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RESEARCH PAPER

Electra scuticifera sp. nov.: Redescription of *Electra pilosa* from New Zealand as a new species (Bryozoa, Cheilostomata)

E. A. Nikulina

Geological Institute Christian-Albrechts-University, Kiel

A new species of the genus *Electra* is described from the Indo-West Pacific. *Electra scuticifera* sp. nov., a common bryozoan on coasts of New Zealand, was until now regarded as conspecific to the Atlantic species *Electra pilosa*. Morphologic and morphometric comparisons between *E. pilosa* the New Zealand bryozoan revealed differences in morphology of colonies and zooids, sizes of zooids and thickness of spines. Phylogenetic relationships, evolution, geography, and ecology of the new species are briefly discussed.

Electrida, taxonomy, phylogeny, Tasman Sea

INTRODUCTION

The problem of species discrimination in electrids is great due to their variable morphology. One such variable species is *Electra pilosa* (Linnaeus, 1767). These bryozoans were described from the North-East Atlantic and then subsequently found in the North-West Atlantic (Dawson 1859; Packard 1863), Indo-West Pacific (Hincks 1880), the Arctic Sea (Smith 1879; Nordgaard 1896; Bidenkap 1900), the Mediterranean (Heller 1867; Calvet 1902), and the North-West Pacific (Ruiz et al. 2000). *E. pilosa* became regarded as a cosmopolitan species with variable morphology. Later, the Mediterranean form of *E. pilosa* was redescribed as a separate species *E. posidoniae* Gautier, 1954. Comparative study based on genome-sequencing and phylogenetic analyses (Nikulina et al. 2007) confirmed the species status of *E. posidoniae*. The same study revealed the deep genetic divergence of *E. pilosa* distributed in the Indo-West Pacific region, New Zealand, from both the Atlantic *E. pilosa* and the Mediterranean *E. posidoniae.* Mitochondrial and nuclear ribosomal genes provided concordant results, suggesting a history of reproductive isolation. There are also ecological differences between the Atlantic *E. pilosa*, the brackish-water species, and the New Zealand bryozoans, inhabiting waters with normal marine salinity. All of

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these results supported the New Zealand form of *E. pilosa* as a separate species. The latter is the main object of the presented taxonomic study that is based on a morphological comparison of both *Electra*.

The bryozoan *E. pilosa* plays a significant role in faunistic, ecological, physiological, evolutional, and biogeographical studies (Silén 1987; Ruiz et al. 2000, Nikulina 2002; Hewitt et al. 2004; Nikulina and Schäfer 2006; Nikulina et al. 2007).

The changed concept of this species warrants a re-examination of specimens from different localities, a revision of geographic distribution, and ecoclimatic preferences of *E. pilosa* and its relatives, including the new bryozoan *Electra scuticifera* sp. nov. described here.

METHODS

Bryozoans were collected during 2003 and 2004 in several localities of the Tasman Sea, coasts of New Zealand (West Coast and Maori Bay), from the upper sublittoral, within the biocoenosis of brown algae. Details of the collection localities are reported in Table 1. Specimens of *E. pilosa* necessary for comparison were collected in the western Baltic Sea (Kiel Bay) and in the North-East Atlantic (Helgoland). All samples were preserved in 98% ethanol or dried. On account of the high morphological similarity of these two species, all specimens were previously identified genetically (Nikulina et al. 2007). Parts of the same colonies were studied using scanning electron microscopy (SEM). SEM photographs were used for the following measurements: the length and the width of zooids, and the thickness of setiform proximal-median spines (Fig. 1). All statistical calculations and tests were prepared using PAST software (Hammer et al. 2001). To evaluate the statistical significance of size differences, I applied the Welch corrected t-test, and a permutational t-test. Additionally, I tested differences in medians with the two-tailed Mann-Whitney U test. A cluster analysis was also prepared. A dendrogram was constructed by a hierarchical clustering routine procedure (UPGMA algorithm on the average Chord distances) using the following variables: zooid length, zooid width, and thickness of the setiform proximal-median spine.

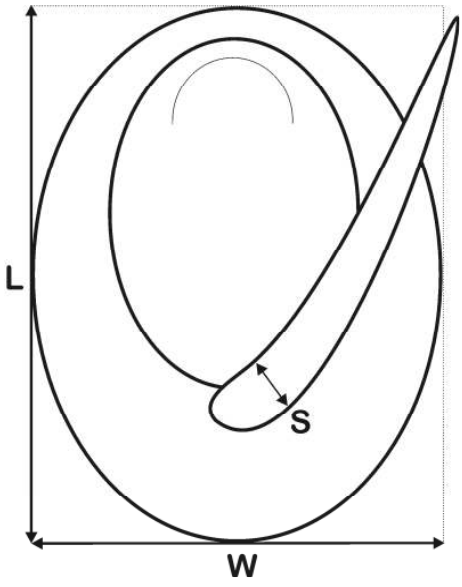

Figure 1 Measurements of zooids: L – length; W – width; S – thickness of the setiform proximal-median spine.

Table 1 Samples studied.

Morphologic material		**Genetic data**		**Locality**
Notes to the specimen	Type No	mtDNA (LSU) EMBL No	nDNA (SSU) EMBL No	
Holotype	SMF1727	AJ971087	-	West
Paratype	SMF1728	-	-	Coast
Additional material		AJ971086 AJ971088	-	42º 42' S 170º 57' E
	SMF1729	AJ971068-AJ971083	AM075769	Maori Bay 36º 53' S 174º 26' E

Table 2 Morphologic comparison between *Electra scuticifera* sp. nov. and *Electra pilosa*. Number of measurements is 40 per species

Feature	***E. scuticifera***	***E. pilosa***
Colony shape	Rounded lobate	Star-shaped
Zooid length, μm		
Mean	508	636
Range min-max	425-575	522-730
Std. dev.	36,1	80,7
Std. error	8,27	18,0
Zooid width, μm		
Mean	328	345,5
Range min-max	288-380	273-455
Std. dev.	20,7	50,7
Std. error	4,74	11,35
Ø Spine, μm		
Mean	82,0	49,5
Range min-max	58,8-100	45-63
Std. dev.	16,34	6,29
Std. error	3,65	1,41

RESULTS

The values of lengths, widths and thickness of spines are presented in the Table 2 as mean, range, standard error, and standard deviation, calculated for 40 zooids. The morphometrical analyses provided statistically significant differences between North Atlantic *E. pilosa* and the bryozoan from New Zealand at least in two characters: zooidal length and thickness of the setiform proximal-median spine. All three tests provided $p << 0,01$ for the zooidal width. The assumption of similarity was rejected within the 95% confidence interval by all tests, with the excep-

tion of Mann-Whitney U test (Tab. 3). Cluster analysis discriminated the two species on the basis of their morphometric characters providing two non-overlapping clusters.

Table 3 *P*-values in various statistical tests.

Test	Zooid length	Zooid width	Ø Spine
Welch *t*	$9{,}3 \cdot 10^{-13}$	0,045	$1{,}4 \cdot 10^{-8}$
Permutational *t*	<< 0,01	0,035	<< 0,01
Mann-Whitney U	$2{,}9 \cdot 10^{-11}$	0,735	$4{,}0 \cdot 10^{-7}$

TAXONOMY

Family ELECTRIDAE Stach, 1937
Genus *Electra* Lamouroux, 1816
Electra scuticifera sp. nov.

Etymology. From Latin words *scutica* (whip) and ferre (to bear).

Holotype. New Zealand, Tasman Sea, West Coast, sublittoral, 2004; Senckenberg Museum, Frankfurt am Main, bryozoan Type SMF 1727, alcohol fixed, one part is dried and coated with Pd-Pt (Fig. 2 and 3); EMBL Data Base, Accession number AJ971087, partial sequence of mitochondrial LSU, IV and V domain.

Paratype. The same data as for holotype, SMF 1728 (Fig. 4a).

Other material. New Zealand, Tasman Sea, Maori Bay, sublittoral, 2003; the colony part coated with Pd-Pt; SMF 1729 (Fig. 4b). More than 100 colonies on brown alga, dried (all SMF 1729), genetic data reported in Table 1.

Diagnosis. This species is characterised by irregularly circular or slightly lobate incrusting colonies, white to brownish, with a prickly or hairy appearance; usually ovoid zooids with spacious opesium and gymnocyst occupying about one-third of the frontal surface and covered with round pseudopores. The opesium is surrounded by three to seven (usually five) spines, which are simple protrusions of the mural rim, chitinous or slightly calcified. Median-proximal spine is generally larger and thicker than the rest of the spines.

Description. Colonies form circular or slightly lobate patches, incrusting hard substrate (Fig. 2). Zooids are typically ovoid, rounded rhomboid or rectangular (Fig. 3a-c). Gymnocysts occupying about one-third or less of the frontal surface, calcified and slightly translucent, closely perforated with round pores. Opesia oval, spacious, with a distinct rim.

Operculum simple, with a thin chitinous sclerite. Three to seven spines occur around the opesia. In some zooids the spines are absent. The median-proximal spine is almost always present, generally larger than the rest, thick (up to 100 μm in di-

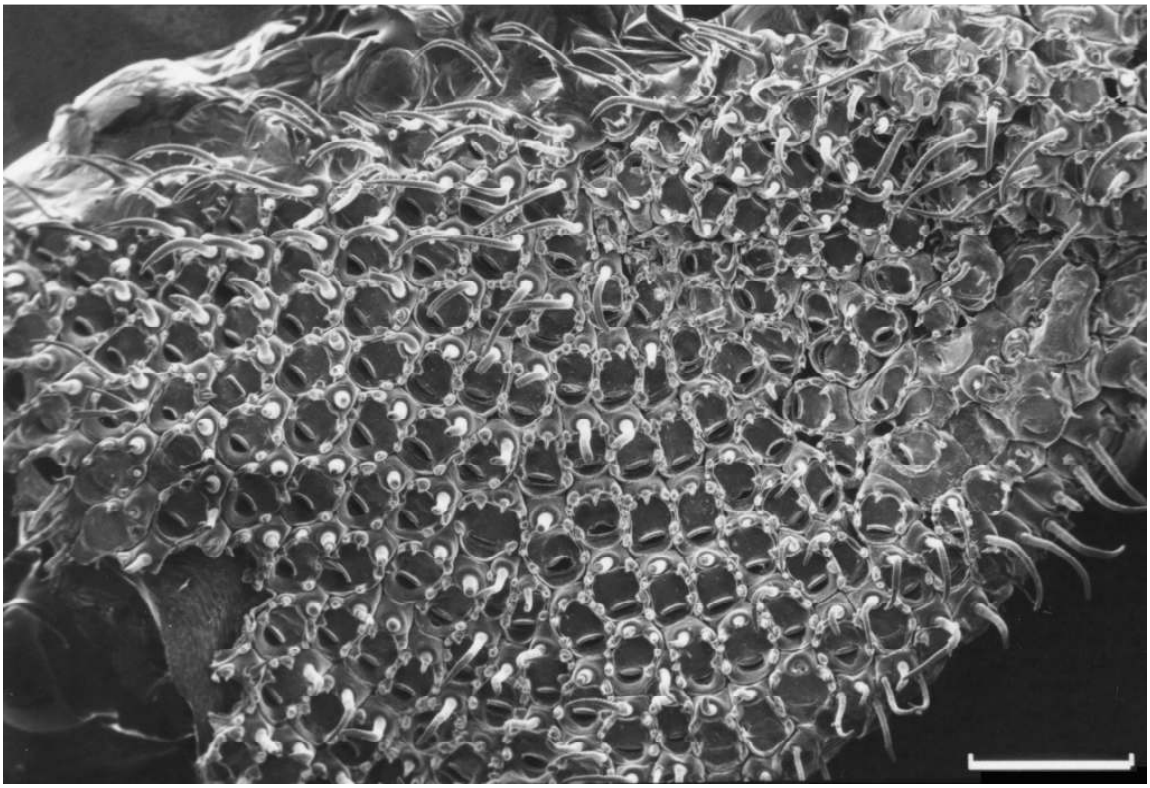

Figure 2 *Electra scuticifera* sp. nov.: colony morphology. Holotype, SMF 1727. The scale bar corresponds to 1000 μm.

ameter), and sometime attains one to two times the length of the zooid. The basal part of the spine becomes more or less calcified, the remaining part is usually chitinous and brown. Other spines are short and thin, mostly calcified, conical in shape. Points of the spines are light brown. Zooids arranged in alternating series, sometimes not very regular.

Measurements. The measurements are presented in Table 2.

Taxonomic remarks. Hincks was the first author who mentioned these bryozoans from New Zealand (Hincks 1880). Until now *E. scuticifera* sp. nov. has been regarded as *E. pilosa* (Nikulina et all. 2007). The morphological differences between the two species are as follows:

Colonies of *E. scuticifera* sp. nov. are rounded or lobate in contrast to the star-shaped colonies of *E. pilosa.* Spines in zooids of *E. scuticifera* sp. nov. are usually more chitinized, brownish and thick. Often zooids have obtuse, heavily chitinized proximal median spines up to 100 μm in diameter (Fig. 4a, b); in *E. pilosa* well-developed proximal median spines are pointed, long and no more than about 60 μm in diameter (Fig. 4c). Zooids of *E. scuticifera* sp. nov. are smaller and relatively shorter; they have also thicker spines (Tab. 2).

The species *Electra lesueuri* d'Hongt, 1979, described from Western Australia, possess reduced gymnocysts with no or rare pores

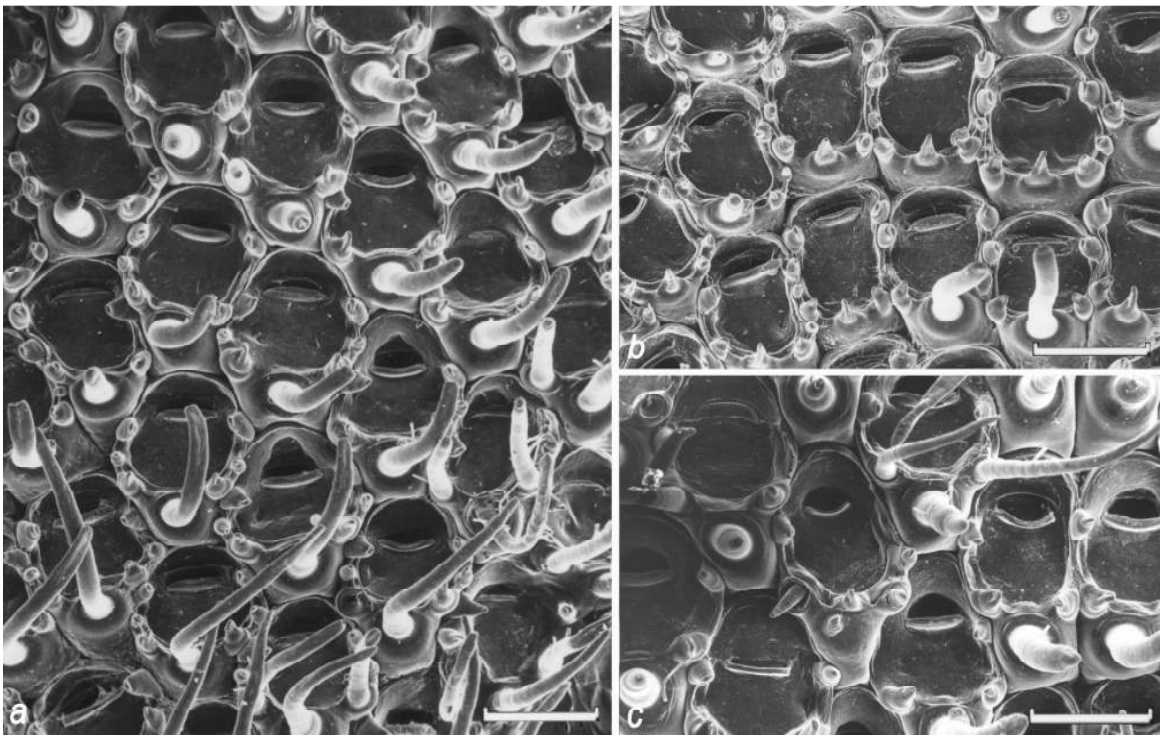

Figure 3 *Electra scuticifera* sp. nov: *a-c* – details of zooid morphology. Holotype, SMF 1727. The scale bar corresponds to 300 μm.

and setiform median-proximal spines of 50 μm (d'Hongt 1979). These features allow for the discrimination *E. lesueuri* from *E. scuticifera* sp. nov.

Phylogenetic relationships. Evolution of *E. scuticifera* sp. nov. was reconstructed previously by Nikulina et al. 2007 based on phylogeographical analyses of mitochondrial and nuclear rDNA data. *E. scuticifera* sp. nov. was resolved as the most basal taxon within the monophyletic group consisting of *E. scuticifera* sp. nov., *E. pilosa*, and *E. posidoniae*. These species exhibit a Tethyan distribution, and the pattern of speciation obtained is in agreement with the disjunction of the Tethys Sea. Separation between the Mediterranean and Indian Ocean during the early-middle Miocene lead to isolation and divergence of *E. scuticifera* sp. nov. from other related lineages, distributed in the Atlantic-Mediterranean area. One of them was the ancestral lineage for *E. pilosa* and *E. posidoniae*. The separation between Mediterranean and Atlantic Ocean at the end of the Miocene caused the divergence between *E. pilosa* and *E. posidoniae.* Such biogeographical scenario is concordant with predicted divergence times estimated from molecular distances using the molecular clock hypothesis.

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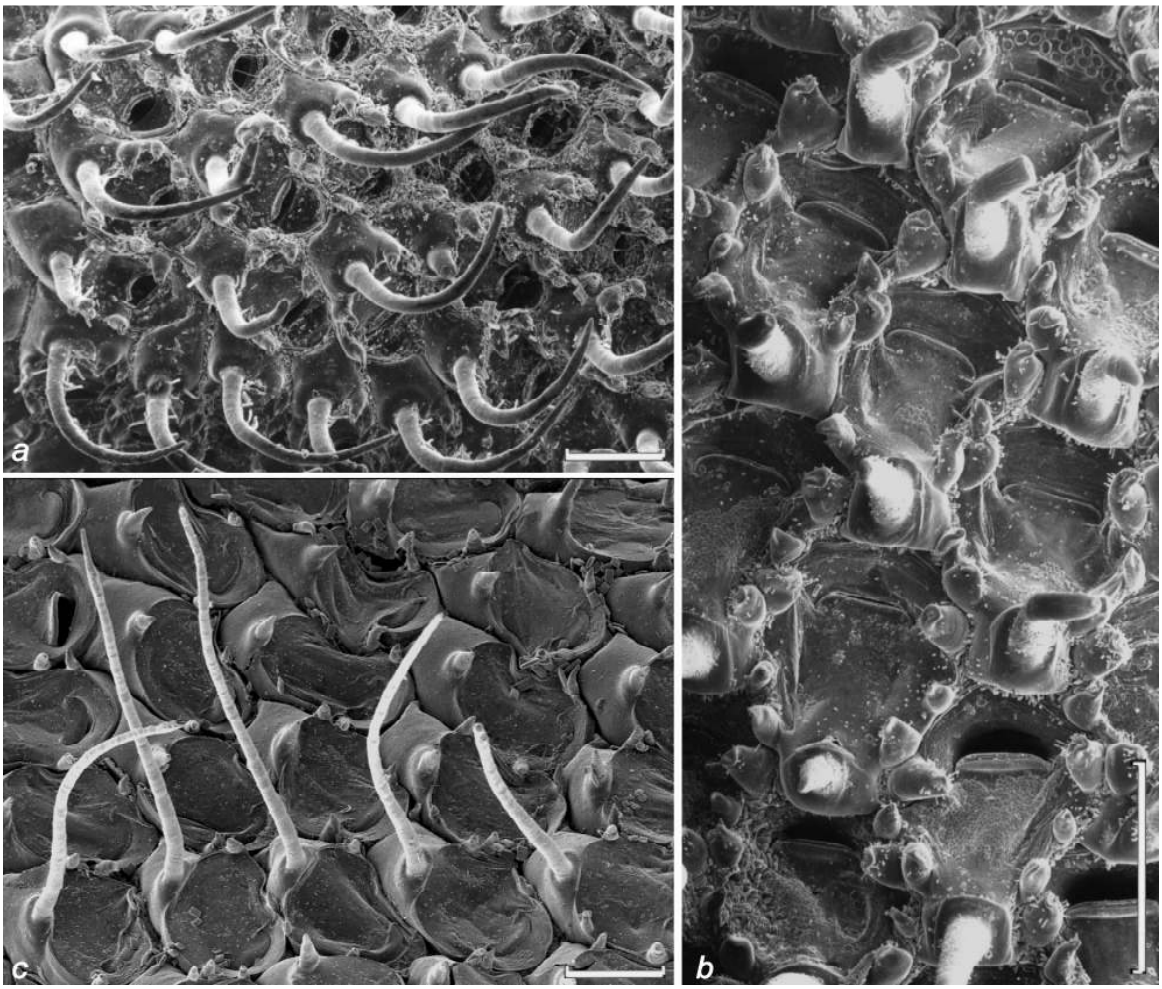

Figure 4 *Electra scuticifera* sp. nov. and *Electra pilosa*, details of zooid morphology: *a – E. scuticifera*, paratyp, SMF 1728; *b – E. scuticifera*, additional material, SMF 1729; *c – E. pilosa* from the Kiel Bight, Baltic Sea. The scale bar corresponds to 300 µm.

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Dr. Elena A. Nikulina (en@gpi.uni-kiel.de)
Geologisches Institut der Christian-Albrechts-Universität
Olshausenstr. 40, 24118 Kiel