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Aquatic Invasions Records

Occurrence of the alien kelp *Undaria pinnatifida* (Laminariales, Phaeophyceae) in Mar del Plata, Argentina

Pablo Ezequiel Meretta[1]*, Carolina Verónica Matula[1] and Graciela Casas[2]

1 *EGEM, Ecología y Genética Marina – IIMC, Instituto de Investigaciones Marinas y Costeras, CONICET – FCEyN, Universidad Nacional de Mar del Plata, Funes 3350 (7600) Mar del Plata, Provincia de Buenos Aires, Argentina*
2 *Centro Nacional Patagónico, CONICET, Boulevard Brown 2915, U9120ACD Puerto Madryn, Argentina*

E-mail: pabloemeretta@gmail.com (PEM), cmatula@mdp.edu.ar (CVM), graciela@cenpat.edu.ar (GC)

**Corresponding author*

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Abstract

Undaria pinnatifida (Harvey) Suringar 1873 is native to Northern Asia and has become well established in the Mediterranean Sea, Atlantic Europe, New Zealand, Tasmania, Australia, Pacific coasts of United States and Mexico and Patagonia Argentina. On the 13th of September of 2011 sporophytes of *U. pinnatifida* were found growing from the subtidal-intertidal limit to 4.5 m depth in Mar del Plata. This contribution brings the first *Undaria pinnatifida* report in Mar del Plata and extends 1300 km the northern distribution limit of this kelp in Argentina.

Key words: invasive species; Japanese kelp; Alariaceae; *Undaria pinnatifida*; harbour; Argentina

Introduction

Marine algal invasion is among the most common anthropogenic impacts on coastal systems around the world (Kraufvelin and Salovius 2004; Lotze et al. 2006). Invasive algal species in many cases change the coastal ecosystems, modifying local algal communities structure, and consequently the associated benthic fauna (Buschbaum et al. 2006; Williams and Smith 2007). A widely known example is the edible invasive algae *Undaria pinnatifida* (Harvey) Suringar 1873. This kelp is native to Northern Asia, where it is cultivated for food. It has been introduced worldwide in different coastal areas accidentally or intentionally for cultivation purposes. The most important vector of accidental seaweed dispersion is vessel traffic, through fouling of ship hulls (as gametophytes or small sporophytes) or, less commonly, via the discharge of ballast water (as spores) (Williams and Smith 2007).

Undaria pinnatifida (hereafter referred to as *Undaria*) has become well established in the Mediterranean Sea and the north and south of both Atlantic and Pacific Oceans. The first known introduction was to the Mediterranean French coast in 1971; it was then recorded from the Atlantic coasts of Spain and England (Perez et al. 1981; Boudouresque et al. 1985; Fletcher and Manfredi 1995; Salinas et al. 1996). It was also introduced into New Zealand, Tasmania, Australia and the Pacific coasts of the United States and Mexico (Hay and Luckens 1987; Sanderson 1990; Campbell and Burridge 1998; Silva el al. 2002; Aguilar–Rosas et al. 2004).

In Argentina, the first record of this species dates from 1992 in Nuevo Gulf (Northern Patagonia), where its introduction was thought to be the result of the discharge of ballast water from international vessels or cargo ships (Piriz and Casas 1994; Casas and Piriz 1996). In late 2000, the occurrence of *Undaria* was reported in Camarones Bay (Casas 2005). In 2005 it was found in the Natural Reserve of Ría Deseado in Southern Patagonia, also likely due to the discharge of ballast water (Martin and Cuevas 2006), and in 2007 it was reported in San José Gulf, located to the north of the Nuevo Gulf (Casas and Schwindt 2008) (Figure 1). Thus, it does not present a clear dispersion pattern in Argentina. Dellatorre et al. (2011) discuss, based on seawater temperature data and the broad

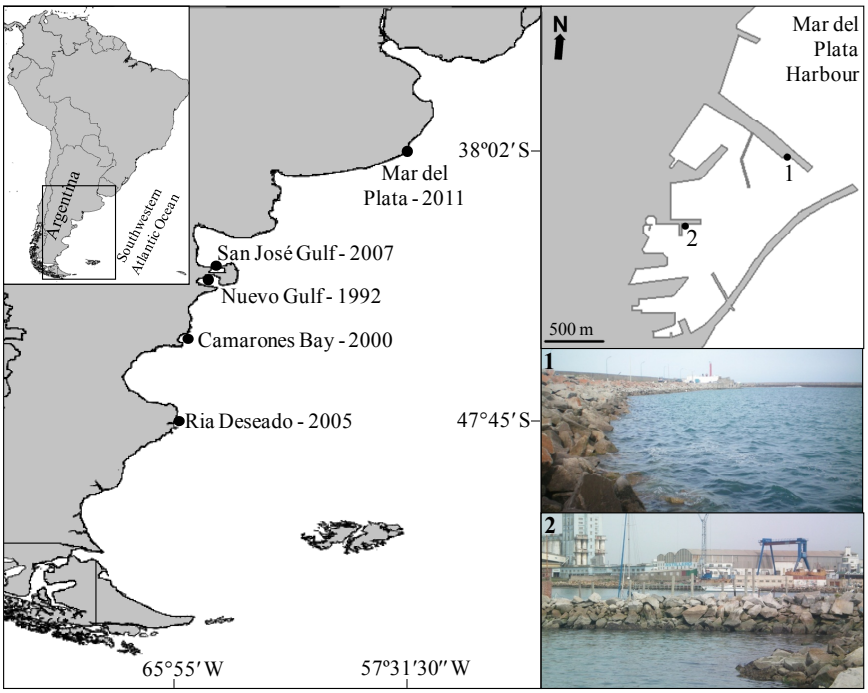

Figure 1. Study area, record site and spread in Argentina of *Undaria pinnatifida*. (1) Breakwater "Norte"; (2) breakwater "C".

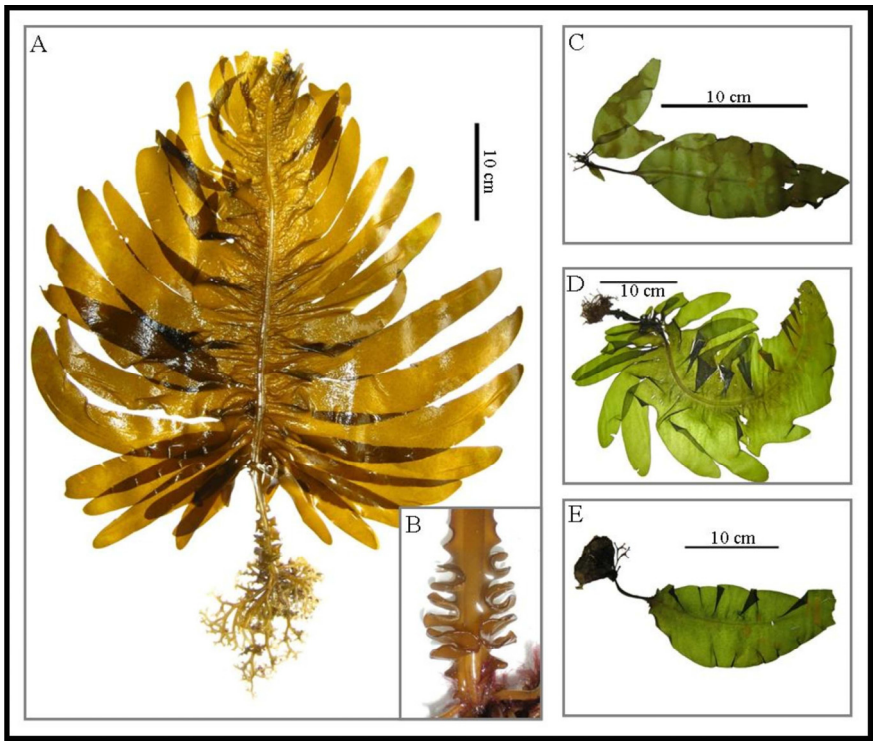

Figure 2. *Undaria pinnatifida* morphotypes: (**A** and **D**) Mature sporophyte of *Undaria pinnatifida*; (**B**) Sporophyll detail; (**C**) Small immature specimen; (**E**) Specimen fixed to the alien tunicate *Ciona intestinalis* (Linnaeus, 1767). Scale bar: 10 cm. Photographs by C.V. Matula.

thermal tolerance of this species, the potential for further dispersal northwards, suggesting that temperature will not limit further spread to the northern coasts of Argentina.

Materials and methods

Undaria was found inside Mar del Plata Harbour (38º02′00″S, 57º31′30″W) during the course of a SCUBA survey in September 2011 (late winter). This coast is characterized by a semidiurnal tidal regime with 0.60 to 0.90 m amplitude (Isla and Aliotta 1999). The sea surface temperature varies from 21°C in February to 7 °C in August (SHN 2011) and the salinity varies between 32.6 PSU and 34.6 PSU, with an average of 33.7 PSU (Martos et al. 2004). Inside the harbour, low currents and high turbidity characterize the area. The seafloor is divided into boulders of ortho-quartzite rocks surrounding breakwaters and a fine–grained muddy bottom.

On the 20th of September and 4th of October of 2011 SCUBA surveys were conducted on the breakwaters “Norte” and “C”, inside Mar del Plata harbour (Figure 1). Population censuses were performed by swimming along 10 × 2 m-wide transects placed perpendicular to the breakwaters. At 5 m intervals, we registered the bottom depth at which any *Undaria* was encountered. Additional random samples were obtained. We measured thallus length, wet weight and morphological characteristics. Consequently, density, vertical distribution, and mean thallus length and weight were determined.

Results

In breakwater “Norte”, healthy and whole specimens (sporophytes) were growing in the subtidal, as deep as 4.5 m depth, in an aggregated distribution. In contrast, just below mean lower low water, *Undaria* formed very large patches. Density and number of individuals of *Undaria* were lower on the 20th of September (3.88 ind.m^{-2}, SE = 2.81; N=37) than on the 4th of October (8.56 ind.m^{-2}, SE = 5.85; N=87). Density and number of individuals increased between the two survey periods, and these differences were statistically significant ($t = -2.252$, $p < 0.05$, for density; $X^2 = 18.3$, $p < 0.05$, for number of indiviuals).

The samples presented a mean thallus length of 34.30 cm (SE = 20.31), with the smallest and largest individuals measuring 1.7 and 86 cm respectively. More than 82% of the specimens encountered had midribs and 64% of them presented the sporophyll, the distinctive reproductive structure of this species (Casas 2005) (Figure 2). Smaller individuals (less than 14 cm) did not present either of these two structures (Figure 2C). No *Undaria* was found in breakwater “C”, which is separated from breakwater "Norte" by 1000 m (Figure 1).

All specimens were attached by their holdfasts to ortho-quartzite rocks of variable sizes and slopes or to the tunicate *Ciona intestinalis* (Linnaeus, 1767), another common harbour alien species (Figure 2E). It was also common to see small immature individuals fixed to the holdfast of bigger mature ones. Individuals of *Undaria* were virtually absent on the vertical walls of the harbour and on neighbouring soft bottom areas. Voucher specimens were deposited at the Museo Argentino de Ciencias Naturales “Bernardino Rivadavia” (MACN) under the catalogue numbers BA 47518 and BA 47519.

Discussion

A young and apparently growing population of *Undaria* was found in the Mar del Plata Harbour, one of the most important commercial harbours in Argentina. The introductory vector is still unknown, but we consider that a simple drift arrival is unlikely because the nearest *Undaria* population is located 1300 km to the south and currents would have facilitated further settlement points in between. In Argentina there is only one area where aquaculture exists, but this activity is related to mussel cultivation and it is situated at 3000 km to the south from Mar del Plata. As this Harbour receives national and international cargo ships and fishing vessels, the recent invasion is more probably due to the arrival of ships from Patagonia or an introduction from other world areas. This new record extends, by 1300 km, the northern distribution limit of *Undaria pinnatifida* in Argentina and reflects the progressive expansion of this invasive kelp into the south-western Atlantic coast.

No other kelp species are present in Mar del Plata (Parma et al 1987; Negri et al. 2004). Since 2006 the authors have been conducting monthly SCUBA surveys on breakwater “Norte”, and

Undaria has never been observed. Its discovery on the 13th of September of 2011 at relatively high densities suggests that this new population is growing rapidly.

Elsewhere in Argentina, Casas et al. (2004) found that the presence of *Undaria* had a negative impact on algal biodiversity, while Irigoyen et al. (2011) observed a higher benthic invertebrate richness and diversity attributable to the provision of new habitat structures. Taking into account the above, and considering this species has a high capacity to colonize new substrata and to grow rapidly, major changes might be expected in Mar del Plata benthic community.

This contribution is the first *Undaria pinnatifida* report inside Mar del Plata Harbour and one of the few reports documenting a population of *Undaria* in an initial phase. However more surveys must be conducted in order to understand the evolution of the invasion and to evaluate the impact of this invasive kelp on the native benthic community.

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