

Turbanella amphiatlantica, a new species of Gastrotricha (Macrodasyida) from eastern North America and northwest Europe

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Abstract

A new species, *Turbanella amphiatlantica* n. sp. is described, which has collection locations on both sides of the Atlantic Ocean, in both the mid-Atlantic and northeastern United States and in both the British Isles and northwestern Europe. The descriptive materials include three independent drawings and five MPEG videos. Preliminary salinity tolerance experiments indicate a very high degree of euryosmotic capabilities, as do the estuarine and marine conditions under which it has been found. We consider to be *T. amphiatlantica* several instances of specimens provisionally identified as other species, e.g. *Turbanella mustela* or *T. otti*, leaving the published distributions of these two species as originally described, namely the eastern Pacific Ocean and the upper Adriatic Sea, respectively.

Keywords: Meiofauna, Benthos, Systematics, North America, Europe, British Isles, Turbanellidae, new species

Introduction

There are several species of *Turbanella* which give appearances of distributions on both sides of the Atlantic Ocean. They include: *T. ambronensis* Remane, 1943, *T. bocqueti* Kaplan, 1957 sensu Boaden, 1974, *T. cornuta* Remane, 1924, *T. hyalina* Schulze, 1857 and now *T. amphiatlantica* n. sp., but not, as we argue, *T. mustela* Wieser, 1957. Their locations are summarized in Hummon (2009), but see also d'Hondt (1971), Hummon (1997) and Todaro et al. (2008). All of these species are intertidal, sometimes shallow subtidal, and hence are expected to be euryosmotic over a wide range of salinities. *T. amphiatlantica* n. sp. was first found by Hum-

mon in the state of New York (1967), then a little later by Hummon on the west coast of Scotland and the Isle of Man (1977), in Massachusetts by Ellis, in Virginia by Ruppert and western France also by Ruppert (ca. 1976). Subsequently it was found commonly in Maryland (1996) by Hummon and Kelly. Independent drawings were made of specimens from New York, Massachusetts and Scotland, with videos from an estuary in Maryland. One of the questions we address is whether *T. mustela*, which has been provisionally reported from both sides of the Atlantic, actually occurs outside the eastern Pacific, or were the identifications made from the morphologically most likely known species, given the pool then known in the

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genus. A similar question is whether *T. otti*, which was provisionally reported from northern Ireland, actually occurs outside the upper Adriatic Sea.

Materials and Methods

Our collection and observation procedures are most fully given in Hummon (2008). They consist of whole-beach transects from low to high water, with 6–10 sampling sites taken for each transect and 3–10 sampling depths taken to ground water depths per site. Samples were insulated and kept at 10–15 °C until faunistic analysis could be completed, usually within a week. Specimens were observed using a Nikon Lab-Phot II, fitted with DIC optics for objective magnifications of 40× and 63× oil. Drawings of *Turbanella amphiatlantica* n. sp. were made using a drawing tube or its equivalent, with dorsal and ventral views being mirror images of one another. Videos were completed using a Dage-MTI CCD72 camera with primary image enhancement and recorded on SVHS tapes, later to be digitized and converted to MPEG-2 videos.

Abbreviations and conventions: Morphological symbols and conventions are as follows: L, length; W, width; H, height; Lt, length, total, from anterior tip of head to posterior tip of caudum and its adhesive tubes; LPh, length, pharynx from anterior tip of head to PhJIn; PhJIn, junction between pharynx and intestine; TbA/TbL/TbD/TbV/TbP, adhesive tubes of the anterior, lateral, dorsal, ventral, and posterior (caudal) group; U, percentage units of Lt from anterior to posterior. Columns: longitudinal in orientation, rows: transverse in orientation. The caret ^ refers to a type locality; latitude and longitude are given only for the type locality; locations and dates of collection for other localities can be found in the Global Data Base (Hummon 2009).

Sediment analyses were done by wet sieving about 100 milliliters (ml) of sediment through a series of 8 centimeter (cm) diameter sieves at 1 Phi intervals from 2 millimeter (mm) to 62 micrometer (µm) openings. Fractions were dried, weighed and the results plotted as curves that were fitted using probability paper, and the 16, 50 and 84 percent levels read to yield size and sorting. Results are part of a database of 1000 plus sediments, the textual summary of which is included in Hummon 2009, with standardized photos of sediments in

Petri dishes available on CD.

Procedures for determining Incipient Somatic Lethal Limits (Lethal Concentration of salinity under which 50 % mortality occurred over 24 hours = $LC_{50/24}$) of *T. amphiatlantica* n. sp. were conducted following acclimatization for three days at two temperatures, 24 and 12 °C, and at one salinity, 12 parts per thousand (ppt). Test conditions were more restricted than those reported in Hummon (1975a,b) owing to the moderate numbers of specimens with which we had to work and the limited number of constant temperature chambers that were available. Tests were conducted at the same two temperatures (24 °C and 12 °C) and a range of salinities (0.5, 1.0, 2.0, 36, 40, 46 and 48 ppt), with 10 and 8 animals per test, respectively, at the higher and lower temperatures. Lower salinities were created by serially diluting seawater of 30 ppt to desired concentrations with distilled water, higher salinities by partially freezing seawater to achieve a pool of 60 ppt water and then serially diluting to desired concentrations above 30 ppt; salinities were measured using an Atago S-10 hand refractometer. Results were obtained when fewer than 50 % of the animals tested showed a whole-body response after 24 hours under test conditions.

Taxonomic Account

Order Macroaspidida

Family Turbanellidae

Genus *Turbanella* Schultze, 1853

Turbanella amphiatlantica new species

[Trb amfa]

Figs. 1–3

Turbanella sp. E Hummon (1974: p. 212)

Turbanella sp. A Hummon (2001–2009: [N Amer, NW European Databases]).

Turbanella mustela Boaden (1976: p. 467); *Turbanella* cf. *mustela* Ruppert (1977: Figs. 1J, K, T and 10 lower left).

Not *Turbanella* cf. *mustela* Ruppert (1977: Fig. 1L) Probably *Turbanella* aff. *otti* Boaden (1980: p. 28, Tab. 2).

Diagnosis. Adult lectotype being described Lt 636 µm; LPh 170 µm to PhJIn at U27. Head sculptured in front, with ciliary tufts at the corners and a snout-like oral protuberance,

bearing a circumcephalic band of cilia and very pronounced, acutely angled cones laterally at U07; neck constriction slight, just above the level of the TbA; trunk wavy, protruding with every TbL, broadest in the mid-body region, thinning gradually to the narrow caudal base; caudum is small and narrow, incised from its tips to U95, with a short medial cone. Glands 33–34 per side, small to medium, most inconspicuously distributed in 2 columns. TbA 6 per side, medial-most slightly shorter than the others, occurring on fleshy hands that insert at U10; TbL/VL/DL 28 per side (insertions difficult to distinguish), more closely spaced along the rear-gut, but often asymmetrically arranged, with 1 in the fore and 3 in the rear half of the pharynx, and the others along the intestine, 1 of these behind the anal opening, and all but the last one bearing support structures and cilia at the apices of those structures, the last tube being naked; TbD 15 per side, with 2 in the rear of the pharynx and the others along the intestine, none bearing support structures, but all bearing apical cilia; TbP 7 per side, lengthening from medial to lateral, inserted along the trailing edge of each lobe; ‘cirrata’ tubes [Seitenfüßchen] of medium length occur at U35. Locomotor ciliature runs from beneath the head sculpture rearward in 2 bands to the anus. Mouth terminal, narrow, protruding, surrounded by cilia; buccal cavity sub-cylindrical; walls lightly cuticularized; pharynx broadens rearward to the basal pharyngeal pores; intestine narrows fore to aft, with a broadening around the ventral anus at U90. Hermaphroditic; paired testes begin behind the PhJIn, the vasa deferentia continuing briefly rearward, before recurving to the fore and exiting just behind the PhJIn; ovaries bilateral, with ova (3–4) developing rear to fore, the largest ova occurring in the mid-gut region.

Description: Adult lectotype being described Lt 636 μm (Fig. 1) (other adults 540–700 μm [Fig. 2 and Videos]); L to PhJIn 170 μm (other adults 147–192 μm) at U27 (other adults at U27–U28). Body medium to long, of medium thickness (unless compressed); head sculptured in front (W expanding from 54 to 72 μm), with ciliary tufts (L 10–20 μm) at the corners and a snout-like oral protuberance (W 26 μm), bearing a circumcephalic band of cilia (L 28–30 μm) and very pronounced acutely angled cephalic cones (W 126 μm) laterally at U07; neck constriction slight (W 69 μm) just above the level of the TbA;

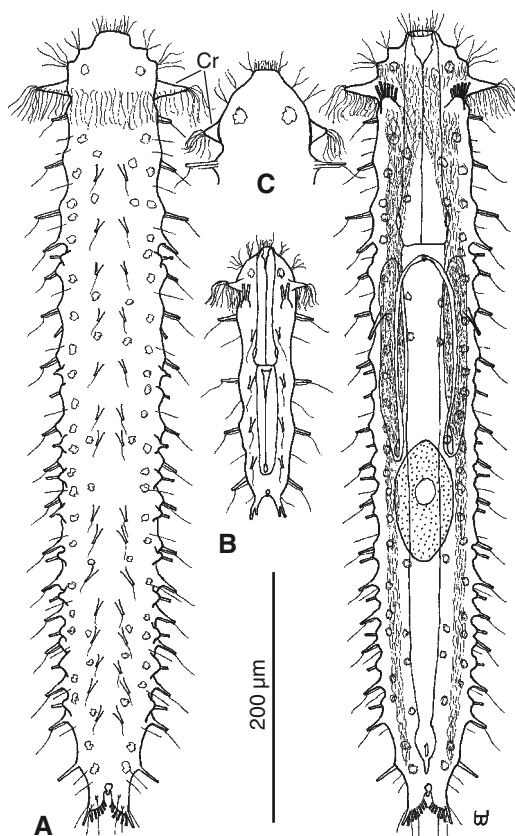


Fig. 1. *Turbanella amphiatlantica* n. sp. adult (Lt 636 μm , LPh 170 μm) from Orient Point, Montauk, New York, collected in 1967 and drawn by W. D. Hummon. **A.** Dorsal view, showing sculptured head with acutely angled cephalic cones, dorsal and lateral ciliation, distribution of internal glands, and adhesive tubes (lateral and dorsolateral series – TbL/DL, dorsal series – TbD, and posterior [caudal] series – TbP), and ventral view, showing locomotor cilia, distribution of internal glands, digestive and reproductive tracts, and adhesive tubes (anterior series – TbA, TbL/DL, TbP and ‘cirrata’ tubes, [located laterally just behind the PhJIn]); **B.** Combined dorsal/ventral view of the same species (Lt 216 μm , LPh 94 μm) from Shinnecock Inlet (Inside), New York, showing less sculptured head with acutely angled cephalic cones, dorsal and lateral ciliation, first internal glands, and adhesive tubes (all series – TbA, TbL/DL, TbD, TbP and ‘cirrata’ tubes); **C.** The fore end of *T. cornuta* adult, showing less sculptured head with less acutely angled cephalic cones, lateral ciliation, first internal glands, and first adhesive tubes (TbL); all drawings are to the same scale. WDH original drawings.

trunk wavy, protruding with every TbL, broadest in the mid-body region (W 89 μm), thinning gradually to the narrow caudal base (W 31 μm);

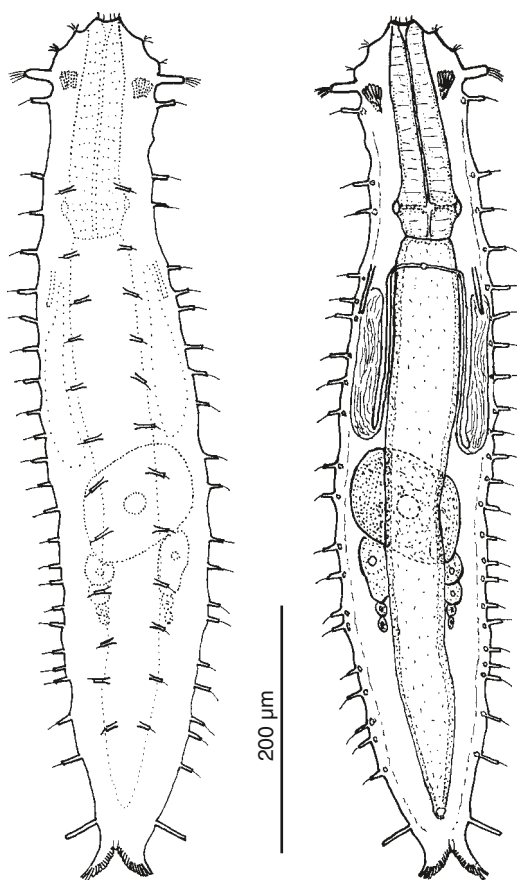


Fig. 2. *Turbanella amphiatlantica* n. sp. adult (Lt 700 μ m, LPh 192 μ m) from Nahant, Massachusetts, collected about 1976 and drawn by C. Ellis. Left: dorsal view, showing sculptured head with acutely angled (almost digiform) cephalic cones, dorsal and lateral ciliation, and adhesive tubes (TbL, TbP); right: ventral view, showing digestive and reproductive tracts, and adhesive tubes (TbA, TbL, TbP and 'cirrata' tubes).

caudum is small (L 26, W at tips 41 μ m), incised from its tips to U95, with a short medial cone (L 3 μ m). Glands 33–34 per side, small to medium, most inconspicuously distributed in 2 columns.

Adhesive tubes: TbA 6 per side (L 10–12 μ m), the medial-most slightly shorter than the others, occurring on fleshy hands that insert at U10; TbL/VL/DL 23–30 per side (insertions difficult to distinguish in adults, L 4–17 μ m, the shorter ones just beginning to develop), more closely spaced along the rear-gut, but often asymmetrically arranged, with 1 in the fore and 2–3 in the rear half of the pharynx, and the others along the intestine,

one of these behind the anal opening, and all but the last one bearing support structures and cilia at the apices of the supports, the last tube being naked; TbD 12–15 per side (L 8–10 μ m), with 1–2 in the rear half of the pharynx and the others along the intestine, none bearing support structures, but all bearing apical cilia; TbP 7–11 per side (L 4–12 μ m), lengthening from medial to lateral, inserting along the trailing edge of each lobe; 'cirrata' tubes [Seitenfüsschen] (L 24 μ m) occur at U35.

Ciliation: Mouth is surrounded with short sensory cilia (L 8–12 μ m), with longer vibratile cilia on either side (L 16–20 μ m) and at the corners of the head sculpturing; cilia (L 28–30 μ m) form a circumcephalic band at U07; sensory cilia (L 20–28 μ m) occur along the trunk in a dorsolateral column, of 14–15 per side; in addition, each of the TbL except the last bears a cilium (L 18–20 μ m) from the rear apex of the tube support, some of the younger tubes not having either supports or cilia. Ventral locomotor cilia (L 8–10 μ m) extend from beneath the head sculpturing rearward in 2 longitudinal bands that trace the lateral body margins to the level of the anus, remaining separate except beneath the head.

Digestive tract: Mouth terminal, narrow (W 16 μ m), protruding; buccal cavity sub-cylindrical; walls lightly cuticularized; pharynx broadens to the basal pharyngeal pores at U24; intestine narrows fore to aft, with a broadening around the ventral anus at U90.

Reproductive tract: Hermaphroditic; paired testes begin behind the PhJIn, the vasa deferentia continuing briefly rearward, before recurving to the fore and opening just behind the PhJIn at U28; ovaries bilateral as seen from the Nahant specimen [Fig. 2, Lt 700 μ m], with ova (3–4) developing rear to fore, the largest ovum occurring (97 $\times$ 47 μ m) in the mid-gut region.

Ecology: Sparse to common in frequency of occurrence (fewer than 10 % to 60 % of samples), scarce to prevalent in abundance (3–5 % to more than 30 % of a sample, sometimes a dominant [dom]); littoral in fine, medium sorted, to very fine-very coarse, very poorly sorted sand at 0–15 cm depth, high water neap [HWN] to low water spring [LWS], but higher on (to high water spring [HWS]) and deeper in (10–30 cm) the beach, when con-generics are also found (as at Plage d'Eyrac). Specimens recorded from Maryland were all found under low salinity conditions of 11 ppt (Driftwood), down to 6–7 ppt (Beverly,

Breezy Point, North Beach and Sandy Point) and 1.5–2.5 ppt (Bowleys Quarters, Edgemere and Pinehurst)

Geographical distribution

ANE – British Isles: Isle of Man (Rue Point); Scotland (Kirkcolm); **NW Europe: France** (Plage d'Eyrac (as *T. cf. mustela*) [Ruppert photo, 1977]); **The Netherlands** (Goeree (as *T. mustela*)).

ANW – North America: Maryland (Beverly [video], Bowleys Quarters, Breezy Point [video], Driftwood [video], Edgemere [dom], North Beach [dom] [3-videos], Pinehurst [video], Sandy Point [dom]); **Massachusetts** (Nahant); **New York** (^Montauk (41°04' N/71°51' W), Shinnecock Inlet Inside); **Virginia** (Chesapeake Bay Unspecified (as *T. cf. mustela*) [Ruppert photo, 1977]).

Remarks. There are seven MPEG 2 (and MPEG 1) video sequences of *Turbanella amphiatlantica* n. sp., all from Maryland, USA. Of these, five are found in Hummon (2009). They are #1668, an adult of Lt 569 µm (LPh 159 µm) from Breezy Point; #1659, an adult of Lt 545 µm (LPh 152 µm) from Driftwood; #1656, an adult of 540 µm (LPh 147 µm) from North Beach; #1673, a subadult of Lt 445 µm (LPh 141 µm) from Beverly; and #1678, a juvenile of 204 µm (LPh 92 µm) from Pinehurst. The juvenile (Fig. 1b) from Montauk, Long Island NY, has Lt 216 µm (LPh 94 µm) PhJIn at U26; it has cephalic cones like that of the adult and TbA 2 per side, TbL 4 per side, TbD 4 per side, and TbP 2 per side. The adult forehead with cephalic cones (Fig. 1c) is that of *Turbanella cornuta* also from Montauk. A formal diagnosis for the *Turbanella amphiatlantica* subadult from Kirkholm, Scotland [Fig. 3] is as follows:

Subadult Lt 480 µm; LPh 137 µm to PhJIn at U28. Head sculptured in front (W from 48, expanding to 70 µm), with ciliary tufts (L 10–16 µm) at the corners and a snout-like oral protuberance (W 26 µm), bearing a circumcephalic band of cilia (L 18–20 µm) and very pronounced acutely angled cephalic cones (W 112 µm) laterally at U08; neck constriction slight (W 64 µm) just above the level of the TbA; trunk wavy, protruding with every TbL, broadest in the mid-body region (W 84 µm), thinning gradually to the medium caudal base (W 42 µm); caudum is small (L 25, W at tips 71 µm), incised from its tips to U95, with a short medial cone (L 3 µm). Glands 36–37 per side, small to medium, most inconspicuously distributed in

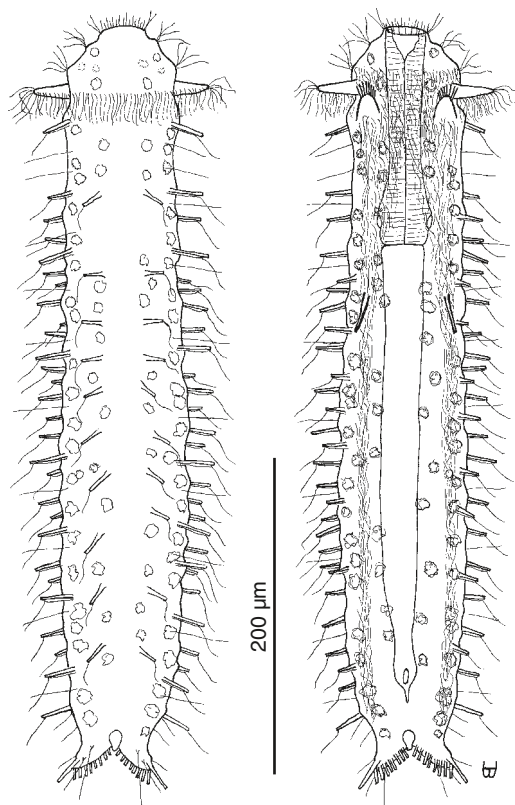


Fig. 3. *Turbanella amphiatlantica* n. sp. subadult (Lt 480 µm, LPh 192 µm) from Kirkholm, Scotland, collected in 1977 and drawn by W. D. Hummon. Left: dorsal view, showing sculptured head with acutely angled cephalic cones, dorsal and lateral ciliation, distribution of internal glands, and adhesive tubes (TbL, TbP); right: ventral view, showing digestive and reproductive tracts, and adhesive tubes (TbA, TbL, TbP and 'cirrata' tubes).

2 columns. TbA 8 per side, medial-most shorter than the others, occurring on fleshy hands that insert at U12; TbL/VL/DL (11+8+9 =) 28 per side (insertions are less difficult to distinguish in subadults than adults), more closely spaced along the mid-gut, but often asymmetrically arranged, with 1 in the fore and 3 in the rear half of the pharynx, and the others along the intestine, 1 of these behind the anal opening, and all but the last one bearing support structures and cilia at the apices of the support structures, the last tube being naked; TbD 10 per side, with 1 in the rear half of the pharynx and the others along the intestine, none bearing support structures, but all bearing apical cilia; TbP 9 per side, lengthening

from medial to lateral, inserted along the trailing edge of each lobe; 'cirrata' tubes [Seitenfüßchen] (L 25 μ m) occur at U35. Locomotor ciliature extends from beneath the head sculpture rearward in 2 bands to just past the anus. Mouth terminal, narrow (W 18 μ m), protruding, surrounded by cilia (L 6–16 μ m); buccal cavity sub-cylindrical; walls lightly cuticularized; pharynx broadens to the basal pharyngeal pores at U25; intestine narrows fore to aft, with a swelling around the ventral anus at U85. Reproductive systems undeveloped.

Etymology. The species is named by virtue of its apparent co-occurrence on both sides of the north Atlantic (Greek: *amphi* + *atlantic*, referring to the both sides of the Atlantic Ocean). These might prove to be cryptic (sibling) species, but the analysis has not yet been done.

Taxonomic affinities. *Turbanella amphiatlantica* n. sp. is the only medium to large species in the genus with a stepped head, sharp lateral cephalic cones on the head, a PhJIn of U27–U28, a narrow mouth, a body profile that appears undulated by insertions of its TbL; also with TbA 6 per side; a TbL (VL/DL) formula of 23–30=1, 2–3/19–25, 1 (1 in the fore and 2–3 in the rear half of the pharynx/19–25 along the intestine, with 1 occurring behind the anus); a TbD formula of 12–15=0, 1–2/11–13, 0; TbP 7–11 per side, arrayed along the rear edge of each caudal lobe; and 'cirrata' tubes at U35; with a short caudal cone.

Salinity Tolerances. There are only a few species of *Turbanella* for which any salinity tolerances have been measured: *T. hyalina* by Boaden & Erwin (1971), *T. ocellata* by Hummon (1975a), *T. ambronensis* and partially *T. cornuta* by Hummon (1975b), and *T. cornuta* and *T. cf. mustela* by Ruppert (1977). Measurements on *T. amphiatlantica* (Kelly 1997 and present paper) yield another species.

Turbanella hyalina, having been measured in a very different way from the others, does not yield comparable results. *T. hyalina* was tested by Boaden & Erwin (1971: p. 481, Fig. 1) under varying concentrations of salinity and left until half of the specimens were 'affected'. There were near linear relations from a few minutes at 0 ppt and at 60 ppt to 21 hours at 27 ppt. No acclimatization conditions were given.

Ruppert (1977: p. 241) placed living *Turbanella*

cf. mustela in a watch glass with distilled water, after which it swelled initially, but survived for two days. Subjecting *T. cornuta* to the same treatment resulted in death within minutes.

The LC_{50/24} for the mid-Atlantic *Turbanella ocellata* (Hummon 1975a: p. 259, Fig. 1) showed two similar inverse 'C'-shaped curves that began with 70 ppt at 6 °C in the upper left, continued around to 35 and 39 ppt at 36 °C (with 32 ppt, 14 °C and 27 °C acclimatization) at the right, then down and around to 12 and 3 ppt at 32 °C for the two acclimatization conditions, and finally to 5 ppt for both conditions at 24 °C, and 5–8 ppt for both conditions at temperatures down to 6 °C.

The LC_{50/24} for the north-eastern Atlantic *Turbanella ambronensis* (Hummon 1975b: Fig. 2) showed similar curves at top and bottom salinities at 14 °C, but maximal salinities of only 29–31 ppt for the same two acclimatization conditions that were used for *T. ocellata* (temperatures below 14 °C were not tested). Only one reading of LC_{50/24} was made for *T. cornuta* from the same location (Hummon 1975b: Tab. V), it being 6 ppt at 14 °C under the lower acclimatization conditions, there being insufficient specimens to do further testing.

The LC_{50/24} for *Turbanella amphiatlantica* n. sp. in the lower estuarine portion of Chesapeake Bay (Sandy Point, Maryland) was 2 to 40 ppt and 0.5 to 45 ppt at 12 °C (with 12 ppt at 24 °C and 12 °C acclimatization).

Discussion

Taxonomy. *Turbanella amphiatlantica* n. sp. is represented by specimens described and illustrated in Figs. 1–3, from New York, Massachusetts and Scotland, and the five video sequences from Maryland, all belonging to the same species. What then of additional specimens that might also fit this description? Reference is made to *T. cf. mustela* of Ruppert (1977: Fig. 1J, K, L, T and Fig. 10 lower left) [our Figs. 4, 5] and *T. aff. otti* of Boaden (1980: p. 28 and Tab. 2), neither identity being more than provisional. They are taken up in order of their presentation.

Turbanella mustela Wieser, 1957 has recently been redescribed by Hummon (2010). For perspective, the following diagnosis comes from Hummon (unpublished): Turbanellidae on XIX, a revision of the account of *T. mustela* alone, published earlier in 2010, to an account based

on comparative diagnoses of all 28 described species and several as yet undescribed species in the genus:

Adult Lt 370–550 μm ; LPh 120–132 μm to PhJIn at U34–U28. Head sculptured in front (W expanding from 42 to 64 μm), with snout-like oral protuberance (W 17 μm), bears a circumcephalic band of cilia at U07 and very pronounced lateral rod-like cephalic cones tipped by a loose tuft of sensory hairs (W 94 μm) at U08; neck constriction slight just above the level of the TbA; trunk wavy, protruding with every TbL, broadest in the mid-body region (W 62 μm), thinning gradually to the caudal base (W 36 μm); caudum is moderately cleft (L 28, W at tips 60 μm), incised from its tips to U94, lacking a medial cone. Glands 40–50 per side, small to medium, most inconspicuous. TbA 6–9 per side, the medial-most shorter than the others, occurring on fleshy hands that insert at U12; TbL/VL 14–18 per side, evenly spaced, but often asymmetrically arranged, with 1 in the fore and 1 in the rear half of the pharynx, and the others along the intestine, only 1 of these behind the anal opening, none with support structures, but all bearing cilia at their tips; TbD 8–9 per side, with 1 in the rear of the pharynx (sometimes 1 in the fore), the others along the intestine, none bearing apical cilia; TbP 7–14 per side, lengthening from medial to lateral, inserted along the trailing edge of each lobe; ‘cirrata’ tubes [Seitenfüsschen] (L 21 μm) occur at U41. Locomotor ciliature runs from beneath the head rearward in 2 bands. Mouth terminal, narrow (W 10 μm), protruding; buccal cavity sub-cylindrical; walls lightly cuticularized; pharynx narrow throughout, except near conspicuous basal pharyngeal pores at U25; intestine of similar width throughout; anus is ventral at U86. Hermaphroditic, probably protandric; paired testes begin just before the PhJIn, the vasa deferentia continuing rearward, then recurving to the fore and exiting just behind the PhJIn at U29; a developing ovum occurs (80 $\times$ 35 μm) in the mid-gut region.

T. mustela differs from *T. amphiatlantica* in the following ways: while barely overlapping in size, adult *mustela* are smaller (Lt 370–550 μm) than adult *amphiatlantica* (Lt 540–700 μm), with a relatively longer pharynx (*T. mustela*: PhJIn at U34–U28), compared with (*T. amphiatlantica*: PhJIn at U28–U27). Cephalic cones are rod-like in *T. mustela* and acutely angled in *T. amphiatlantica*. TbA and TbP overlap in numbers (6–9 and 7–14 per side) for *T. mustela* vs. (6 and 7–11) for

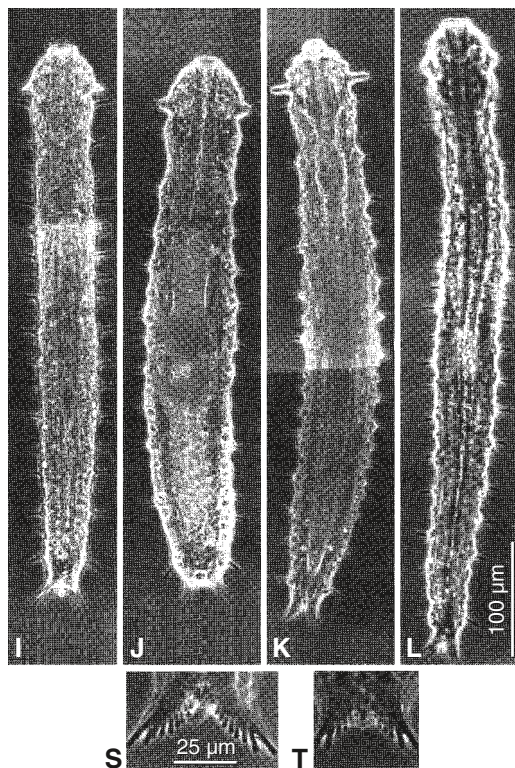


Fig. 4. Photographs taken by E. E. Ruppert (1977: Fig. 1 I, J, K, L, S, T). Figs. 1 I, S are of *Turbanella cornuta*, living adult specimen from Arcachon, France and caudum of subadult specimen (no location given). Figs. 1 J, T are of *T. cf. mustela*, living adult specimen from Arcachon, France and caudum of adult specimen (no location given). Fig. 1 K is of *T. cf. mustela*, living adult specimen from Chesapeake Bay, Virginia. Fig. 1 L is of *T. cf. mustela*, living adult specimen from Bogue Banks, North Carolina. Figs. 1 J, K, T are here considered to be of *Turbanella amphiatlantica* n. sp., but not Fig. 1 L.

T. amphiatlantica, but TbL and TbD clearly differ (14–18 and 8–9 per side) for *T. mustela* vs. (23–30 and 12–15) for *T. amphiatlantica*. Finally, the ‘cirrata’ tubes insert further to the rear in *T. mustela* (U41) than in *T. amphiatlantica* (U35), and the former lacks a caudal cone, while the latter has one. An uncritical glance might confuse them.

We accept Ruppert’s (1977: Fig. 1 K) *Turbanella cf. mustela* from the Chesapeake Bay, Virginia as a *T. amphiatlantica* (Lt unknown, but mature as shown by the presence of testes, PhJIn at U27, very pronounced acutely angled cephalic cones, TbL at least 18 per side), found in a region where *T. amphiatlantica* occurs frequently, but of unknown

location (Ruppert, personal communication). We also accept Ruppert's (1977: Fig. 1 T) *Turbanella* cf. *mustela* as a *T. amphiatlantica* (caudum only, without location, but with TbP 5 on one side and 6 on the other, perhaps indicating a subadult, one with a very distinct caudal cone). We have more trouble with Ruppert's (1977: Fig. 1 J and Fig. 10 lower left, possibly a photo and sketch of the same animal) *Turbanella* cf. *mustela* from Arcachon, France, which is shown with cephalic cones unlike those of either *T. mustela* or *T. amphiatlantica* (Lt unknown, but ovigerously mature, PhJIn at c. U30, TbA 6 per side, TbL 13-15 per side, TbD 9 per side, and TbP 5 per side). The 'cirrata' tubes insert to the rear (U37) of the specimen sketched in Fig. 10 (lower left), but then those sketched for *T. cornuta* Fig. 10 (far right) are also further to the rear (U35) than is usual for that species; both show caudal cones. What allows us to accept the specimen named *Turbanella* cf. *mustela* from Arcachon provisionally as a *T. amphiatlantica* is its caudal cone and its tolerance to salinities lower than those of *T. cornuta* (Ruppert 1977: p. 241).

Another report of *Turbanella mustela* from northwestern Europe is that of Boaden (1976), from Goeree, in the Netherlands, at 25 ppt salinity in a riverine estuary. This identification is of specimens that "agree well with the original description" of Wieser (1957), and hence are not accompanied by the hedge abbreviations, cf. or aff. Most of the original description from Wieser could apply to either *T. mustela* or *T. amphiatlantica*, except that the former lacks a caudal cone and has a few more TbA per side, an overlapping number of TbL plus some sublateral tubes per side, an unstated number of TbD per side that begins at the same level in both species, and an overlapping number of TbP per side, with 'cirrata' tubes as yet unknown to Wieser (they being first noted in *Turbanella cirrata* by Papi also in 1957). It is easier to choose from among a pool of species that have been described, than from a pool that includes species that are as yet unknown.

The last occurrence that we must consider is that of *Turbanella* aff. *otti* Schrom, 1972 by Boaden (1980: p. 28, Tab. 2), with no comment except that it has a tolerance for redox potential discontinuity (RPD) and black layer sand (dissolved oxygen 4.2-10.4 milliliters per liter (ml/l), Ph 6.2-8.0, Eh 58-180 millivolt (mv) from Millin Bay, N. Ireland. Why the choice of *T. aff. otti* was not stated and remains unclear, but it means that the specimens were not to be identified with any species of *Tur-*

banella with which Boaden was familiar, namely those of the British Isles or the west central coast of Italy that had by that time been described. For perspective, the following diagnosis comes from Hummon (unpublished): Turbanellidae on XID, based on the only published description of *T. otti* on record, that of Schrom (1972):

Adult, Lt 380-400 μ m, LPh 140-150 μ m to PhJIn at U37. Head tapered (W 41 μ m), with triangular cephalic cones of medium length (W 56 μ m) laterally at U10 that lean to the rear and bear tufts of cilia (L 7-12 μ m) and two circumcephalic bands of sensory cilia (L 14-16 μ m) at U04 and U08; neck constriction (W 38 μ m) at U12; trunk broadest (W 52 μ m) along the rear pharynx, narrowing very gradually aft; caudal base broad (W 37 μ m); caudal lobes short (L 15 μ m) with medium spread (W 62 μ m), incising to U96, with a peg-like caudal cone (L 10 μ m). Epidermal glands not seen. TbA 5-6 per side, borne transversally on broad, short fleshy hands that insert on the ventral surface at about U13; TbL 10-15 per side (L 14 μ m), asymmetrically and unevenly spaced at U14-U90, with 2 along the fore, 3 along the rear pharynx, and the others along the intestine; TbD 10-12 per side (L 14 μ m) at U20-U85, with 2-3 along the rear pharynx, and the others along the intestine; TbL and TbD all have apical cilia (L 10-15 μ m); TbP 6 per side, increasing in length medial to lateral (L 7-12 μ m). Mouth of medium breadth (W 12 μ m), surrounded by short cilia (L 2-4 μ m); buccal cavity short, cup-shaped, lightly cuticularized; pharyngeal pores basal at U27; intestine broad in front, narrow behind; anus at about U93. Locomotor cilia form two longitudinal bands, united beneath the head. Hermaphroditic, testes paired, occurring behind the PhJIn, the vasa deferentia continuing rearward; bilateral ovaries lie along the rear mid-gut, ova (several at a time) developing rear to fore, the largest (55 $\times$ 44 μ m) above the rear fore-gut.

This is yet a smaller species than either *T. mustela* or *T. amphiatlantica*, but nothing is said by Boaden (1980) of size, or any other morphological feature. We consider that this species which Boaden reported was more likely *Turbanella* cf. *amphiatlantica* than *T. aff. otti*, the latter otherwise having no published distribution outside the upper Adriatic Sea.

Finally, a specimen appearing in Ruppert (1977) as Fig. 1 L, a living adult specimen from Bogue Banks, N. C. and identified as *Turbanella*

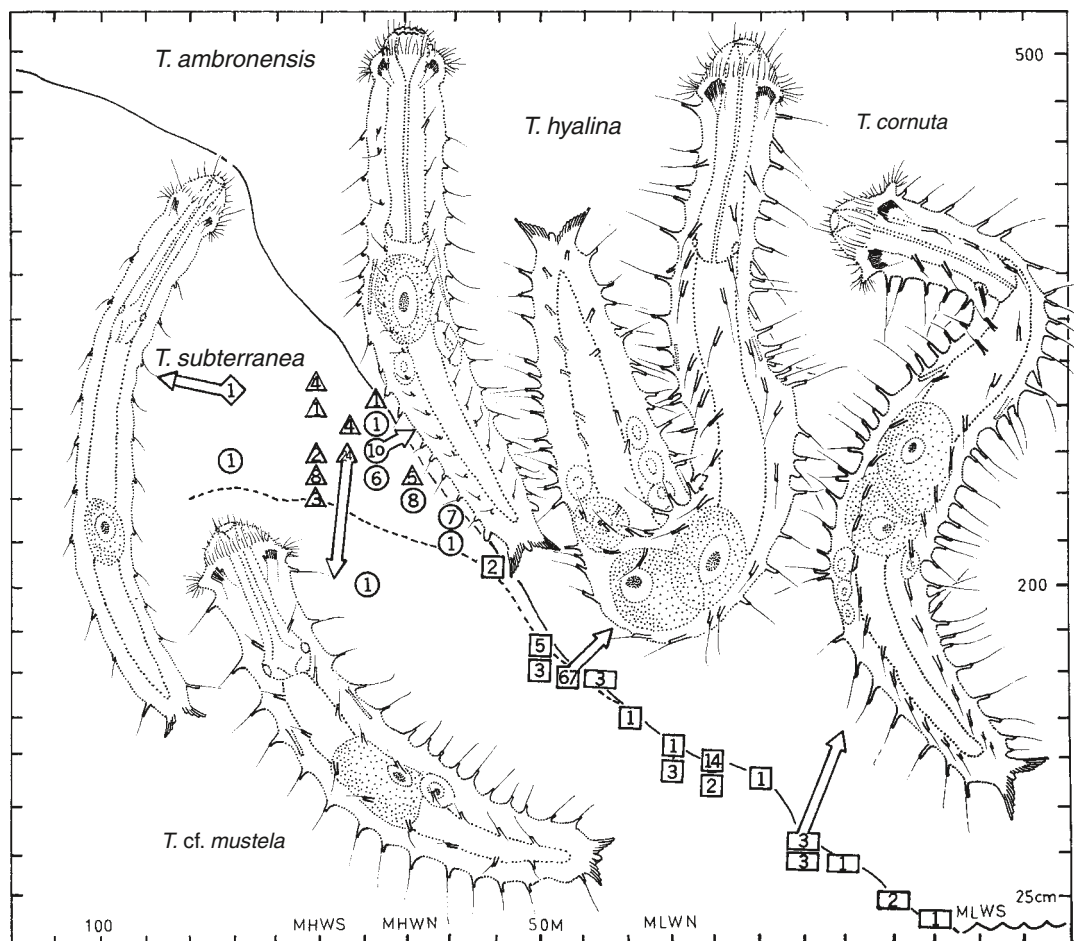


Fig. 5. A sketched illustration of several species of *Turbanella* that were found to co-occur on Plage d'Eyrac, Archacchon France. The specimen depicted lower left, which was called *T. cf. mustela*, is here considered to be of *Turbanella amphiatlantica* n. sp.

cf. mustela, is in our considered opinion neither *T. mustela* nor *T. amphiatlantica*. While its length and its PhJIn would be about right (Lt 575 μ m and PhJIn at U28), its body conformation is like neither species and its cephalic cones are too short and too broad at the base. Further information from Bogue Banks will be needed to clarify its identity.

Salinity Tolerances. The salinity tolerances of a number of *Turbanella* species appear to be highly euryosmotic, but that of *T. amphiatlantica* n. sp.

from Sandy Point, Maryland especially so, perhaps equaled by the untested species and populations that occur in the brackish waters of the upper Baltic Sea, namely *T. lutheri* and perhaps some populations of *T. hyalina* and *T. cornuta*. This leads to the question of whether there are physiological populations or subspecies that differ genetically or reproductively from one another on the basis of differing tolerances to salinity or to levels of RPD? Physiological data are insufficient at present to answer this question, but perhaps in the future genetic data can lead to its resolution.

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