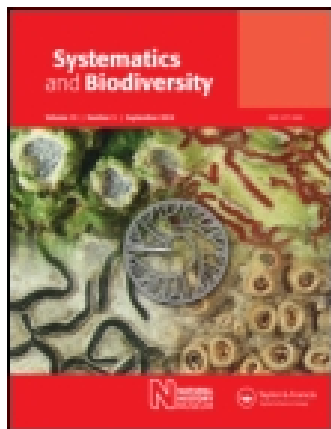


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### On biotas and their names

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## Perspective

### On biotas and their names

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Biogeographers working under different approaches have proposed several terms to refer to biotas, e.g. the flora and fauna of a region, and to name subsets of taxa within such biotas. It is not clear whether they refer exactly to the same entities and which is the most adequate term to refer to them. Ten concepts refer to the set of taxa that inhabit an area at a single temporal plane (concrete biota, chronofauna, area of endemism, nuclear area, phytocorion, centre of endemism, generalized track, biogeographical assemblage, taxonomic assemblage, and species assemblage), whereas another nine concepts refer to subsets of taxa within a biota (biotic element, historical source, historical component, faunal element, cenocron, dispersal pattern, distributional pattern, lineage, and historical biota). Three concepts can be ascribed to both groups, depending on the author considered (horofauna, chorotype and biotic component). I propose to use the terms ‘biota’ and ‘cenocron’ as general terms, within a framework of integrative pluralism. Biotas can be considered individuals, for which the terms area of endemism, generalized track or chorotype can be preferred for specific analyses. Cenocrons incorporate a temporal dimension when implying explicitly or implicitly a different time of their incorporation to the biota.

**Key words:** areas of endemism, biogeography, biotas, chorotypes, generalized tracks, integrative pluralism

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## Introduction

Biogeography is the study of the geographic distribution of taxa and their attributes in space and time (Hausdorf & Hennig, 2007). Some of the issues addressed by biogeographers include species distribution, the geography of diversity, the geography of traits, endemism, biogeographic regionalization, biotic assembly on islands, biotic evolution, and conservation biogeography (Morrone, 2012). For analysing biotic evolution, there are different (and conflictive) approaches, known as dispersalism, pan-biogeography, cladistic biogeography, comparative phylogeography, and evolutionary biogeography, among others, that have disputed extensively over the relative merits of their approaches, but have not interacted toward their integration (Lomolino *et al.*, 2006; Morrone, 2009).

For almost a century, biogeographers working under different approaches have proposed several concepts (with their corresponding terms) to refer to biotas. A biota corresponds to the flora and fauna of a region (Merriam-Webster, 2014). The terms ‘fauna’ (used exclusively for animal taxa) and ‘flora’ (used exclusively for plant taxa)

are equivalent. The use of these different concepts and terms has promoted disagreements among the different biogeographic approaches and thus impeded interaction among biogeographers. Additionally, authors have proposed specific terms to refer to subsets of taxa within such biotas. Although some authors (Arrigoni, 1973; Reig, 1981; Savage, 1982; Morrone, 2001, 2009; Casazza & Minuto, 2009; Gámez *et al.*, 2014) have already noted that there are similarities among some of these terms, it is not clear whether they refer exactly to the same entities and which is the most adequate term to refer to them.

My objective is to review these concepts, to discuss their similarities and differences, to determine which entities they refer to, and to try to discuss their possible use in an integrative pluralist framework.

## Concepts

The following concepts have been used in biogeography to refer to biotas:

**Biotic element:** this term was used by Dunn (1931) to refer to a subset of the taxa within a fauna, although he did not provide a formal definition. Müller (1973: 3) defined a biotic element as the ‘species and subspecies

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which resemble each other in their geographical distribution, and which can be ascribed to a single dispersal centre'. Reig (1981: 27) defined a biotic element as a 'group of taxa that are distinguished as a discrete unit in the process of cenogenesis, either by their community of origin or geographic-evolutionary history (ancestry), by their membership to a given cenocron, or by their autoctonous or allochthonous character'. Hausdorf (2002: 651) defined a biotic element as 'a group of taxa whose ranges are significantly more similar to each other than to those of taxa of other such groups' (see also Hausdorf & Hennig, 2003; Morrone, 2005; Giokas & Sfenthourakis, 2008; Casazza & Minuto, 2009). The terms 'element', 'historical source unit', and 'historical component' (Savage, 1973, 1974, 1982) refer to a similar concept.

**Concrete biota:** Tolmachev (1931) introduced the term 'concrete flora' and Chernov (1975) the term 'concrete fauna'. A concrete biota consists of 'all species encountered in all habitats within a certain area around a basic locality' (Penev, 1997: 91). Penev (1997) noted that 'concrete biotas' were similar to ecological 'communities', although the latter are characterized not only by their species but also by some measure of abundance, richness, frequency, biomass, etc.

**Horofauna:** this term was coined by Smith (1949: 220) to refer to 'faunae of similar origin (both temporal and zoogeographic), as opposed to faunae of the ordinary sense, of similar position (area of occupation)'. According to Smith (1949), the term 'faunal element' adopted by others for the same concept, was in certain cases ambiguous, because it could be used to refer either to a 'horofauna' or to a 'regional fauna'. Halffter (1964) used the term 'horofauna' to refer to what he characterized as a 'dispersal pattern'. Reig (1981: 27–28) characterized a horofauna as an 'assemblage of the species of an animal taxon or of all the animal groups that coexist and diversify in a given area during a prolonged time, thus representing a lasting biogeographic unit'.

**Chronofauna:** was defined as 'a geographically restricted, natural assemblage of interacting animal populations that has maintained its basic structure over a geologically significant period of time' (Olson, 1952: 181).

**Area of endemism:** is the basic unit of cladistic biogeography (Nelson & Platnick, 1981; Parenti & Ebach, 2009). Areas of endemism were defined as 'fairly small areas that have a significant number of species that occur nowhere else' (Nelson & Platnick, 1981: 390) and as 'area[s] of non-random distributional congruence among different taxa' (Morrone, 1994: 438). Similar definitions have been provided by Platnick (1991), Linder (2001), Crisci *et al.* (2003), Szumik & Goloboff (2004) and Quijano-Abril *et al.* (2006). Some authors have explicitly placed their definitions of areas of endemism in a phylogenetic framework. For example, Harold & Mooi (1994: 262) defined an area of endemism as a 'geographic region

comprising the distributions of two or more monophyletic taxa that exhibit a phylogenetic and distributional congruence and having their respective relatives occurring in other such-defined regions' and Parenti & Ebach (2009: 59) defined it as an 'area occupied by at least two purportedly monophyletic taxa – at least two, because an area occupied by just one taxon will have no history shared with any other area'. Hausdorf (2002: 648) considered that areas of endemism are 'delimited by barriers, the appearance of which entails the formation of species restricted by these barriers'. Crother & Murray (2011: 1012) defined an area of endemism as a 'spatially and temporally bounded geographical area with species. Neither species alone nor geographical areas alone are sufficient for diagnosis'. Crother & Murray (2011) considered that: (1) the spatial and temporal boundaries of areas of endemism are flexible, as is their existence, because both species and areas of endemism are interactors, involved in processes that can eradicate, shrink or expand these areas; (2) they are also reducible in that they are nested within one another; and (3) operationally, areas of endemism may contain at least one unique species or a unique combination of species. The terms 'phytocorion' (White, 1978, 1983), 'nuclear area' (Reig, 1981) and 'centre of endemism' (Laffan & Crisp, 2003) are equivalent to 'area of endemism'. The term 'endemic area' (Parenti & Ebach, 2009) refers to the distributional area of a taxon, so it is not equivalent to 'area of endemism'.

**Generalized or standard track:** is the basic unit of panbiogeography (Croizat, 1958, 1964). A track is 'a graph of geographic distribution' (Croizat, 1964: 7) or 'a line drawn on a map that connects the different localities or distribution areas of a particular taxon or group of taxa' (Craw *et al.*, 1999: 20). A generalized track is 'composed of individual tracks' (Craw *et al.*, 1999: 21) or is 'a set of two or more individual tracks that are compatible or congruent according to a specified criterion (for example, shared baselines or compatible track geometries)' (Crisci *et al.*, 2003: 57).

**Cenocron:** this concept was defined by Reig (1962: 131) to refer to an 'animal or plant group or community, whatever its origin, which enters into a given area between definite limits of geological time'. It was proposed explicitly in a dispersalist framework 'to distinguish the process of dispersal and the following relatively synchronic implantation in a fauna of a group of alloctonous irrupting organisms' (Reig, 1981: 25). Cenocrons have been also defined as 'sets of taxa that share the same biogeographic history, constituting identifiable subsets within a biotic component by their common biotic origin and evolutionary history' (Morrone, 2009: 18).

**Dispersal pattern:** Halffter (1962, 1964, 1976) used the term 'dispersal pattern' as a model used to compare the geographical distributions of different taxa inhabiting the same area. Halffter (1976) considered that a dispersal pattern was

'the present distribution of a cenocron' and that Reig's (1962) term 'cenocron' was 'equivalent to the better-known term of horofauna, and refers to a group of organisms which originated in or become integrated as such in a given area, which have coexisted for a prolonged period and have [a] common biogeographic history' (Halffter, 1976: 5).

**Chorotype:** this term was introduced by La Greca (1963, 1964, 1975). Chorotypes were defined as 'items of a classification based on distribution patterns such as deduced from the comparative analysis of the geographical ranges of species, genera and higher taxa' (Vigna Taglianti *et al.*, 1999: 31–32) or 'groupings of species with similar distribution patterns' (Sans-Fuentes & Ventura, 2000: 757). Gómez-González *et al.* (2004), Báez *et al.* (2005) and Zunino (2005) provided similar definitions. Vigna Taglianti *et al.* (1999) noted that the term chorotype has been used by different authors to indicate different entities: (1) a recurrent type of geographical distribution; (2) an assemblage of species with certain ecological requirements within a given geographical area; (3) an assemblage of species supposed to share a common biogeographical history; (4) groups of species supposed to be phylogenetically related and originated in the same area; and (5) an assemblage of species restricted to a given biogeographical region, as recognized by climatic and phytogeographical criteria.

**Distributional pattern:** is 'the coincident form that the distributional areas of a set of taxa (monophyletic groups) adopt as a consequence of a common biogeographic history' (Reig, 1981: 28). For a similar use of this term see Savage (1982). According to Halffter (1987: 96–97), a distributional pattern represents the 'synthesis of the essential features of the distribution of a set of coexisting organisms that originated or became integrated in a given area and time, are subjected to the same macroecological pressures for a prolonged period, live under the same physiographic conditions, and have a common biogeographic history' (see also Halffter *et al.*, 1995). This term was used by Halffter (1987) to replace the term 'dispersal pattern', previously used by him, when he adopted an evolutionary (vicariance-dispersal) approach.

**Lineage:** there are two Spanish terms originally defined by Ringuélet (1957, 1961) that may be translated as lineages. 'Abolengo' (Ringuélet, 1957) refers to the 'affinity between groups of organisms or taxa determined by their common geographic origin and evolutionary history during the early origin of their biogeographic evolution. 'The affinity by ancestry is independent of the current distribution of the pertinent groups' (Reig, 1981: 23). 'Estirpe' (Ringuélet, 1961) refers to a 'group of determined organisms that constitute a discrete element of a fauna by its community of origin and geographic-evolutionary history (ancestry)' (Reig, 1981: 27).

**Historical biota:** Salthe (1985: 244) used this term to refer to 'groups of species that have been in the biota

together for a very long period of time'. He recognized it as a level of the genealogical hierarchy (in contrast to the 'biogeographic region', which he considered to belong to the ecological hierarchy), because he assumed that there was 'association by descent' among some supraspecific taxa in these biotas. A similar idea applied to ecological communities has been proposed by Webb *et al.* (2002).

**Assemblage:** the term 'assemblage' has been used commonly in the last decades of the 20th century to refer to the taxa that belong to a biota. Some examples are 'biogeographical assemblage' (Rosen, 1988; Rosen & Smith, 1988), 'taxonomic assemblage' (Rosen, 1992) and 'species assemblage' (Cracraft, 1994).

**Biotic component:** Roig-Juñent (1992: 108) used this term to refer to the 'origin of the organisms belonging to a biota'. Morrone (2009: 18) defined 'biotic components' as 'sets of spatiotemporally integrated taxa that coexist in given areas, representing biogeographic units, from a synchronic or proximal perspective'.

## A possible integration

Ten of the concepts analysed refer to the set of taxa that inhabit an area at a single temporal plane: concrete biota, chronofauna, area of endemism, nuclear area, phytocorion, centre of endemism, generalized track, biogeographical assemblage, taxonomic assemblage and species assemblage (Table 1). From an ontological viewpoint, some of these concepts implicitly or explicitly refer to biotas, which may be conceptualized as lineage-forming individuals (Ghiselin, 1980; Crother & Murray, 2013), in a similar way to species (see de Queiroz, 1999). The individuality of biotas is due to the common biogeographic history of the taxa that they include, although they exhibit reticulation due to geodispersal and biogeographic convergence (Morrone, 2009). Some of these concepts are operational; for example, nuclear areas have been used by De Lattin (1957) and Müller (1973) to identify dispersal centres, and Savage (1982: 496) considered that generalized tracks 'may be used as a basis for estimating patterns, regardless of biogeographic theory'. Reig (1981) and Morrone (2001, 2009) noted the similarities between generalized tracks and areas of endemism, and Gámez *et al.* (2014) considered that they were both alternative graphical representations of biotic components *sensu* Morrone (2009).

Nine concepts refer to subsets of taxa within a biota that incorporate a temporal dimension when implying explicitly or implicitly a different time of their incorporation to the biota: biotic element, historical source, historical component, element, cenocron, dispersal pattern, distributional pattern, lineage and historical biota (Table 1). Reig (1981) considered that a lineage was equivalent to a historical source unit (Savage, 1973) or a historical

**Table 1.** Concepts applied to biotas or subsets within them.

Concepts	Applied to biotas	Applied to subsets within biotas
area of endemism	Nelson & Platnick (1981), Platnick (1991), Harold & Mooi (1994), Morrone (1994), Linder (2001), Hausdorf (2002), Crisci <i>et al.</i> (2003), Szumik & Goloboff (2004), Quijano-Abril <i>et al.</i> (2006), Parenti & Ebach (2009), Crother & Murray (2011)	
biogeographical assemblage	Rosen (1988), Rosen & Smith (1988)	
biotic component	Morrone (2009)	Roig-Juñent (1992)
biotic element		Dunn (1931), Müller (1973), Reig (1981), Hausdorf (2002), Hausdorf & Hennig (2003), Morrone (2005), Giokas & Sfenthourakis (2008), Casazza & Minuto (2009)
cenocron		Reig (1962, 1981), Morrone (2009)
centre of endemism	Laffan & Crisp (2003)	
chorotype	La Greca (1963, 1964, 1975), Sans-Fuentes & Ventura (2000), Gómez-González <i>et al.</i> (2004), Báez <i>et al.</i> (2005), Zunino (2005), Vigna Taglianti <i>et al.</i> (1999)	Vigna Taglianti <i>et al.</i> (1999)
chronofauna	Olson (1952)	
concrete biota	Tolmachev (1931), Chernov (1975), Penev (1997)	
dispersal pattern		Halffter (1962, 1964, 1976)
distributional pattern		Reig (1981), Savage (1982), Halffter (1987), Halffter <i>et al.</i> (1995)
element		Savage (1982)
generalized track	Croizat (1958, 1964), Craw <i>et al.</i> (1999), Crisci <i>et al.</i> (2003)	
historical biota		Salthe (1985)
historical component		Savage (1974)
historical source unit		Savage (1973)
horofauna	Reig (1981)	Smith (1949)
lineage		Ringuelet (1957, 1961), Reig (1981)
nuclear area	Reig (1981)	
phytocorion	White (1978, 1983)	
species assemblage	Cracraft (1994)	
taxonomic assemblage	Rosen (1992)	

component (Savage, 1974). These concepts are used to refer to a taxonomic assemblage that has dispersed from another area during a defined lapse of time and then became integrated to the biota.

There are three concepts that can be ascribed to both groups, depending on the author considered: horofauna, chorotype and biotic component (Table 1). Horofauna *sensu* Reig (1981), chorotype *sensu* Sans-Fuentes and Ventura (2000) and biotic component *sensu* Morrone (2009) refer to all the taxa from a biota. Horofauna *sensu* Smith (1949) and Halffter (1962), chorotype *sensu* Vigna Taglianti *et al.* (1999) and biotic component *sensu* Roig-Juñent (1992) refer to a subset of taxa within a biota.

In order to refer to the first group of concepts, I (Morrone, 2009) adopted the umbrella term 'biotic

component', although I did not realize that Roig-Juñent (1992) had previously used it with the alternative meaning. The most general term that may be used to refer to them is simply 'biota', although 'area of endemism', 'generalized track' and 'chorotype' (*sensu* Vigna Taglianti *et al.*, 1999, sections 1, 2 and 5) are operational concepts that may be preferred when undertaking specific biogeographic analyses. Crother & Murray (2011) made an ontological argument for areas of endemism as individuals, which Gámez *et al.* (2014) extended to 'biotic components'. One way to conceptualize the individuality of biotas is to consider them as 'mereological sums' (Crother & Murray, 2011), meaning that they are individuals composed of parts ('cenocrons') that are themselves individuals. As noted by Brogaard (2004) when discussing



the individuality of species, a natural consequence of adopting such view is pluralism, which constitutes an adequate framework for evolutionary biogeography (Morrone, 2009).

For the second group of concepts, the term 'cenocron' seems adequate. 'Cenocrons' can deal with the process of geodispersal and refer specifically to assemblages that disperse into a biota and have different ages. Dating of the cenocrons depends largely on the dating of the clades that are assigned to them, which in turn depends on the fossil record, geological information and molecular-based age estimates (Magallón, 2004) and hypothesizing on the time when they dispersed into the biota. This is a really complex issue that involves dating of the lineages, phylogenetic hypotheses and distributional data of the taxa and their relatives. Thus, at the moment identification of cenocrons is quite speculative.

The use of the terms 'biota' and 'cenocron' may contribute to integration of different biogeographic approaches. I conceptualize this integration within the framework of integrative pluralism (Mitchell, 2002, 2003), assuming that integration does not necessarily imply unification (Mitchell & Dietrich, 2006). Their use can allow taking into account the patterns resulting from both vicariance ('biotas') and dispersal ('cenocrons'). From an ontological viewpoint, biotas belong to the ecological hierarchy, whereas cenocrons belong to the genealogical hierarchy (Salthe, 1985), meaning that biotas are interactors (Dawkins, 1982) and cenocrons are replicators (Hull, 1980). This distinction has been found useful by biogeographers; for example, when contrasting horofauna versus cenocron (Reig, 1981), biogeographic region versus historical biota (Salthe, 1985) and biotic component versus cenocron (Morrone, 2007, 2009). I hope this analysis helps in the understanding of some biogeographic debates among proponents of different approaches and contributes to provide common ground for integrative pluralism in biogeography.

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