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Species diversity and biogeographical patterns of *Laurencia* sensu stricto (Rhodophyta) in the Atlantic OceanDiversidad de especies y patrones biogeográficos de *Laurencia* sensu stricto (Rhodophyta) en el océano AtlánticoOscar E. Hernández<sup>1,2</sup>, Abel Sentíes<sup>2</sup>, Kurt M. Dreckmann<sup>2</sup>, Valéria Cassano<sup>3</sup> and Mutue T. Fujii<sup>4</sup><sup>1</sup> Estudiante del Doctorado en Ciencias Biológicas y de la Salud. Universidad Autónoma Metropolitana, Unidad Iztapalapa. A.P. 55-535, CDMX, 09340, México<sup>2</sup> Departamento de Hidrobiología, Universidad Autónoma Metropolitana-Iztapalapa, A.P. 55-535, CDMX, 09340, México<sup>3</sup> Departamento de Botânica, Universidade de São Paulo, Rua do Matão 277, São Paulo 05508-090, Brazil<sup>4</sup> Núcleo de Pesquisa em Ficologia, Instituto de Botânica, Av. Miguel Estéfano, 3687-04301-902 São Paulo, Brazil  
e-mail: oehc90@gmail.com**Recibido:** 31 de mayo de 2017.**Aceptado:** 30 de octubre de 2017.Hernández O. E., A. Sentíes, K. M. Dreckmann, V. Cassano and M. T. Fujii. 2017. Species diversity and biogeographical patterns of *Laurencia* sensu stricto (Rhodophyta) in the Atlantic Ocean. *Hidrobiológica* 27 (3): 301-314.**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

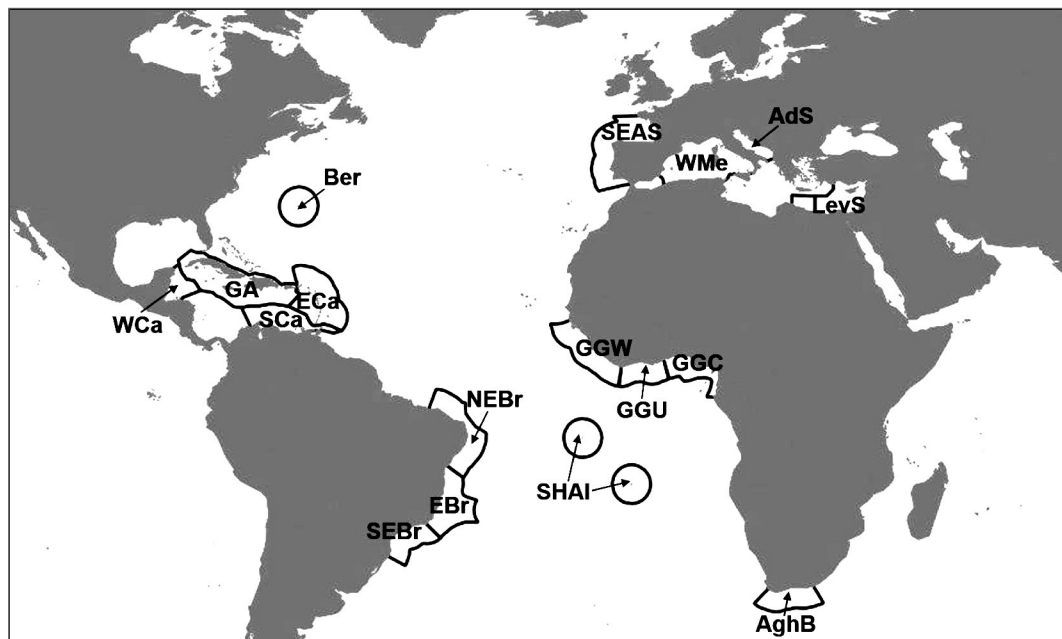


Figure 1. Marine ecoregions used in the PAE analysis, modified from Spalding *et al.*, (2007): Adriatic Sea (AdS), Aghulas Bank (AghB), Bermuda (Ber), Eastern Brazil (EBr), Eastern Caribbean (Eca), Greater Antilles (GA), Gulf of Guinea Central (GGC), Gulf of Guinea Upwelling (GGU), Gulf of Guinea Western (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 (Diannelidis, 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, Gammarrh, 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).



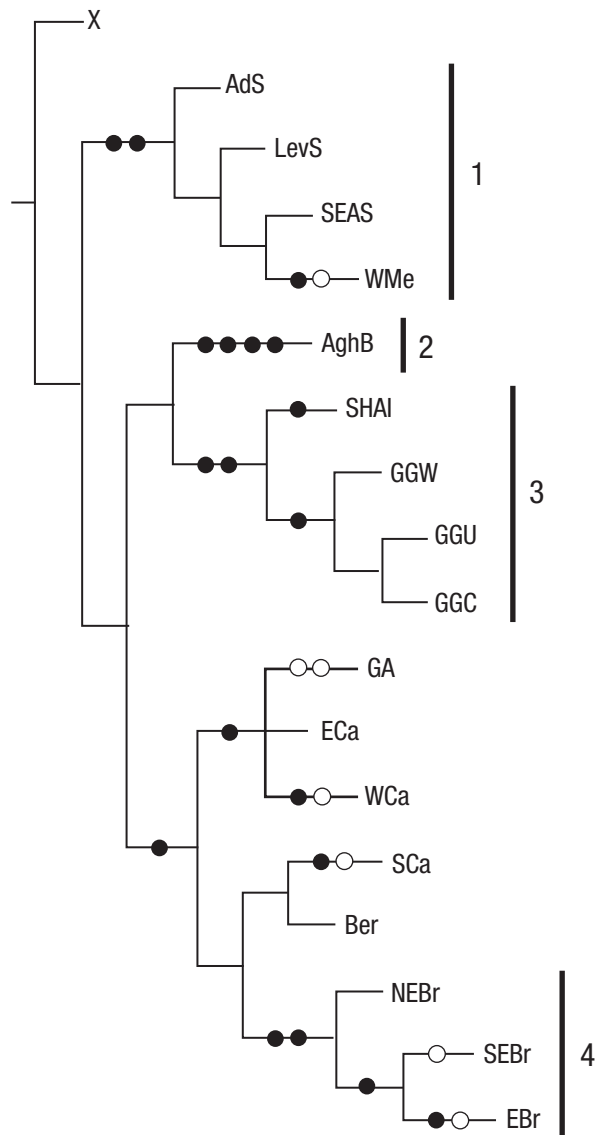


Figure 2. Areas of endemism defined in the PAE analysis. 1) Northwestern Atlantic, 2) South Africa, 3) Gulf of Guinea, and 4) Brazil. The black dots represent restricted species or synapomorphies and the white dots represent homoplasies.

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

<sup>\*</sup>Species also distributed in the Indo-Pacific. <sup>+</sup>Species also distributed in the Macaronesian Archipelago.

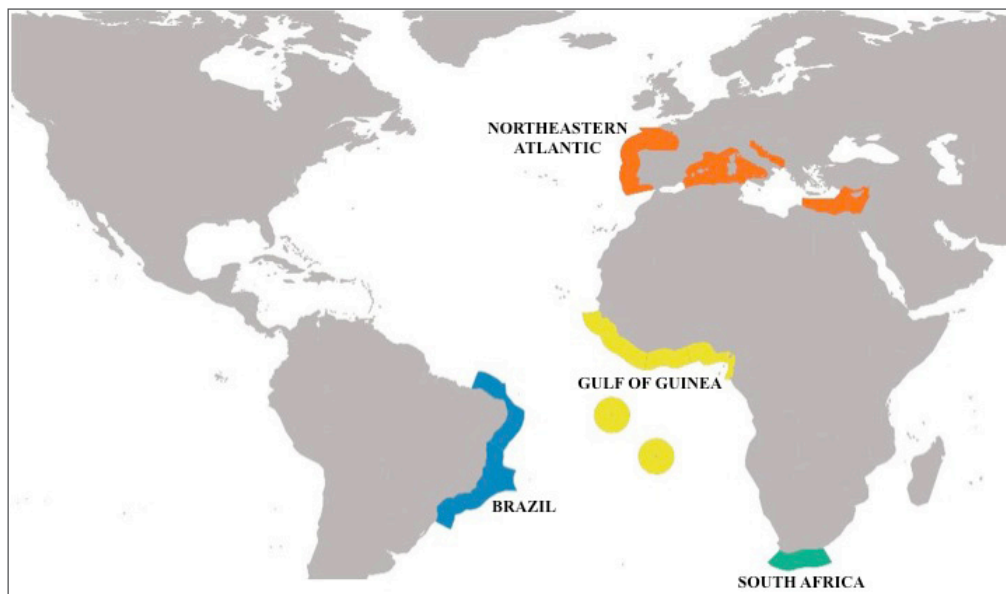


Figure 3. Map of the areas of endemism of *Laurencia* in the Atlantic Ocean.

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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