

Species diversity and biogeographical patterns of *Laurencia* sensu stricto (Rhodophyta) in the Atlantic Ocean

Diversidad de especies y patrones biogeográficos de *Laurencia* sensu stricto (Rhodophyta) en el océano Atlántico

Oscar E. Hernández^{1, 2}, Abel Senties², Kurt M. Dreckmann², Valéria Cassano³ and Mutue T. Fujii⁴

¹ Estudiante del Doctorado en Ciencias Biológicas y de la Salud. Universidad Autónoma Metropolitana, Unidad Iztapalapa. A.P. 55-535, CDMX, 09340, México

² Departamento de Hidrobiología, Universidad Autónoma Metropolitana-Iztapalapa, A.P. 55-535, CDMX, 09340, México

³ Departamento de Botânica, Universidade de São Paulo, Rua do Matão 277, São Paulo 05508-090, Brazil

⁴ Núcleo de Pesquisa em Ficologia, Instituto de Botânica, Av. Miguel Estéfano, 3687-04301-902 São Paulo, Brazil
e-mail: oehc90@gmail.com

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ABSTRACT

Background. Recent morphological and phylogenetic studies of *Laurencia* in the Atlantic Ocean have modified our current knowledge of the group. Approximately 23% of the worldwide generic diversity has been recorded in this region. **Goals.** Update the checklist of the *Laurencia* species in the Atlantic and describe the distribution patterns within the genus. **Methods.** We obtained records of *Laurencia* species in the Atlantic from a review of the literature and distributional data were used to define areas of endemism through a PAE (Parsimony of Areas of Endemism) analysis. **Results.** We propose an updated checklist of the 30 currently recognized species of *Laurencia* in the Atlantic Ocean; this checklist also includes taxonomic synonyms, nomenclatural remarks, and a detailed distribution for each species. The distributional range for the genus in the Atlantic extends from Bermuda and Northern Europe in the North Atlantic to Brazil and South Africa in the South Atlantic. We were able to define four areas of endemism: Brazil with four endemic species, the Gulf of Guinea with four endemic species, the northeastern Atlantic with three endemic species, and South Africa with four endemic species; also documented was one secondary area (Macaronesian Islands) with the endemic species *L. viridis*. Moreover, 17 of the 30 species of the Atlantic are also distributed in the Indo-Pacific, of which five are amphi-Atlantic species. **Conclusions.** The patterns found are related to geological events that occurred in the past, a fact that allows us to formulate a vicariance hypothesis about these species biogeographic history. Therefore, future work that will document new species and the clarification of taxonomic problems will allow researchers to continue enriching this hypothesis.

Key words: Area of endemism, biogeography, PAE analysis, red algae.

RESUMEN

Antecedentes. Los recientes estudios morfológicos y filogenéticos de *Laurencia* para el océano Atlántico han modificado el conocimiento actual sobre la diversidad del grupo, registrándose para esta región, aproximadamente el 23% de la diversidad del género a nivel mundial. **Objetivos.** Actualizar el listado de especies de *Laurencia* presentes en el Océano Atlántico y definir sus patrones de distribución. **Métodos.** Se obtuvieron los registros de las especies del género a partir de una revisión bibliográfica, utilizando los datos de distribución para la definición de patrones biogeográficos mediante un análisis de PAE. **Resultados.** Se propone un listado actualizado que contiene 30 especies de *Laurencia* reconocidas taxonómicamente para el Océano Atlántico; además se incluyen sinónimos, notas nomenclaturales y la distribución a detalle de cada una de las especies. El intervalo de distribución del género se extiende desde Bermuda y el norte de Europa para el Atlántico Norte, hasta Brasil y Sudáfrica en el Atlántico Sur. Se definieron cuatro áreas de endemismo: Brasil con cuatro especies endémicas, Golfo de Guinea con cuatro especies restringidas, Noreste del Atlántico con tres especies endémicas y Sudáfrica con cuatro especies endémicas; además de un área secundaria (Islas de la Macaronesia) con *L. viridis* como especie endémica. Por otro lado, 17 de las 30 especies registradas para el Atlántico se distribuyen también en el Indo-Pacífico, de las cuales cinco son especies anfi-Atlánticas. **Conclusiones.** Los patrones encontrados han sido relacionados con eventos geológicos que han ocurrido en el pasado, permitiendo ofrecer una hipótesis de vicarianza sobre su historia biogeográfica. Por lo tanto, trabajos futuros sobre el reconocimiento de nuevas especies y el esclarecimiento de problemas taxonómicos permitirá continuar enriqueciendo dicha hipótesis.

Palabras clave: Áreas de endemismo, biogeografía, Análisis de PAE, algas rojas.

INTRODUCTION

There is a need for an updated checklist of *Laurencia* (Rhodophyta, Ceramiales) in the Atlantic Ocean that accounts for recent morphological and phylogenetic studies that have modified our current knowledge of the group. For instance, the “*Laurencia* complex” has replaced the former concept of *Laurencia sensu lato*. The genus *Laurencia sensu stricto* (s.s.) (Garbary & Harper, 1998; Nam, 2006; Gil-Rodríguez *et al.*, 2012), and the following seven genera belonging to the complex (mentioned above): *Osmundea* Stackhouse, *Chondrophyucus* (Tokida *et Saito*) Garbary *et J. T. Harper*, *Palisada* K. W. Nam, *Yuzurua* (K.W. Nam) Martin-Lescanne, *Laurenciella* Cassano, Gil-Rodríguez, Senties, Díaz-Larrea, M. C. Oliveira *et M. T. Fujii*, *Coronaphycus* Metti and *Ohelopapa* F. Rousseau, Martin-Lescanne, Payri *et L. Le Gall*. These genera differ in the number of pericentral cells cut off by the vegetative axial segments, the origin of spermatangial branches, and the origin of tetrasporangia from determined cells (Saito, 1967; Nam *et al.*, 1994; Garbary & Harper, 1998; Nam, 1999, 2006, 2007). Molecular phylogenetic data also support distinction among them (Martin-Lescanne *et al.*, 2010; Cassano *et al.*, 2012a; Metti *et al.*, 2015; Rousseau *et al.*, 2017).

Laurencia comprises 130 taxonomically recognized species worldwide (Guiry & Guiry, 2017). In particular, 18 species of the genus have been recorded for the Western Atlantic (from North Carolina to Brazil) and 21 for the Eastern Atlantic (Europe and Africa). These represent 23% of the species richness worldwide. Phylogenetic studies of some *Laurencia* species in the Atlantic have shown the artificiality of the wide ranges of distribution of some species, such as *L. microcladia* and *L. obtusa* (Cassano *et al.*, 2012a) that have been eliminated from the Brazilian flora.

The area of endemism is defined as the sympatric congruence between two or more endemic species, based on the fact that these species share a common spatial history (Platnick, 1991; Morrone, 2007). Other areas that can be documented are the secondary areas, which have only one endemic species or the so-called relic species that are important because these areas may be later isolations where species radiation has not yet occurred (Ippi & Flores, 2001; Vargas *et al.*, 2008). The PAE (Parsimony Areas of Endemism) analysis is a method that allows us to identify areas of endemism from area cladograms. In a manner similar to phylogenetic systematics, at least two synapomorphic characters (restricted species) will define areas of endemism (Morrone, 2013).

One important outcome of this taxonomic updating is to provide a better understanding of the biogeographical patterns. With the present updated checklist, we will discuss endemism and the widespread geographic distribution of *Laurencia* species in the Atlantic.

MATERIALS AND METHODS

Records for *Laurencia* for the Atlantic Ocean were obtained from primary sources (these sources are indicated for each species in Results section). We complemented information with the online database Algae Base (Guiry & Guiry, 2017). Parsimony Analysis of Endemity (PAE; Rosen, 1988) was used in a biogeographical analysis. For this analysis, an $r \times c$ binary matrix (presence and absence) was constructed, where r (rows) displays the 17 Atlantic ecoregions proposed by Spalding *et al.* (2007) (Fig. 1) and c (columns) contains 24 of the 30 species recorded for the Atlantic Ocean. Because they could be found practically all over

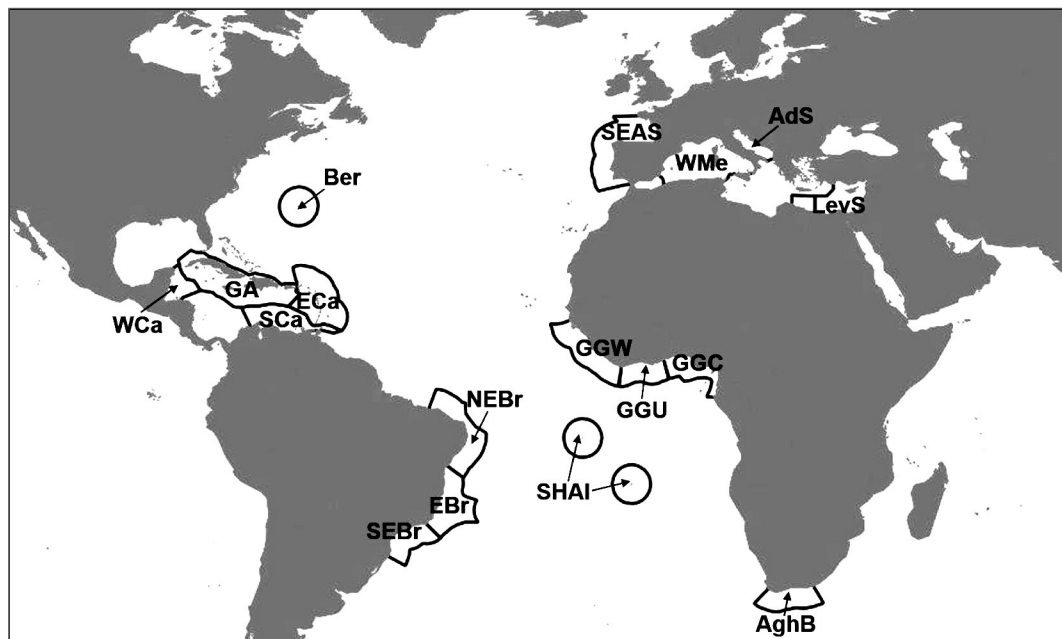


Figure 1. Marine ecoregions used in the PAE analysis, modified from Spalding *et al.*, (2007): Adriatic Sea (AdS), Aghulas Bank (AghB), Bermuda (Ber), Eastern Brazil (EBr), Eastern Caribbean (Eca), Greater Antilles (GA), Gulf of Guinea Central (GGC), Gulf of Guinea Upwelling (GGU), Gulf of Guinea Western (GGW), Levantine Sea (LevS), Northeastern Brazil (NEBr), Southern Caribbean (Sca), South European Atlantic Shelf (SEAS), Southeastern Brazil (SEBr), St. Helena and Ascension Islands (SHAI), Western Caribbean (WCa), and Western Mediterranean (WMe).

the Atlantic, we did not include *L. brongniartii* J. Agardh, *L. caduciramulosa* Masuda *et* S. Kawaguchi, *L. dendroidea* J. Agardh, *L. intricata* J. V. Lamouroux, *L. microcladia* Kützing, and *L. obtusa* (Hudson) J.V. Lamouroux. In addition, the Macaronesian Islands were excluded from the analysis because they are considered to be a transition zone with species from other areas of Atlantic (see Haroun & Prud'homme van Reine, 1993; Tuya & Haroun, 2009), and may affect our distributional patterns (Medina, 2007). Parsimony analysis was done through a heuristic search using TBR+TBR routines with the NONA program, using the WinClada software (Nixon, 1999). A strict consensus tree was built from the most parsimonious trees.

Six "species *inquirenda*" (*L. alsidiidormis* Zanardini *ex* Fraudentfeld, *L. alsidioides* P. L. Crouan *et* H.M. Crouan, *L. botryocephala* Kützing, *L. canariensis* Montagne *ex* Kützing, *L. moriformis* Kützing and *L. trifaria* Kützing) did not provide information about their geographical distribution and were recorded only once by their respective authors. Null or limited herbarium material prevented us from being totally certain about these taxa. Categories of areas (patterns) were defined: Those containing an endemic species (Secondary Area); those with congruence in geographical distribution of two or more endemic species (Area of Endemism), that is, clades defined by two or more synapomorphies; and widespread species (amphi-Atlantic Areas). In addition, we defined areas containing two or more endemic species without total congruence in the geographic distribution of these, known as areas of Partial Congruence.

RESULTS

Checklist of *Laurencia* species

Laurencia aldingensis Saito *et* Womersley

Type locality: Aldinga Reef, South Australia.

Distribution: Tropical Southwestern Atlantic: BRAZIL: Espírito Santo (Carvalho *et al.*, 2006; Fujii *et al.*, 2011) and Rio de Janeiro (Fujii *et al.*, 2011).

Laurencia brachyclados Pilger

Type locality: Annobon Island, Equatorial Guinea, West Africa.

Distribution: Gulf of Guinea: EQUATORIAL GUINEA: Annobon Island (John *et al.*, 2004).

St. Helena and Ascension Islands: ASCENSION ISLAND (John *et al.*, 2004).

Laurencia brongniartii J. Agardh

Type locality: Martinique, West Indies.

Remarks: Dizerbo & Herpe (2007) and Stokes *et al.* (2004) considered this an introduced species in southeast France and Ireland, respectively.

Distribution: Gulf of Guinea: GHANA (John *et al.*, 2004).

Lusitanian: CANARY ISLANDS: El Hierro and Lanzarote (uncertain record) (Gil-Rodríguez *et al.*, 2012). FRANCE: Brest (Dizerbo & Herpe, 2007).

Tropical Northwestern Atlantic: COSTA RICA: Punta Coclas (Fernández & Alvarado, 2004). CUBA: Havana (Suárez, 2005). MARTINIQUE (Womersley, 2003). MEXICO: Quintana Roo (Senties & Fujii, 2002).

Northern European Seas: IRELAND (Stokes *et al.*, 2004).

Laurencia caduciramulosa Masuda *et* Kawaguchi

Type locality: Hon Tre Island, Tien Hai Islands, Hatien, Kien-Giang Province, Vietnam.

Distribution: Lusitanian: CANARY ISLANDS: Tenerife (Gil-Rodríguez *et al.*, 2012).

Mediterranean Sea: FRANCE: Mediterranean coast (Klein & Verlaque, 2005). GREECE: Zakynthos Island (Tsikira & Haritonidis, 2005). ITALY: Linosa Island (Furnari *et al.*, 2001; Serio *et al.*, 2006).

St. Helena and Ascension Islands: ASCENSION ISLAND (Tsiamis *et al.*, 2014a).

Tropical Northwestern Atlantic: CUBA: Havana (Senties *et al.*, 2010) and Rincón del Guanabo (Suárez *et al.*, 2015). USA: Florida (Collado-Vides *et al.*, 2014).

Tropical Southwestern Atlantic: BRAZIL: Bahia (Torrano-Silva & Oliveira, 2013) and Rio de Janeiro (Cassano *et al.*, 2006).

Laurencia caraibica P.C. Silva

Type Locality: Abraham Bay, Mariguana (Mayaguana), Bahamas.

Distribution: Tropical Northwestern Atlantic: BAHAMAS: Abraham Bay (Schneider *et al.*, 2010). BELIZE: Carry Bow Cay (Norris & Bucher, 1982) and Pelican Cays (Littler & Littler, 1997). CUBA: Bucunayagua, Guanahacabibes and Havana (Suarez, 2005). JAMAICA (Taylor, 1960). LESSER ANTILLES (Taylor, 1969). MEXICO: Campeche, Quintana Roo, Tamaulipas, and Veracruz (Ortega *et al.*, 2001; Senties & Fujii, 2002). VENEZUELA (Ganesan, 1990).

Tropical Southwestern Atlantic: BRAZIL: Rio Grande do Norte (Villaza *et al.*, 2010) and Bahia (Creed *et al.*, 2010).

Warm Temperate Northwest Atlantic: BERMUDA: Bermuda Island, Gibbet Island, and Somerset Island (Schneider *et al.*, 2010).

Laurencia catarinensis Cordeiro-Marino *et* M.T. Fujii

Type locality: Mole Beach, Santa Catarina Island, Brazil.

Distribution: Lusitanian: CANARY ISLANDS: El Hierro, Fuerteventura, Gran Canaria, La Gomera, La Palma, Lanzarote and Tenerife (Machín-Sánchez *et al.*, 2012).

Warm Temperate Southwestern Atlantic: BRAZIL: Santa Catarina (Fujii & Senties, 2005; Machín-Sánchez *et al.*, 2012) and São Paulo (Fujii *et al.*, 2006).

Tropical Southwestern Atlantic: BRAZIL: Rio Grande do Norte (Fujii & Senties, 2005; Machín-Sánchez *et al.*, 2012), Espírito Santo (Machín-Sánchez *et al.*, 2012) and Rio de Janeiro (Fujii & Senties, 2005).

***Laurencia chondrioides* Borgesen**

Type locality: Saint John Island, U. S. Virgin Islands.

Remarks: Only one record outside the Atlantic (Philippines) by Silva *et al.*, (1987). In the Mediterranean Sea (France and Israel) it is regarded as an invasive species (Klein & Verlaque 2011; Hoffman *et al.*, 2014).

Distribution: Lusitanian: CANARY ISLANDS: Lanzarote (Gil-Rodríguez *et al.*, 2012).

Mediterranean Sea: FRANCE: Hyères and Porquerolles Island (Klein & Verlaque, 2011). GREECE: Zakynthos Island (Tsirika & Haritonidis, 2005). ISRAEL: Achziv Beach, Achziv Reserve, Haifa-Bat Galim Beach, Rosh Hanika and Shavei Zion (Hoffman *et al.*, 2014). ITALY: Aeolian Islands, Lachea Island (Gómez-Garreta *et al.*, 2001), Linosa Island (Serio *et al.*, 2006), Tremiti Islands (Gómez-Garreta *et al.*, 2001) and Tuscany (Rindi *et al.*, 2002). SPAIN: Balearic Islands and Columbretes Island (Gómez-Garreta *et al.*, 2001).

Tropical Northwestern Atlantic: CUBA: Canarreos Archipelago and Alonzo Cay (Suárez, 2005). MEXICO: Quintana Roo (Ortega *et al.*, 2001). VIRGIN ISLANDS: St John (Klein & Verlaque, 2011).

***Laurencia coronopus* J. Agardh**

Type locality: “*in mare Nigro ad littus Tauriae*” (Black Sea).

Remarks: Gómez-Garreta *et al.*, (2001) suggested that a revision using recent taxonomic criteria should be made to corroborate if this species actually belongs to *Laurencia* or whether it belongs to *Chondrophycus* or *Osmundea*.

Distribution: Black Sea: BULGARIA: Athopol (Gómez-Garreta *et al.*, 2001; Kamenarska *et al.*, 2006; Kamenarska *et al.*, 2009). ROMANIA LITTORAL: (Caraus, 2012; Gómez-Garreta *et al.*, 2001).

Mediterranean Sea: FRANCE: Herault (Gómez-Garreta *et al.*, 2001).

***Laurencia corymbosa* J. Agardh**

Type locality: Cape of Good Hope, South Africa.

Distribution: South Africa: CAPE OF GOOD HOPE (Silva *et al.*, 1996).

***Laurencia decumbens* Kützing**

Type locality: New Caledonia.

Distribution: Tropical Northwestern Atlantic: BERMUDA: Bermuda Island (Schneider & Lane, 2005). VENEZUELA (Ganesan, 1990).

Tropical Southwestern Atlantic: BRAZIL: Atol das Rocas (Villaça *et al.*, 2010).

***Laurencia dendroidea* J. Agardh**

Type locality: Brazil.

Remarks: According to Cassano *et al.* (2012b), using molecular and morphological characters, the taxa that have been identified as *L. filiformis*, *L. majuscula*, and *L. obtusa* in Brazil

correspond to *L. dendroidea*. Similarly, *L. majuscula* in the Canary Islands corresponds to *L. dendroidea*.

Distribution: Gulf of Guinea: CAMEROON, GABON, and GHANA (John *et al.*, 2004).

Lusitanian: CANARY ISLANDS: Fuerteventura, Gran Canaria, La Palma, Lanzarote, and Tenerife (Gil-Rodríguez *et al.*, 2012). MADEIRA ARCHIPELAGO: Madeira (John *et al.*, 2004). Mediterranean Sea: FRANCE [uncertain record (Gómez-Garreta *et al.*, 2001)]. GREECE: Zakynthos Island (Tsikira & Haritonidis, 2005). ITALY: Lecce and Linosa Island (Gómez-Garreta *et al.*, 2001; Serio *et al.*, 2006).

Tropical Northwestern Atlantic: BARBADOS (Taylor, 1960, Wynne *et al.*, 2014). BERMUDA (Taylor, 1960). COSTA RICA (Taylor, 1960). JAMAICA (Taylor, 1960). LESSER ANTILLES (Taylor, 1960). NETHERLANDS ANTILLES, TRINIDAD AND TOBAGO, and VENEZUELA (Taylor, 1960).

Tropical Southwestern Atlantic: BRAZIL: Bahia (Oliveira *et al.*, 2013). Espirito Santo (Oliveira *et al.*, 2013; Fujii *et al.*, 2006) and Rio de Janeiro (Cassano *et al.*, 2012b, Oliveira *et al.*, 2013)

West African Transition Zone: CAPE VERDE ISLANDS and SALVAGE ISLANDS (John *et al.*, 2004), GAMBIA (John *et al.*, 2004). SENEGAL: North of Senegal (John *et al.*, 2004).

Warm Temperate Northwest Atlantic: USA: North Carolina (Taylor, 1960).

Warm Temperate Southwestern Atlantic: BRAZIL: Santa Catarina (Creed *et al.*, 2010) and São Paulo (Cassano *et al.*, 2012b).

Laurencia epiphylla* F. Boisset *et J. C. Lino

Type locality: Alicante: La Granadella, Jávea, the Mediterranean coast of Spain.

Distribution: Mediterranean Sea: SPAIN: Alicante (Gómez-Garreta *et al.*, 2001).

***Laurencia flexuosa* Kützing**

Type locality: “Ad Caput Bonae Spei”, South Africa.

Distribution: South Africa: CAPE TOWN (Stegenga *et al.*, 1997).

West African Transition: MAURITANIA [uncertain record (John *et al.*, 2004)].

***Laurencia foldatsii* N. Rodríguez de Rios**

Type locality: Taguao, Distrito Federal, Venezuela

Distribution: Tropical Northwestern Atlantic: VENEZUELA (Ganesan, 1990).

***Laurencia galtsoffii* M. Howe**

Type locality: Pearl and Hermes Reef, Hawaiian Archipelago.

Distribution: Gulf of Guinea: GABON, GHANA, and LIBERIA (John *et al.*, 2004).

West African Transition: CAPE VERDE ISLANDS (John *et al.*, 2004).

***Laurencia griseaviolacea* M.J. Wynne**

Type locality: Clovelly, Cape Peninsula, South Africa.

Distribution: South Africa: CAPE TOWN (Stegenga *et al.*, 1997, as *Laurencia peninsularis* H. Stegenga, J. J. Bolton *et al.* R. J. Anderson not *L. peninsularis* Taylor).

***Laurencia intricata* J.V. Lamouroux**

Type locality: Antilles.

Remarks: According to Machín-Sánchez *et al.* (2012), records of *L. intricata* from the Canary Islands correspond to *L. catarinensis*. Therefore, we believe that a taxonomic study of this species from the rest of Macaronesian Archipelago and Western Africa is needed to verify the identity of *L. intricata* from these areas.

Distribution: Gulf of Guinea: SAO TOMÉ AND PRINCIPE, and SIERRA LEONE (John *et al.*, 2004).

Mediterranean Sea: GREECE: Messolonghi (Christia *et al.*, 2011) and Zakynthos Island (Tsikira & Haritonidis, 2005). ITALY: Lino-sa Island (Furnari *et al.*, 2001; Gómez-Garreta *et al.*, 2001). LIBYA: Cyrenaica (Gómez-Garreta *et al.*, 2001).

Tropical Northwestern Atlantic: BAHAMAS (Taylor, 1960). BELIZE: Carrie Bow Cays (Norris & Bucher, 1992) and Pelican Cays (Littler & Littler, 1997). BERMUDA: (Taylor, 1960). CAYMAN ISLAND AND COSTA RICA (Taylor, 1960). CUBA: Canarreos Archipelago, Sabana-Camagüey Archipelago, Nuevitas Bay, Bocas de Alonzo, Coco, Gulf of Batabanó, Guanacahabites, Guardalavaca, Havana, Matanzas, and Villa Clara (Suárez, 2005; Gil-Rodríguez *et al.*, 2010). HISPANIOLA ISLAND and JAMAICA (Taylor, 1960). MARTINIQUE (Rodríguez-Prieto *et al.*, 1999). MEXICO: Campeche (Fujii *et al.*, 2006) and Quintana Roo (Senties & Fujii, 2002, Cassano *et al.*, 2010; Gil-Rodríguez *et al.*, 2010). PANAMA (Taylor, 1960). TRINIDAD AND TOBAGO (Duncan & Lee-Lum, 2006). USA: Florida (Collado-Vides *et al.*, 2011; Fujii *et al.*, 2006). VENEZUELA: Miranda State (Wynne, 2017). VIRGIN ISLANDS: St. Croix (Taylor, 1960).

West African Transition: CAPE VERDE ISLANDS [uncertain record (John *et al.*, 2004)] and SENEGAL (John *et al.*, 2004).

Warm Temperate Northwest Atlantic: USA: Texas (Wynne, 2008).

***Laurencia laurahuertana* Mateo-Cid, Mendoza-González, Senties *et al.* Díaz-Larrea**

Type locality: Punta Herrero, Quintana Roo. México

Distribution: Caribbean Sea and Gulf of Mexico. MEXICO: Quintana Roo (Mateo-Cid *et al.*, 2014).

***Laurencia microcladia* Kützing**

Type locality: West Indies

Remarks: Records of *L. microcladia* from Brazil contain a misapplied name, which correspond to *L. dendroidea* Cassano *et al.* (2012a).

Distribution: Lusitania: AZORES ISLANDS: Santa María Island and Pico (Tittley *et al.*, 2009). CANARY ISLANDS: El Hierro, Fuerteventura, Gran Canaria, La Palma, Lanzarote, and Tenerife (Gil-

Rodríguez *et al.*, 2012). MADEIRA ARCHIPELAGO: Porto Santo (Neto *et al.*, 2001). SALVAGES ISLANDS (John *et al.*, 2004).

Mediterranean Sea: ALGERIA: Alger (Gómez-Garreta *et al.*, 2001; Gil-Rodríguez *et al.*, 2012). CYPRUS: Akamas, GaziMağusa, Girne, Karpasia, Liopetri, and Salamis (Taskin *et al.*, 2013; Tsiamiset *et al.*, 2014b). EGYPT: El Dabaa (Gómez-Garreta *et al.*, 2001). FRANCE: Corsica (Gómez-Garreta *et al.*, 2001) and Hérault (Verlaque, 2001). GREECE: Zakynthos Island (Tsikira & Haritonidis, 2005). ITALY: Lino-sa Island (Serio *et al.*, 2006), Sicilia (Gómez-Garreta *et al.*, 2001), Tuscan Archipelago (Ridi *et al.*, 2002), Italian Adriatic Sea (Gómez-Garreta *et al.*, 2001), Gulfof Taranto (Gómez-Garreta *et al.*, 2001), Cherad islands, and Sardinia (Gómez-Garreta *et al.*, 2001). MALTA: Gozo Island and Malta Island (Comarci *et al.*, 1997). MOROCCO: Alhucemas, Cabo de Agua, Karia Arkemanne, Muelle Colorado, Punta Negrí, Punta de Rostrogordo, and Punta de Sabinilla (Gómez-Garreta *et al.*, 2001). SPAIN: Almería (Soto & Conde, 1989), Balearic Islands (Gómez-Garreta *et al.*, 2001), Catalunya (Gómez-Garreta *et al.*, 2001), and Murcia (Gil-Rodríguez *et al.*, 2012). TURKEY: Akdeniz, Izmir Bay, Gulf of Gökova, Karadeiz and Mersin (Taskin *et al.*, 2008).

Tropical Northwestern Atlantic: BAHAMAS (Taylor, 1960). BELIZE: Carrie Bow Cays (Norris & Bucher, 1982) and Pelican Cays (Littler & Littler, 1997). BERMUDA (Taylor, 1960). CAICOS ISLANDS, CAYMAN ISLANDS, COSTA RICA, JAMAICA, LESSER ANTILLES, NETHERLANDS ANTILLES, and PANAMA (Taylor, 1960). CUBA: Gulf of Batabanó (Suárez, 2005). PUERTO RICO: Arecibo and Santiago Cay (Gil-Rodríguez *et al.*, 2012). TRINIDAD AND TOBAGO (Duncan & Lum-Lee, 2006). USA: Florida (Taylor, 1960). VENEZUELA: Aves Island (Taylor, 1960) and Cumana (Gil-Rodríguez *et al.*, 2012). VIRGIN ISLANDS (Taylor, 1960).

West African Transition: CAPE VERDE ISLANDS: Ilheu Branco and San Nicolau (John *et al.*, 2004, Gil-Rodríguez *et al.*, 2012). MAURITANIA (John *et al.*, 2004). SENEGAL: North of Senegal (John *et al.*, 2004).

***Laurencia minuscula* Schnetter**

Type locality: Puerto López (Alta Guajira), Guajira Department, Colombia.

Distribution: Tropical Northwestern Atlantic: COLOMBIA: Guajira (Schnetter, 1976). CUBA: Havana (Senties *et al.*, 2010).

***Laurencia minuta* Vandermeulen, Garbary *et al.* Guiry**

Type locality: Eilat, Israel.

Distribution: Lusitanian: CANARY ISLANDS: Tenerife (“*taxa inquirenda*” Haroun *et al.*, 2002; John *et al.*, 2004). SPAIN: Galicia (Bárbara *et al.*, 2005).

Mediterranean Sea: CYPRUS: Girne (Taskin *et al.*, 2013). SPAIN: Alicante (Gómez-Garreta *et al.*, 2001). GREECE: Zakynthos Island (Tsikira & Haritonidis, 2005). ITALY: Apulia, Gulf Taranto, Northwestern Italy, and Sicily (Gómez-Garreta *et al.*, 2001), Lino-sa Island (Serio *et al.*, 2006), and Tuscany (Rindi *et al.*, 2002). MALTA: Malta Island (Gómez-Garreta *et al.*, 2001).

***Laurencia natalensis* Kylin**

Type locality: Isipingo Beach, near Durban, South Africa

Distribution: South Africa: Pearly Beach to Agulhas (Stegenga *et al.*, 1997)

***Laurencia nidifica* J. Agardh**

Type locality: Hawaiian Islands

Distribution: Gulf of Guinea: IVORY COAST, GHANA, AND LIBERIA (John *et al.*, 2004).

Lusitania: MADEIRA ARCHIPELAGO: Deserta Grande [uncertain record (Neto *et al.*, 2001)].

St. Helena and Ascension Islands: ST. HELENA (John *et al.*, 2004).

West African Transition: CAPE VERDE ISLANDS (John *et al.*, 2004).

***Laurencia obtusa* (Hudson) J. V. Lamouroux**

Type locality: England.

Remarks: Cassano *et al.* (2012b) confirmed through molecular and morphological characters that records of *L. obtusa* from Brazil correspond to *L. dendroidea*.

Distribution: Black Sea: BULGARIA: Ahtopol area (Dimitrova-Konaklieva, 1981). ROMANIA: Romanian Littoral (Caraus, 2012). TURKEY: Antalya, Dikili Gelibolu, Gökçeada Island, Izmir Bay, Kirklareli, Korfezi, Mersin, and Zonguldak (Gómez-Garreta *et al.*, 2001; Taskin *et al.*, 2008).

Gulf of Guinea: CAMEROON. EQUATORIAL GUINEAN: ANNOBON ISLAND. GHANA. SAO TOME AND PRINCIPE. SIERRA LEONE (John *et al.*, 2004).

Lusitania: AZORES ISLANDS: Faial, Pico, Sao Miguel, Terceira, and Santa Maria (Neto, 1994; Tittley & Neto, 1994). CANARY ISLANDS: El Hierro, Fuerteventura, Gomera, Gran Canaria, La Palma, Lanzarote Island, and Tenerife (John *et al.*, 2004; Gil-Rodríguez *et al.*, 2012). FRANCE: Brittany (Feldmann, 1954), Guernsey (Senties & Fujii, 2002), Hérault (Ben Maizet *et al.*, 1988), and Normandia (Dixon, 1961; Dizerbo & Herpe, 2007). MADEIRA ARCHIPELAGO: Deserta Grande, Ilhéu de Fora, Madeira, Porto Santo, Selvagem Grande, and Selvagem Pequena (John *et al.*, 2004). SALVAGE ISLANDS (John *et al.*, 2004). MAURITANIA (John *et al.*, 2004). PORTUGAL: Beira Litoral, Douro Litoral, and Minho (Araujo *et al.*, 2009). SPAIN: Asturias (Cires-Rodríguez & Cuesta-Moliner, 2010), Basquecoast (Gorostiaga *et al.*, 2004), Cantabria (Martínez-Gil *et al.*, 2007), Galicia (Bárbara *et al.*, 2005; Peña & Bárbara, 2008), and Vigo (Hamel, 1928).

Mediterranean Sea: ALGERIA: Alger, Annaba, Bab El Oued, Bologhine, El Marsa, Rais Hamidou, Sidi Fredj, Southwest of Cap Bordj El Bahri, and Tipaza (Gómez-Garreta *et al.*, 2001). CROATIA: Istria Coast (Munda, 1979). CYPRUS: Dip Karpaz, Farmagusta, Gazi Mağusa, Girne, Karpasia, Kumyali, Koruçaim, Kyrenia, Liopetri, Salamis, and Yeşilirmak (Taskin *et al.*, 2013; Tsiamis *et al.*, 2014b). EGYPT: Alexandria (Gómez-Garreta *et al.*, 2001). FRANCE: Corsica (Gómez-Garreta *et al.*, 2001; Sales & Ballesteros, 2010), Hyères (Augier *et al.*, 1971), Pyrenees Orientales (Gómez-Garreta *et al.*, 2001), and Var (Coppejans, 1972). GREECE: Ionian Islands (Tsikira & Haritonidis, 2005),

Kleisova (Gómez-Garreta *et al.*, 2001; Christia *et al.*, 2011), Rhodos Island (Diapoulis *et al.*, 1986), and Sporades du Nord (Dianellidis, 1953). ISRAEL: Habonim (Gómez-Garreta *et al.*, 2001). ITALY: Adriatic Sea (Furnari *et al.*, 1999; Gómez-Garreta *et al.*, 2001), Gulf of Taranto (Cecere *et al.*, 1996), Napoli (Cinelli, 1971; Feoli & Bressan, 1972), Salerno (Edwards *et al.*, 1975), Sicilia (Serio *et al.*, 2006; Gómez-Garreta *et al.*, 2001), Tuscany (Rindi *et al.*, 2002), and Sardinia (Furnari *et al.*, 2003). LIBYA: Bengazi-Sabri, Cyrenaica, Derna, and Tripoli (Gómez-Garreta *et al.*, 2001). MALTA: Gozo Island (Cormaci *et al.*, 1997). MOROCCO: Cabo de Agua, Cabo Quilates, Cal Iris, Cala Bonita, Cala Charranes, Cala Viñas, Cazaza, Chafarinas Islands, Karia Arkemane, Mar Chica, Playa del Quemado, Punta Negri, Punta de Rostrogordo, and Sammar (Gómez-Garreta *et al.*, 2001). SPAIN: Andalusia (Conde *et al.*, 1996; Conde & Flores-Maya, 2000), Balearic Islands (Gómez-Garreta *et al.*, 2001), Catalunya (Ballesteros, 1981; Rodríguez-Prieto & Polo-Albertí, 1988, 1998), Murcia (Pérez-Ruzafa & Honrubia, 1984; Pérez-Ruzafa, 1990), and Valencia (Barcelo & Seoane, 1982). TUNISIA: Bahiret, Bechateur, Bizerte, Cap Blanc, Cap Farina, Cap Serrat, Cathage, Djerba, El Bibane, Gabès, Gammarth, Ghar El Khebir, Gulf of Gabès, Iles Cani, Kelibia, Kerkennah, Korba, Korbous, La Goulette, La Marsa, Mer de Bou Grara, Monastir, Le Galiton, Raf Raf, Raouad, Ras el Fartass, Salambô, Sidi Bou Said, Sfax, Sidi Raïs, Tabarka, Zarzis, and Zembra (Gómez-Garreta *et al.*, 2001).

Northern European Seas: ENGLAND: Sussex and Devon (Lipkin & Silva, 2002). IRELAND: Antrim (Morton, 1994), Clare (De Valéra *et al.*, 1979), Derry (Morton, 1994), Donegal (Morton, 2003), Down (Morton, 1994), Cork, Dublin, Galway, Kerry, Leitrim, Mayo, and Wexford (Guiry, 1978). SWEDEN (Athanasiadis, 1996).

Tropical Northwestern Atlantic: BAHAMAS: Berry Island (Senties & Fujii, 2002). BARBADOS (Wynne *et al.*, 2014). BELIZE: Carrie Bow Cay (Norris & Bucher, 1982) and Pelican Cays (Littler & Littler, 1997). BERMUDA: St. Georges Island (Senties & Fujii, 2002; Taylor, 1960). CAICOS ISLAND, CAYMAN ISLANDS, and COLOMBIA (Taylor, 1960). CUBA: Havana City (Senties & Fujii, 2002), Camagüey, Juventud Island, and Matanzas, and Villa Clara (Suárez, 2005). DOMINICAN REPUBLIC: Santo Domingo (Senties & Fujii, 2002). GUADELOUPE: Pointe de la Verdure (Fujii *et al.*, 2006). JAMAICA (Taylor, 1960). MARTINIQUE: Pointe des Salines and Ste. Anne (Rodríguez-Prieto & Michanek, 1999). MEXICO: Campeche, Quintana Roo, and Tamaulipas (Ortega *et al.*, 2001; Senties & Fujii, 2002), Veracruz and Yucatán (Ortega *et al.*, 2001). NETHERLANDS ANTILLES: Bonaire and Curaçao (Senties & Fujii, 2002). PANAMA: Galeta Point (Senties & Fujii, 2002). PUERTO RICO: Guanica and Jaobos (Senties & Fujii, 2002). TRINIDAD AND TOBAGO: Tobago (Taylor, 1960; Senties & Fujii, 2002). USA: Florida (Littler *et al.*, 2008). VENEZUELA: Aves Island, Cabagua, Margarita Island, and Pelona Island (Taylor, 1960; Senties & Fujii, 2002; Fujii *et al.*, 2006). VIRGIN ISLANDS (Taylor, 1960).

Warm Temperature Northwestern Atlantic: USA: Texas (Wynne, 2008).

West African Transition: CAPE VERDE ARCHIPELAGO (John *et al.*, 2004). GAMBIA (John *et al.*, 2004). SENEGAL: North Senegal (John *et al.*, 2004).

***Laurencia oliveirana* Yoneshigue**

Type locality: Ponta da Cabeça, Cabo Frio, Rio de Janeiro State, Brazil.

Distribution: Tropical Southwestern Atlantic: BRAZIL: Rio de Janeiro (Fujii *et al.*, 2012) and Bahia (Fujii & Senties, 2005).

Warm Temperate Southwestern Atlantic: BRAZIL: Rio Grande do Sul and São Paulo (Fujii & Senties, 2005).

***Laurencia pyramidalis* Bory ex Kützing**

Type locality: Granville, Normandy, France.

Distribution: Lusitania: AZORES: Pico, Santa Maria, and Sao Miguel (Machín-Sánchez *et al.*, 2014). CANARY ISLANDS: Fuerteventura, La Gomera, Lanzarote, and Tenerife (Machín-Sánchez *et al.*, 2014). FRANCE: Finistère (Bouxin & Dizerbo, 1971) and Normandy (Machín-Sánchez *et al.*, 2014). MADEIRA ARCHIPELAGO: Ponta de São Jorge-Casi, Porto Moniz-Piscinas, and Seixal-Praia da Laje (Machín-Sánchez *et al.*, 2014). PORTUGAL: Minho (Araujo *et al.*, 2009). SPAIN: Asturias (Cires-Rodríguez & Cuesta-Moliner, 2010; Díaz *et al.*, 2008), BasqueCoast (Gorostiaga *et al.*, 2004), Cantabria (Martínez-Gil *et al.*, 2007), Galicia (Bárbara *et al.*, 2005) and Sisargas Island (Veiga *et al.*, 1998).

Mediterranean Sea: CYPRUS: Dip Karpaz and Gazi Mağusa (Taskin *et al.*, 2013). ITALY: Adriatic Sea (Furnari *et al.*, 1999) and Sardinia Island (Serio *et al.*, 2004). SPAIN: Andalusia (Conde *et al.*, 1996), Catalunya (Ballesteros, 1981), and Murcia (Pérez-Ruzafa & Honrubia, 1984).

Northern European Seas: GREAT BRITAIN and IRELAND (Hardy & Guiry, 2003).

***Laurencia tenera* C. K. Tseng**

Type locality: Shek-O, Hong Kong.

Distribution: Gulf of Guinea: IVORY COAST, GHANA, LIBERIA, SIERRA LEONE, and TOGO (John *et al.*, 2004).

West African Transition: CAPE VERDE ISLANDS, GAMBIA, MAURITANIA, and SENEGAL (John *et al.*, 2004).

St Helena and Ascension Islands: ST. HELENA (John *et al.*, 2004).

***Laurencia translucida* M. T. Fujii et Cordeiro-Marino**

Type locality: Padres beach, Aracruz, Espírito Santo State, Brazil.

Distribution: Warm Temperate Southwestern Atlantic: BRAZIL: São Paulo (Creed *et al.*, 2010).

Tropical Southwestern Atlantic: BRAZIL: Bahia, Ceará, and Pernambuco Espírito Santo (Fujii *et al.*, 2006), Rio de Janeiro (Creed *et al.*, 2010).

***Laurencia venusta* Yamada**

Type locality: Koshiki-jima, Kagoshima Prefecture and Goto-retto, Nagasaki Prefecture, Japan.

Distribution: Tropical Northwestern Atlantic: MEXICO: Quintana Roo (Senties & Fujii, 2002).

Tropical Southwestern Atlantic: BRAZIL: Espírito Santo (Fujii & Senties, 2005).

***Laurencia viridis* Gil-Rodríguez et Haroun**

Type locality: Canary Islands: Tenerife: Punta Hidalgo-Baja Negra.

Distribution: West African Transition: CAPE VERDE ISLANDS (John *et al.*, 2004).

Macaronesian Archipelago. AZORES: Santa María (Machín-Sánchez *et al.*, 2014). CANARY ISLANDS: El Hierro, Fuerteventura, Gran Canaria, La Gomera, La Palma, Lanzarote, and Tenerife (John *et al.*, 2004; Gil-Rodríguez *et al.*, 2012; Machín-Sánchez *et al.*, 2014). MADEIRA ARCHIPELAGO: Ilhéu de Fora, Ponta de Sao Jorge, Porto Santo, and Salvagem Pequena (John *et al.*, 2004; Machín-Sánchez *et al.*, 2014).

Species inquirenda***Laurencia alsidiiformis* Zanardini ex Fraudenfeld**

Type locality: Spalato, Dalmatian coast.

***Laurencia alsidioides* P. L. Crouan et H.M. Crouan**

Type locality: I. Guadeloupe, Caribbean Sea.

***Laurencia botryocephala* Kützing**

Type locality: "Ad Caput Bonae Spei" Cape of Good Hope.

***Laurencia canariensis* Montagne ex Kützing**

Remarks: Gil Rodríguez *et al.* (2012) suggested that it should be considered an uncertain species. According to John *et al.* (1994), *L. canariensis* and *L. caespitosa* are synonyms of *Osmundea hybrida* (De Candolle) K. W. Nam.

Type locality: Canary Islands.

***Laurencia moriformis* Kützing**

Type locality: Cape of Good Hope.

***Laurencia trifaria* Kützing**

Type locality: Cape of Good Hope.

PAE Analysis. The area cladogram obtained had the following parameters: Length = 28, Consistency Index=0.85 and Retention Index=0.88. The strict consensus tree of the 3 equally parsimonious trees is presented (Fig. 2). Cladogram topology suggests four areas of endemism: South Africa (AghB) with four restricted species, Brazil (EB, NEB, and SEB) with four restricted species, Northeastern Atlantic (WMe, SEAS, LevS, and AdS) with three restricted species, and Gulf of Guinea (SHAI, GGU, CV, GGW, and GGC) with four restricted species (Fig. 3). Some of these species, however, are also distributed in the Indo-Pacific (see Table 1). In addition, we have defined three categories of areas: partial congruence (areas with partial congruence between the areas of distribution) composed by GA, ECa, WCa, and SCa (Fig. 2), secondary areas (area with an endemic species, Ippi & Flores, 2001) and widespread species (Table 1).

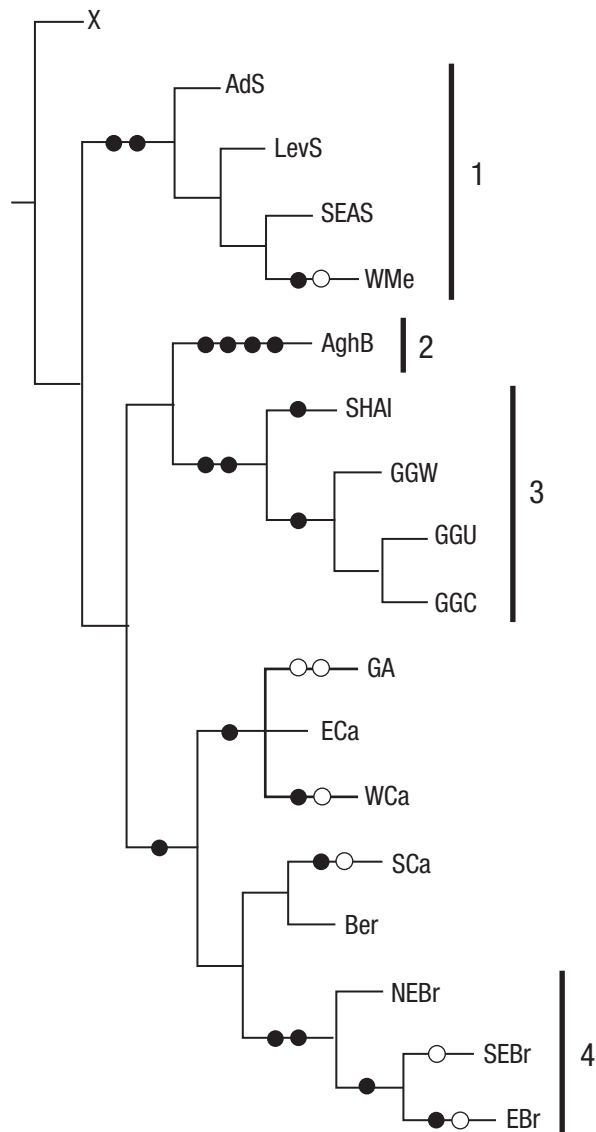


Figure 2. Areas of endemism defined in the PAE analysis. 1) Northwestern Atlantic, 2) South Africa, 3) Gulf of Guinea, and 4) Brazil. The black dots represent restricted species or synapomorphies and the white dots represent homoplasies.

DISCUSSION

The nomenclature from genus to species, valid names, and taxonomic synonyms of *Laurencia* are a fundamental part of the checklist here proposed and a topic of continuing discussion among taxonomists. Checklists allow for the documentation of species distributions, the biodiversity within certain areas, and offer the possibility of using this information to carry out a biogeographical analysis; thus, considering the taxonomic remarks, uncertain records, reports of invasion, and introduction of species allows us to obtain biogeographical natural patterns or approximate reality. Taxonomic validity of the records and the recognition of the distribution limits of the species area are essential requirements in biogeographic works (Morrone, 2013). In turn, areas of

endemism and secondary areas can be defined, and widespread species identified.

On endemism. Areas of endemism (non-endemic species) are defined as the sympatric distribution congruence of two or more taxa belonging to a given category (e.g., order, family, genus or species) (Morrone, 2013). However, when we take *Laurencia*, the Caribbean Sea is defined by partial congruence in the distribution of two or more species (group GA, ECa, WCa, and SCa; see Fig. 2). Endemic species inhabit this region, such as *L. laurahuertana* in the western Caribbean, *L. foldatsii* in the southern Caribbean, *L. chondrioides*, and *L. minuscula* in the Caribbean Sea in general, but their distributional congruence is not total, and the PAE analysis does not define this area for two or more synapomorphies. Furthermore, the Caribbean Sea is the Atlantic biotic area with the highest species richness of *Laurencia* (13 spp). This biogeographic pattern is also shared by the distributional diversity of several unrelated taxa, such as coastal fishes, mangroves, coral reefs, and seagrasses in the Atlantic Ocean (Tittensor *et al.*, 2010).

According to Tapia-Silva *et al.* (2015), a mathematical analysis of the geographic distribution of the macroalgal species richness can reveal high diversity spots that, in the case of macroalgae, coincide well with the major distribution of the great marine environments in the area (mangroves, coral reefs and seagrasses): the Mexican Caribbean barrier reef, the Veracruz reef system, and the Alacran reef system at Puerto Progreso, Yucatan (Vilchis *et al.*, in press). Studies have shown higher macroalgal diversity in the Indo-Pacific area than in the Atlantic (Kerswell, 2006), and when comparing worldwide *Laurencia* data (Tapia *et al.*, 2015) this pattern is confirmed. Areas of endemism in the south Atlantic were also found in Brazil, Gulf of Guinea, and South Africa, which are also reported to contain endemic species (Brown & Lomolino, 1998); furthermore, it was found that the Gondwana breakup is the geological process that explains this endemism.

Other areas such as the Northwestern Atlantic, Europe, and the Caribbean Sea share *Laurencia* species with other regions (i.e., the Indo-Pacific), and the influence of vicariance events such as the closing of Isthmus of Panama and the final closure of the Tethys seaway in the Eastern Atlantic (Cowman & Bellwood, 2013) has not been studied.

Secondary areas. These areas are defined by the presence of one endemic species. When this happens, for example, in the Macaronesian Archipelago with *L. viridis*, the area is inhabited mostly by species that are also distributed in other places (9 spp.), and the number of endemic species is smaller compared to the defined areas of endemism. In the Macaronesian Archipelago, the phycofloristic composition reveals elements in common with the littoral of continental Europe and the North of Africa (Haroun and Prud'Homme van Reine, 1993; Tuya & Haroun, 2009). This is because the geological origin of the Macaronesian islands dates to the early Miocene (20 my) (Brown & Lomolino, 1998), allowing the colonization of species from other areas. Thus, this region is a special biotic area that could be researched using an island-biogeography approach.

Widespread species. The genus *Laurencia* in the Atlantic Ocean extends from the coast of Ireland to South Africa, including the Mediterranean Sea and Black Sea; in the western Atlantic, the genus extends from North Carolina, USA, to southern Brazil. Seventeen of these species are also distributed in the Indo-Pacific, of which five are widely distributed in the Atlantic Ocean.

Table 1. Categories of areas defined for *Laurencia* in the Atlantic Ocean.

Categories	Defined Area	Species
Areas of Endemism	Atlantic Northeastern Ocean	<i>L. coronopus</i> , <i>L. minuta</i> [*] , <i>L. pyramidalis</i> [*] .
	Brazil	<i>L. aldingensis</i> [*] , <i>L. catarinensis</i> [*] , <i>L. oliveirana</i> , <i>L. translucida</i> .
	Gulf of Guinea	<i>L. brachyclados</i> [*] , <i>L. galtsoffii</i> [*] , <i>L. nidifica</i> [*] , <i>L. tenera</i> [*] .
	South Africa	<i>L. corymbosa</i> [*] , <i>L. flexuosa</i> , <i>L. griseaviolacea</i> , <i>L. natalensis</i> [*]
Partial Congruence	Caribbean Sea	<i>L. chondrioides</i> , <i>L. epiphylla</i> , <i>L. foldatsii</i> , <i>L. laurahuertana</i> , <i>L. minuscula</i> [*]
Secondary Areas	Macaronesian Islands	<i>L. viridis</i>
	American Atlantic	<i>L. caraibica</i> [*] , <i>L. decumbens</i> [*] , <i>L. venusta</i> [*]
Amphi-Atlantic	Northern Atlantic	<i>L. microcladia</i> ^{*+}
	Widespread in the Atlantic Ocean	<i>L. brongniartii</i> [*] , <i>L. caduciramulosa</i> ^{*+} , <i>L. dendroidea</i> ^{**} , <i>L. intricata</i> [*] , <i>L. obtusa</i> ^{*+}

^{*}Species also distributed in the Indo-Pacific. ⁺Species also distributed in the Macaronesian Archipelago.

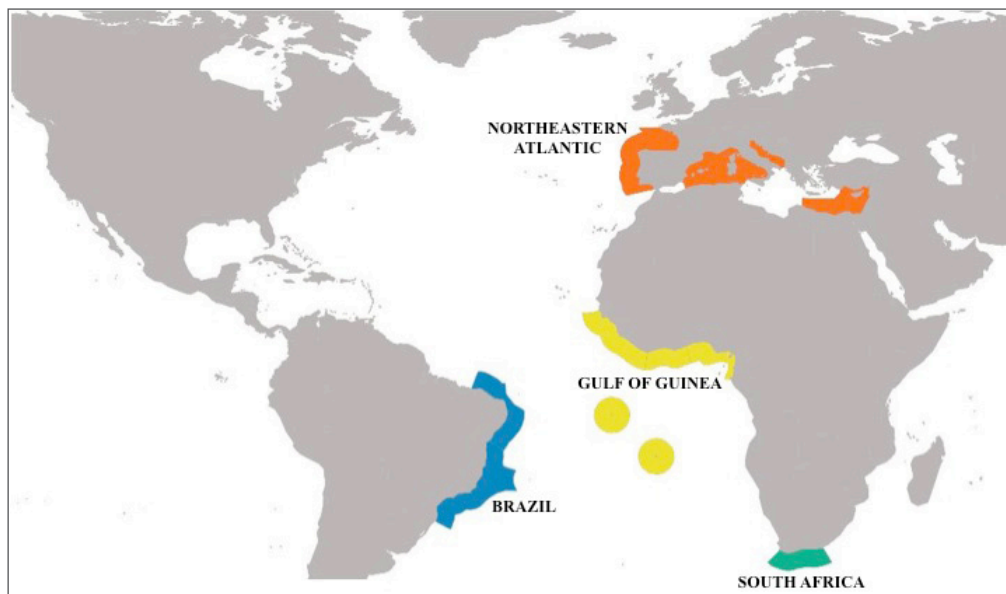


Figure 3. Map of the areas of endemism of *Laurencia* in the Atlantic Ocean.

Recent phylogenetic studies have been useful in detecting misidentifications in the Atlantic, especially in records from Macaronesia, Brazil, and the Mexican Caribbean, although only nine widespread species of *Laurencia* in the Atlantic have a molecular characterization in these places. The use of the molecular-phylogenetic approach on these species in the Atlantic Ocean should allow us to identify new lineages over a wide distribution range, as has happened with other groups of red algae (Skage *et al.*, 2005; Nuñez-Resendiz *et al.*, 2015), and achieve a much better understanding of the historical biogeography of *Laurencia* in the Atlantic Ocean.

According to Miranda and Marques (2011), the two principal obstacles in the biogeographical works are (1) the reliability of species identifications and the consequent uncertainty of the presence of species in a given area, and (2) the difficulty in producing reliable cladograms from phylogenies.

In conclusion, it has been possible to establish a biogeographic pattern in *Laurencia* from the definition of areas of endemism and partial and secondary areas. This pattern has been linked to geological events that occurred in the past. Therefore, the recognition of new species from systematics studies and the clarification of taxonomic problems will allow researchers to continue developing a biogeographic hypothesis for the genus in the Atlantic Ocean.

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REFERENCES

- ARAUJO, R., I. BÁRBARA, M. TIBALDO, E. BERECEBAR, P. DÍAZ-TAPIA, R. PEREIRA, R. SANTOS & I. SOUSA-PINTO. 2009. Checklist of benthic marine algae and cyanobacteria of Northern Portugal. *Botanica Marina* 52 (1): 24-46. DOI: 10.1515/BOT.2009.026
- ATHANASIADIS, A. 1996. *Taxonomisk litteratur och biogeografi av Skandinaviska rödalger och brunalger*. Göteborg. Algologia, Göteborg. 280 p.
- AUGIER, H., C.F. BOUDOURESQUE & J. LABOREL. 1971. Végétation marine de l'île de Port Cros (Parc National). VII. — Les peuplements sciaphiles profonds sur substrat dur. *Bulletin du Museum d'Histoire Naturelle de Marseille* 31: 153-183.
- BALLESTEROS, E. 1981. Contribució al coneixement algològic de la Mediterrània Espanyola: algues bentòniques i litorales de Tossa de Mar (Girona). *Bulletí de la Institució Catalana d'Història Natural* 46 (Sec. Bot. 4): 55-73. Available online at: <http://www.raco.cat/index.php/ButlletilCHN/article/view/235801/318064>.
- BÁRBARA, I., J. CREMADES, S. CALVO, M.C. LÓPEZ-RODRÍGUEZ & J. DOSIL. 2005. Checklist of the benthic marine and brackish Galician algae (NW Spain). *Anales del Jardín Botánico de Madrid* 62 (1): 69-100.
- BARCELO, M. C. & J. A. SEOANE. 1982. Aportació al coneixement de las algues marines de les costes del País Valencià. *Collectanea Botanica* 13 (2): 767-775.
- BEN MAIZ, N., C. F. BOUDOURESQUE, M. LAURENT & R. RIOUALL. 1988. Inventaire bibliographique des macrophytes (Algues, Phanérogames) signales dans l'Étang de Thau (Hérault, France). *Naturalia Monspelienis. Série Botanique* 52: 71-84.
- BOUXIN, H. & A. H. DIZERBO. 1971. Les algues de l'Archipel des Glénan (Finistère). *Botanica Rhedonica. Serie A* (10): 199-226.
- BROWN J. H. & M. V. LOMOLINO. 1998. *Biogeography, 2nd edition*. Sinauer Associates, Massachusetts. 691 p.
- CARAUS, I. 2012. *Algae of Romania: A distributional checklist of actual algae version 2.3*, 3rd revision. University of Bacau, Bacau. 809 p.
- CARVALHO, L. R., M. T. FUJII, N. F. ROQUE & J. H. G. LAGO. 2006. Aldingenin derivatives from the red alga *Laurencia aldingensis*. *Phytochemistry* 67 (13): 1331-1335. DOI: 10.1016/j.phytochem.2006.04.020
- CASSANO, V., M. T. M. DE SZÉCHY & M. T. FUJII. 2006. *Laurencia caduciramulosa* (Ceramiales, Rhodophyta) from Ilha Grande Bay, Rio de Janeiro, Brazil: a recent introduction into the Atlantic Ocean? *Cryptogamie Algologie* 27 (3): 265-277.
- CASSANO, V., M. C. GIL-RODRÍGUEZ, A. SENTÍES & M. T. FUJII. 2008. *Laurencia caduciramulosa* (Ceramiales, Rhodophyta) from the Canary Islands, Spain: a new record for the eastern Atlantic Ocean. *Botanica Marina* 51 (2): 156-158. DOI: 10.1515/BOT.2008.021
- CASSANO, V., M. C. OLIVEIRA, M. C. GIL-RODRÍGUEZ, A. SENTÍES, J. DÍAZ-LARREA & M. T. FUJII. 2012a. Molecular support for the establishment of the new genus *Laurenciella* within the *Laurencia* complex (Ceramiales, Rhodophyta). *Botanica Marina* 55 (4): 349-357. DOI: 10.1515/bot-2012-0133
- CASSANO, V., Y. METTI, A.J.K. MILLAR, M.C. GIL-RODRÍGUEZ, A. SENTÍES, J. DÍAZ-LARREA, M.C. OLIVEIRA & M.T. FUJII. 2012b. Redefining the taxonomic status of *Laurencia dendroidea* (Ceramiales, Rhodophyta) from Brazil and the Canary Islands. *European Journal of Phycology* 47 (1): 67-81. DOI: 10.1080/09670262.2011.647334
- CECERE, E., M. COMARCI, G. FURNARI, A. PETROCELLI, O. SARACINO & D. SERIO. 1996. Benthic algal flora of Cheradi Islands (Gulf of Taranto, Mediterranean Sea). *Nova Hedwigia* 62 (1): 191-214.
- CHRISTIA, C., I. TZIORTZIS, G. FYTTIS, L. KASHTA & E. PASTERGIADOU. 2011. A survey of the benthic aquatic flora in transitional water systems of Greece and Cyprus (Mediterranean Sea). *Botanica Marina* 54 (2): 169-178. DOI: 10.1515/bot.2011.016
- CINELLI, F. 1971. Alghe bentoniche di profondità raccolte alla punta S. Pancrazio nell'Isola di Ischia (Golfo di Napoli). *Giornale Botanico Italiano* 105: 207-236. DOI: 10.1080/11263507109426526
- CIRES-RODRÍGUEZ, E. & C. CUESTA-MOLINER. 2010. Checklist of benthic algae from the Asturias coast (North of Spain). *Boletín Ciencias Naturales RIDEA* 51: 135-212.
- COLLADO-VIDES, L., V. MAZZEI, T. THYBERG & D. LIRMAN. 2011. Spatio-temporal patterns and nutrient status of macroalgae in a heavily managed region of Biscayne Bay, Florida, USA. *Botanica Marina* 54 (4): 377-390. DOI: 10.1515/bot.2011.046
- COLLADO-VIDES, L., V. CASSANO, J. DÍAZ-LARREA, A. DURAN, A. DA-SILVA-MEDEIROS, A. SENTÍES & M. TOYOTA-FUJII. 2014. Spread of the introduced species *Laurencia caduciramulosa* (Rhodomelaceae, Rhodophyta) to the northwest Atlantic: A morphological and molecular analysis. *Phytotaxa* 183 (2): 93-107. DOI: 10.11646/phytotaxa.183.2.2
- CORMACI, M., E. LANFRANCO, J.A. BORG, S. BUTTIGIEG, G. FURNARI, S.A. MICALLEF, C. MIFSUD, F. PIZZUTO, B. SCAMMACCA & D. SERIO. 1997. Contribution to the knowledge of benthic marine algae on rocky substrata of the Maltese Islands (Mediterranean Sea). *Botanica Marina* 40 (1-6): 203-205. DOI: 10.1515/botm.1997.40.1-6.203
- CONDE, F., A. FLORES-MAYA, J. SOTO, M. ALTAMIRANO & A. SÁNCHEZ. 1996. Checklist of Andalusia (S. Spain) seaweeds III. Rhodophyceae. *Acta Botánica Malacitana* 21: 7-33.
- CONDE, F. & A. FLORES-MAYA. 2000. Nuevas adiciones al conocimiento de las macroalgas marinas de la isla de Alborán (Mediterráneo Occidental). *Acta Botánica Malacitana* 25: 180-184.
- COPPEJANS, E. 1972. Resultats d'une étude systématique et écologique de la population algale des côtes rocheuses du Dramont, St Raphael (Var, France). *Biologisch Jaarboek Dodonaea* 40: 153-180.
- COWMAN, P.E. & D.R. BELLWOOD. 2013. Vicariance across major marine biogeographic barriers: temporal concordance and the relative intensity of hard versus soft barriers. *Proceeding of The Royal Society B* 280 (1768): 1-8. DOI: 10.1098/rspb.2013.1541
- CREED, M., M. T. FUJII, M. B. DE B. BARRETO, S.M.P. DE B. GUIMARÃES, V. CASSANO, S. M. B. PEREIRA, M. DE F. DE O. CARVALHO & S. KHADER. 2010. In: Forzza, R.C. (Eds.). *Catálogo de plantas e fungos do Brasil 1. Rhodophyceae*. Pesquisas Jardim Botânico do Rio de Janeiro, pp. 426-436.
- DE VALÉRA, M., C. PYBUS, B. CASLEY & A. WEBSTER. 1979. Littoral and benthic investigations on the west coast of Ireland X. Marine algae of the northern shores of the Burren, Co. Clare. *Proceedings of the Royal Irish Academy* 79B: 259-269.

- DIANNELIDIS, T. 1953. Contribution à la connaissance des algues marines des Sporades du Nord (Cyanophyceae, Chlorophyceae, Phaeophyceae, Rhodophyceae). *Praktika Hellenic Hydrobiology Institute* 6: 41-84.
- DIAPOULIS, A., S. HARITONIDIS & T. KOUSSOURIS. 1986. Spring benthic flora of Rhodos Island, Greece. *Thalassographica* 9: 49-57.
- DÍAZ, P., I. BÁRBARA, A. SECILIA, C. PETEIRO, S. CALVO, N. SÁNCHEZ, A. SANTOLARIA, I. DIEZ, T. GALLARDO, J. CREMADES & J. M. GOROSTIAGA. 2008. Adiciones corológicas a la flora bentónica marina del Cantábrico. *Nova Acta Científica Compostelana (Biología)* 17: 177-189.
- DIMITROVA-KONAKLIEVA, S.D. 1981. Geographical analysis on the marine algae of the Black Sea in the Ahtopol area. *Phytology* 18: 22-35.
- DIXON, P. S. 1961. List of marine algae collected in the Channel Islands during the joint meeting of the British Phycological Society and the Société Phycologique de France September 1960. *British Phycological Bulletin* 2 (2): 71-80. DOI: 10.1080/00071616100650061
- DIZERBO, A. H. & E. HERPE. 2007. *Liste et répartition des algues marines des côtes françaises de la Manche et de l'Atlantique, îles Normandes incluses*. Éditions Anaximandre, Landerneau. 315 p.
- DUNCAN, E. J. & L. M. LEE-LUM. 2006. A checklist of the marine macroalgae of the Republic of Trinidad and Tobago. *Caribbean Marine Studies* 7: 1-96.
- EDWARDS, P., E. BIRD, B. COTGREAVE, A. COSSINS, K. CROMPTON, K. FOWLER, D. HERDSON & J. HUDSON. 1975. Marine phytobenthos of the Castellabate (Cilento) Natural Park, Salerno, Italy. *Phytocoenologia* 1 (4): 403-246.
- FELDMANN, J. 1954. Inventaire de la flore marine de Roscoff. Algues, champignons, lichens et spermatophytes. *Travaux Station Biologique de Roscoff. Nouvelle Série* (Supplement 6): 152 p.
- FEOLI, E. & G. BRESSAN. 1972. Affinità floristica dei tipi di vegetazione bentonica della Cala di Mitigliano (Massa Lubrense, Napoli). *Giornale Botanico Italiano* 106 (5): 245-256. DOI: 10.1080/11263507209426553
- FERNÁNDEZ, C. & J. J. ALVARADO. 2004. El arrecife coralino de Punta Coclas, costa Caribe de Costa Rica. *Revista Biología Tropical* 52 (Supplement 2): 121-129.
- FUJII, M. T. & A. SENTÍES. 2005. Taxonomia do complexo *Laurencia* (Rhodomelaceae, Rhodophyta) do Brasil, com ênfase nas espécies dos estados de Sao Paulo e do Espírito Santo. In: Sentíes, A. & K.M. Dreckmann (Eds.). *Monografías Ficológicas 2*. UAM-Iztapalapa and Red Latinoamericana de Botánica, Cd. de Mexico. pp. 69-135.
- FUJII, M. T., S. M. P. B. GUIMARAES, C. F. D. GURGEL & S. FREDERICO. 2006. Characterization and phylogenetic affinities of the red algae *Chondrophycus flagelliferus* (Rhodomelaceae, Ceramiales) from Brazil on the basis of morphological and molecular evidence. *Phycologia* 45 (4): 432-441. DOI: 10.2216/04-33.1
- FUJII, M. T., V. CASSANO, E. M. STEIN & L. R. CARVALHO. 2011. Overview of the taxonomy and of the major secondary metabolites and their biological activities related to human health of the *Laurencia* complex (Ceramiales, Rhodophyta) from Brazil. *Brazilian Journal of Pharmacognosy* 21 (2): 268-282. DOI: 10.1590/S0102-695X2011005000064
- FURNARI, G., M. COMARCI & D. SERIO. 1999. Catalogue of the benthic marine macroalgae of the Italian coast of the Adriatic Sea. *Boccone* 12: 5-214.
- FURNARI, G., M. CORMACI & D. SERIO. 2001. The *Laurencia* complex (Rhodophyta, Rhodomelaceae) in the Mediterranean Sea: an overview. *Cryptogamie, Algologie* 22 (4): 331-373.
- FURNARI, G., G. GIACCONE, M. COMARCI, G. ALONGI & D. SERIO. 2003. Biodiversità marina delle coste italiane: catálogo de macrofitobenthos. *Biologia Marina Mediterranea* 10(1): 1-482.
- GANESAN, E. K. 1990. *A catalog of benthic marine algae and seagrasses of Venezuela*. Fondo Editorial Conicit, Caracas. 237 p.
- GARBARY, D. J. & J. T. HARPER. 1998. A phylogenetic analysis of the *Laurencia* complex (Rhodomelaceae) of the red algae. *Cryptogamie, Algologie* 19(3): 185-200.
- GIL-RODRÍGUEZ, M. C., V. CASSANO, E. AYLAGAS, A. SENTÍES, J. DÍAZ-LARREA, M.C. OLIVEIRA & M. T. FUJII. 2010. *Palisada flagellifera* (Ceramiales, Rhodophyta) from the Canary Islands, Spain: a new record for the eastern Atlantic Ocean based on morphological and molecular evidence. *Botanica Marina* 53 (1): 31-40. DOI: 10.1515/BOT.2010.010
- GIL-RODRÍGUEZ M. C., M. T. FUJII, V. CASSANO, M. MACHÍN-SÁNCHEZ, E. AYLAGAS & A. SENTÍES. 2012. Los géneros *Laurencia*, *Laurenciella* y *Palisada* (Rhodomelaceae, Rhodophyta) en las Islas Canarias. In: A Sentíes & K.M. Dreckmann (Eds.). *Monografías Ficológicas 4*. M: UAM-Iztapalapa and Universidad de La Laguna, Cd. de México. pp. 43-116
- GÓMEZ-GARRETA, A., T. GALLARDO, M. A. RIBERA, M. CORMACI, G. FURNARI, G. GIACCONE & C. F. BOUDOURESQUE. 2001. Checklist of the Mediterranean seaweeds III. Rhodophyceae Rabenh. 1. Ceramiales Oltm. *Botanica Marina* 44 (5): 425-460. DOI: 10.1515/BOT.2001.051
- GOROSTIAGA, J. M., A. SANTOLARIA, A. SECILIA, C. CASARES & I. DIEZ. 2004. Checklist of the Basque coast benthic algae (North of Spain). *Anales Jardín Botánico de Madrid* 61 (2): 155-180.
- GUIRY, M. D. 1978. *A consensus and bibliography of Irish Seaweeds*. Cramer, Vaduz. 287 p.
- GUIRY, M. D. & G. M. GUIRY. 2017. AlgaeBase. World-wide electronic publication. National University of Ireland, Ireland. Available online at: <http://www.algaebase.org> (downloaded March 25, 2017).
- HAMEL, C. 1928. Les algues de Vigo. *Revue Algologique* 4: 81-95.
- HARDY, F. G. & M. D. GUIRY. 2003. *A check-list and atlas of the seaweeds of Britain and Ireland*. British Phycological Society, London. 435 p.
- HAROUN, R. & W. F. PRUD'HOMME VAN REINE. 1993. A biogeographical study of "*Laurencia*" and "*Hypnea*" species of the Macaronesian region. *Courier Forschungsinstitut Senckenberg* 159: 119-125.
- HAROUN, R.J., M.C. GIL-RODRÍGUEZ, J. DÍAZ DE CASTRO & W.F. PRUD'HOMME VAN REINE. 2002. A checklist of the marine plants from the Canary Islands (central eastern Atlantic Ocean). *Botanica Marina* 45 (2): 139-69.
- HOFFMAN, R., M. STERNBERG & D. SERIO. 2014. First report of *Laurencia chondrioides* (Ceramiales, Rhodophyta) and its potential to be an invasive in the eastern Mediterranean Sea. *Botanica Marina* 57 (6): 449-457. DOI: 10.1515/bot-2014-0053

- IPPI, S. & V. FLORES. 2001. Las tortugas neotropicales y sus áreas de endemismo. *Acta Zoologica Mexicana* 84: 49-63.
- JOHN, D. M., W. F. PRUD'HOMME VAN REINE, G. W. LAWSON, T. B. KOSTERMANS & J. H. PRICE. 2004. A taxonomic and geographical catalogue of the seaweeds of the western coast of Africa and adjacent islands. *Beihefte zur Nova Hedwigia* 127: 1-339.
- KAMENARSKA, Z., A. IVANOVA, R. STANCHEVA, M. STOYNEVA, K. STEFANOV, S. DIMITROVA-KONAKLIEVA & S. POPOV. 2006. Volatile compounds from some Black Sea red algae and their chemotaxonomic application. *Botanica Marina* 49 (1): 47-56. DOI: 10.1515/BOT.2006.006
- KAMENARSKA, Z., J. SERKEDJIEVA, H. NAJDENSKI, K. STEFANOV, I. TSVETKOVA, S. DIMITROVA-KONAKLIEVA & S. POPOV. 2009. Antibacterial, antiviral, and cytotoxic activities of some red and brown seaweeds from Black Sea. *Botanica Marina* 52 (1): 80-86. DOI: 10.1515/BOT.2009.030
- KERSWELL, A. P. 2006. Global biodiversity patterns of benthic marine algae. *Ecology* 87 (10): 2479-2488. DOI: 10.1890/0012-9658(2006)87[2479:GBPOBM]2.0.CO;2
- KLEIN, J. & M. VERLAQUE. 2005. *Laurencia caduciramulosa* Masuda et Kawaguichi (Ceramiales, Rhodophyta), first record for the Mediterranean coast of France. *Cryptogamie Algologie* 26: 209-216.
- KLEIN, J. C. & M. VERLAQUE. 2011. Macroalgae newly recorded, rare or introduced to the French Mediterranean coast. *Cryptogamie Algologie* 31 (2): 111-130. DOI: 10.7872/crya.v32.iss2.2011.111
- LIPKIN, Y. & P. C. SILVA. 2002. Marine algae and seagrasses of the Dahlak Archipelago, southern Red Sea. *Nova Hedwigia* 75 (1-2): 1-90. DOI: 10.1127/0029-5035/2002/0075-0001.
- LITTLER, D. S. & M. M. LITTLER. 1997. An illustrated flora of Pelican Cays, Belize. *Bulletin of the Biological Society of Washington* 9: 1-149.
- LITTLER, D. S., M. M. LITTLER & M. D. HANISAK. 2008. *Submersed plants of the Indian River Lagoon*. OffShore Graphics, Washington, D.C. 286 p.
- MACHÍN-SÁNCHEZ, M., V. CASSANO, J. DÍAZ-LARREA, A. SENTÍES, M.T. FUJII & M.C. GIL-RODRÍGUEZ. 2012. Morphological and molecular evidence demonstrate the amphi-Atlantic distribution of *Laurencia catarinensis* (Ceramiales, Rhodophyta). *Botanica Marina* 55 (3): 241-252. DOI: 10.1515/bot-2011-0049
- MACHÍN-SÁNCHEZ, M., L. LE GALL, A.I. NETO, F. ROUSSEAU, V. CASSANO, A. SENTÍES, M.T. FUJII, J. DÍAZ-LARREA, W.F. PRUD'HOMME VAN REINE, C. BONILLO & M.C. GIL-RODRÍGUEZ. 2014. A combined barcode and morphological approach to the systematics and biogeography of *Laurencia pyramidalis* and *Laurencia marilzae* (Rhodophyta). *European Journal of Phycology* 49 (1): 115-127. DOI: 10.1080/09670262.2014.893017
- MARTIN-LESCANNE, J., F. ROUSSEAU, B. DE REVIERS, C. PAYRI, A. COULOUX, C. CRUAUD & L. LE GALL. 2010. Phylogenetic analyses of the *Laurencia* complex (Rhodomelaceae, Ceramiales) support recognition of five genera: *Chondrophycus*, *Laurencia*, *Osmundea*, *Palisada* and *Yuzurua* stat. nov. *European Journal of Phycology* 45 (1): 51-61. DOI: 10.1080/09670260903314292
- MARTÍNEZ-GIL, M., T. GALLARDO, P. DÍAZ & I. BÁRBARA. 2007. Aportación al conocimiento de las algas marinas bentónicas del litoral comprendido entre el estuario del Río Quejío y Punta de la Mesa, Noja, Cantabria, España. *Botánica Complutense* 31: 41-53.
- MATEO-CID, L.E., A. C. MÉNDOZA-GONZÁLEZ, A. SENTÍES, J. DÍAZ-LARREA & J. A. A. CALDERON. 2014. *Laurencia laurauertana* sp. nov. (Rhodomelaceae, Rhodophyta): an epiphytic species from the Mexican Caribbean. *Phycological Research* 62 (2): 94-101. DOI: 10.1111/pre.12043
- MEDINA. 2007. Empleo de herramientas panbiogeográficas para detectar áreas para conservar: Un ejemplo con taxones dulceacuícolas. In: Luna, I., J. J. Morrone & D. Espinosa (Eds.). *Biodiversidad de la Faja Volcánica Transmexicana*. UNAM, Ciudad de México. Pp. 449-460.
- METTI Y., A. J. MILLAR & P. STEINBERG. 2015. A new molecular phylogeny of the *Laurencia* complex (Rhodophyta, Rhodomelaceae) and a review of key morphological characters result in a new genus, *Coronaphycus*, and a description of *C. novus*. *Journal of Phycology* 51 (5): 929-942. DOI: 10.1111/jpy.12333
- MIRANDA, T. P. & A. C. MARQUES. 2011. Abordagens atuais em biogeografia marinha. Current approaches in marine biogeography. *Revista da Biología* (Vol. Esp. Biogeografía): p. 41-48. DOI: 10.7594/revbio.07.08
- MORRONE, J. J. 2007. *Evolutionary Biogeography: An Integrative Approach*. Columbia University Press, New York. 301p.
- MORRONE, J. J. 2013. Parsimony analysis of endemism (PAE) revisited. *Journal of Biogeography* 41 (5): 842-854. DOI: 10.1111/jbi.12251
- Morton, O. 1994. *Marine algae of Northern Ireland*. Ulster Museum, Botanic Gardens, Belfast. 123 p.
- MORTON, O. 2003. The marine macroalgae of County Donegal, Ireland. *Bulletin of the Irish Biogeographical Society* 27: 3-165.
- MUNDA, I. M. 1979. Some Fucacean associations from the vicinity of Rovinj, Istrian Coast, northern Adriatic. *Nova Hedwigia* 31: 607-666.
- NAM, K. W. 1999. Morphology of *Chondrophycus undulatus* and *C. parvipapillata* and its implications for the taxonomy of the *Laurencia* (Ceramiales, Rhodophyta) complex. *European Journal of Phycology* 34: 455-468.
- NAM, K. W. 2006. Phylogenetic re-evaluation of the *Laurencia* complex (Rhodophyta) with a description of *L. succulenta* sp. nov. from Korea. *Journal of Applied Phycology* 18: 679-697. DOI: 10.1007/s10811-006-9073-3
- NAM, K. W. 2007. Validation of the generic name *Palisada* (Rhodomelaceae, Rhodophyta). *Algae* 22 (2): 53-55.
- NAM, K. W., C. A. MAGGS & D. J. GARBARY. 1994. Resurrection of the genus *Osmundea* with an emendation of the generic delineation of *Laurencia* (Ceramiales, Rhodophyta). *Phycologia* 33 (5): 384-395. DOI: 10.2216/i0031-8884-33-5-384.1
- NETO, A. I. 1994. Checklist of the benthic marine macroalgae of the Azores Archipelago. *Life and Marine Sciences* 12A: 15-34.
- NETO, A. I., D. C. CRAVO & R. J. HAROUN. 2001. Checklist of the benthic marine plants of the Madeira Archipiélago. *Botânica Marina* 44 (4): 391-414. DOI: 10.1515/BOT.2001.049
- NIXON, K. C. 1999. *Winclada* (beta) ver 0.9.9. Published for the author, Ithaca, New York.

- NORRIS, J. N. & K. E. BUCHER. 1982. Marine algae and seagrasses from Carrie Bow Cay, Belize. In: Rützler K. & I. G. Macintyre (Eds.). *The Atlantic Barrier Reef Ecosystem at Carrie Bow Cay, Belize. I. Structure and Communities*. Smithsonian Contributions to the Marine Sciences 12. pp. 167-223.
- NÚÑEZ-RESENDIZ, M. L., K. M. DRECKMANN, A. SENTÍES, J. DÍAZ-LARREA & G. C. ZUCCARELLO. 2015. Genetically recognizable but not morphologically: the cryptic nature of *Hydropuntia cornea* and *H. usneoides* (Gracilariales, Rhodophyta) in the Yucatan Peninsula. *Phycologia* 54 (4): 407-416. DOI: 10.2216/15-009.1
- OLIVEIRA, A. S., D. B. SUDATTI, M. T. FUJII, S. V. RODRÍGUEZ & R. C. PEREIRA. 2013. Inter-and intrapopulation variation in the defensive chemistry of the red seaweed *Laurencia dendroidea* (Ceramiales, Rhodophyta). *Phycologia* 52 (2): 130-136. DOI: 10.2216/12-058.1
- ORTEGA, M. M., J. L. GODÍNEZ & G. GARDUÑO SOLÓRZANO. 2001. Catálogo de algas bentónicas de las costas mexicanas del Golfo de México y Mar Caribe. *Cuadernos del Instituto de Biología* 34: 1-594.
- PEÑA, V. & I. BÁRBARA. 2008. Maëri community in the northwestern Iberian Peninsula: a review of floristic studies and long-term changes. *Aquatic Conservation: Marine and Freshwater Ecosystem* 18: 339-366.
- PÉREZ-RUZAFÁ, I. & M. HONRUBIA. 1984. Aportación al conocimiento de la flora algal bentónica de la costa murciana. III. *Anales de Biología* 2 (Sección Especial 2): 135-146.
- PÉREZ-RUZAFÁ, I. M. 1990. Fenología de las algas del Mar Menor (Murcia, SE de España). *Botanica Complutensis* 16: 21-36.
- PLATNICK, N. I. 1991. On areas of endemism. *Australian Systematic Botany* 4: 6-7.
- RINDI, F., G. SARTONI & F. CINELLI. 2002. A floristic account of the benthic marine algae of Tuscany (Western Mediterranean Sea). *Nova Hedwigia* 74(1-2): 201-250. DOI: 10.1127/0029-5035/2002/0074-0201
- RODRÍGUEZ-PRieto, C., G. MICHANEK & C. IVON. 1999. Benthic marine algae from Martinique (Lesser Antilles). *Scientia Gerudensis* 24: 79-86.
- RODRÍGUEZ-PRieto, C. & L. POLO-ALBERTÍ. 1988. Aportación a la fenología de algas bentónicas de substrato duro de la Costa Brava (Gerona). *Actes del Simposi Internacional de Botànica Pius Font I Quer 1, Criptogamia*: 143-149.
- RODRÍGUEZ-PRieto, C. & L. POLO-ALBERTÍ. 1998. Anàlisi fitosociològica de la comunitat de *Cystoseira mediterranea* de Palamós (Mediterrània nordoccidental). *Acta Botanica Barcinonensis* 45: 141-156.
- ROSEN, B. R. 1988. From fossil to earth history: Applied historical biogeography. In: Myers A.A. & P. Giller (Eds.). *Analytical biogeography: an integrated approach to the study of animal and plant distributions*. Wiley, Chichester, Sussex. pp. 201-262.
- ROUSSEAU, F., D. GEY, A. KURIHARA, C.A. MAGGS, J. MARTIN-LESCANNE, C. PAYRI, B. DE REVIERS, A.R. SHERWOOD & L. LE GALL. 2017. Molecular phylogenies support taxonomic revision of three species of *Laurencia* (Rhodomelaceae, Rhodophyta), with the description of new genus. *European Journal of Taxonomy* 269: 1-19. DOI: 10.5852/ejt.2017.269
- SAITO, Y. 1967. Studies on Japanese species of *Laurencia* with special reference to their comparative morphology. *Memoirs of the Faculty of Fisheries, Hokkaido University* 15: 1-81.
- SALES, M. & E. BALLESTEROS. 2010. Long-term comparison of algal assemblages dominated by *Cystoseira crinite* (Fucales, Heterokontophyta) from Cap Corse (Corsica, north western Mediterranean). *European Journal of Phycology* 45 (4): 404-412. DOI: 10.1080/09670262.2010.498585
- SCHNEIDER, C.W. & C.E. LANE. 2005. Notes on the marine algae of the Bermudas. 7. Additions to the flora, including *Chondracanthus saundersii* sp. nov. (Rhodophyta, Gigartinales) based on *rbcL* sequence analysis. *Phycologia* 44: 72-83.
- SCHNEIDER, C. W., C. E. LANE & G. W. SAUNDERS. 2010. Notes on the marine algae of the Bermudas. 11. More additions to the benthic flora and a phylogenetic assessment of *Halymenia pseudofloresii* (Halymeniales, Rhodophyta) from its type locality. *Phycologia* 49 (2): 154-168. DOI: 10.2216/PH09-46.1
- SCHNETTER, R. 1976. Nuevas algas bentónicas del litoral Caribe de Colombia. *Caldasia* 11 (53): 57-60.
- SENTÍES, A. & M. T. FUJII. 2002. El complejo *Laurencia* (Rhodomelaceae, Rhodophyta) en el Caribe Mexicano. In: Senties, A. & K.M. Dreckmann (Eds.). *Monografías Ficológicas 1*. UAM-Iztapalapa and Red Latinoamericana de Botánica, Cd. de Mexico. pp. 119-192.
- SENTÍES, A., A. ARECES, J. DÍAZ-LARREA & M.T. FUJII. 2010. First records of *Laurencia caduciramulosa* and *L. minuscula* (Ceramilales, Rhodophyta) from the Cuban archipelago. *Botanica Marina* 53 (5): 433-438. DOI: 10.1515/bot.2010.048
- SERIO, D., G. FURNARI & M. COMARCI. 2004. On the occurrence of *Laurencia pyramidalis* Bory ex Kutzing (Rhodophyta, Ceramilales) in the Mediterranean Sea. *Cryptogamie Algologie* 25 (4): 329-336.
- SERIO, D., G. ALONGI, M. CATRA, M. COMARCI & G. FURNARI. 2006. Changes in the benthic algal flora of Linosa Island (Straits of Sicily, Mediterranean Sea). *Botanica Marina* 49 (2): 135-144. DOI: 10.1515/BOT.2006.018
- SILVA, P. C., E. G. MEÑEZ & R. L. MOE. 1987. Catalog of the benthic marine algae of the Philippines. *Smithsonian Contributions to Marine Sciences* 27: 1-179. DOI: 10.5479/si.1943667X.27.1
- SILVA, P. C. P. W. BASSON & R. L. MOE. 1996. Catalogue of the benthic marine algae of the Indian Ocean. *University of California Publications in Botany* 79: 1-1259.
- SKAGE, M., T.M. GABRIELSEN & J. RUENESS. 2005. A molecular approach to investigate the phylogenetic basis of three widely used species groups in the red algae genus *Ceramium* (Ceramilales, Rhodophyta). *Phycologia* 44: 353-360.
- SOTO, J. & F. CONDE. 1989. Catálogo florístico de las algas bentónicas marinas del litoral de Almería (Sureste de España). *Botánica Complutense* 15: 61-83.
- SPALDING, M. K., H. E. FOX, G. R. ALLEN, N. DAVIDSON, Z. A. FERDAÑA, M. FINLAYSON, B. J. HALPERN, M. A. JORGE, A. LOMBARDA, S. A. LOURIE, K. D. MARTIN, E. McMANUS, J. MOLNAR, C. A. RICCHIA & J. ROBERTSON. 2007. Marine ecoregions of the world: a bioregionalization of coastal and shelf areas. *BioScience* 57 (7): 573-583. DOI: 10.1641/B570707
- STEGENGA, H., J. J. BOLTON & R. J. ANDERSON. 1997. *Seaweeds of the South African west coast*. Bolus Herbarium, University of Cape Town. 655 p.

- STOKES, K., K. O'NEILL & R.A. McDONALD. 2004. *Invasive species in Ireland*. Unpublished report to Environment & Heritage Service and Natural Parks & Wildlife Service, Belfast. 152 p.
- SUÁREZ, A. M. 2005. Lista de las macroalgas marinas cubanas. *Revista de Investigaciones Marinas* 26 (2): 93-148.
- SUÁREZ, A. M., B. MARTÍNEZ-DARANAS & Y. ALFONSO 2015. Macroalgas marinas de Cuba. Editorial UH, La Habana. 264 p.
- TAPIA-SILVA, F. O., O. E. HERNÁNDEZ-CERVANTES, M. I. VILCHIS-ALFARO, A. SENTÍES & K. M. DRECKMANN. 2015. Mapping of algae richness using spatial data interpolation. *The International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences* XL-7/W3: 1005-1008. DOI: 10.5194/isprsarchives-XL-7-W3-1005-2015
- TASKIN, E., M. ÖZTÜRK, O. KURT & M. ÖZTÜRK. 2008. *The check-list of the marine algae of Turkey*. Ecem Kirtasiye, Manisa. 87 p.
- TASKIN, E., M. ÖZTÜRK, O. KURT & S. UCLAY. 2013. Benthic marine algae in the Northern Cyprus (eastern Mediterranean Sea). *Journal of Black Sea/Mediterranean Environment* 19 (2): 143-161.
- TAYLOR, W. R. 1960. *Marine algae of the eastern tropical and subtropical coasts of the Americas*. The University of Michigan Press, Ann Arbor. 870 p.
- TAYLOR, W. R. 1969. Notes on the distribution of West Indian marine algae particularly in the Lesser Antilles. *Contribution from the University of Michigan Herbarium* 9: 125-203.
- TITTENSOR, D. P., C. MORA, W. JETZ, H. K. LOOTZE, D. RICARD, E. V. BERGHE & B. WORM. 2010. Global patterns and predictors of marine biodiversity across taxa. *Nature Letters* 466 (7310): 1098-1103. DOI: 10.1038/nature09329
- TITTLE I. & A. I. NETO. 1994. "Expedition Azores 1989": Benthic marine algae (seaweeds) recorded from Faial and Pico. Archipelago. *Life and Marine Sciences* 12A: 1-13.
- TITTLE, I., A. I. NETO & M. I. PARENTE. 2009. The marine algal (seaweed) flora the Azores: additions and amendments 3. *Botanica Marina* 52 (3): 7-14. DOI: 10.1515/BOT.2005.030
- TORRANO-SILVA, B. N. & OLIVEIRA, E. C. 2013. Macrophytobenthic flora of the Abrolhos Archipelago and the Sebastião Gomes Reef, Brazil. *Continental Shelf Research* 70: 150-158. DOI: 10.1016/j.csr.2013.09.019
- TSIAMIS, K., A. F. PETERS, D. N. SHEWRING, A. O. ASENSI, P. VAN WEST & F. C. KÜPPER. 2014a. Marine benthic algal flora of Ascension Island, South Atlantic. *Journal of Marine Biological Association of the United Kingdom* [advance access]: 1-8. DOI: 10.1017/S0025315414000952
- TSIAMIS, K., E. TASKIN, S. ORFANIDIS, P. STAVROU, M. ARGYROU, P. PANAYOTIDIS, T. TSIOLI, B. A. CICEK, M. MARCOU & F. C. KÜPPER. 2014b. Checklist of seaweeds of Cyprus (Mediterranean Sea). *Botanica Marina* 57 (3): 153-166. DOI: 10.1515/bot-2014-0006
- TSIKIRA, A. & S. HARITONIDIS. 2005. A survey of the benthic flora in the National Marine Park of Zakynthos (Greece). *Botanica Marina* 48 (1): 38-45. DOI: 10.1515/BOT.2005.002
- TUYA, F. & R. J. HAROUN. 2009. Phytogeography of Luisitanian Macaronesia: biogeographic affinities in species richness and assemblage composition. *European Journal of Phycology* 44 (3): 405-413. DOI: 10.1080/09670260902836246
- VARGAS, S., H.M. GUZMAN & O. BREEDY. 2008. Distribution patterns of the genus *Pacificorgia* (Octocorallia: Gorgoniidae): track compatibility analysis and parsimony analysis of endemism. *Journal of Biogeography* 35 (2): 241-247.
- VEIGA, A. J., J. CREMADES & I. BÁRBARA. 1998. A catalogue of the benthic marine algae of the Sisargas Islands (N.W. Iberian Peninsula, Spain). *Boletim do Museu Municipal do Funchal* (Suppl. 5): 481-493.
- VERLAQUE, M. 2001. Checklist of the macroalgae of Thau Lagoon (Hérault, France), a hot spot of marine species introduction in Europe. *Oceanologica Acta* 24 (1): 29-49. DOI: 10.1016/S0399-1784(00)01127-0
- VILCHIS, M.I., K.M. DRECKMANN, E.A. GARCÍA-TREJO, O.E. HERNÁNDEZ & A. SENTÍES. (in press). Patrones de distribución de las grandes macroalgas en el Golfo de México y Caribe mexicano: Una contribución a la biología de la conservación. *Revista Mexicana de Biodiversidad*.
- VILLAÇA, R., A. C. FONSECA, V. K. JENSEN & B. KNOPPERS. 2010. Species composition and distribution of macroalgae on Atol das Rocas, Brazil, SW Atlantic. *Botanica Marina* 53 (2): 113-122. DOI: 10.1515/BOT.2010.013
- WOMERSLEY, H. B. S. 2003. *The marine benthic flora of southern Australia - Part IIID Ceramiales - Delesseriaceae, Sarcomeniaceae, Rhodomeleaceae*. Australian Biological Resources Study/State Herbarium of South Australia, Canberra/Adelaide. 533 p.
- WYNNE, M. J. 2008. A checklist of the benthic marine algae of the coast of Texas. *Gulf of Mexico Science* 2008 (1): 64-87.
- WYNNE, M. J. 2017. A checklist of benthic marine algae of the tropical and subtropical western Atlantic: fourth revisión. *Nova Hedwigia Beihefte* 145: 7-202.
- WYNNE, M. J., T. BRADSHAW & C. M. S. CARRINGTON. 2014. A checklist of the benthic marine algae of Barbados, West Indies. *Botanica Marina* 57 (3): 167-184. DOI: 10.1515/bot-2014-0007