

A new species of *Didemnum* (Ascidiacea, Tunicata) from the Atlantic coast of North America

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Abstract

Didemnum lahillei Hartmeyer, 1909 from Europe, *Didemnum vexillum* Kott, 2002 from the eastern coast of New Zealand and *Didemnum vestum* sp.nov. from the Atlantic coast of the USA, have similar three dimensional growth forms and are found attached to vertical and undersurfaces. These three species have been informally proposed as conspecific and invasive, but are found to have significant differences from one another and from some other species that share some of their characteristics. Although the New Zealand species appears not to have been observed before populations were found in Whangamata Harbour late in 2001, both the European and the newly described North American species have been known from the vicinity of their type locations (but not elsewhere) since 1872 and 1921 respectively. Significant taxonomic investigations of the American ascidian fauna have not been pursued since the publication of Van Name's monograph (1945) in which, despite the diversity of this vast continent, only nine *Didemnum* spp. are documented. Access to previously unexplored habitats and regions will undoubtedly result in the discovery of undescribed indigenous taxa and reflect an urgent need for taxonomic work to reveal their biology and relationships.

Key words: *Didemnum lahillei*, *Didemnum perlucidum*, *Didemnum misakiense*, *Didemnum vestum*, *Didemnum vexillum*, conspecific, invasive, three-dimensional growth form, spicules, provisional identification, indigenous pest species, New Hampshire, Mediterranean, New Zealand

Introduction

Recent publicity has been given to three *Didemnum* spp. with a similar complex, three-dimensional growth form occurring, respectively, off the Atlantic coast of North America, the South Island of New Zealand and the Mediterranean, the North Sea and the English

Channel. Despite any evidence that would support this view, except (presumably) that the colonies are the same colour and superficially look similar, they have been provisionally pronounced to be conspecific and efforts have been made to effect their acceptance as a single invasive species (USGS, 2004 and Lambert, 2004). In this paper, these species are compared and their relationships assessed.

Two colonies of a *Didemnum* sp. from New Hampshire on the eastern coast of North America have been examined and found to belong to a new species for which they constitute the types. The species is compared with *D. vexillum* Kott, 2002 from New Zealand and *D. lahillei* Hartmeyer, 1909 from the Mediterranean, the North Sea and English Channel. Each species is found to be distinct. They have been compared also with other similar species, viz. *D. perlucidum* Monniot, 1983 from the West Indies, *D. perlucidum*: Rocha and Monniot, 1995 from Brazil, *D. perlucidum*: C. and F. Monniot, 1987 from French Polynesia, and *D. perlucidum*: Monniot, 1995 from New Caledonia; and other species known from Japan and the south-western Pacific with which they could be confused or with which any one may be conspecific.

It should be noted that taxonomic understanding of the Didemnidae of the Atlantic coast of the USA and the West Indies is based largely on accounts by Van Name (1910, 1921, 1945) complemented by work on the didemnids of Guadeloupe by Monniot (1983). Since the publication of these works, there has been a growing appreciation of the relative taxonomic significance of those morphological characters that can be observed in the polymorphic and variable colonies and contractile and convergent zooids of species in this family (Kott, 2001). Modern taxonomic revisions are urgently needed if populations of these organisms in marine assemblages are to be accurately identified and properly managed. The conglomerate of species, probably none actually being members of the Indo-West Pacific nominal species, contained in *Didemnum candidum*: Van Name, 1921 and 1945 is evidence of this need for revision (see Kott, 2001).

Energetic and conscientious efforts applied to understanding the taxonomic status of the species involved may be more productive than activities designed to promote the acceptance of unidentified or "provisionally" identified material as "invasive", despite (as in the present case) inadequate description and the lack of evidence that introduced species are involved.

The institutions in which the type material is lodged are indicated by the following acronyms:

USNM, United States National Museum of Natural History, Smithsonian Institution,
Washington DC, USA

QM, Queensland Museum, Brisbane, Queensland, Australia

Description

Didemnum vestum sp. nov.

?*Didemnum candidum*: Van Name, 1921: 323 (part); 1945: 839 (part).

Not *Didemnum lahillei* Hartmeyer, 1909: 1450

Didemnum cf. *lahillei*: Lambert, 2004:3 (part, specimens from New Hampshire only).

Didemnum lahillei (unpublished provisional designation): ? Lambert in USGS 2004: 1 (part, specimens from New Hampshire only) *fide* Lambert, 2004: 3.

Distribution. Type locality: Portsmouth Harbour, Newcastle, New Hampshire USA, on Coast Guard Pier 3m, coll. L. Harris 19 July 2002, holotype USNM 1069121 (portion of holotype QM G308595); paratype QM G308754. Previously recorded: ? New Hampshire and south to Florida and the Gulf of Mexico (as *D. candidum*: Van Name 1921, 1945, part); ? Gulf of Mexico (identified as *Didemnum perlucidum* by G. Lambert, *fide* J. Culbertson *pers.com.*)

Description. The holotype, the larger of two available colonies, is an irregular tongue shape about 7cm long, varying from one to 4cm wide, but not more than 1cm thick. It is fixed at one end to mussel byssus threads. Both under and upper surfaces are even, but the upper surface is divided by deep crevices into broad convolutions and rounded ridges which sometimes are produced into short lobes that may over-grow one another resulting in a sort of large-scale woven appearance. These overgrowths of the surface are tightly apposed to the underlying surface and do not enclose secondary spaces to form a spongy colony- the colony being relatively firm. The shallow, horizontal common cloacal spaces are at thoracic level. Common cloacal apertures are large openings in the deep crevices. Zooids are crowded and evenly spaced. From the surface they appear as small yellowish spots in a pale yellow colony. Branchial apertures are small and inconspicuous except where very sparse spicules, confined to a layer in the thin surface test, form a ring around, and sometimes line the margin of, each stellate opening. However parts of the larger colony and the whole of the smaller one are aspiculate. The internal test core of both colonies is pale yellow, translucent, soft and aspiculate. Occasionally debris is included in the middle of the central test core. Spicules are distinctly stellate and relatively small (to 0.035mm but usually about 0.02mm diameter). They have five to seven and occasionally nine robust sharply pointed conical rays in optical transverse section. The ray length/spicule diameter ratio is 0.26 to 0.28. Spicule rays do not appear compact in the micrographs prepared from this material, separate parallel rods being evident in each conical ray. This may be an artefact resulting from fixation and/or preservation.

Zooids are yellowish, with a deeper yellow egg and stomach. They are small and, in the examined colonies, contracted. The branchial siphon is a short cylinder with six sharp points around the opening. The atrial aperture is sessile and lacks an anterior tongue. The oesophageal neck is not especially long, although in these contracted zooids the anterior origin of the retractor muscle could be deceptive, and in relaxed zooids it could be free

from some distance down the oesophageal neck. Lateral organs are a pair of small ventrally directed cups, one from the posterior part of each side of the thorax. Thoraces are small and although the contracted thoraces obscure the actual number, six stigmata can be readily detected in the anterior row on one side of the branchial sac in vegetative buds. The vas deferens coils eight times around the outer part of the large, top-shaped, undivided testis. Up to eight short stolon vessels with round terminal ampullae project from the concave (ventral) side of the double gut loop. Larvae have not been detected in the type material.

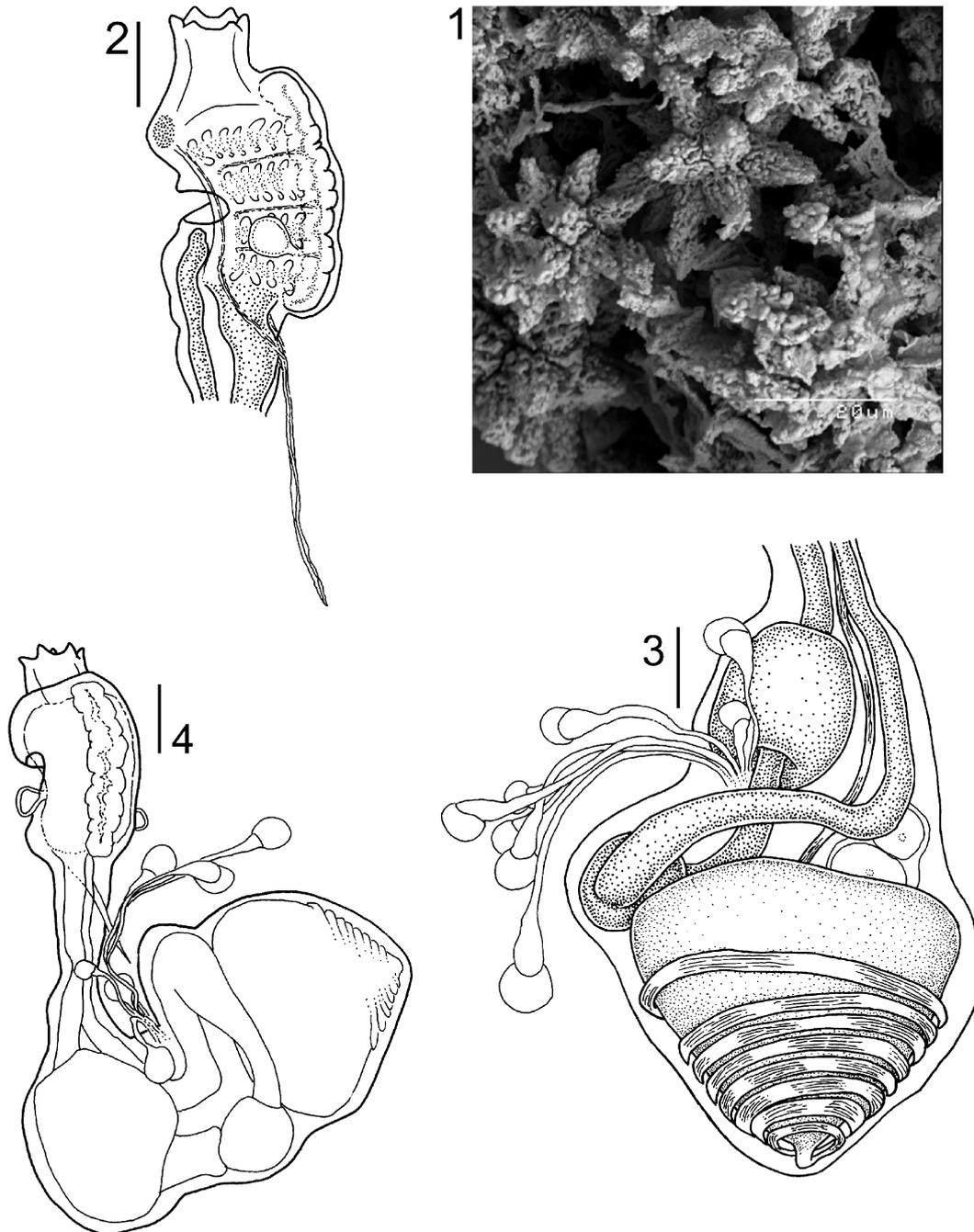
Larvae from similar (but undescribed) colonies in the Gulf of Mexico have six ectodermal ampullae along each side of the three antero-median adhesive organs (*fide* J. Culbertson, *pers. comm.*), although these may not be conspecific. However, the probability that the larvae of the present species do have six pairs of ectodermal ampullae is supported by Lambert's (2004: 4) report that larvae from New England colonies of the present species are "identical" to those of *D. lahillei* (which are known to have six pairs of ectodermal ampullae).

Remarks. The unusually large number of stolon vessels found in the newly recorded specimens has not been reported previously in species of this genus, and their significance is not understood. They may be ephemeral, or they may be found to be a characteristic of the species.

Didemnum candidum; Van Name, 1921, 1945 represents a conglomerate of different species (see Kott, 2001) some of which appear to resemble the present new species. These include the complex fleshy sometimes aspiculate, "peculiar" sponge-like colonies to 13cm from the Gulf of Mexico and others with small stellate spicules less than 0.02mm diameter with relatively few robust conical rays (Van Name 1921: Fig 19) from the New England coast. Although they need revision, these may all be conspecific. Van Name (1921, 1945: 83) described the large specimens from the Gulf of Mexico as having "a deeply convoluted and plicated surface penetrated in different directions by numerous canals and passages of different diameter (giving) a sponge-like character.....(with) zooids and common cloacal canals opening on the walls of clefts and canals". Undescribed material from the same location identified as *D. perlucidum* (by G. Lambert *fide* Culbertson *pers. comm.*), but with six pairs of larval ampullae (rather than the four pairs in *D. perlucidum*), has the same growth form as Van Name's (1945) colonies from the Gulf of Mexico as well as the type specimens of the present species from the New England coast.

Lambert (2004: 4; see also ? Lambert in USGS, 2004) compared (but did not describe) specimens from Europe identified (by F. Monniot) as *Didemnum lahillei* Hartmeyer, 1909, and states that "all morphological aspects of the adult zooids, colony, spicules and larvae are identical" (to the north American specimens); and she contends that they are also conspecific with the New Zealand *D. vexillum* Kott, 2002, *D. lahillei* being the senior synonym. The basis for the view that these species are conspecific appears to be the similarity of their three-dimensional colonies, their pale yellow colour in life, large (0.6–0.7mm long

trunk) larvae with six lateral ampullae along each side of the three antero-median adhesive organs and the distribution of spicules which are only sparse in the internal test.



FIGURES 1–4, *Didemnum vestum* sp. nov. (QM G308595, holotype): 1, spicules; 2, thorax; 3, abdomen; 4, whole zooid. Scale bars, 1: 0.02mm; 2–4: 0.1mm.

Didemnum lahillei Hartmeyer, 1909, a *nom. nov.* for *Leptoclinum gelatinosum* Giard, 1872, from the Mediterranean, the North Sea and the English Channel has a complex three-dimensional colony that occupies vertical or under surfaces. It is reported to be either a honey yellow colour, or chocolate brown or other colours and is sometimes marbled in life (Lafargue, 1968, 1975; Lafargue and Laubier, 1980; and Lafargue and Wahl, 1987). It has only seven stigmata in the anterior rows and 8 coils of the vas deferens. It resembles the present new species in the numbers of stigmata and vas deferens coils, and probably in its larvae. Nevertheless, apart from their small size (to 0.03mm diameter) the spicules of *D. lahillei* are burr-like with many needle like rays (see especially Lafargue and Laubier, 1980, Pl.VB) and readily distinguished from the stellate spicules with relatively few short conical rays that characterise the present new species.

The small burr-like spicules of *D. lahillei* are also very different from those of *D. vexillum* Kott, 2002, a species recorded from vertical substrates in Whangamata Harbour, New Zealand which has been proposed (Lambert, 2004 and USGS, 2004) as a junior synonym of *D. lahillei*, but without any supporting evidence. The New Zealand species is readily distinguished from the newly described northern Atlantic species and the European *D. lahillei*. Spicules are present surrounding the zooids in the surface in a thicker layer than in either the present new species or *D. lahillei* and they also form a layer lining the common cloacal canals and cavities. In some places zooids are arranged along each side of circular common cloacal canals rather than being evenly spaced. Primary common cloacal canals often extend into capacious posterior abdominal cavities and these, together with the large secondary spaces enclosed by overgrowth of lobes from the surface, create particularly spongy colonies. Spicules are larger (to 0.06mm diameter) than either of the other species, they have more conical rays (nine to eleven in optical transverse section) than the present species and the zooids have more stigmata (eight or nine in the anterior row) and nine coils of the vas deferens surround the testis.

Didemnum lutarium Van Name, 1910 (*D. candidum* sub sp. *lutarium* Van Name, 1921, 1945) from the Atlantic coast of the USA between New Hampshire and Florida (see Van Name, 1945) has small spicules and sometimes lobed colonies. It is distinguished by the presence of spicules throughout the test and its subdivided testis. *Didemnum lutarium*: Rocha and Monniot, 1995 also has a subdivided testis but its spicule rays are blunt rather than pointed cones and it appears to have been misidentified.

Didemnum incanum (Herdman, 1899) from the south-western Pacific, has similar colonies, spicules and zooids to the present species, and similar ridges develop from the surface of colonies taken from vertical substrates (see Kott, 2001). Like *D. vexillum*, the species has nine vas deferens coils, but is distinguished from it by a thicker layer of spicules in the surface (surrounding the zooids), smaller spicules (to 0.04mm diameter), fewer (5-9) and longer spicule-rays with a ray-length/spicule diameter ratio to 0.375, and a smaller larval trunk, a long tail and only 4 pairs of ectodermal ampullae. The present new species from New Hampshire has similar but smaller and sparser spicules with shorter rays and probably its larval trunk is longer with six pairs of ectodermal ampullae.

The Japanese species, *Didemnum misakiense* Oka and Willey, 1892 has a similar three-dimensional colony to the present species and equally small spicules. However the spicules have eight or nine rays in optical transverse section and the rays are said to have blunt or truncated tips (see Tokioka 1967, Japanese specimens only) while the present species has spicule rays with pointed tips.

D. pardum Nishkawa, 1990, another Japanese species, has stellate spicules with eight to ten rays in optical transverse section similar to but smaller (0.04mm diameter) than *D. vexillum*, similar larvae (although the six ectodermal ampullae on each side are subdivided) and more (to 11) coils of the vas deferens

Didemnum perlucidum Monniot, 1983, recorded from wharf piles and other substrates from Guadeloupe, has large colonies of similar size (to 8cm), shape and spicule distribution (including aspiculate colonies) to the present species and similar large zooids with seven stigmata in the anterior rows and eight coils of the vas deferens around the undivided testis. However the species from Guadeloupe has encrusting, thin, sheet-like colonies and does not form the same lobed and three-dimensional colonies found in either *D. lahillei*, *D. vexillum* or the present new species; and it has an almost spherical, small larva (the trunk 0.5mm diameter) with the tail wound completely around it and only four pairs of anterior ectodermal ampullae rather than the six pairs that appear to be characteristic of the present species. *Didemnum perlucidum*: Monniot *et al.*, 1985; C. and F. Monniot, 1987 from French Polynesia and 1994 from French Equatorial Africa and Monniot, 1995 from New Caledonia are largely undescribed, although their larvae with 4 pairs of ectodermal ampullae as in the type material from Guadeloupe constitute a clear distinction from the present species. *Didemnum perlucidum*: Rocha and Monniot, 1994 from Brazil appears to have been misidentified, having larger spicules and fewer coils of the vas deferens than the nominal species.

Didemnum vestum. from the Atlantic coast of North America, with a complex, three dimensional colony, is distinguished from other *Didemnum* species with a similar growth form by its small stellate spicules (to 0.03mm diameter) with five to seven stout conical rays in optical transverse section, eight coils of the vas deferens and six or seven stigmata in the anterior row of the branchial sac. Its larvae appear to have six pairs of ectodermal ampullae, although this requires confirmation.

Conclusion

In the more than half a century since the publication of Van Name's (1945) monograph, the taxonomic study of American ascidians has been neglected. That work, based on published works and existing museum collections, included ascidian species from the Arctic and SubAntarctic, Bering Sea and the western coast of South America as well as the Pacific and Atlantic coasts of North America and Canada and the tropical Caribbean region. It would be naïve to suggest that the diverse habitats encompassed by these vast

regions had been adequately sampled or that the whole ascidian fauna of this continent was represented by the (approximately) 400 species in the monograph. In fact, there are only five *Didemnum* spp. (in addition to four polar and sub-polar species) in the publication and it is clear that the American ascidian fauna is relatively unknown. Now, in the 21st century, with the increasing use of SCUBA, photography and television, collections and observations can be made in previously inaccessible locations and habitats. Further, opportunities to access the habitats and locations are increased by the frequency of environmental monitoring, the use of marine habitats for various urban, recreational, agricultural and engineering projects including the development of maritime facilities. Under these circumstances, only the availability of taxonomic expertise will ensure the accurate identification of organisms that are observed for the first time and ensure their appropriate and objective management.

In the present case, assessment of the biogeography of the species concerned should take into account the following considerations:

1. specimens included in *D. candidum*: Van Name 1945, probably conspecific with the newly described species, *Didemnum vestum*, were recorded from the Gulf of Mexico and the New England coast as early as 1921.
2. specimens of *D. lahillei* were recorded from the Mediterranean as early as 1872.
3. *Didemnum vexillum* was recorded only in 2002 but, as Kott (2002) pointed out, it is known only from New Zealand and, in the absence of data to the contrary, the simplest explanation of its occurrence is that it is indigenous.

This is not to say that indigenous species will not become pests if new and suitable habitats become available to them. Nevertheless, in documenting the spread of populations it surely is appropriate to regard the absence of records as just that, and not necessarily evidence of prior non-occurrence.

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