



The presence of *Chaetozone corona* (Polychaeta: Cirratulidae) in the Mediterranean Sea: an alien or a native species?

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Abstract: The re-examination of specimens previously reported as *Chaetozone setosa* or *Chaetozone* sp. from Izmir Bay and its vicinity (Aegean Sea, eastern Mediterranean) showed that these specimens belonged to a species new to the Mediterranean fauna, *Chaetozone corona*. This species was previously reported from the coasts of southern California (type locality) and western Atlantic (Brazil). It was only found at stations where the environment was more or less degraded due to high loads of organic matter from Izmir city and tuna-fish farms. As it was widely distributed in the area and existed among material collected in 1980 in Izmir Bay, it is not certain if this is an alien or native species. At this stage, its status should be considered as cryptogenic. To give a reliable conclusion, previous reports of *C. setosa* as a pollution indicator species in the Mediterranean dating from 1927, should be re-examined. The present study provides more information on the morphology, ecology and reproduction of *C. corona*.

Résumé : La présence de *Chaetozone corona* (Polychaeta : Cirratulidae) en Mer Méditerranée : une espèce indigène ou introduite ? Le réexamen de spécimens précédemment signalés comme *Chaetozone setosa* ou *Chaetozone* sp. du golfe d'Izmir et alentour (Mer Égée, bassin méditerranéen oriental) a prouvé que ces spécimens appartiennent à l'espèce *Chaetozone corona*, nouvelle pour la faune méditerranéenne. Cette espèce a été précédemment signalée des côtes de la Californie méridionale (localité type) et de l'Océan atlantique occidental (Brésil). Cette espèce a seulement été récoltée aux stations où l'environnement est plus ou moins dégradé en raison des rejets importants de matière organique de la ville d'Izmir et des activités d'élevage de thon rouge. Cette espèce étant largement distribuée dans le secteur et présente au sein de matériels récoltés en 1980 dans le golfe d'Izmir, il est difficile de dire si l'espèce est introduite ou indigène. A ce stade, son statut devrait être considéré comme cryptique. Pour obtenir une conclusion fiable, des signalements anciens de *C. setosa* en tant qu'espèce indicatrice de pollution, datés de 1927 en Méditerranée, devraient être examinés de nouveau. La présente étude fournit plus d'informations sur la morphologie, l'écologie et la reproduction de la *C. corona*.

Keywords: *Chaetozone corona* • Cirratulidae • Cirratulid • Polychaeta • Eastern Mediterranean Sea • Aegean Sea • Alien species • Turkey

Introduction

The family Cirratulidae Ryckholdt, 1851 comprises 11 genera and 159 species worldwide (Beesley et al., 2000) and 10 genera and 21 species in the Mediterranean Sea (authors' database). The genus *Chaetozone* Malmgren, 1867 is represented by three species in the Mediterranean; *Chaetozone caputesocis* (Saint-Joseph, 1894), *C. setosa* Malmgren, 1867 and *C. gibber* Woodham & Chambers, 1994. *Chaetozone setosa* has frequently been reported from semi-polluted sediments of the Mediterranean Sea and has therefore been widely used as a pollution-indicator species in pollution monitoring studies (Ergen, 1992; Zenetos et al. 1994; Simboura et al., 1995; Borja et al., 2000; Simboura & Zenetos, 2002; Solis-Weiss et al., 2004).

Of the 21 species of cirratulids reported from the Mediterranean, four species are considered to be alien; *Cirriformia semicineta* (Ehlers, 1905), *Timarete dasylophius* (Marenzeller, 1879), *Timarete anchylochaeta* (Schmarda, 1861) and *Monticellina dorsobranchialis* (Kirkegaard, 1959). Of these species, *C. semicineta* was reported only from the coast of Lebanon (Laubier, 1966; Bitar & Kouli-Bitar, 2001), *T. dasylophius* only from the Sea of Marmara (Rullier, 1963), *T. anchylochaeta* from both the Sea of Marmara (Rullier, 1963) and the coast of Lebanon (Laubier, 1966; Bitar & Kouli-Bitar, 2001), and *M. dorsobranchialis* from the eastern (Harmelin, 1969) and western (Gusso et al., 2001) Mediterranean Sea. However, due to the lack of adequate descriptions of these species based on Mediterranean material and the broad distribution range of the latter species (type locality: eastern Atlantic coast), Çinar et al. (2005) and Zenetos et al. (2005) regarded the occurrence of *C. semicineta*, *T. dasylophius* and *T. anchylochaeta* in the Mediterranean questionable and excluded *M. dorsobranchialis* from the list of alien species for the Mediterranean Sea. Consequently, no established alien cirratulid species occur in the Mediterranean, whereas 53 established and casual alien species in other families of polychaetes have been reported there (Zenetos et al., 2005).

The re-examination of benthic material collected from the Aegean Sea during pollution monitoring studies revealed a cirratulid species new to the Mediterranean fauna, *Chaetozone corona* Berkeley & Berkeley, 1941.

The present study aims to re-describe this species based on the eastern Mediterranean material and to give its bio-ecological features in the area.

Material and Methods

Specimens of *Chaetozone corona* were collected between 2.5 and 50 m depths from Ildiri, Gerence, Izmir and Nemrut Bays located on the Turkish Aegean coast (Fig. 1). An anchor dredge and a Van Veen grab were used to collect benthic samples at 8 stations. On board the ship, the samples were washed through a 0.5 mm mesh sieve and fixed with a 5% formaldehyde solution. In the laboratory, materials were sorted under a stereomicroscope and specimens identified to species or genus level.

The specimens previously identified as *Chaetozone setosa* or *Chaetozone* sp. in the area were re-examined and re-identified as *Chaetozone corona*. The length of the largest specimens and the width on chaetiger 10 were measured using an ocular micrometer. Two specimens of *C. corona*, collected near the type locality (off San Diego, California) and deposited at the Zoological Museum of Copenhagen (ZMUC), were examined and compared with the specimens collected from the Aegean Sea.

The photographs of *Chaetozone corona* were taken with a digital camera (Olympus, Camedia, C-7070) attached to stereo and compound microscopes.

The specimens are deposited at Ege Üniversitesi Su Ürünleri Fakültesi Müzesi (ESFM), Izmir, Turkey.

Results and Discussion

A total of 37 specimens of *Chaetozone corona* were found in the area. A description of the species and its bio-ecological features are as follows.

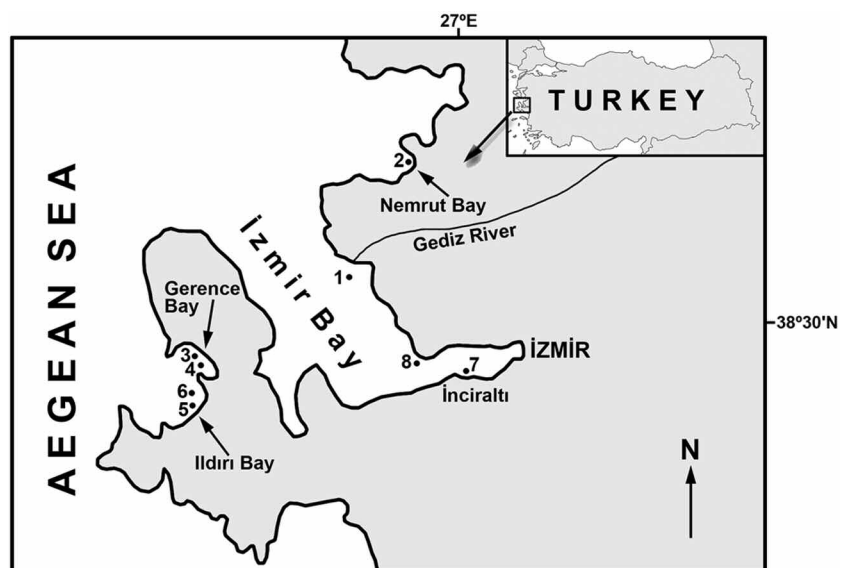


Figure 1. Location of the investigated area and the sampling sites.

Figure 1. Carte de la région étudiée et stations d'échantillonnage.

Chaetozone corona Berkeley & Berkeley, 1941
(Figs 2, 3 & 4)

Chaetozone spinosa corona Berkeley and Berkeley, 1941: 45-46.

Chaetozone corona: Hartman, 1960: 125; 1961: 109-110; 1969: 235, figs. 1-3; Blake, 1996: 285-287, fig. 8.6.

Material examined

ESFM-POL/80-8, 17.1.1980, Izmir Bay, sta. 1, 38°25'58"N-26°56'54"E, dredge, sandy mud, 15 m, 2 individuals; ESFM-POL/99-35, 27.5.1999, Izmir Bay, sta. 8, 38°25'58"N-26°56'54"E, grab, mud, 2.5 m, 2 individuals; ESFM-POL/01-104, 4.10.2001, Nemrut Bay, sta. 2, 36°45'9"N-26°56'1"E, grab, sandy mud, 15 m, 13 individuals; ESFM-POL/03-301, 3.6.2003, Gerence Bay, sta. 3, 38°27'23"N-26°27'33"E, dredge, sandy mud, 47 m, 1 individual; ESFM-POL/03-275, 2.7.2003, Izmir Bay, Inciralti, sta. 7, 38°24'54"N-27°02'23"E, grab, sandy mud with shell fragments, 9 m, 1 individual; ESFM-POL/04-561, 16.9.2004, Inciralti, Izmir Bay, sta.7, 38°24'54"N-27°02'23"E, grab, sandy mud with shell fragments, 9 m, 9 individuals; ESFM-POL/04-909, 27.5.2004, Ildiri Bay, 38°23'50"N-26°27'00"E, sta. 5, dredge, *Posidonia oceanica*, 17 m, 1 individual; ESFM-POL/04-126, 15.1.2004, Izmir Bay, Inciralti, 38°24'54"N-27°02'23"E, sta. 7, grab, sandy mud with shell fragments, 9 m, 1 specimen; ESFM-POL/04-780, 29.6.2004, Izmir Bay, Inciralti, 38°24'54"N-27°02'23"E, sta. 7, sandy mud with shell fragments, 9 m, 5 specimens; ESFM-POL/05-499, 1.12.2005, Gerence Bay, 38°27'10"N-26°28'31"E, sta. 4, dredge, sandy mud, 50 m, 1 individual; ESFM-POL/05-500, 3.6.2005, Ildiri Bay, 38°23'45"N-26°28'20"E, sta. 6, dredge, *Posidonia oceanica*, 15 m, 1 individual.

Additional material examined

ZMUC-POL-1856, 13.10.1983, off San Diego, California, 32°39'98"N-117°16'27"W station A-11, 4.5 m, coll. City of San Diego Quality Group, 2 specimens (largest one complete, 16.5 mm long, 2 mm wide, with 62 chaetigers).

Description

Largest specimen (ESFM-POL/01-104) complete, posteriorly regenerating, 19.5 mm long, 1.8 mm wide, with 62 chaetigers (Fig. 2A). Body pinkish cream-coloured due to dense eggs in coelomic cavity. Other specimens, without gametes, pale brownish; dorsal side of prostomium, dorsal, lateral and ventral sides of peristomium, and ventral side of chaetiger 1 (rarely chaetiger 2) of some specimens with black irregular speckles (Figs 2B, C & 3). Branchiae pale yellow to white, dorsal tentacles brownish. Body thickened, somewhat cylindrical anteriorly, then becoming slightly

compressed posteriorly. A longitudinal groove (which may be an artifact of fixation) present on ventral surface of some specimens.

Prostomium directed anteriorly, triangular in shape, with blunt tip; with a pair of black eyes laterally (Figs 2B, C & 3). Peristomium with one large anterior and 2 shorter posterior rings, dorsally inflated, extending as a median ridge or crest to anterior side of chaetiger 1; dorsal tentacles attached between peristomium and chaetiger 1 (Fig. 2C). Parapodia dorsally elevated, with small parapodial lamellae bearing noto- and neurochaetae. First pair of branchiae emerging on posterior-lateral sides of dorsal tentacles; subsequent branchiae arising from posterior edge of parapodia; branchiae present on all chaetigers, except for chaetigers in regenerated part. Notopodia on chaetiger 1 bearing only 14 capillary chaetae; capillary chaetae almost 580 µm long; with fine fibrils along one edge (Fig. 4). Neuropodia on chaetiger 1 with 12 capillary chaetae and 2 spines; capillary chaetae similar to those on notopodia; spines pale yellow, slightly curved with bluntly pointed tips. Capillary chaetae increasing in length up to chaetigers 20-25, reaching 1700 µm long; then gradually shortening towards posterior end (maximum 430 µm long); capillary chaetae on posterior parapodia thinner and smooth, without fibrils. Spines on notopodia first present from chaetiger 5. However, specimens (ESFM-POL/05-499 and ESFM-POL/04-780) with spines first appeared on both noto- and neuropodia of chaetiger 1 (Fig. 4). Notopodia of chaetiger 10 with 10 capillaries and 4 spines; neuropodia of chaetiger 10 with 10 capillaries and 5 spines. Spines increasing in size and darkening towards posterior end; pale yellow on anterior parapodia vs. amber coloured on posterior parapodia. In middle part of body (chaetiger 30) notopodia with 6 capillaries and 4 spines; neuropodia with 5 capillaries and 5 spines (Fig. 4). Posterior segments with noto- and neuropodial spines together form partial cinctures; notopodia with 5 capillaries and 6 spines; neuropodia with 5 capillaries and 8 spines (Fig. 4). Chaetal arrangements varying between body regions and specimens; for example chaetae arranged as one capillary and one spine in middle parapodia (Fig. 4), whereas two or three capillaries between spines in posterior parapodia (Fig. 4). Number of capillary chaetae and spines varying between specimens; maximally 6 spines on posterior neuropodia in specimens smaller than 12 mm long. Pygidium as long as two posterior-most segments, with blunt tip; anus in dorsal position (Fig. 4).

Reproduction

The largest specimen (ESFM-POL/01-104) had mature oocytes in the coelomic cavity; diameter ± S.E. (Standard error) = 104.8 ± 0.99 µm, range: 95-110 µm (n = 20). Blake (1996) and Petersen (1999) reported the diameter of oocytes of specimens collected from southern California to

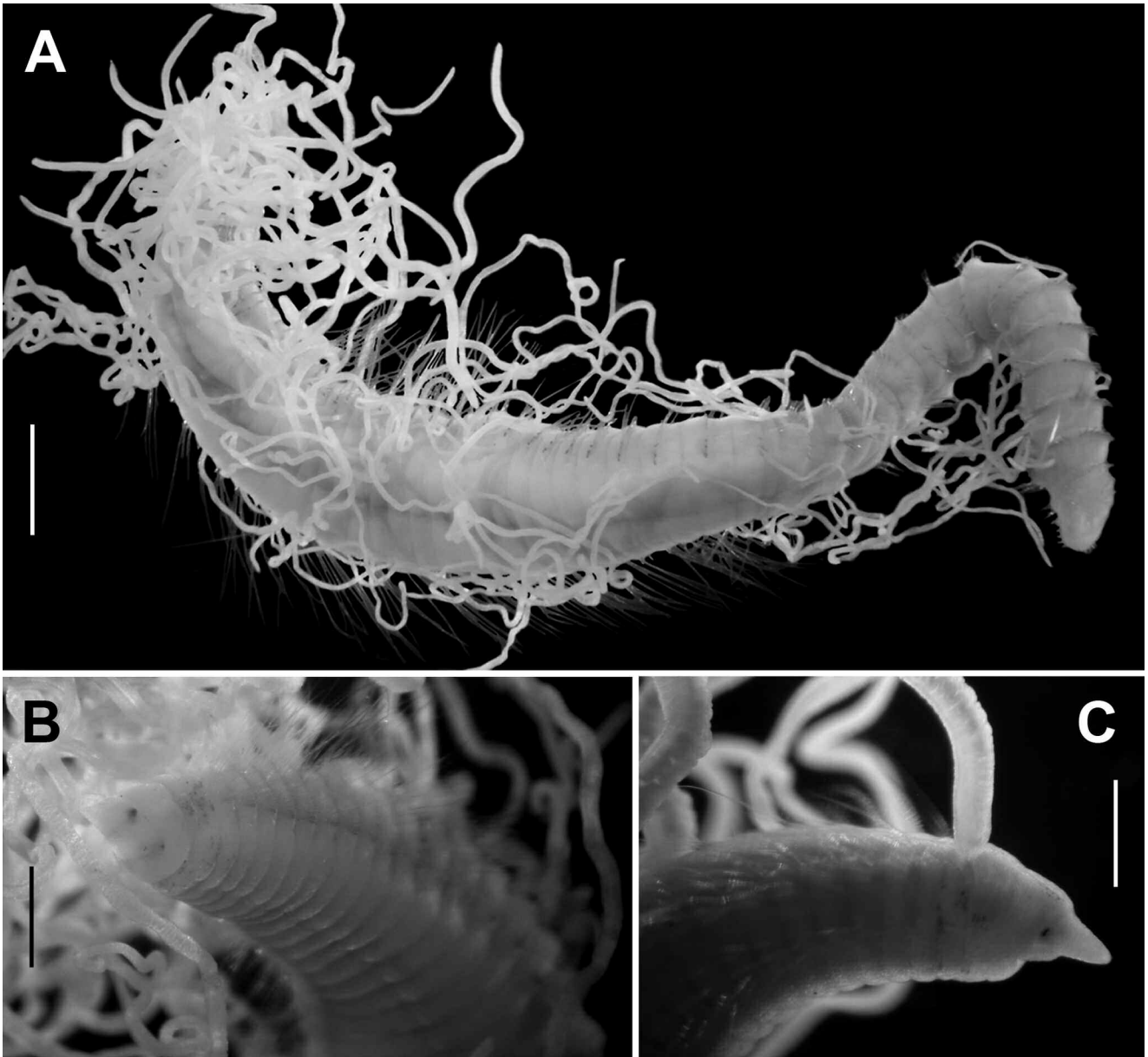


Figure 2. *Chaetozone corona*. **A.** Body, dorsal view (ESFM-POL/01-104). **B.** Anterior end, ventro-lateral view (ESFM-POL/01-104). **C.** Anterior end, lateral view, indicating the placement of the dorsal tentacle (ESFM-POL/04-909). Scale bars: A = 1.8 mm, B = 1 mm and C = 0.5 mm.

Figure 2. *Chaetozone corona*. **A.** Corps, vue dorsale (ESFM-POL/01-104); **B.** Extrémité antérieure, vue ventro-latérale (ESFM-POL/01-104). **C.** Extrémité antérieure, vue latérale, témoin de l'insertion de la tentacule dorsale (ESFM-POL/04-909). Échelle : A = 1,8 mm, B = 1 mm and C = 0,5 mm.

be 75 μ m. The difference in egg sizes between the two populations could be due to the fact that the specimens possess the eggs at different developmental stages.

Remarks

Morphological features of the Mediterranean *Chaetozone corona* specimens were similar to those of the original and subsequent descriptions of *C. corona* by Berkeley &

Berkeley (1941), Hartman (1969) and Blake (1996). However, Blake (1996) stated that capillaries of *C. corona* are thin and lack serrations or wings. This is true for capillaries on posterior parapodia of the specimens in the present study, but anterior capillaries have minute fibrils on one edge. However, these fibrils could be an artifact, resulting from damage of capillaries. Some anterior capillaries without fibrils can support this assumption. The

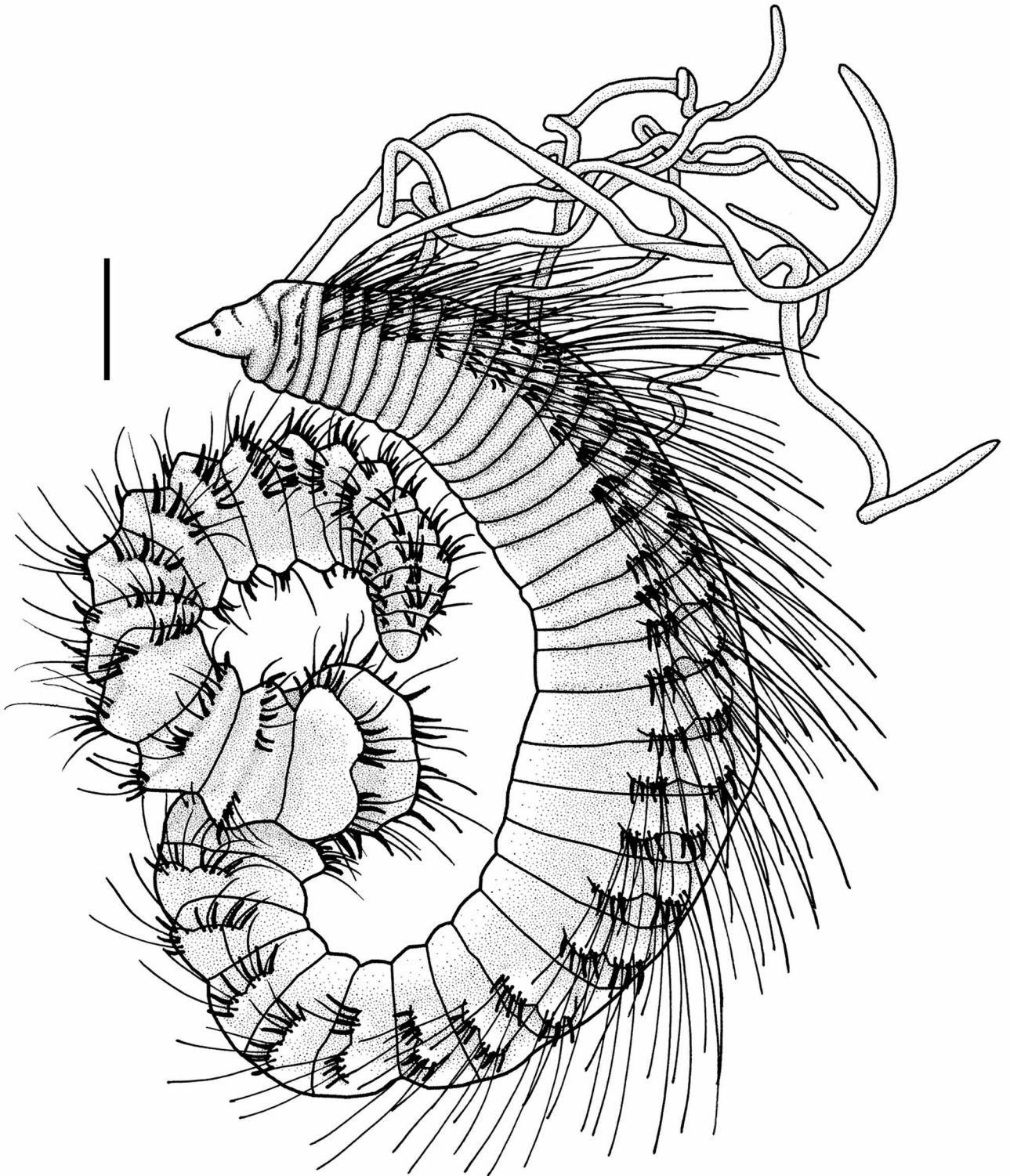


Figure 3. *Chaetozone corona*. Whole body, lateral view (ESFM-POL/05-499). Scale bars: 0.5 mm.
Figure 3. *Chaetozone corona*. Corps entier, vue latérale (ESFM-POL/01-104). Échelle : 0,5 mm.

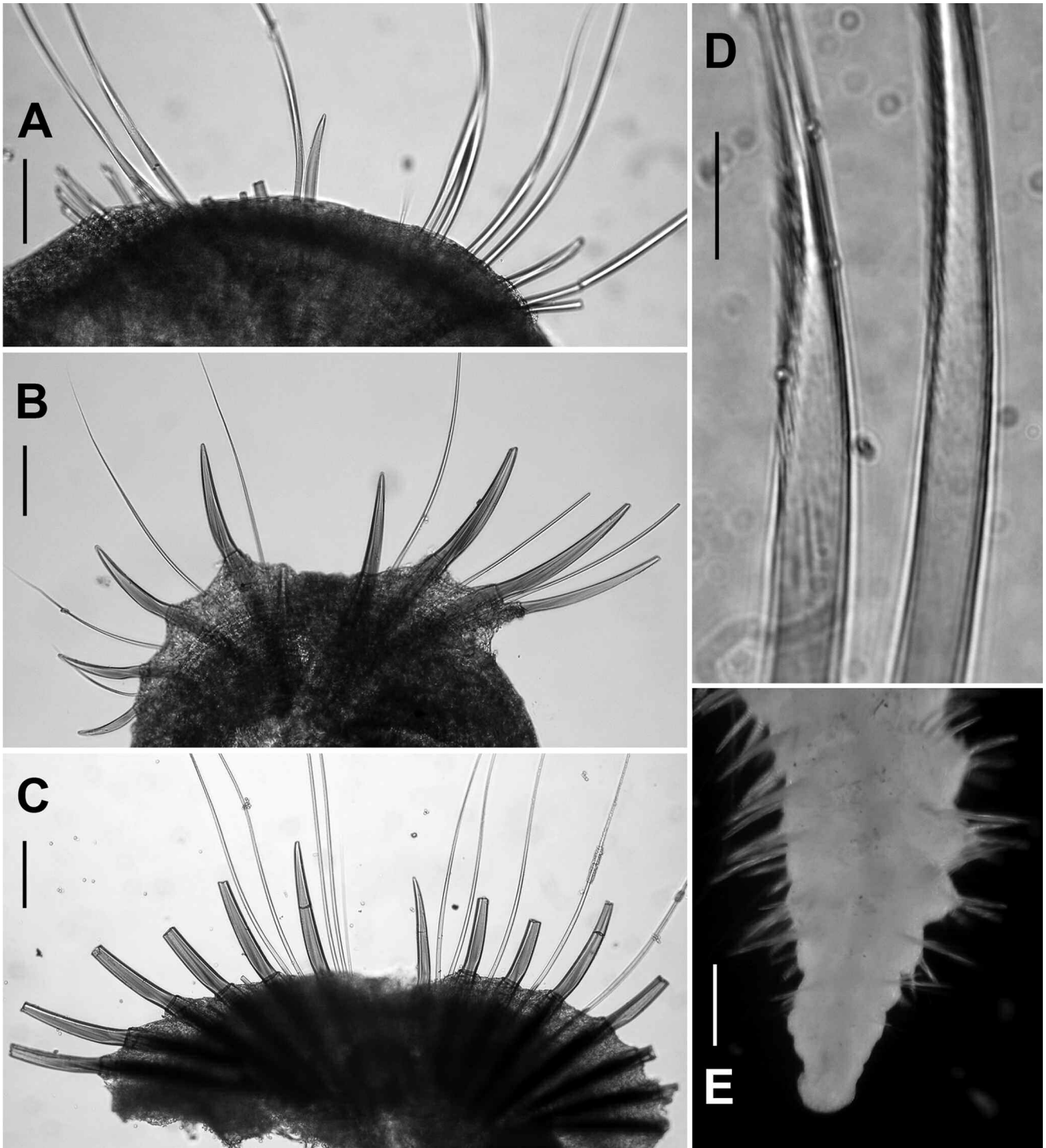


Figure 4. *Chaetozone corona*. **A.** Anterior parapodium (chaetiger 1) (ESFM-POL/04-780). **B.** Middle parapodium (chaetiger 30) (ESFM-POL/04-780). **C.** Posterior parapodium (chaetiger 50) (ESFM-POL/01-104). **D.** Capillary chaetae on chaetiger 1 with fine fibrils along one edge (ESFM-POL/04-780). **E.** Posterior part and pygidium, dorsal view (ESFM-POL/05-499). Scale bars: A = 75 μ m, B = 90 μ m, C = 120 μ m, D = 20 μ m and E = 200 μ m.

Figure 4. *Chaetozone corona*. **A.** Parapode antérieur (sétigère 1) (ESFM-POL/04-780). **B.** Parapode moyen (sétigère 30) (ESFM-POL/04-780). **C.** Parapode postérieur (sétigère 50) (ESFM-POL/01-104). **D.** Soies capillaires sur un parapode antérieur avec les fibrilles fines le long d'un bord (ESFM-POL/04-780). **E.** Partie postérieure et pygidium, vue dorsale (ESFM-POL/05-499). Échelle : A = 75 μ m, B = 90 μ m, C = 120 μ m, D = 20 μ m and E = 200 μ m.

size of worms between two distant populations of *C. corona* are similar; 18-25 mm long with 50-60 chaetigers in southern California (Hartman, 1969), 19.5 mm (posteriorly regenerating) with 62 chaetigers in the Mediterranean Sea (this study).

Chaetozone corona is mainly characterized by having a pair of eyes, pointed prostomium, long capillaries in the anterior region and neuropodial spines first appearing on chaetiger 1. In the Mediterranean the other *Chaetozone* species with eyes are *C. gibber* and *C. caputesocis* but they have neuropodial spines that first appear on chaetigers 90 and 10, respectively. *Chaetozone setosa* was frequently reported from the polluted soft substrate of the Mediterranean Sea (Ergen, 1992; Zenetos et al., 1994; Simboura et al., 1995; Borja et al., 2000; Simboura & Zenetos, 2002; Solis-Weiss et al., 2004). However, *C. setosa* is now widely recognized to be a species complex and is mainly characterized by the absence of eyes and first appearance of neuropodial spines on chaetiger 40 (Chambers, 2000).

Ecology

Chaetozone corona was previously reported from fine mud, silt, coarse sand and mud between 0 and 119 m off southern California (Berkeley & Berkeley, 1941; Hartman, 1960, 1961 & 1969; Blake, 1996); on *Halodule wrightii* Ascherson between 1 and 3 m off southeast Brazil (Atlantic Ocean) (Omena & Creed, 2004). This species was found on sandy mud and *Posidonia oceanica* (L.) Delile between 2.5 and 50 m depth in the Aegean Sea. The common feature between stations in the Aegean Sea where *C. corona* was found is that all stations had a semi-polluted environment. Benthic samples were taken near a tuna fish farm in Gerence and Ildiri Bays. Although the area near the farm was partly covered with *P. oceanica* beds, a phanerogame sensitive to high loads of organic matter, the presence of opportunistic species such as *Capitella capitata* (Fabricius, 1780) and *Prionospio fallax* Söderstrom, 1920 together with pollution sensitive organisms such as syllids showed that the area was partly disturbed. In Izmir Bay, specimens of *C. corona* were found at stations near the mouth of the polluted Gediz River (see Ergen et al., 2002) and near Inciralti, which is near the pollution discharge points and Alsancak Harbour (Çinar et al., 2006). Çinar et al. (2006) found this species only at the station near Inciralti, but it was absent from stations near Alsancak Harbour and the inner-most part of Izmir Bay, which were highly polluted.

Knowledge about the density and biomass of *Chaetozone corona* is lacking. In Izmir Bay, the density and biomass (wet weight) of *C. corona* varied from 10 ind.m⁻² and 0.084 g.m⁻² (winter 2004 at station 7) to 70 ind.m⁻² and 0.56 g.m⁻² (spring 2004 at station 7). As this species was previously confused with *C. setosa* in the Mediterranean Sea, the density score

given for *C. setosa* in the Mediterranean might indicate the population size of *C. corona* in the area; up to 430 ind.m⁻² in July 1989 in Izmir Bay (unpublished list, Ergen, 1992), up to 3060 ind. m⁻² in June 1989 in Saronikos Gulf (Greece) and up to 140 ind.m⁻² in April 1991 in Faliro Bay (Greece) (Zenetos et al., 1994). However, one should keep in the mind that the reports of *C. setosa* in the Mediterranean might have been of two or three different species.

Distribution

Chaetozone corona was previously reported from the eastern Pacific (off southern California, western Mexico and Gulf of California) (Blake, 1996) and the western Atlantic Oceans (off Brazil) (Omena & Creed, 2004). The present study extends its distributional range to the Mediterranean Sea. The re-examination of specimens which were collected from Izmir Bay in 1980 and identified as *Chaetozona setosa* revealed that the specimens are *C. corona*. This indicates that this species has been present in the area for a long time. As it occurred on semi-polluted soft sediments, the reports of *C. setosa* in the Mediterranean Sea, which were found in the same environment, should be checked. The re-examination of material collected from polluted sediments in Izmir Bay indicated that *C. setosa* does not occur in the area but the two other species of *Chaetozone*, namely *C. gibber* and *C. corona*, do occur. As *C. corona* is widely distributed in the area and had been misidentified as *C. setosa*, it is not possible to establish if this species is alien to the Mediterranean. Specimens of *Chaetozone* species previously reported from semi-polluted sediments from the Mediterranean Sea should be re-examined. The presence of *C. setosa* in the Mediterranean dates back to 1927 (Fauvel, 1927), before *C. corona* was described. The description of *C. setosa* by Fauvel (1927) shows that his specimens do not belong to *C. corona* as his specimens lacked eyes. However, Chambers (2000) postulated that the part of the specimens that Fauvel identified as *C. setosa* belonged to other species. Therefore, the Fauvel's material of *C. setosa* in fact has a mixture of species. At this stage, we are not certain if Fauvel's material had specimens of *C. corona* or not, his material, if it still exists, should be re-examined.

The presence of *Chaetozone corona* only in the polluted environments of the Mediterranean, which are more susceptible to bioinvasions than pristine sites, particularly via ballast waters (Koçak et al., 1999; Occhipinti Ambrogi & Savini, 2003; Çinar et al., 2006), suggests that it might have been introduced to the Mediterranean from the eastern Pacific (off southern California). However, the taxonomic confusion still existing on the genera *Chaetozone* in the Mediterranean hinders us to give a conclusive judgment, so its status should be considered as cryptogenic (i.e. species with no definite evidence of their native or introduced status) at this stage.

Acknowledgments

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