Marine Biodiversity Records, page 1 of 5. © Marine Biological Association of the United Kingdom, 2012
doi:10.1017/S1755267211000510; Vol. 5; e34; 2012 Published online

Record of *Viminella flagellum* (Alcyonacea: Ellisellidae) in Italian waters (Mediterranean Sea)

M. GIUSTI[1], M. BO[2], G. BAVESTRELLO[2], M. ANGIOLILLO[1], E. SALVATI[1] AND S. CANESE[1]

[1]ISPRA (ex ICRAM), Via di Casalotti 300, 00166 Roma, Italy, [2]Dipartimento di Scienze del Mare, Università Politecnica delle Marche, 60131 Ancona, Italy

The occurrence of the whip coral Viminella flagellum *in Italian waters (Strait of Sicily, Mediterranean Sea), is reported for the first time. The specimens were photographed and sampled at locations situated from 130 to 250 m depth on the north-eastern coasts of Pantelleria Island, by means of a remotely operated vehicle, during a research cruise carried out by ISPRA in May 2010 on-board of the RV 'Astrea'. A description of the living colonies and other taxonomic characteristics is given. Our finding extends the known geographical distribution of this species in the Mediterranean Sea to the Strait of Sicily.*

Keywords: *Viminella flagellum*, mesophotic zone, ROV exploration, biogeography, Pantelleria Island

Submitted 21 February 2011; accepted 6 April 2011

INTRODUCTION

Viminella flagellum (Johnson, 1863) (family Ellisellidae) is a whip-like gorgonian characterized by unbranched colonies up to 3 m high and has been only uncommonly observed with one or a few side branches (Carpine & Grasshoff, 1975; Fabricius & Alderslade, 2001; Grasshoff & Bargibant, 2001; Weinberg & Grasshoff, 2003). In the longest specimens the distal portion may be coiled, giving rise to a spiral structure that may detach generating young colonies (Grasshoff & Bargibant, 2001) as commonly observed for other whip alcyonaceans (Walker & Bull, 1983).

Viminella flagellum is mainly diffused along the Eastern Atlantic coasts (Azores Islands, Cape Verde Islands, Canaries Islands, Madeira, Josephine Bank, Great Meteor Bank and Moroccan coast), where it may form dense meadows, especially over seamount plateaux, and may reach great depths (up to about 1000 m, but usually below 350 m) (Grasshoff, 1972; Carpine & Grasshoff, 1975; Brito & Ocaña, 2004).

This species, together with *Ellisella paraplexauroides* (Stiasny, 1936), are the only two Mediterranean components of the family Ellisellidae. The species was first recorded by Carpine & Grasshoff (1975) at 120 m depth off of western Corsica, and a dubious record exists from Naples (Simpson, 1910; Grasshoff, 1972). Several other records from the Alboran and Balearic Seas (Alboran Isle, Seco de los Olivos Seamount, Seco de Palos Seamount and Emile Baudot Seamount) were recently obtained through remotely operated vehicle (ROV) explorations conducted by Aguilar *et al.* (2006) (Figure 1).

In these Mediterranean localities, the species was always recorded between 90 and 200 m depth, generally on rocky substrata arising from detritic bottoms. *Viminella flagellum* may form dense monospecific aggregations, but was also recorded in mixed assemblages with *Callogorgia verticillata* (Pallas, 1766), *Eunicella verrucosa* (Pallas, 1766) and several species of other sea fans, like *Swiftia pallida* Madsen, 1970, *Paramuricea macrospina* (Koch, 1882), and *E. paraplexauroides* (Aguilar *et al.*, 2006). In the Atlantic, (Tenerife, Canary Islands) the species was described as occurring on detritic bottoms associated with *C. verticillata*, and on soft bathyal bottoms together with *Isidella elongata* (Esper, 1788) (Brito & Ocaña, 2004). The specimens from Corsica were yellow-orange (Carpine & Grasshoff, 1975), as those described on the Josephine Bank (Grasshoff, 1972), but those photographed through ROV explorations along the Spanish coasts, and in most of the Atlantic spots, were generally white (Grasshoff, 1972; Aguilar *et al.*, 2006). Unlike the Atlantic specimens, the Mediterranean ones are usually less than 1 m high and characterized by a thinner basal diameter of the stem (Grasshoff, 1972; Carpine & Grasshoff, 1975).

The majority of Mediterranean deep coral species have been described only on the basis of dredged specimens and fragments, therefore our knowledge concerning natural populations of these anthozoans is very limited (Bo *et al.*, 2011). The aim of this study is the description of a population of *V. flagellum* observed through ROV explorations in the coastal waters of Pantelleria Island (Strait of Sicily). Morphological data of the specimens are provided together with a description of their habitat and geographical distribution in the Mediterranean basin.

MATERIALS AND METHODS

Pantelleria Island is situated 85 km south-west of Sicily and represents the emerged top of a volcano situated in the centre of the Strait of Sicily rift zone (Civile *et al.*, 2008).

Corresponding author:
M. Giusti
Email: michela.giusti@isprambiente.it

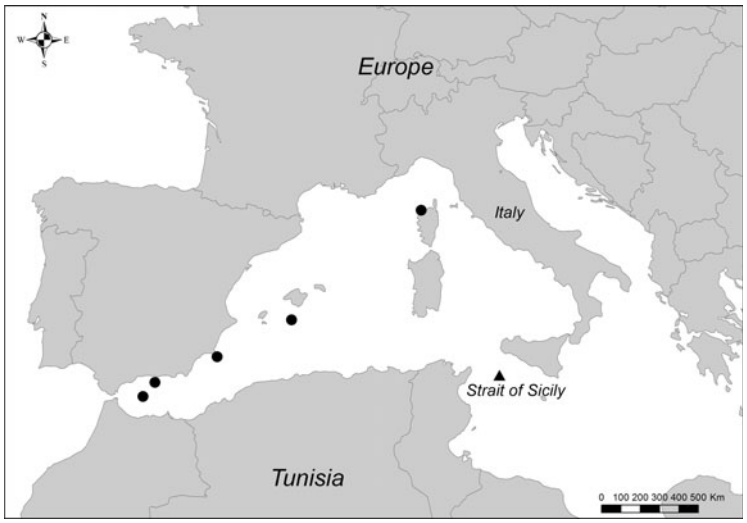

Fig. 1. Map of the geographical distribution of *Viminella flagellum* (black dots) in the Mediterranean Sea. Black triangle is the present record.

This feature, defined by deep troughs with bathymetric lows reaching depths of over 1300 m, is located in the part of the Strait of Sicily which is considered to represent the limit between the western and eastern Mediterranean Sea (Bianchi, 2007). The study area, named Cala Caruscia, in the north-east side of Pantelleria (Figure 2), was explored through a ROV survey conducted in May 2010 on-board of the RV 'Astrea'. The ROV was equipped with a digital camera (Nikon D80, 10 megapixel), an underwater strobe (Nikon SB 400), a high definition video camera (Sony HDR-HC7) and a 3 jaw grabber (SeaBotix Inc.) used for sample collection. The ROV was also equipped with a depth sensor, a compass, and three laser beams spaced 10 cm apart, to form an equilateral triangle, used as reference scale to assist the observers in estimating frame area and the size (height and width) of the photographed samples. Photographic and direct samplings were carried out in the mesophotic zone, between 130 and 250 m depth. Photographs were analysed to describe the general morphology of the whip coral colonies and their *in vivo* appearance. Gorgonian sclerites were analysed at SEM after dissolving the coenenchyme in sodium hypochlorite. A fragment fixed in 95° ethanol was used for the morphological analysis of polyps carried out with SEM and stereomicroscope.

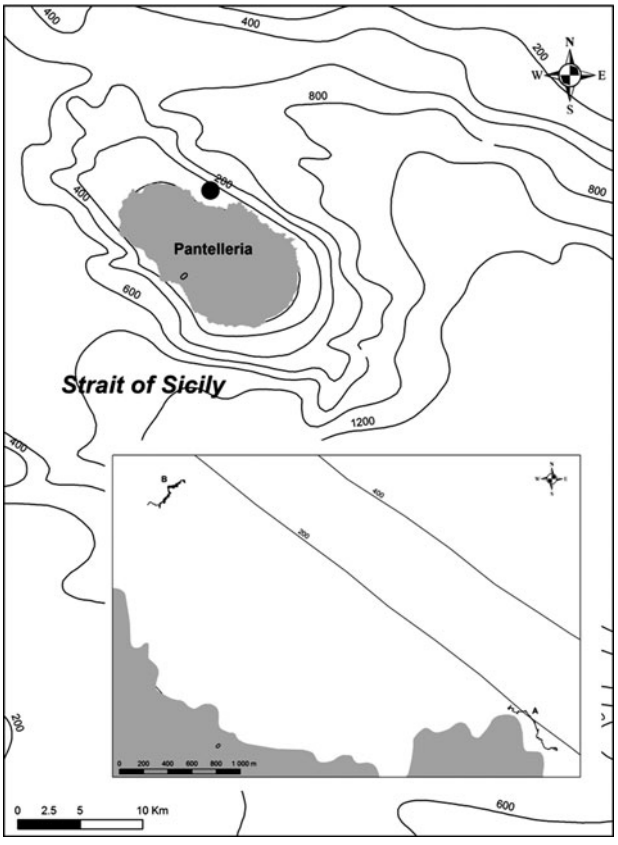

Fig. 2. Map of the sampling area (black dot). In the inset are shown the remotely operated vehicle tracks.

RESULTS

The two ROV tracks carried out in the study area (Figure 2 inset, A & B) (845 m and 620 m long, respectively) covered a surface of approximately 4600 m^2. The explored area is characterized by inclined rocky walls extending up to approximately 200 m depth, after which the bottom turns into heavily silted rocky boulders ending into a gently inclined soft bottom slope.

In total, 10 colonies of *V. flagellum* were observed sparsely occurring on the rocky bottom (Figure 3A–D). Specimens, characterized by a white-orange colour, were found at depths ranging between 156 and 242 m and inside a community mainly composed of a mixed assemblage of *V. flagellum*, *Swiftia pallida* (Figure 3A) and other undetermined small gorgonians. Encrusting sponges and ascidians were the only other components of the benthic assemblage, strongly influenced by the sediment deposition.

The colonies' height ranged from 2 to 79 cm (on average 41.2 ± 8.0 cm) and their basal diameter was approximately 2–3 mm. Most of them were unbranched with only 3 specimens bearing one or two branches (Figure 3C). The length of the branches varied between 2 and 20 cm (on average 7.4 ± 3.5) and the distance from the base to the first ramification ranged from 1 to 30 cm (on average 14.0 ± 6.0 cm). No epibionts were recorded on the colonies.

During the ROV survey, a sample of 49 cm length, was collected from an unbranched colony 79 cm high (Figure 3A, E). The observed polyps were monomorphic and highly contractile.

Underwater images indicate the presence of extended polyps characterized by tentacles almost of the same length of calyces (Figure 3F). In the studied apical portion, polyps were arranged in two longitudinal opposite rows (Figure 3F–H). Commonly, calyces may show different inclinations with respect to the main stem (Figure 3H). In the most basal portions of the colony instead, the photographs indicate the presence of multiple rows of calyces extending almost perpendicularly from the stem, a feature previously described by other authors (Carpine & Grasshoff, 1975). Calyces (up to 1.5 mm high) (Figure 3I) were characterized by thick walls and upon contraction, the polyps formed knobs on the surface of the branches.

Sclerites were colourless, highly tuberculated and can be described as belonging to various types (Figure 3J): symmetrical double heads (up to 55 μm high) that are densely packed on the surface of the coenenchyme (Figure 3Ja), slightly elongated double heads, capstans, and spindles (between 60 and 80 μm high) that are organized in the subsurface of the coenenchyme and in the wall of calyces (Figure 3Jb–e), and 60 μm high rods occurring on the pharynx of the anthocodiae (Figure 3Jf). The size of the observed sclerites was slightly smaller than that reported for Atlantic species (Carpine & Grasshoff, 1975).

DISCUSSION

Viminella flagellum is an Atlantic–Mediterranean species living in temperate and subtropical waters. Until now, with the exception of a record on the western coast of Corsica, knowledge about the species' occurrence in the Mediterranean Sea was limited to the immediate surroundings of the Gibraltar Strait (Alboran Isle, Seco de los Olivos and Seco de Palos) and the Balearic Sea (Marion Boudet Seamount). The present record, occurring on the norhth-eastern coast of Pantelleria Island, in the Strait of Sicily, is the most eastern

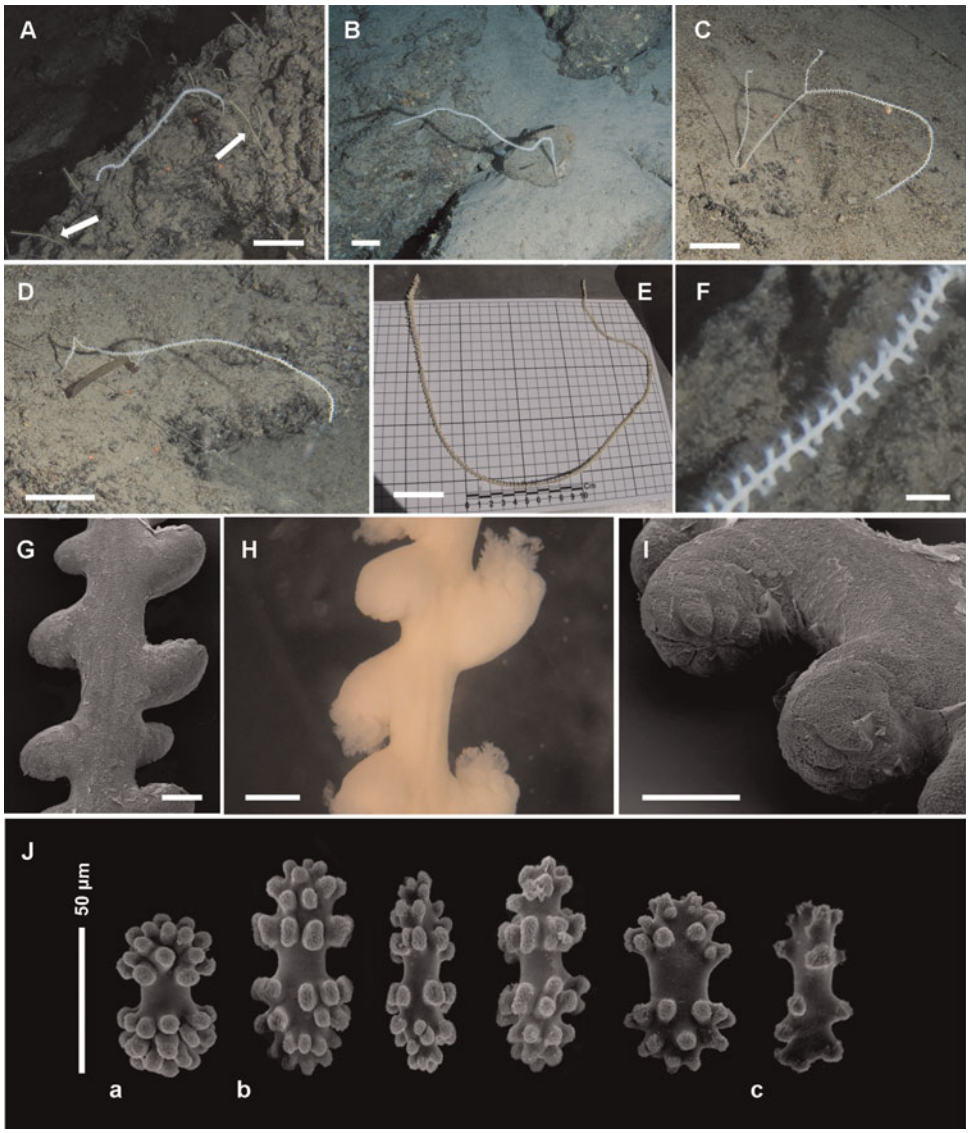

Fig. 3. *Viminella flagellum* from Pantelleria. A–D. Underwater photographs of *V. flagellum*. Sparse single stem white colonies living on rocky bottoms. Occasionally (Figure C), colonies may be ramified. The sea bottom host few other species, for example colonies of *Swiftia pallida* (Figure A, yellow colonies indicated by arrows); (E) collected specimen; (F) expanded polyps of a living colony; (G–H) SEM and stereomicroscope photographs of the arrangement of calyces on the apical portion of the stem; (I) Close-up view of calyces; (J) sclerites of *V. flagellum* composed of: a. double head from the superficial layer of coenenchyme; b. thick capstan; c. slender capstan; d, e. blunt spindle and deformed double-head from the deeper layer of the coenenchyme and from calyces; f. rod from the pharynx. Scale bar: A–D: 10 cm, E: 5 cm, F: 5 mm, G–I 1 mm.

record of the species in the Mediterranean, and represents the first observation of the species in Italian waters thereby increasing the number of recorded anthozoan alcyonacean species in Italian waters (Morri *et al.*, 2008) to 26. Moreover, this record extends to about 250 m the bathymetric distribution limit of the species in the Mediterranean basin.

Unlike previously described specimens, the Pantelleria colonies are characterized by a limited height extension and by a thin basal diameter. The highest and thickest specimens ever described were found on the Meteor Bank (Grasshoff, 1972), and were about 4 times the length and 3 times the thickness of the presently described colonies. It is known that highly energetic environments, such as seamounts, often host very dense whip coral meadows (Genin *et al.*, 1986), since these organisms are the best adapted to turbulent conditions, due also to their thick basal stem.

Almost no data are available on the population structure of the meadows of *V. flagellum*, Grasshoff (1972) reported a patchy distribution with densely colonized rocky areas alternated with non-colonized sandy zones. The images reported by Aguilar *et al.* (2006) indicate very dense meadows in the Mediterranean populations. In the studied area of Pantelleria, colonies show a sparse distribution and no traces of aggregations are observed probably in relation to a low food availability of the area.

The predominant Mediterranean water circulation explains the gradual colonization of the southern coasts of the basin by Atlantic species entering the Strait of Gibraltar. In particular, the recorded distribution of the studied species seems related to different branches of the incoming Atlantic waters flowing from the Strait of Gibraltar along the Algerian coast towards the Strait of Sicily. It is also to be noted that the southern side of the Balearic Archipelago (where, recently, populations of *V. flagellum* were discovered) is influenced, during summer, by a superficial input of Atlantic waters through eddies that stem from the main Algerian current (Bianchi, 2007).

The Strait of Sicily represents, from a geomorphologic and oceanographic point of view, an important boundary area, where species are known to be subjected to great selective pressures (Bianchi & Morri, 2000; Pinardi & Masetti, 2000; Bianchi *et al.*, 2002; Bianchi, 2007).

The presence of *V. flagellum* in both the Strait of Sicily and the Balearic Islands may be explained also by some common environmental and oceanographic features of these two areas. Both are characterized by an intense geostrophic circulation of water masses and by a complex topography, that, due to the presence of islands and seamounts, generate mesoscale eddies and convergent fronts (López-Jurado *et al.*, 1995; Pinot *et al.*, 1995; Vélez-Belchí & Tintoré, 2001; García *et al.*, 2003; Oray *et al.*, 2005; Alemany *et al.*, 2006). The peculiar ocean circulation patterns found in these areas are at the base of a high biological productivity, thereby contributing to the presence of biodiversity hotspots (Greenpeace International, 2009). The anthropogenic threats exerted on these vulnerable habitats and species gives to these areas high priority for inclusion in any future comprehensive and fully representative network of marine protected areas for the Mediterranean basin.

ACKOWLEDGEMENTS

We thank the crew members of RV 'Astrea' for their precious help and work during field operations, our colleague Dr Giulia Mo and two anonymous referees whose comments helped to improve the paper. This work was financed by Italian Ministry of the Environment, Land and Sea protection.

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Correspondence should be addressed to:
M. Giusti
ISPRA (ex ICRAM), Via di Casalotti 300, 00166 Roma
Italy
e-mail: michela.giusti@isprambiente.it