N, 27°15′55″E) on the central Aegean Sea coast of Türkiye. The diving site is a shallow, small cove with a sandy and rocky substrate up to 3 m deep, and dense seagrass meadows (*Posidonia oceanica*) at greater depths. Since the squids approached the divers very closely, it was possible to estimate their approximate mantle lengths, which ranged from 20 cm for two individuals to 30 cm for the third. Additional observations of three more bigfin reef squid individuals (of the same size classes) were made at the same cove on 20 September 2025, just slightly farther offshore and at a greater deepth (7 m) than the previous observation site. Wide-angle underwater photographs were taken with a Panasonic DMC-TZ10 compact digital camera, while close-up images were captured using an Olympus OM-1 mirrorless dSLR camera equipped with a 90 mm lens. Species identification was based on photographic records following Jereb & Roper (2010), and nomenclature follows the WoRMS Editorial Board (2025).

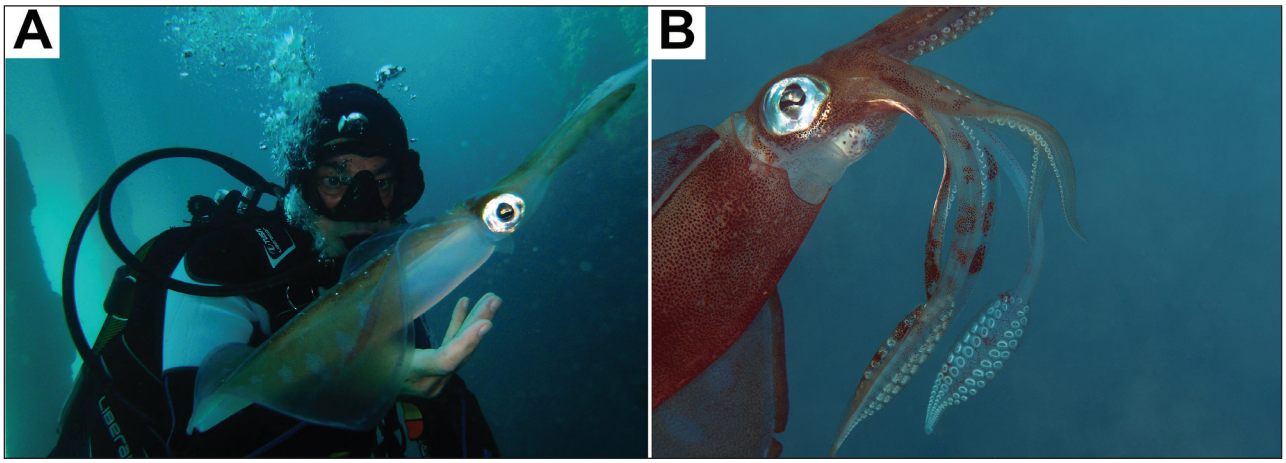

Fig. 1: Underwater photographs of** Sepioteuthis lessoniana **from Kuşadası Bay, Aegean Sea, Türkiye. A) Lateral view (photograph by C. Gedikoğlu), B) Close-up showing tentacular clubs (photograph by R. Kirman).
Sl. 1: Podvodne fotografije vrste** Sepioteuthis lessoniana **iz zaliva Kuşadası (Egejsko morje, Turčija). A) stranski pogled (foto: C. Gedikoğlu), B) bližnji posnetek, ki prikazuje tentakularne kijaste izrastke (foto: R. Kirman).

RESULTS AND DISCUSSION

A close examination of underwater photographs confirmed the species to be *S. lessoniana*, which is characterized by a broadly elliptical cuttlefish-like morphology with thick, muscular, oval fins extending over 85% of the mantle length to the posterior end, forming a continuous edge without separate lobes (Fig. 1A), suckers arranged in four series on proximal tentacular clubs, enlarged median manal suckers, and large eyes (Fig. 1B); all consistent with the descriptions of Jereb & Roper (2010). The proportion of fin length relative to mantle length is the key diagnostic feature that distinguishes the bigfin reef squid from the other Mediterranean confamilial members and facilitates species identification from underwater photographs.

Documenting the first introductions of invasive species in a country or region is crucial for early detection and rapid response, although this is often hindered by observer lag (delay between the species' actual arrival and its first published record) (González-Moreno *et al.*, 2025). Our study site, Kuşadası Bay, has been regularly and frequently monitored through scuba diving and underwater photography by the author over the past decade, providing the research team with the opportunity to rapidly detect any newly arrived species to the region. The initial bigfin reef squid observation in August 2025 thus most likely reflects a recent development that warrants close monitoring. Since the location of this new record is over 300 nautical miles north of the site where the species was previously observed (Fethiye Bay), we speculate that the bigfin reef squid may already be present in other areas of the southern Aegean shores (*i.e.*, Gökova Bay), where it is currently unrecorded. The spreading pattern of *S. lessoniana* along the Turkish coastline (Fig. 2) is consistent with that of several other Lessepsian species that first established populations on the southern Anatolian shelf and then gradually expanded their distribution ranges toward the Aegean Sea, following the prevailing counterclockwise currents of the Mediterranean Sea (Çinar *et al.*, 2021).

During our diving observations in Kuşadası Bay, bigfin reef squid were first encountered hovering in midwater, then two individuals approached a nearby crevice. Both were estimated to exceed 20 cm in mantle length, indicating sexual maturity according to the developmental stage descriptions of Segawa (1987). Based on the reproductive

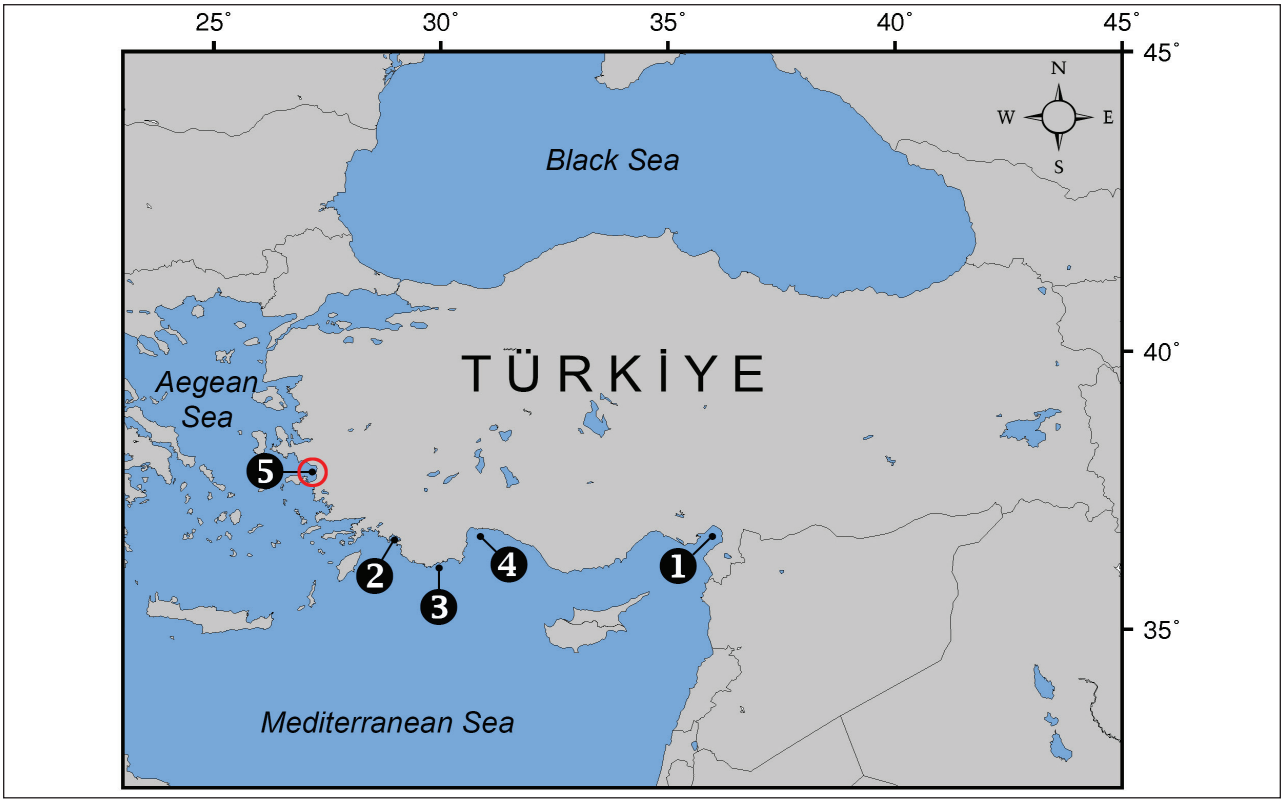

Fig. 2: Location of the** S. lessoniana **observation in the Aegean Sea (encircled in red). Previous occurrence records from Türkiye are indicated in chronological order: 1) Iskenderun Bay (Salman, 2002), 2) Fethiye Bay (anonymous, 2009), 3) Kaş (Draman, 2012), 4) Antalya Bay (Salman** et al.**, 2023), 5) Kuşadası Bay (present study).
Sl. 2: Lokacija opazovanja vrste** S. lessoniana **v Egejskem morju (obkroženo z rdečo). Predhodni zapisi o pojavljanju v Turčiji so navedeni v kronološkem zaporedju: 1) zaliv Iskenderun (Salman, 2002), 2) zaliv Fethiye (anonimno, 2009), 3) Kaş (Draman, 2012), 4) zaliv Antalya (Salman in sod., 2023), 5) zaliv Kuşadası (pričujoča raziskava).

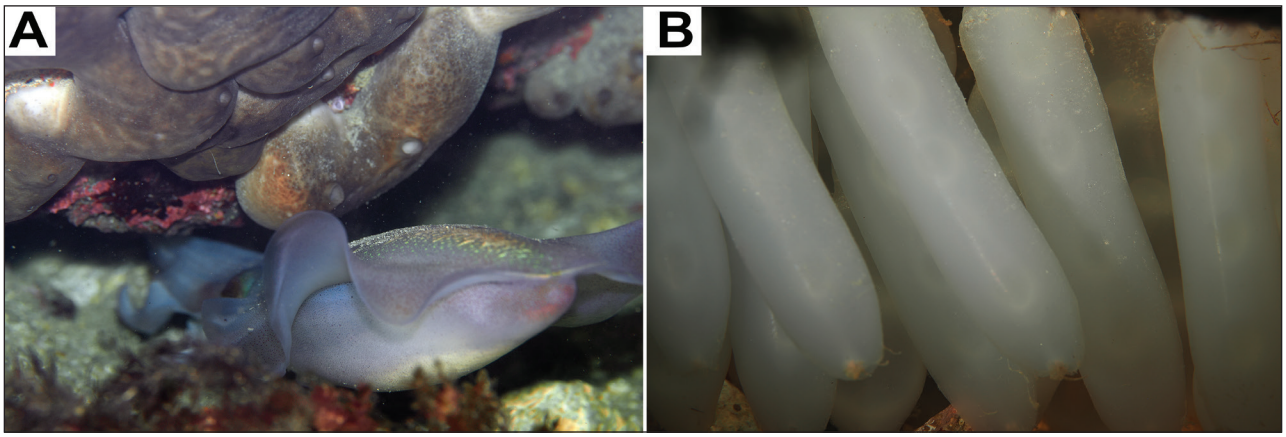

Fig. 3: Breeding behavior of** S. lessoniana **observed at the study site. A) Female entering the crevice to lay eggs, B) Egg masses attached to the crevice roof (photographs by R. Kirman).
Sl. 3: Razmnoževalno vedenje vrste** S. lessoniana**, opazovano na lokaciji raziskave. A) Samica, ki vstopa v razpoko, da bi odložila jajčeca, B) Jajčne mase, pritrjene na strop razpoke (foto: R. Kirman).

body patterns described for the species (Lin *et al*., 2017), the smaller individual (ca. 20 cm ML) exhibiting spots on the dorsal mantle, was identified as a female, whereas the larger one (30 cm ML), displaying lines on the dorsal mantle, was identified as a male. As the female entered the crevice and stayed inside for a short period (Fig. 3A), the male remained stationary outside. Similar activity – later confirmed as spawning behavior – has been reported for the southern reef squid (*S. australis*) in the Indo-Pacific region (Larcombe & Russell, 1971). After both individuals left the area, we approached the crevice and observed the egg masses. There were multiple batches of capsules attached to the crevice roof (Fig. 3B). Photographs from our study site indicate the presence of 2 to 6 egg masses, with each capsule – according to the literature (Jereb & Roper, 2010) – potentially containing up to 13 eggs. Field observations from the Pacific further indicate that adult *S. lessoniana* migrate from offshore to shallow inshore areas for spawning (Segawa, 1987), and that reproduction occurs almost year-round (Jereb & Roper, 2010; Chen *et al*., 2015), with seasonal peaks ranging from two (spring and autumn; Ching *et al*., 2017) to three (winter, spring, and summer; Kimoto *et al*., 2023), depending on the ecosystem.

The bigfin reef squid is distributed throughout the central and eastern Mediterranean Sea; however, its potential threat to local food webs and biodiversity is not currently a focus of ongoing research efforts. Lefkaditou *et al*. (2009) highlighted potential competition with native species, such as *Loligo vulgaris*, as both generally occupy similar habitats (*i.e.*, sandy bottoms and seagrass beds) and are abundant at depths of up to 100 m (Jereb & Roper, 2010). Such interspecies interactions might lead to changes in fisheries practices due to shifts in catch composition. Owing to its high commercial value in artisanal and nearshore fisheries across the Indo-Pacific, the bigfin reef squid is one of the most extensively studied loliginid species within its native range; however, its life-history traits in newly colonized environments remain under-researched and quantifying the actual ecological and socioeconomic consequences will require targeted studies. It is important to note that Mediterranean records of *S. lessoniana* should be critically validated (Bello *et al*., 2020), as substantial morphological and genetic evidence suggests extremely high levels of cryptic diversity within the species complex (Cheng *et al*., 2015).

Several biological traits of *S. lessoniana* may increase its potential to exhibit invasive characteristics and colonize new areas. These include rapid growth, a relatively short lifespan (up to 7 months) with first maturity at 120 days (Kavitha *et al*., 2024), year-round reproduction (Jereb & Roper, 2010), flexible spawning substrate selection (Kimoto *et al*., 2023), and high tolerance to thermal fluctuations (Chiang *et al*., 2024). Together, these traits contribute to quick rapid population responses to favorable environmental conditions, facilitating reproduction and range expansion. Our recent observation of occurrence and breeding activity of *S. lessoniana* along the central Aegean Sea coast provides strong evidence of an established population in the region, although it remains unclear whether it can withstand existing physical and ecological pressures. Since invasive species often exhibit complex interactions with members of recipient ecosystems, implementing appropriate environmental management decisions is a challenging task (Katsanevakis *et al*., 2014). Priority should therefore be given to assessing the magnitude of potential impacts, which requires in-depth research of the life histories and ecologies of native and Lessepsian loliginid species to evaluate possible competition.

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ZNATNO RAZŠIRJANJE AREALA VRSTE *SEPIOTEUTHIS LESSONIANA* (CEPHALOPODA: LOLIGINIDAE), V EGEJSKEM MORJU NA PODLAGI PODVODNIH OPAZOVANJ IN FOTOGRAFIRANJA

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POVZETEK

*Velikoplavuti grebenski ligenj (*Sepioteuthis lessoniana*) je daleč najbolj razširjen lesepski glavonožec v Sredozemskem morju in je od prve zabeležbe pred skoraj dvema desetletjema znatno razširil svoj areal. V Turčiji je bil doslej zabeležen le na severno obalo Levantskega morja, z zapisi o pojavljanju iz zalivov Iskenderun, Antalya in Fethiye. Ta raziskava prvič poroča o prisotnosti vrste* S. lessoniana *ob egejski obali Turčije, kar kaže na znatno širjenje njenega območja razširjenosti proti severu. Pri opazovanih osebkih sta avtorja zaznala razmnoževalno vedenje, v obalnih razpokah pa je bilo odloženih več jajčnih mas, kar kaže na morebitno prisotnost uspešno razmnožujoče se populacije v regiji.*

Ključne besede: velikoplavuti grebenski ligenj, lesepska selivka, širjenje areala, invazivna vrsta, prvi zapis o pojavljanju

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