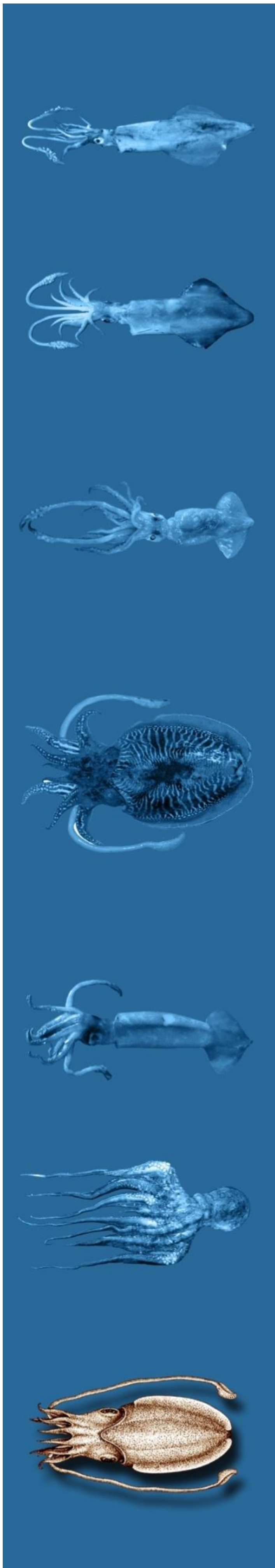
# Cephalopod biology and fisheries in European waters: species accounts



## *Sepia elegans*

Elegant cuttlefish

# 7 *Sepia elegans* Blainville, 1827

**Patrizia Jereb, Ignacio Sobrino, A. Louise Allcock, Sonia Seixas, and Evgenia Lefkaditou**

### Common names

Seiche élégante (France), seppia elegante (Italy), choco-elegante (Portugal), choquito (Spain), elegant cuttlefish (UK) (Figure 7.1).

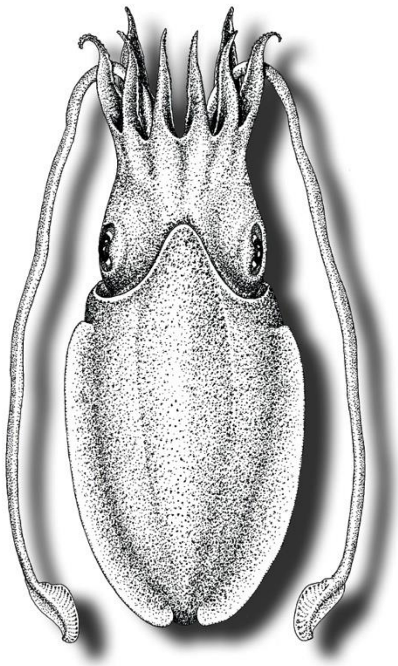


**Figure 7.1.** ***Sepia elegans*. Dorsal view. From Guerra (1992)**

### Synonyms

*Sepia rupellaria* Férussac and d'Orbigny, 1835, *Sepia biserialis* Blainville, 1827, *Sepia italica* Risso, 1854.

## 7.1 Geographic distribution

The elegant cuttlefish, *Sepia elegans* Blainville, 1827, is found in the Northeast Atlantic, from northwestern Scotland and Ireland (Massy, 1928; Stephen, 1944; Nesis, 1982/87) (Figure 7.2) down to Namibia (Sánchez, 1988; Roeleveld, 1998). It is present in the Celtic Sea (Lordan *et al.*, 2001a) and the English Channel (Marine Biological Association of the United Kingdom, 1931; Roper and Sweeney, 1981) and off the French and Iberian Atlantic coasts (Guerra, 1992). It is caught on the Sahara Bank (e.g. Bravo de Laguna, 1989; Balguerias *et al.*, 2000) and extends south to northern Namibian waters (Sánchez, 1988), where it has been recorded at 21°S (Roeleveld, 1998). Records from the Agulhas Bank exist (Filippova *et al.*, 1995), but, as noted by Roeleveld (1998), the geographic position reported by the authors is apparently incorrect. *Sepia elegans* is also widely distributed throughout the Mediterranean Sea (Mangold and Boletzky, 1987; Bello 2004; Salman, 2009), including western and central Mediterranean parts (Mangold-Wirz, 1963a**;** Sánchez, 1986a; Belcari and Sartor, 1993; Jereb and Ragonese, 1994; Giordano and Carbonara, 1999**;** Relini *et al.*, 2002; Cuccu *et al.*, 2003a), the Adriatic Sea (Casali *et al.*, 1998; Krstulović Šifner *et al.*, 2005; Piccinetti *et al.*, 2012)**,** the Ionian Sea (Tursi and D'Onghia 1992; Lefkaditou *et al.*, 2003a; Krstulović Šifner *et al.*, 2005), the Aegean Sea, and the Levant Basin (D'Onghia *et al.*, 1992; Salman *et al.*, 1997, 1998; Lefkaditou *et al.*, 2003b; Duysak *et al.*, 2008). It has been recorded in the Sea of Marmara (Katağan *et al.*, 1993; Ünsal *et al.*, 1999).


**Figure 7.2.** ***Sepia elegans*****. Geographic distribution in the Northeast Atlantic and Mediterranean Sea.**

## 7.2 Taxonomy

### 7.2.1 Systematics

Coleoidea – Decapodiformes – Sepiida – Sepiidae – *Sepia.*

### 7.2.2 Type locality

Sicily, central Mediterranean Sea.

### 7.2.3 Type repository

Originally Muséum National d'Histoire Naturelle, Laboratoire Biologie Invertebres Marins et Malacologie, 55, rue de Buffon, 75005 Paris 05, France**.** Syntypes; specimens not extant [fide Lu *et al.* (1995:315)].

## 7.3 Diagnosis

### 7.3.1 Paralarvae

This species does not have paralarvae *sensu* Young and Harman (1988). Hatching size is assumed to be 4 mm ML (Mangold-Wirz, 1963a).

### 7.3.2 Juveniles and adults

*Sepia elegans* is a small species, with adult males growing up to 75 mm ML (Ciavaglia and Manfredi, 2009) and females up to 89 mm ML (Adam, 1952). Maximum total weight is ca. 60 g. The mantle is oblong, more than twice as long as wide, with the dorsal anterior margin triangular, acute, and projecting strongly forward. Male and female arms are subequal in length. The left ventral arm is hectocotylized in males (Figure 7.3). It bears 1–2 rows of normal-sized suckers proximally, followed by 9–11 rows of reduced minute suckers medially, followed by normal-sized suckers to the arm tip; suckers are set in two dorsal and two ventral series displaced laterally.

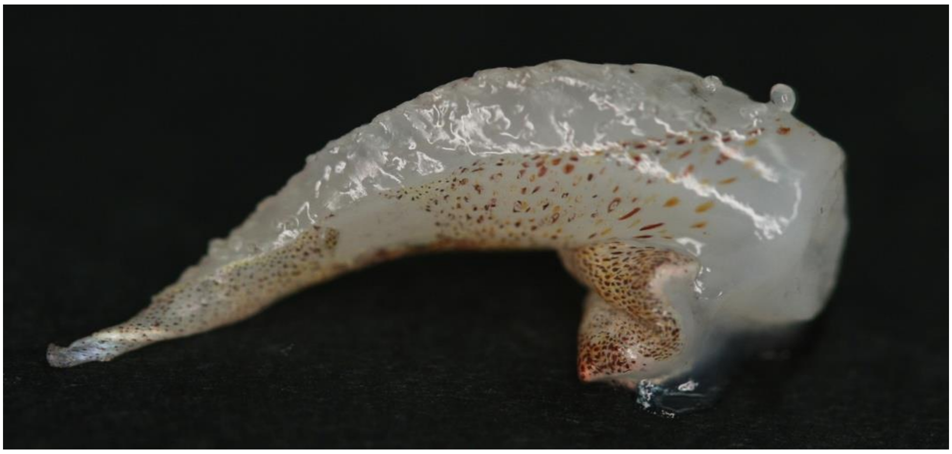


**Figure 7.3. S*epia elegans.* Left arm III hectocotylized. Photo: Carlos Farias.**

Tentacular clubs are short and oval, and the sucker-bearing surface is flattened. There are 6–8 suckers in transverse rows. Suckers differ markedly in size. There are 3–4 greatly enlarged suckers in the middle of the club, and although several dorsal suckers are enlarged, they are never as large as the medial suckers. The cuttlebone is oblong and convex in lateral view. It tapers to a sharp point anteriorly and posteriorly, is recurved ventrally, and its dorsal surface is evenly convex. The last loculus is convex. The anterior striae are an inverted U-shape. The spine is very small, "rather like a small calcareous ridge than a true spine" (Nesis, 1982/1987). Lateral wings are present, but are very small. The animal is reddish brown in life, but paler than *S. orbignyana.* There are a few scattered chromatophores on the head, and the dorsal mantle surface is peppered with scattered purple-black chromatophores, but the fins and the ventral mantle surface are pale (Adam and Rees, 1966; Nesis, 1982/1987; Neige and Boletzky, 1997; Reid *et al.*, 2005). The beaks are illustrated in Figure 7.4.

**Figure 7.4. S*epia elegans.* Lower beak (left) and upper beak (right). Photo: Carlos Farias.**

## 7.4 Remarks

Floating cuttlebones may enter the eastern side of the North Sea and be found stranded on the Belgian and Dutch coasts (Adam, 1933); however, live *S. elegans* have never been found in the North Sea (e.g. Adam, 1933; Roper and Sweeney, 1981; Nesis, 1982/87). Recent observations confirm this (J. Goud, pers. comm.). The species has been reported from the Agulhas Bank (37°12′S 22°30′E) by Filippova *et al.* (1995), but as noted by Roeleveld (1998), the position given in Filippova's paper is incorrect because it lies south of the Agulhas Bank, in ca. 4000 m depth.

On the basis of morphological features (Khromov, 1987a; Khromov *et al.*, 1998), and, subsequently, genetic divergence (Pérez-Losada *et al.*, 1996; Sanjuan *et al.*, 1996), it has been suggested that *S. elegans* and *S. orbignyana* belong to a different subgenus from the genus *Sepia sensu stricto*, i.e. to the subgenus *Rhombosepion*. Morphometric analysis of both cuttlebone and statoliths, based on landmarks, may prove a useful taxonomic tool for the separation of *S. elegans* from closely related species (Neige and Boletzky, 1997; Lombarte *et al.*, 2006).

## 7.5 Life history

Although this species spawns year-round, seasonal migrations and seasonal peaks in spawning have been described in some areas. It lives for 12–18 months. There is no paralarval stage.

### 7.5.1 Egg and juvenile development

The eggs (maximum recorded diameter 5 mm; Guerra, 1984) are attached to available hard substrata, such as alcyonarian (typically *Alcyonium palmatum*) shells, on muddy bottoms, or, less frequently, on coral formations (Mangold-Wirz, 1963a). They closely resemble *S. officinalis* eggs, except for the dimensions (smaller in *S. elegans*) and colour (whitish and translucent in *S. elegans*). The attachment of the eggs to *Alcyonium palmatum* is quite an elaborate and complex procedure, at the end of which the egg resembles a stone on a ring slipped onto the alcyonarian finger-like appendage, as described in detail by Bouligand (1961). After hatching, juveniles immediately adopt a benthic lifestyle.

### 7.5.2 Growth and lifespan

Growth in mantle length is 2.8 mm month$^{-1}$ for males and 3.0 mm for females in the Sicilian Channel (central Mediterranean) (Ragonese and Jereb, 1991), i.e. slightly faster than estimated in the western Mediterranean by Mangold-Wirz (1963a) and in the Ría de Vigo by Guerra (1984) (2–2.5 mm month$^{-1}$). Females attain larger size and are comparatively heavier than males at any given mantle length, and animals become more slender as size increases (Bello, 1988; Guerra and Castro, 1989; Ragonese and Jereb, 1991; Lefkaditou *et al.*, 2007; Ramos *et al.*, 2009; A. Moreno, unpublished data). The largest individuals recorded by Guerra and Castro (1989) were 61 mm ML (males) and 67 mm ML (females). Length–weight relationships are available for several areas (Table 7.1).

Female tentacular clubs are significantly longer than male ones (Bello, 1991a). Bello and Piscitelli (2000) showed that *S. elegans* females ingest more food at any given size and suggested that a cause–effect relationship between sex-related club size and growth rate existed. Subsequent observations on *S. elegans* and *S. orbignyana* demonstrated the existence of a positive correlation between body condition and tentacular club length in males and females of both species (Bello, 2006), and strongly corroborated the hypothesis that there is indeed a cause–effect relationship.

From observations in the field, lifespan is estimated to range between 12 and 18–19 months (Mangold-Wirz, 1963a; Guerra, 1984; Guerra and Castro, 1989), somewhat less than the values obtained by preliminary estimates with length-frequency distribution analysis (i.e. ca. 2 years, Ragonese and Jereb, 1991). However, length-frequency distributions are generally polymodal (see also Guerra and Castro, 1989), making it difficult to identify microcohorts clearly, and growth estimation by means of length-frequency methods is difficult (e.g. Caddy, 1991).

**Table 7.1.** ***Sepia elegans.*** **Length–weight relationships in different geographic areas for females (F), males (M), and sexes combined (All). Original equations converted to W =** $aML^b$**, where W is body mass (g) and ML is dorsal mantle length (cm).**

| Region | *a* | *b* | Sex | Reference |
|---|---|---|---|---|
| Ría de Vigo | 0.374 | 2.272 | F | Guerra and Castro (1989) |
| | 0.327 | 2.311 | M | |
| Portuguese waters | 0.289 | 2.420 | F | A. Moreno, pers. comm. |
| | 0.356 | 2.190 | M | |
| Gulf of Cádiz | 0.239 | 2.476 | F | Ramos *et al.* (2009) |
| | 0.227 | 2.577 | M | |
| Sicilian Channel | 0.257 | 2.506 | F | Ragonese and Jereb (1991) |
| | 0.286 | 2.342 | M | |
| Adriatic Sea | 0.196 | 2.606 | F | Bello (1988) |
| | 0.208 | 2.500 | M | |
| Aegean Sea | 0.229 | 2.515 | F | Lefkaditou *et al.* (2007) |
| | 0.248 | 2.441 | M | |

### 7.5.3 Maturation and reproduction

In the Ría de Vigo, males outnumber females in spring and autumn, and the overall sex ratio recorded by Guerra and Castro (1989) was 1.18:1 in favour of males.

The smallest mature males measure 20 mm ML (Volpi *et al.*, 1990), and the smallest mature females 30 mm ML (Guerra and Castro, 1989). In Portuguese waters, ca. 60–70% of males and females are mature at ca. 35 and 45 mm ML, respectively (A. Moreno, pers. comm.), and in the Catalan Sea (western Mediterranean), the equivalent figures are 45 mm ML for males and 65 mm ML for females (Mangold-Wirz, 1963a).

In the Mediterranean and the eastern Atlantic, mature males and females are found throughout the year, which suggests a continuous spawning period (Mangold-Wirz, 1963a; Guerra, 1992; Belcari, 1999a; Reid *et al.*, 2005). As a consequence of this, recruitment is virtually continuous, although alternating peaks and troughs have been observed in the Mediterranean (Bello, 1983–1984; Casali *et al.*, 1988; Volpi *et al.*, 1990; Jereb and Ragonese, 1991a; Würtz *et al.*, 1991; D'Onghia *et al.*, 1992; Ciavaglia and Manfredi, 2009), and two major peaks, one in spring–summer the other in late autumn–mid-winter, have been observed in the Gulf of Cádiz (eastern Atlantic; Ramos *et al.*, 2009).

In the Catalan Sea, spermatophore length ranges between 3.5 and 5.5 mm, depending on male size, and the maximum number of spermatophores found in a mature male has been 95. Mature, smooth eggs measure between 3.7 and 4.2 mm, depending on female size, and mature females carry up to 250 eggs (>1 mm) in their ovaries; however, as is normal for "large" eggs in cephalopods, only a proportion of the eggs reach maturity (Mangold-Wirz, 1963a). It is difficult to establish a correlation between the total number of smooth eggs in the ovary and the actual total number of smooth eggs produced by a female, because spawning is protracted; when captured, mature females may already have spawned a fraction of their smooth eggs. The maximum number of smooth eggs recorded in a mature female (of 62 mm ML) was 57 (Mangold-Wirz, 1963a). Total fecundity in females from the Gulf of Cádiz varied between 61 and 942 oocytes (in specimens of 34 and 64.2 mm ML, respectively).

## 7.6 Biological distribution

### 7.6.1 Habitat

*Sepia elegans* is a sublittoral species, living on sandy and sand-muddy bottoms. It has been found at various depths, from very shallow (e.g. 2 m in the Ría de Vigo, northwestern Spain, Guerra, 1985a; 6 m in the northern Tyrrhenia Sea, Belcari and Sartor, 1993; 12 m in the southern Tyrrhenian Sea, Bello *et al.*, 1994) down to 494 m (Jereb and Ragonese, 1991a). Records deeper than 450 m are sporadic (e.g. Jereb and Ragonese, 1991a; D'Onghia *et al.*, 1996; Lefkaditou *et al.*, 2003a; A. Moreno, pers. comm.), and most distributional ranges reported for the Mediterranean and the eastern Atlantic indicate maximum depths of <400 m (Adam, 1952; Mangold-Wirz, 1963a; Lumare, 1970; Guerra, 1985a, Sánchez, 1986a; Mannini and Volpi, 1989; Katağan and Kokatas, 1990; Würtz *et al.*, 1991; D'Onghia *et al.*, 1992; Belcari and Sartor, 1993; Bello *et al.*, 1994; González and Sánchez, 2002; Relini *et al.*, 2002; Massutí and Reñones, 2005).

It is the peculiar structure of the cuttlebone, which is small, narrow, with closely packed septa, and modified sutures (Ward, 1991), that allows *S. elegans* to reach these remarkable depths and to be among the deepest living *Sepia* species known. However, depths below the maximum recorded may be lethal for the species (Ward and Boletzky, 1984).

The depth ranges at which maximum concentrations of animals are found vary between areas and seasons (Mangold-Wirz, 1963a; Sánchez, 1986a; Restuccia and Ragonese, 1986; Jereb and Ragonese, 1991a; Würtz *et al.*, 1991; Sánchez *et al.*, 1998a; Belcari, 1999a; Colloca *et al.*, 2003). In addition, migrations can be related to reproduction (see below).

In the Sea of Marmara, the species has been found in brackish waters (salinity between 18 and 25; Ünsal *et al.*, 1999), but in northwestern Spain, it inhabits the outer and central basin of the Ría de Vigo (Guerra 1985a; Guerra and Castro, 1989), indicating a high degree of tolerance to salinity variation, although the species does not enter the internal basin of the Ría de Vigo, where there are marked fluctuations in salinity and temperature (Guerra and Castro, 1989). This indicates that *S. elegans* is a more stenohaline and stenothermic species than *S. officinalis*.

### 7.6.2 Migrations

A spring–summer migration of the whole population to coastal spawning grounds (40–70 m depth) has been described for the species in the western Mediterranean (Mangold-Wirz, 1963a; Guerra, 1992), and similar displacements have been observed in the Tyrrhenian Sea (off the Tuscany coast; Belcari, 1999a). However, this migratory pattern does not seem to be displayed in other areas, such as the Ría de Vigo (northwestern Spain; Guerra and Castro, 1989) or the Sicilian Channel (Jereb and Ragonese, 1991a), and both presence and absence of migration have been reported for the Adriatic Sea (Casali *et al.*, 1988; Ciavaglia and Manfredi, 2009).

## 7.7 Trophic ecology

### 7.7.1 Prey

The species feeds mainly on small crustaceans, fish, and polychaetes (Reid *et al.*, 2005) (Table 7.2). Detailed studies on feeding (e.g. Guerra, 1985b; Castro and Guerra, 1990) suggested that neither diet composition nor prey size varied with body size or maturity. No seasonal changes in diet were observed. However, Bello (1991a, 2006) reported differences in feeding habits between males and females; females eat significantly larger quantities of crabs (Brachyura) and shrimps (Palaemonidae) than males, and the average weight of the stomach contents is greater in females. In the Thermaikos Gulf, Greece, the species feeds mainly on crustaceans and secondarily on fish, and the trophic level is estimated to be 3.53 (Fryganiotis *et al.*, 2007).

**Table 7.2. Prey composition of *Sepia elegans*, as known from studies in the Northeast Atlantic and the eastern Mediterranean Sea (compiled from Guerra, 1985b[1]; Castro and Guerra, 1990[2]; Vafidis *et al.*, 2009[3]).**

| Taxon | Species |
|---|---|
| **Osteichthyes** | |
| Callionymidae | *Callionymus lyra* (dragonet)[2], |
| Gobiidae | *Aphia minuta* (transparent goby)[1], indet.[2], *Pomatoschistus pictus* (painted goby)[2] |
| **Crustacea** | |
| Decapoda | |
| Pleocyemata-Anomura | *Galathea intermedia*[2], *Porcellana platycheles*[2], *Pisidia longicornis*[1,2] |
| Pleocyemata-Brachyura | *Liocarcinus* spp.[1,2], *Polybius henslowii*[1], Portunidae indet.[2], indet.[3] |
| Pleocyemata-Caridea | *Crangon crangon*[1,2], Hippolytidae indet.[2], Majidae indet.[2], *Palaemon adspersus*[1,2], *P. serratus*[1], *Palaemon* spp.[2], Palaemonidae indet.[2], *Processa edulis*[2], indet.[3] |
| Euphausiacea | indet.[3] |
| Mysida | indet.[2] |
| Ostracoda | indet.[3] |
| Amphipoda | Caprellidea indet.[2], *Gammarus* spp.[1], Gammaridea indet.[2], indet.[3] |
| Isopoda | indet.[3] |
| **Cephalopoda** | indet.[3] |
| **Polychaeta** | indet.[2,3] |
| **Nemertea** | indet.[3] |
| **Cnidaria** | Hydrozoa indet.[3] |
| **Algae** | *Posidonia oceanica*[1], *Zostera marina*[1], indet.[1] |

### 7.7.2 Predators

*Sepia elegans* has been found in the stomachs of several fish species, including medium-sized hake (*Merluccius merluccius*) (18–44 cm) in the Gulf of Cádiz (Á. Torres, pers. comm.). It is also preyed upon by *S. officinalis* and *Loligo vulgaris* off the south coast of Portugal (Coelho *et al.*, 1997; Alves *et al.*, 2006) and is eaten by the bottlenose dolphin (*Tursiops truncatus)* in Spanish waters of the western Mediterranean Sea (Blanco *et al.*, 2001) (Table 7.3).

**Table 7.3. Known predators of *Sepia elegans* in the Mediterranean Sea and Northeast Atlantic.**

| Taxon | Species | References |
|---|---|---|
| Cephalopoda | Common cuttlefish (*Sepia officinalis*) | Alves *et al.* (2006) |
| | European squid (*Loligo vulgaris*) | Coelho *et al.* (1997) |
| Chondrichthyes | Lesser spotted dogfish (*Scyliorhinus canicula*) | Kabasakal (2002), Šantić *et al.* (2012) |
| | Bull ray (*Pteromylaeus bovinus*)<br>Marbled electric ray (*Torpedo marmorata*) | Capapé (1977)<br>Capapé *et al.* (2007) |
| | Thornback ray (*Raja clavata*) | Kabasakal (2002), Šantić *et al.* (2012) |
| Osteichthyes | Common dolphinfish (*Coryphaena hippurus*) | Massutí *et al.* (1998) |
| | European hake (*Merluccius merluccius*) | Á. Torres, pers. comm. |
| | Greater amberjack (*Seriola dumerili*) | Matallanas *et al.* (1995) |
| | John Dory (*Zeus faber*) | Silva (1999b) |
| Cetacea | Bottlenose dolphin (*Tursiops truncatus*) | Blanco *et al.* (2001) |

## 7.8 Other ecological aspects

### 7.8.1 Parasites

Females harbour a dense bacterial community in their accessory nidamental glands, in the lumina of these organs' tubules (Grigioni *et al.*, 2002), as observed in other sepiolids and myopsid squids. Information on the effects of this bacterial community on *S. elegans* physiology is lacking, although studies on bacterial presence in *S. officinalis* revealed correlations between sexual maturity, the colour of the gland, and the total number of bacteria (Van den Branden *et al.*, 1980). Parasites of *S. elegans* include *Aggregata* sp. and *Pennella* sp. (González *et al.*, 2003).

### 7.8.2 Contaminants

High levels of cadmium have been reported in the elegant cuttlefish (Bustamante *et al.*, 2002b), indicating that efficient detoxification mechanisms have been developed. The high bioavailability of cadmium in the digestive gland cells also indicates a high potential for the trophic transfer of the metal to predators of *S. elegans*. Studies on biochemical composition of tissues distinguished this species from others with a benthic lifestyle and indicated lower lipid and higher protein contents in the gonad (Rosa *et al.*, 2005a).

## 7.9 Fisheries

*Sepia elegans* is one of the most abundant cephalopod species in the Catalan Sea, Tyrrhenian Sea, Sicilian Channel, Adriatic Sea, Ionian Sea, and Aegean Sea (Mangold-Wirz, 1963a; Lumare, 1970; Mandić and Stjepcević, 1983; Panetta *et al.*, 1986; Sánchez, 1986a; Jereb and Ragonese, 1991a; Würtz *et al.*, 1991; Belcari and Sartor, 1993; D'Onghia *et al.*, 1996). It is taken mainly as bycatch in the Mediterranean and West African bottom otter-trawl fisheries. Other fishing gears that catch the species include beam trawls (Ünsal *et al.*, 1999) and fish traps (Belluscio and Ardizzone, 1990), and *S. elegans* represents a major fraction of discards in southern Portuguese coastal fisheries (Sendao *et al.*, 2002).

Separate landing statistics are not reported for this species, which, however, represents a significant percentage of the catches in some areas of its distributional range, where it is marketed fresh and frozen (Reid *et al.*, 2005). In the Mediterranean, it is marketed along with *S. orbignyana* and small *S. officinalis* and constitutes a valuable resource locally (Jereb and Ragonese, 1991a). In the Sicilian Channel, research estimated an exploitation rate of 0.73 for the species, which suggests intense fishing pressure on the resource (Ragonese and Jereb, 1991). In the Gulf of Cádiz in the eastern Atlantic, landings ranged between 30 and 110 t year$^{-1}$ in the period 1993–2008 (I. Sobrino, pers. comm.).

## 7.10 Future research, needs, and outlook

Of the three genera currently recognized within the family Sepiidae (see Khromov *et al.*, 1998, for a recent review), *Sepia* is the most speciose; more than 100 species have been described. However, many species are poorly known, and the systematics of the genus is not yet settled. Among the many questions still unresolved is the validity of the subdivision of the genus into six subgenera or "species complexes" (see Khromov *et al.*, 1998; see also the **Remarks** section). Further research is needed to clarify the systematics of the group and the position of this species within the group.

The species is an important resource in many areas of its distributional range and is subjected to intense fishing pressure in some areas. Detailed studies on its ecology might help preclude potential overexploitation, and separate recording of different cuttlefish species in landings should be encouraged.