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# The Teuthoidea (Cephalopoda, Mollusca) fauna of the Aegean Sea: comparison with the neighbouring seas and notes on their diet composition

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Sampling carried out at 47 stations in the Aegean Sea revealed the presence of 10 teuthoid species. A checklist of the Mediterranean and Black Sea teuthoid species, as well as their distribution in the Mediterranean territorial areas and the Black Sea, is presented. The comparison of the faunas of the Mediterranean territorial areas showed that the number of species decreases as follows: Western Mediterranean, Central Mediterranean, Aegean Sea, Adriatic Sea, Levantine Sea, while in the Black Sea no teuthoid species exist. Species with a cosmopolitan distribution dominate in all Mediterranean areas followed in numbers by the Atlanto-Mediterranean species. One species is characterized as a lessepsian migrant while no endemic species exist. The examination of the diet composition of the 10 teuthoid species showed that they mainly feed on Crustacea followed by Pisces.

**Keywords:** Teuthoidea, Aegean Sea, distribution, diet composition.

## INTRODUCTION

The existing information on the teuthofauna of the Aegean Sea is included in a limited number of focused papers (Vardala-Theodorou *et al.*, 1991; Lefkaditou *et al.*, 2000) and in papers which deal with the Aegean cephalopod fauna in general (Paspaleff, 1943; Digby, 1949; D'Onghia *et al.*, 1991, 1995; Katagan *et al.*, 1993; Salman *et al.*, 1997, 1999, 2002, 2003; Lefkaditou *et al.*, 1999, 2003a; Lefkaditou, 2007). Furthermore, some scattered information has been given in a number of broader studies (Athanassopoulos, 1917; Degner, 1926; Belloc, 1948; Kallianiotis *et al.*, 2000; Koutsoubas *et al.*, 2000; Machias *et al.*, 2001; Arvanitidis *et al.*, 2002b). According to the above information, the teuthofauna of the Aegean Sea (including the Sea of Marmara) consists of 22 species.

In respect to the diet composition of teuthoid species, there is only some scattered information which mainly concerns species living in the Atlantic or the Indo-Pacific Oceans (e.g., Mangold, 1983; Nixon, 1987; Hernández-Garcia, 1992; Hanlon & Messenger, 1996), or species with commercial interest such as loliginids and ommastrephids (e.g. Lipinski & Linkowski, 1988; Lordan *et al.*, 1998; Guerra, 1992; Pierce *et al.*, 1994; Rocha *et al.,* 1994; Rasero *et al.*, 1996; Sánchez *et al.*, 1998), while concerning the Mediterranean Sea, there are rather a few studies on certain teuthoid species (e.g., Sánchez, 1982; Hasan *et al.*, 1994; Quetglas *et al.,* 1999).

This paper aims to provide new information: i) on the teuthofauna of the Aegean Sea and to compare it with the corresponding ones of the neighbouring seas and (ii) on the diet composition of the teuthoid species collected in the Aegean Sea.

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## MATERIALS AND METHODS

A total of 318 teuthoid specimens collected from 47 stations located in the Aegean Sea (Fig. 1) was examined. The samples were obtained using fishing nets, bottom trawls, various types of traps and by free or SCUBA diving at depths of 5-1000 m. Mantle length (ML) and sex were determined for each specimen. The species identifications were mainly based on the keys given by Nesis (1987), Roper *et al.* (1984) and other recent relevant publications.

In order to study the diet composition of the collected teuthoid species, a total of 156 specimens belonging to 10 species were examined. The stomach contents of all examined individuals, was washed through a 125 μm sieve. All prey items were identified to the lowest possible taxonomic level, and counted. For the analysis of the data collected, the methods described by Hyslop (1980), Williams (1981) and Kelleher *et al.* (2000) were used and the following indices were calculated:

$$\text{Frequency of occurrence (F): } F = n\ 100/N_s$$

$$\text{Percentage of prey (N): } N = n'\ 100/N_p$$

where n = the number of stomachs containing a certain prey; $N_s$ = the total number of stomachs examined; n′ = the total number of individuals of a certain prey; $N_p$ = the total number of prey items. According to N values, prey categories were distinguished as preferential (N > 50%), secondary (10% < N < 50%) and accidental (N < 10%).

All specimens examined have been deposited at the Museum of the Department of Zoology, Aristotle University of Thessaloniki (MDZAUT).

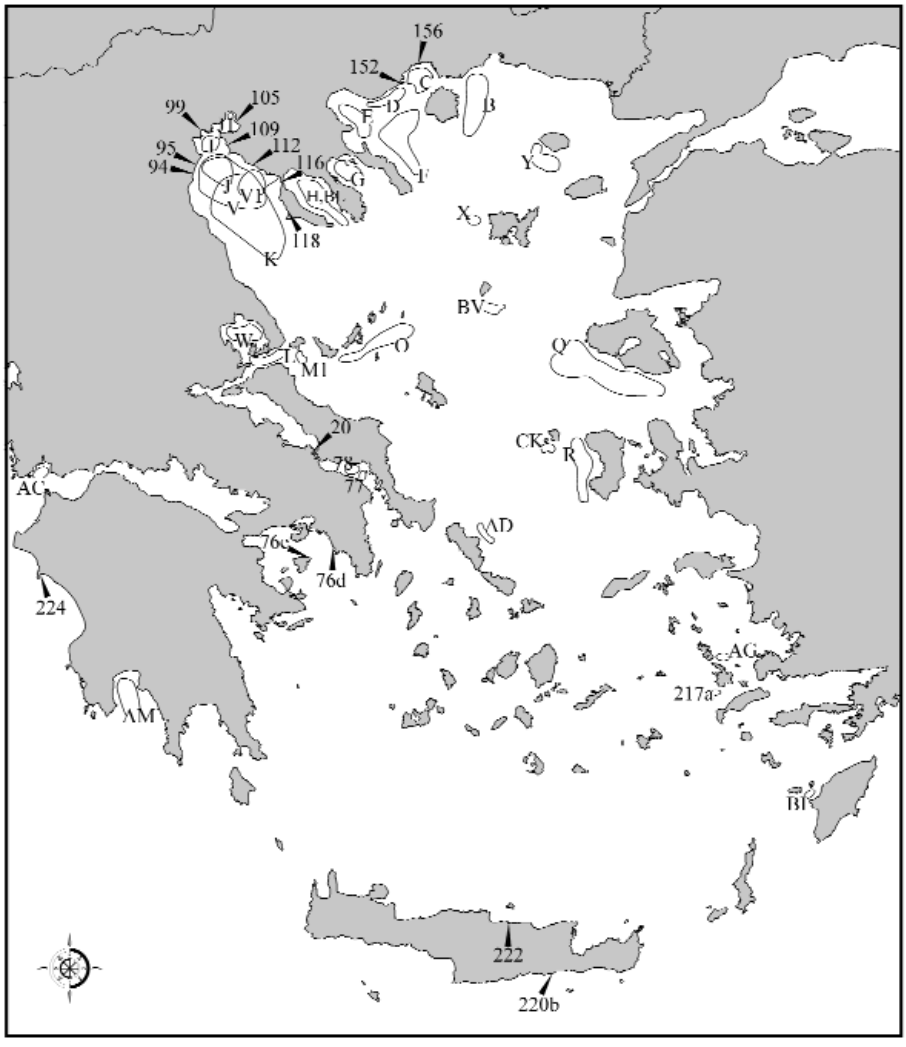


FIG. 1. Map of the Aegean Sea, indicating the sampling stations. The black arrows indicate locations where samplings were carried relatively close to the coast, with various methods.

## RESULTS

The 10 teuthoid species collected from the Aegean Sea during the present study along with the information on their distribution and diet composition are presented below. The taxonomic classification followed is that given by Jereb & Roper (2005) and Roper *et al.* (1984).

### Order TEUTHOIDEA Naef, 1916

### Suborder MYOPSIDA d'Orbigny, 1845

#### Family LOLIGINIDAE d'Orbigny, 1848

*Alloteuthis media* (Linnaeus, 1758)

Material examined: 35 ♂♂, 26 ♀♀, 26 juveniles (juv.): stations (stas.) 77, 78, 94, 217a, 222, AM, BL, C, D, E, H, J, J1, K, L, R, V, W and Y; depth 5-900 m; $ML_{max}$ ♂ = 64 mm, $ML_{max}$ ♀ = 140 mm.

Distribution: Very common species all over the Aegean (e.g., Paspaleff, 1943; Lefkaditou, 2007).

An Atlanto-Mediterranean species (Table 1), known from all over the Mediterranean and the Atlantic regions (e.g., Jatta, 1896; Bellini, 1929; Torchio, 1968; Bello, 1986, 1990; Salman *et al.*, 2002; Laptikhovsky *et al.*, 2002).

Diet composition: Prey categories found in the examined stomachs and their frequency of occurrence index (F) and prey percentage index (N) values are given in Table 2. The examination of 41 individuals (26 ♂♂, 15 ♀♀) showed that Crustacea was the most abundant and frequent prey category (F = 63.41%, N = 61.29%) followed by Pisces (F = 56.10%, N = 37.10%) (Table 2). Among Crustacea, Decapoda Natantia was the most dominant prey category (F = 56.10%, N = 37.10%).

*Loligo forbesi* Steenstrup, 1856

Material examined: 9 ♂♂, 7 ♀♀: stas. 78, 105, 112, 118, 224, AD, J, K, Q and V; depth 5-346 m; $ML_{max}$ ♂ = 200 mm, $ML_{max}$ ♀ = 170 mm.

Distribution: A species known from the north (Paspaleff, 1943; D'Onghia *et al.*, 1991, 1995; Salman *et al*., 1997; Salman & Laptikhovsky, 2002) and the south Aegean Sea (Lefkaditou *et al.*, 2003a).

An Atlanto-Mediterranean species (Table 1), known from all over the Mediterranean (e.g., Carus, 1889-1893; Jatta, 1896; Bellini, 1929; Bonnet, 1973; Soro & Piccinetti-Manfrin, 1989; Salman *et al.*, 1998) and the Atlantic regions (e.g., Arnold, 1979; Pereira *et al.*, 1998).

Diet composition: The stomach contents of ten individuals (4 ♂♂, 6 ♀♀) were examined. The most abundant and frequent prey category was Crustacea (F = 90.00%, N = 60.00%), while second in order was Pisces (F = 80.00%, N = 40.00%) (Table 2).

*Loligo vulgaris* Lamarck, 1798

Material examined: 16 ♂♂, 23 ♀♀: stas. 76d, 76e, 77, 94, 95, 99, 105, 109, 156, 220b, 222, 224, AC, E, H, I, J, J1, K, V and V1; depth 5-270 m; $ML_{max}$ ♂ = 170 mm, $ML_{max}$ ♀ = 216 mm.

Distribution: A species known from various areas in the Aegean Sea (e.g., Athanassopoulos, 1917; Lefkaditou *et al.*, 2003a).

A common Atlanto-Mediterranean species (Table 1), known from all over the Mediterranean and the Atlantic regions (e.g., Vèrany, 1851; Jatta, 1896; Adam, 1966; Bonnet, 1973; Nesis, 1987; Soro & Piccinetti-Manfrin, 1989; Sweeney & Roper, 1998).

Diet composition: The stomach contents of 25 (12 ♂♂, 13 ♀♀) individuals were examined. The most abundant prey category was Crustacea (F = 64.00%, N = 53.33%), while second in order was Pisces (F = 72.00%, N = 42.22%) (Table 2).

### Suborder OEGOPSIDA d'Orbigny, 1845

#### Family ENOPLOTEUTHIDAE Pfeffer, 1900

*Abralia veranyi* (Rüppell, 1844)

Material examined: 7 ♂♂, 40 ♀♀: stas. B, CK, F, M1, X; depth 30-1000 m; $ML_{max}$ ♂ = 40 mm, $ML_{max}$ ♀ = 46 mm.

Distribution: A species reported from both the south and the north Aegean Sea (D'Onghia *et al.*, 1991, 1995; Salman *et al.*, 1997; Lefkaditou *et al.*, 2003a).

An Atlanto-Mediterranean species (Table 1), known from all over the Mediterranean and the Atlantic regions (e.g., Bonnet, 1965; Adam, 1966; Berdar & Cavallaro, 1975; Morales & Guerra, 1977; Bello, 1990; Jereb & Ragonese, 1994).

Diet composition: The examination of the stomach contents of 11 individuals (5 ♂♂, 6 ♀♀) showed that Crustacea (F = 90.91%, N = 66.67%) was the most dominant prey category while Pisces (F = 45.45%, N = 23.81%) was the second prey category. Among Crustacea, Decapoda Natantia was the most dominant prey category (F = 81.82%, N = 42.86%) followed by Euphasiacea (F = 45.45%, N = 23.81%) (Table 2).

TABLE 1. Check list of the Mediterranean Teuthoidea and their distribution in certain geographical areas of the Mediterranean and the Black Seas, with reference to their presence in the Atlantic and Indo-Pacific Oceans

| Mediterranean species | WM | CM | AD | AS | LB | BS | AO | IP | ZC | VD (m) |
|---|---|---|---|---|---|---|---|---|---|---|
| **Loliginidae d'Orbigny, 1848** | | | | | | | | | | |
| *Alloteuthis media* (Linnaeus, 1758) | + | + | + | + | + | | + | | AM | 2-600 (5-900) |
| *Loligo forbesi* Steenstrup, 1856 | + | + | + | + | | | + | | AM | 50-600 (5-346) |
| *Loligo vulgaris* Lamarck, 1798 | + | + | + | + | + | | + | | AM | 2-500 (5-270) |
| *Sepioteuthis lessoniana* Lesson, 1830 | | | | | + | | | + | LM | 0 – 100 |
| **Enoploteuthidae Pfeffer, 1900** | | | | | | | | | | |
| *Abralia veranyi* (Rüppell, 1844) | + | + | + | + | + | | + | | AM | 47-800 (30-1000) |
| *Abraliopsis pfefferi* Joubin, 1896 | + | + | | + | + | | + | + | C | 66-800 |
| **Ancistrocheiridae Clarke, 1988** | | | | | | | | | | |
| *Ancistrocheirus lesueurii* (de Férussac & d'Orbigny, 1835) | + | | | + | | | + | + | C | 80-2000 |
| **Pyroteuthidae Clarke, 1988** | | | | | | | | | | |
| *Pterygioteuthis giardi* Fischer,1896 | + | | | | | | + | + | C | 5-500 |
| *Pyroteuthis margaritifera* (Rüppell, 1844) | + | + | | + | + | | + | + | C | 2606-4435 |
| **Octopoteuthidae Berry, 1912** | | | | | | | | | | |
| *Octopoteuthis sicula* Rüppell, 1844 | + | + | | + | + | | + | + | C | 100-1478 |
| *Taningia danae* Joubin, 1931 | + | | | | | | + | + | C | 55-900 |
| **Onychoteuthidae Gray, 1849** | | | | | | | | | | |
| *Ancistroteuthis lichtensteinii* (de Férussac & d'Orbigny, 1835) | + | + | + | + | | | + | + | C | 5-1271 |
| *Onychoteuthis banksii* (Leach, 1817) | + | + | + | + | + | | + | + | C | 5-800 |
| **Cycloteuthidae Naef, 1923** | | | | | | | | | | |
| *Cycloteuthis sirventi* Joubin, 1919 | + | | | | | | + | + | C | 750-810 |
| **Histioteuthidae Verill, 1881** | | | | | | | | | | |
| *Histioteuthis bonnellii* (de Férussac, 1835) | + | + | + | + | | | + | + | C | 107-3703 |
| *Histioteuthis corona* (Voss & Voss, 1962) | + | | | | | | + | + | C | 554- 830 |
| *Histioteuthis reversa* (Verrill, 1880) | + | + | + | + | | | + | + | C | 46-1766 (415-569) |

TABLE 1. continued

| Mediterranean species | WM | CM | AD | AS | LB | BS | AO | IP | ZC | VD (m) |
|---|---|---|---|---|---|---|---|---|---|---|
| **Ctenopterygidae Grimpe, 1922** | | | | | | | | | | |
| *Chtenopteryx sicula* (Vérany, 1851) | + | + | | + | + | | + | + | C | 46-1099 (121) |
| **Brachiotheuthidae Pfeffer, 1908** | | | | | | | | | | |
| *Brachioteuthis riisei* (Steenstrup, 1882) | + | + | + | + | + | | + | + | C | 5-3000 |
| **Ommastrephidae Steenstrup, 1857** | | | | | | | | | | |
| *Illex coindetii* (Vérany, 1839) | + | + | + | + | + | | + | | AM | 5-1000 (5-1000) |
| *Ommastrephes bartramii* (Lesueur, 1821) | + | + | + | + | | | + | + | C | 5-1500 |
| *Sthenoteuthis pteropus* (Steenstrup, 1855) | + | + | + | | | | + | + | C | 90-800 |
| *Todarodes sagittatus* (Lamarck, 1798) | + | + | + | + | + | | + | | AM | 0-1000 (30-415) |
| *Todaropsis eblanae* (Ball, 1841) | + | + | + | + | + | | + | + | C | 20-700 (5-1000) |
| **Thysanoteuthidae Keferstein, 1866** | | | | | | | | | | |
| *Thysanoteuthis rhombus* Troschel, 1857 | + | + | | + | | | + | + | C | 5-650 |
| **Chiroteuthidae Gray, 1849** | | | | | | | | | | |
| *Chiroteuthis picteti* Joubin, 1894 | + | | | | | | + | + | C | 750-950 |
| *Chiroteuthis veranyi* (de Férussac, 1835) | + | + | + | + | + | | + | + | C | 107-840 |
| **Cranchiidae Prosch, 1849** | | | | | | | | | | |
| *Bathothauma lyromma* Chun, 1906 | + | | | | | | + | + | C | 200-1125 |
| *Cranchia scabra* Leach, 1817 | + | | | | | | + | + | C | 200-900 |
| *Galiteuthis armata* Joubin, 1898 | + | + | + | | + | | + | + | C | 750-2208 |
| *Megalocranchia speculator* (Chun, 1906) | + | | | | | | + | + | C | 5-2000 |
| *Teuthowenia megalops* (Prosch, 1847) | + | | | | | | + | | AM | 46-1000 |
| Total number of species: 32 | 31 | 21 | 16 | 20 | 15 | 0 | | | | |

WM = Western Mediterranean, CM = Central Mediterranean, AD = Adriatic Sea, LB = Levantine Basin, AS = Aegean Sea (including the Sea of Marmara), BS = Black Sea, AO = Atlantic Ocean, IP = Indo-Pacific Ocean (Red Sea). Zoogeographical characterisation (ZC): AM, Atlanto-Mediterranean; C, Cosmopolitan species; LM, Lessepsian migrants. VD = Vertical distribution according to the literature; in parenthesis, the authors data

Family HISTIOTEUTHIDAE Verrill, 1881

*Histioteuthis reversa* (Verrill, 1880)

Material examined: 3 ♂♂: stas. M1, X; depth 415-569 m; $ML_{max}$ ♂ = 75 mm.

Distribution: A species known from the north and the south Aegean Sea (D'Onghia *et al.*, 1991, 1995; Lefkaditou *et al.*, 1999, 2003a; Salman *et al.*, 2003).

A cosmopolitan species (Table 1) known from all over the Mediterranean (except the Levantine basin) and the Atlantic and Pacific oceans (e.g., Vèrany, 1851; Torchio, 1965, 1968; Voss, 1969; Berdar *et al.*, 1983; Mangold & Boletzky, 1988 as *Histioteuthis elongata*; Bello, 1990; Voss *et al.*, 1998).

Diet composition: The stomach contents of the 3 individuals were examined. Four prey categories were identified: Decapoda Natantia (2 prey items), Euphausiacea (1 prey item), Chaetognatha (1 prey item) and Pisces (2 prey items).

Remarks: Voss *et al.* (1998) considered that *Histioteuthis elongata* (Voss & Voss, 1962) is the mature stage of *Histioteuthis reversa*.

Family CHTENOPTERYGIDAE Grimpe, 1922

*Chtenopteryx sicula* (Vérany, 1851)

Material examined: 1 ♂: sta. BV; depth 121 m; ML = 30 mm.

Distribution: A species recently found in the northeastern Aegean Sea (Salman *et al.*, 2003) and in the south Aegean Sea (Lefkaditou *et al.*, 2003a).

A cosmopolitan species (Table 1) known from the Western and Central Mediterranean (e.g., Torchio, 1966; Mangold-Wirz, 1973; Jereb & Ragonese, 1994), from the Levantine Basin (e.g., Degner, 1926; Adam, 1966) and the Atlantic and Pacific oceans (e.g., Okutani, 1973; Morales & Guerra, 1977).

Diet composition: During the analysis of the stomach content of the collected individual, 3 prey categories were found, all belonging to Crustacea: Decapoda Natantia (2 prey items), followed by Euphasiacea and Mysidacea (1 prey item for each).

Family OMMASTREPHIDAE Steenstrup, 1857

*Illex coindetii* (Vérany, 1839)

Material examined: 36 ♂♂, 49 ♀♀: stas. 20, 77, 95, 99, 105, 109, 156, 222, AG, BI, C, E, F, G, H, I, J, J1, K, O, Q, R, V and W; depth 5-1000 m; $ML_{max}$ ♂ = 145 mm, $ML_{max}$ ♀ = 194 mm.

Distribution: A common species known from various areas of the Aegean Sea (e.g., Degner, 1926; Salman *et al.*, 2003).

An Atlanto-Mediterranean species (Table 1) known from all over the Mediterranean and Atlantic regions (e.g., Jatta, 1896; Adam, 1966; Bello, 1990; D'Onghia *et al.*, 1995; Pereira *et al.*, 1998).

Diet composition: The stomach contents of 49 individuals (28 ♂♂, 21 ♀♀) were examined. Crustacea (F = 69.39%, N = 49.46%) was the most dominant prey category, followed by Pisces (F = 85.71%, N = 47.31%), Mollusca Cephalopoda (F = 4.08%, N = 2.15%) and Tunicata (F = 2.04%, N = 1.08%) (Table 2).

*Ommastrephes bartramii* (Lesueur, 1821)

Material examined: 1 ♀: sta. 116; depth: unknown (washed ashore); ML = 608 mm.

Distribution: A species found only in the south Aegean Sea, particularly around Rhodes Island and in the north Aegean Sea from the northern Turkish Aegean coasts (Katagan *et al.*, 1992) and the Izmir Bay (Akyol & Şen, 2004).

A cosmopolitan species (Table 1) known from the Western Mediterranean (e.g., Torchio, 1966), the Adriatic Sea (e.g., Jatta, 1896), the Central Mediterranean (e.g., Jereb & Ragonese, 1994) and the Atlantic and Pacific oceans (e.g., Clarke, 1966; Okutani, 1973).

Diet composition: Mysidacea (Crustacea), Cephalopoda (Mollusca) and Pisces were represented in the examined stomach with one prey item each.

Remarks: According to Dunning (1998), the largest female caught in the southwest Pacific had 610 mm ML and the largest male caught in the same region had a 400 mm ML. Akyol & Şen (2004) caught a female individual with 550 mm ML from the Izmir Bay (north Aegean Sea). The individual examined in the present study was washed ashore in the Potidaia beach (Thermaikos Gulf) on March 2004 and its mantle length was 608 mm.

*Todarodes sagittatus* (Lamarck, 1798)

Material examined: 1 ♂, 2 ♀♀: stas. H, K and M1; depth 30-415 m; $ML_{max}$ ♂ = 221 mm, $ML_{max}$ ♀ = 205 mm.

Distribution: A species known from various areas of the Aegean Sea (e.g., Belloc, 1948; Lefkaditou *et al.*, 2003a).

An Atlanto-Mediterranean species (Table 1) found in all Mediterranean and several Atlantic regions (e.g., Jatta, 1896; Bellini, 1929; Bello, 1990; Hernández-García, 1992; D'Onghia *et al.*, 1995; Salman *et al.*, 1998).

TABLE 2. Prey categories found in the stomachs of individuals in all examined species

| Species | *Abralia veranyi* | | *Alloteuthis media* | | *Illex coindetii* | | *Loligo forbesi* | | *Loligo vulgaris* | | *Todaropsis eblanae* | | **All species** | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Prey category | Ns = 11 | | Ns = 41 | | Ns = 49 | | Ns = 10 | | Ns = 25 | | Ns = 12 | | Ns = 148 | |
| | F | N | F | N | F | N | F | N | F | N | F | N | F | N |
| **Crustacea** | **90.91** | **66.67** | **63.41** | **61.29** | **69.39** | **49.46** | **90.00** | **60.00** | **64.00** | **53.33** | **50.00** | **40.91** | **68.24** | **56.32** |
| Amphipoda | – | – | 9.76 | 6.45 | 6.12 | 3.23 | 10.00 | 5.00 | 8.00 | 4.44 | – | – | 6.76 | 3.47 |
| Copepoda | – | – | 2.44 | 1.61 | – | – | – | – | – | – | – | – | 0.68 | 0.38 |
| Decapoda | | | | | | | | | | | | | | |
| Natantia | 81.82 | 42.86 | 56.10 | 37.10 | 55.10 | 29.03 | 90.00 | 45.00 | 64.00 | 40.00 | 50.00 | 31.82 | 60.81 | 36.02 |
| Brachyura | – | – | 4.88 | 3.23 | – | – | – | – | – | – | – | – | 1.35 | 0.77 |
| Euphausiacea | 45.45 | 23.81 | 7.32 | 4.84 | 22.45 | 11.83 | – | – | – | – | 8.33 | 4.55 | 13.51 | 7.60 |
| Mysidacea | – | – | 12.20 | 8.06 | 10.20 | 5.38 | 20.00 | 10.00 | 16.00 | 8.89 | 8.33 | 4.55 | 10.81 | 6.13 |
| Tanaidacea | – | – | – | – | – | – | – | – | – | – | – | – | 0.68 | 0.38 |
| | | | – | | | | | | | | | | | |
| **Pisces** | **45.45** | **23.81** | **56.10** | **37.10** | **85.71** | **47.31** | **80.00** | **40.00** | **72.00** | **42.22** | **91.67** | **59.09** | **72.30** | **41.00** |
| | | | | | | | | | | | | | | |
| **Others** | | | | | | | | | | | | | **5.41** | **2.68** |
| Cnidaria Hydrozoa | – | – | 2.44 | 1.61 | – | – | – | – | – | – | – | – | 0.68 | 0.38 |
| Mollusca Cephalopoda | 9.09 | 4.76 | – | – | 4.08 | 2.15 | – | – | – | – | – | – | 1.35 | 0.77 |
| Polychaeta | 9.09 | 4.76 | – | – | – | – | – | – | 8.00 | 4.44 | – | – | 2.03 | 1.15 |
| Tunicata | – | – | – | – | 2.04 | 1.08 | – | – | – | – | – | – | 0.68 | 0.38 |

Ns = total number of stomachs examined; F = frequency of occurrence index; N = percentage of prey index

Diet composition: Crustacea and Pisces were represented in all 3 examined stomachs (3 prey items each). Crustacea consisted of 4 prey categories: Decapoda Natantia (2 prey items), Amphipoda (1 prey item), Euphasiacea (1 prey item) and Tanaidacea (family Tanaideae, with 1 prey item). One prey item belonging to Polychaeta was also found in one of the examined stomachs.

*Todaropsis eblanae* (Ball, 1841)

Material examined: 18 ♂♂, 18 ♀♀: stas. 105, 152, BL, F, H, K and V; depth 5-1000 m; $ML_{max}$ ♂ = 144 mm, $ML_{max}$ ♀ = 128 mm.

Distribution: It has been known from various areas in the Aegean Sea (e.g., D'Onghia *et al.*, 1991; Lefkaditou *et al.*, 2003a).

A cosmopolitan species (Table 1) known from all the Mediterranean regions (e.g., Morales, 1958; Torchio, 1966; Ruby & Knudsen, 1972; Bello, 1990), and the Atlantic and Indian Oceans (e.g., Arnold, 1979; Nesis, 1987).

Diet composition: The stomach contents of 12 individuals (8 ♂♂, 4 ♀♀) were examined. Pisces (F = 91.67%, N = 59.09%) was the most dominant prey category. Crustacea (F = 50.00%, N = 40.91%) was the second most dominant prey category. Among Crustacea, Decapoda Natantia (F = 50.00%, N = 31.82%) was the most dominant category followed by Euphausiacea (F = 8.33%, N = 4.55%) and Mysidacea (F = 8.33%, N = 4.55%).

The distribution of Teuthoidea species in the main geographical areas of the Mediterranean is given in Fig. 2, while the teuthoid fauna composition in the Mediterranean regarding the zoogeographical characterization of the species is given in Fig. 3. The percentages of the three zoogeographical categories in the Mediterranean territorial are given in Fig. 4.

In Table 2, the prey categories found in the stomachs of all the examined teuthoid species, as well as the frequency of occurrence index (F) and prey percentage index (N) values for each prey category of each species (where possible), are given. Crustacea (F = 68.24%, N = 56.32%) was the most dominant prey category and can be characterized as preferential prey, while Pisces (F = 72.30%, N = 41.00%) was the second most dominant prey and can be characterised as secondary prey. Among Crustacea, Decapoda Natantia (F = 60.81%, N = 36.02%) was the most dominant prey category. Euphasiacea was second (F = 13.51%,

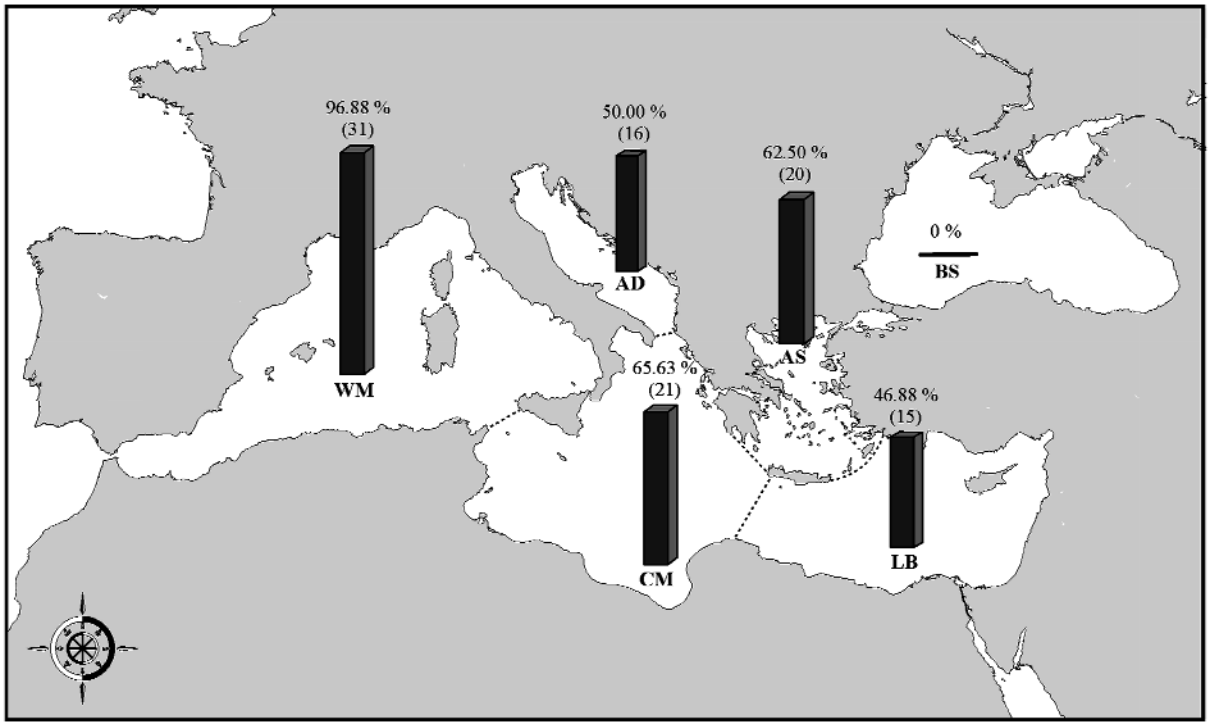


FIG. 2. Distribution of the known species of Teuthoidea in the main geographical areas of the Mediterranean and the Black Seas, as numbers and percentages of the total Mediterranean species number (abbreviations as in Table 1).

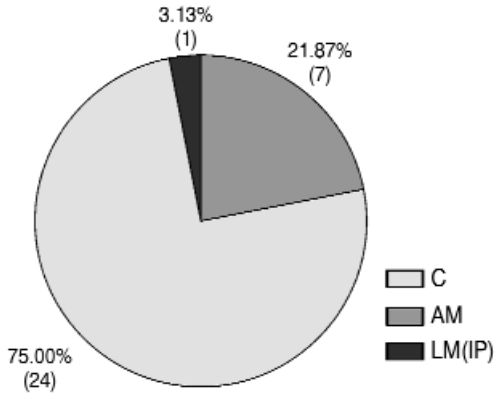


FIG. 3. Teuthoid fauna composition in the Mediterranean Sea (percentages and numbers), regarding the zoogeographical characterization of the species (abbreviations as in Table 1).

N = 7.60%), followed by Mysidacea (F = 10.81%, N = 6.13%) and Amphipoda (F = 6.76%, N = 3.47%), while Decapoda Brachyura, Tanaidacea and Copepoda were participating in very low percentages. Cephalopoda, Polychaeta Annelida, Tunicata and Cnidaria Hydrozoa were the least frequent and abundant prey categories participating with very low percentages in the diet composition of the teuthoids (F = 5.41%, N = 2.68%).

## DISCUSSION

### *Aegean Sea fauna*

In this study 10 species of Teuthoidea were found and studied, one of which belongs to the genus *Alloteuthis*: *A. media* (Linnaeus, 1758). However, the species *A. subulata* has been also reported from the Aegean Sea. Furthermore, Anderson (1996) (cited in Laptikhovsky *et al.*, 2002), using cladistic analysis showed that all three *Alloteuthis* species are taxonomic equivalents. Laptikhovsky *et al.* (2002) also noted that the distinction of the Mediterranean species *A. media* and *A. subulata* is impossible and they considered that both species are probably intraspecific forms.

Except for the 10 species found in the present study, 10 more species of Teuthoidea are known from the Aegean Sea (Table 1): *Abraliopsis pfefferi* Joubin, 1896 (Degner, 1926); *Ancistrocheirus lesueurii* (de Férrusac & d'Orbigny, 1835) (Lefkaditou *et al.*, 1999; Salman et al., 2002); *Pyroteuthis margaritifera* (Rüppell, 1844) (D'Onghia *et al.*, 1995; Lefkaditou *et al.*, 1999; Salman *et al.*, 2003); *Octopoteuthis sicula* (Rüppell, 1844) (Salman *et al.*, 2002; Lefkaditou *et al.*, 2003a), *Onychoteuthis banksii* (Leach, 1817) (Degner, 1926); *Ancistroteuthis lichtensteinii* (de Férrusac &

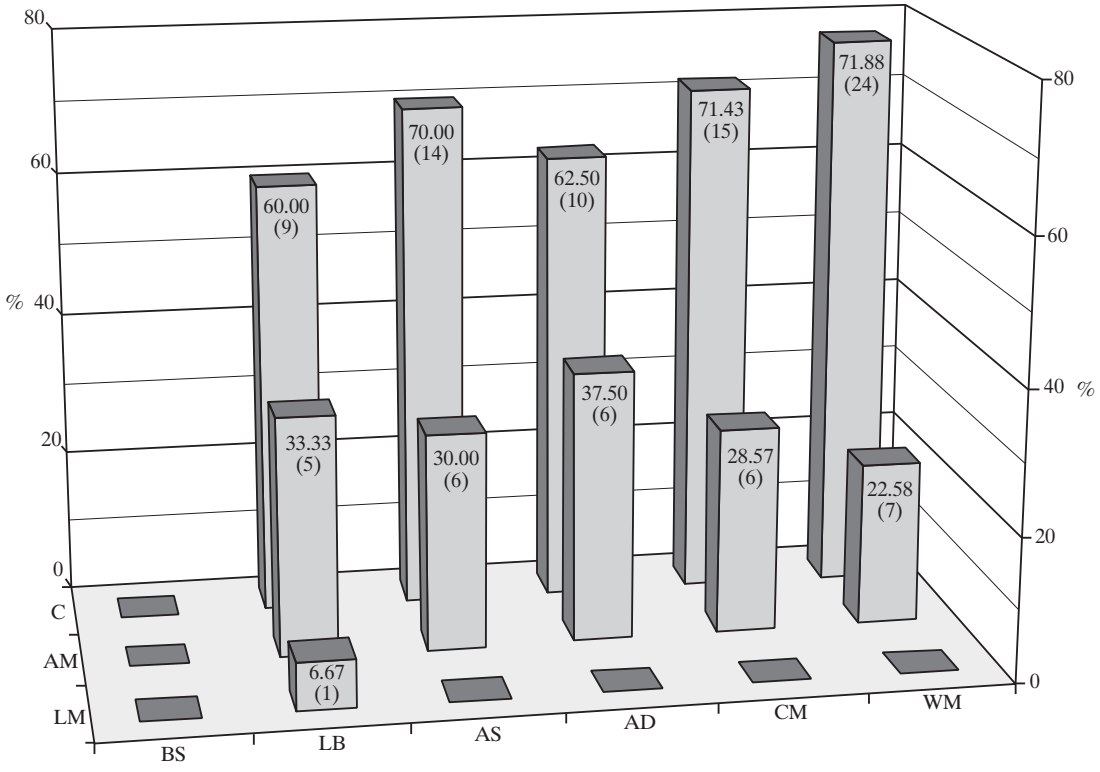


FIG. 4. Percentages of the three zoogeographical categories in the Mediterranean territorial and the Black Sea; calculations have been made for the total of species known from each area (abbreviations as in Table 1).

d'Orbigny, 1835) (Salman *et al.*, 2002); *Histioteuthis bonnellii* (de Férussac, 1835) (Salman *et al.*, 2003); *Brachioteuthis riisei* (Steenstrup, 1882) (Lefkaditou *et al.*, 2000; Salman *et al.*, 2003); *Thysanoteuthis rhombus* Troschel, 1857 (Vardala-Theodorou *et al.*, 1991; Salman *et al.*, 2003); *Chiroteuthis veranyi* (de Férussac, 1835) (Degner, 1926; Lefkaditou *et al.*, 1999; Salman *et al.*, 2003).

Except from the 10 above species, Salman *et al.* (1999, 2002) have also reported the species *Octopoteuthis megaptera* (Verrill, 1885) from the Aegean Sea based on a specimen collected near Bodrum. However, this sample should be probably considered an adult form of *Octopoteuthis sicula* (Rüppell, 1844). Lefkaditou agrees with this view, since she considers this certain specimen collected by Salman *et al.* (1999) as identical with the specimen of *O. sicula* she collected from Myrtoan Sea, Southern Aegean Sea (Lefkaditou *et al.*, 2003a).

Thus, the Teuthoidea fauna of the Aegean Sea numbers 20 species.

*Comparison of the Aegean fauna with those of the neighbouring seas*

Torchio (1968), based on literature information, numbered 29 Mediterranean species of Teuthoidea, while Mangold & Boletzky (1988) reviewing the Mediterranean cephalopod fauna recorded 27 teuthoid species. Bello (2003) recorded 30 species of Teuthoidea.

The review of the relevant literature showed that, up to day, 32 valid species of Teuthoidea are known from the Mediterranean Sea. Their distribution in the certain territorial areas of the Mediterranean Sea and the Black Sea and the Atlantic and the Indo-Pacific Oceans, according to the literature, is given in Table 1 and Fig. 2.

**Western Mediterranean (WM)**: 31 species, 96.88% of the known Mediterranean fauna (e.g., Jatta, 1896; Morales, 1958; Bonnet, 1965; Roper *et al.*, 1998). In the Western Mediterranean, *Sepioteuthis lessoniana* has not been reported due to its Indo-Pacific origin and the fact that this species is considered as a Lessepsian migrant. The highest number of teuthoid species in the western basin of Mediterranean should be attributed to the fact that the influx of Atlantic species is initially limited in this large basin, which has a wide range of physico-chemical parameters and permits the settlement of both cold and warm water species in its northern and southern parts respectively (Koukouras *et al.*, 2001, 2007; Koukouras & Karachle, 2005).

**Central Mediterranean (CM)**: 21 species, 65.63% of the known Mediterranean fauna (e.g., Berdar *et al.*, 1983; Tursi *et al.*, 1994; Lefkaditou *et al.*, 2003b). Central Mediterranean comes second in teuthoid species number. This should mainly be attributed to its direct neighbouring with the Western Mediterranean, the pelagic mode of life of this group, as well as to the satisfactory sampling effort carried out in this area.

**Adriatic Sea (AD)**: 16 species, 50.00% of the known Mediterranean fauna (e.g., Torchio, 1968; Bello, 1990). The Adriatic (Table 1, Fig. 2), although intensively sampled, displays a relatively low species number. This should probably be attributed to: (a) its considerably restricted communication with the western basin (Ovchinnikov, 1966; Theocharis *et al.*, 1993), (b) the smaller amplitude of temperature variations (e.g., Delépine *et al.*, 1987) and (c) the shallow waters of its northern part with relatively low winter temperatures and low salinity (e.g., Lacombe & Tchernia, 1960).

**Aegean Sea (AS)**: 20 species, 62.50% of the known Mediterranean fauna (e.g., Degner, 1926; Salman *et al.*, 1997; Lefkaditou *et al.*, 2003a). Although Aegean Sea is more distant from Gibraltar (the main pathway of enrichment for the Mediterranean fauna) than the Adriatic, it is inhabited by a larger number of species. The main reasons for the higher species number in the Aegean could be: (a) its more direct communication with the western basin (e.g., Ovchinnikov, 1966) and (b) the greater amplitude of the temperature variations (e.g., Delépine *et al.*, 1987) and (c) the variable topography and the presence of areas with high biological productivity (Valavanis *et al.*, 2004) which favors the distribution of pelagic squids that distributed at open seawaters and are known to be significantly correlated with hydrographic regimes (e.g., Coehlo, 1995; Arvanitidis *et al.*, 2002b).

**Levantine Basin (LB)**: 15 species, 46.88% of the known Mediterranean fauna (e.g., Rees, 1955; Demetropoulos, 1969; Salman *et al.*, 2002). The lowest species number of the Levantine Basin, in comparison with those of other Mediterranean areas should be probably attributed to its impoverished fauna (Por & Dimentman, 1989; Koukouras & Russo, 1991; Koukouras *et al.*, 2001; Arvanitidis *et al.*, 2002a), as well as to the less intensive sampling effort carried out in the area.

**Black Sea (BS)**: No cephalopods are known from the Black Sea. A record of *Illex coindetii* in this area

(Roper *et al.*, 1984) is based on an error according to Mangold & Boletzky (1988). The absence of teuthoid and cephalopod species in general, in the Black Sea is a result of the peculiar oceanographic conditions prevailing in the area, especially the low salinities and temperatures and the abiotic conditions in its deeper layers (Caspers, 1957; Mangold & Boletzky, 1988; Longhurst, 1998).

As it can be seen from Fig. 3, most species have a cosmopolitan distribution, while few are Atlanto-Mediterranean and only one species is a Lessepsian migrant. The absence of Mediterranean endemic species should be probably attributed to the fact that the Teuthoidea are nectonic organisms and most of them live in mid-waters throughout their life cycle (Mangold & Boletzky, 1988), therefore presenting a wide geographic distribution within the temperate and subtropical/tropical zones.

From Fig. 4 it is obvious that, as it was also demonstrated for the entire Mediterranean Sea, in each Mediterranean area separately, cosmopolitan species dominate, followed by Atlanto-Mediterranean species. Furthermore in each Mediterranean region, the numbers of species of each zoogeographical category seem to decline from the west to the east. The above considerations are also supported by the views of Mangold & Boletzky (1988), Koukouras *et al.* (2001) and Arvanitidis *et al*. (2002a).

The teuthoids have a wide vertical distribution (Table 1). Most of the species are eurybathic living from the surface down to more than 1000 m depth.

*Teuthoidea diet composition*

Information on the feeding habits of certain species of Teuthoidea has been given by various authors (e.g., Lordan *et al.*, 1998; Rasero *et al.*, 1996; Quetglas *et al.*, 1999). However there is no information for all the species of this group. In this paper, aggregate information on the feeding habits of the Teuthoidea fauna of the Aegean Sea is given for the first time.

The results of this study show that in all teuthoid species, the most preferable prey category is Crustacea, followed by Pisces, except for *Todaropsis eblanae* where Pisces was the dominant prey category, followed by Crustacea. In the relevant literature, it has been reported that teuthoids feed on crustaceans in early life stages whereas fish and cephalopods are preferential preys in the subsequent stages (e.g., Mangold, 1983; Nixon, 1987; Sauer & Lipinski, 1991; Pierce *et al.*, 1994; Rodhouse & Nigmatullin, 1996; Lordan *et al.*, 1998; Sánchez *et al.*, 1998). Furthermore, *Illex coindetii* young, immature squids show a higher proportion of euphasiids in their diet, a fact that indicating a major relationship with the pelagic domain, while adult squids are more closely associated to the sea bottom at least during the day, as indicated by the presence in the stomach of prey like benthic amphipods, other cephalopods and fish inhabiting sandy and muddy bottoms (Castro & Hernández-García, 1995). By contrast, Quetglas *et al.* (1998, 1999) showed that the juveniles of *Todarodes sagittatus* populations in the Balearic Sea (Western Mediterranean) feed mainly on fishes while adults prey more actively on crustaceans. The present study shows that Crustacea were found in almost all examined stomachs of individuals with mantle lengths between 29 and 608 mm, followed by Pisces. The wide variety of prey categories in the teuthoid diet revealed in this study confirms the general aspect that cephalopods (including Teuthoidea) are voracious predators that feed on a wide variety of live preys (Mangold, 1983; Nixon, 1987; Rodhouse & Nigmatullin, 1996).

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