Palaeogeography, Palaeoclimatology, Palaeoecology 454 (2016) 75–81

Contents lists available at ScienceDirect

Palaeogeography, Palaeoclimatology, Palaeoecology

journal homepage: www.elsevier.com/locate/palaeo

The mutual climatic range technique is (usually) not the area of sympatry technique when reconstructing paleoenvironments based on faunal remains

R. Lee Lyman

Department of Anthropology, 107 Swallow Hall, University of Missouri, Columbia, MO 65211, USA

ARTICLE INFO

Article history:
Received 25 February 2016
Received in revised form 15 April 2016
Accepted 16 April 2016
Available online 18 April 2016

Keywords:
Area of sympatry
Mutual climatic range
Paleoclimate
Paleoenvironment
Paleoenvironmental reconstruction

ABSTRACT

Names applied to particular analytical techniques must be explicit and distinctive. The potential that two distinct techniques of paleoenvironmental reconstruction that use ancient faunal remains, each with a particular name, might be confused in the future has recently become a reality. The name "mutual climatic range" (MCR), coined and developed in the 1980s and concerning the modern climatic (not geographic) co-occurrence of species represented in a prehistoric collection of remains, has been applied multiple times to a different technique first published in 2009. The new MCR technique is very similar to a distinct one developed in the 1950s and 1960s that focuses on the location of the geographic co-occurrence of species in an assemblage relative to the location of the deposit producing the remains. The older method has been known as the "area of sympatry" (AOS) technique since 1966. Histories of the AOS and original MCR techniques suggest they were developed independently. The new MCR technique seems to have been developed without knowledge of the two earlier ones. To avoid future confusion of one technique with the other, it is suggested that the new one be renamed the UTM-MCR technique because rather than use isopleths of climatic variables, as the AOS technique does, it considers climatic variables within 10 × 10 km UTM squares.

Contents

1. Introduction

Reconstruction of past environments and climates based on stratigraphically delimited sets of prehistoric faunal remains has, since about 1960, evolved into a vibrant and exciting field (Rainger, 1997; Terry, 2009). A number of distinct analytical techniques that depend on taxonomic identities of the faunal remains have been developed (Andrews, 1996; Reed, 2013). One such technique involves what are referred to as *indicator taxa*, one or more species that have well-known and relatively narrow ecological tolerances such that their appearance in a particular assemblage of remains is readily taken to signify a particular environment or climate existed in the site area when the species' remains were accumulated and deposited (e.g., Lyman, 2014). Another technique requires tracking shifts in the abundances of multiple taxa over the time span represented by multiple assemblages and, based on the environments occupied by those taxa at some relative

http://dx.doi.org/10.1016/j.palaeo.2016.04.035

frequencies today, inferring shifts in environments that correspond with shifts in taxonomic abundances (e.g., Blois et al., 2010).

The labels applied or names given to the two analytical techniques described—indicator taxon, taxonomic abundances, respectively—are commonsensical and imply what a particular technique involves. My concern in this paper is that two other distinct techniques used by paleozoologists interested in paleoenvironmental reconstruction were originally given distinct names, but one of those distinctive names has now been applied to a version of the other analytical technique. My goals here are two. First, by describing the two techniques that have been given the same name, I intend to clear up potential confusion. I argue that when terminology or names for particular techniques are used interchangeably, misunderstanding of the strengths and weaknesses of an analytical technique can occur. Second, I argue that when the same name is given to two distinct analytical techniques, inaccurate knowledge of disciplinary history may result.

I reference numerous individual pieces of literature in the following. Although not exhaustive, these citations are empirical evidence demonstrating the names, descriptions, and applications of the two techniques have been widely and frequently published. They underscore the fact that the name of a well-publicized technique can inadvertently be applied to another technique. Throughout the discussion I use the term *assemblage* to signify a collection of ancient faunal remains recovered from a single geographic location—a *site*—and one or more approximately contemporaneous geological deposits.

2. Histories of two distinct analytical techniques

A common analytical procedure during the twentieth century was to use the geographic ranges of species as a coarse indication of paleoenvironments, particularly when ecological tolerances of the species were unknown (e.g., Gidley and Gazin, 1938; Slaughter, 1967). For instance, taxa today found to the north of the deposit containing their remains were thought to indicate a cooler, perhaps moister, environment in the past than at present whereas taxa today found to the south of the deposit were interpreted to indicate a warmer, perhaps drier environment than at present. This is still an important method (Birks et al., 2010). But likely as a result of the assumption that the geographic ranges of species were influenced by environmental factors (Lundelius, 1983), it is not surprising that in the middle of the twentieth century paleozoologists developed techniques that simultaneously considered particular details of the ranges of multiple taxa. Both of the techniques described below rest on the key assumption that the ecological tolerances of extant species represented in an assemblage of ancient animal remains have not changed in the time between the accumulation and deposition of those remains and today (Atkinson et al., 1987; Graham and Semken, 1987).

2.1. Area of sympatry technique

What became known as the area of sympatry (AOS) technique emerged from analyses of North American Quaternary paleozoologist Claude W. Hibbard's collections at the University of Michigan (Semken, 1988). The extent to which Hibbard influenced the development of the technique is unclear. What is clear is that by the middle 1950s Hibbard was aware that some of the prehistoric faunas he was studying included species that were today allopatric but which seemed on the basis of stratigraphic associations to represent sympatric distributions in the past (e.g., Hibbard, 1955, 1960). The analytical utility of modern geographic ranges of multiple taxa for paleoenvironmental reconstruction was on his mind, and his collaborators and students were likely also thinking along these lines.

Perhaps the first analytical determination of overlapping geographic ranges for paleoecological purposes was by Smith (1954:288) who studied an Illinoian local fish fauna and mapped the area "where all of these species occur together today." Smith (1954:288) referred to this area as one where the represented species "now occur together" and noted that it encompassed the southern Great Lakes region, an area far to the north of the Oklahoma panhandle where the ancient fish remains had been recovered. Smith (1954) thus concluded his prehistoric fauna represented cooler and moister conditions than at present in the site area when the assemblage was accumulated. Etheridge (1958:100, 99) subsequently determined the area where species represented in a Sangamon interglacial lizard fauna "now occur together" by "superimposing the extant [modern] ranges of the lizards." Five of six species he identified were today sympatric and showed the area of co-occurrence to be south of the paleontological site. Etheridge (1958:100) concluded that the "vegetation and climate" of the paleontological site had been like that of the area of co-occurrence—warmer and drier than today—at the time the lizard remains were accumulated and deposited.

Reed and Braidwood (1960:168), perhaps independently of Hibbard's colleagues, noted that the modern ranges of two bird species represented in a prehistoric zooarchaeological assemblage overlapped "only in upland areas" some distance from the site that contained the remains. The site was, however, also in an upland area and thus they inferred the co-occurrence of the birds denoted a "similar environment" in the site area as the modern area of co-occurrence at the time the bird remains were deposited. Stephens (1960:1698) "plot[ted] the present-day ranges of [the extant] forms [of small mammals in an assemblage] and derive[d] an area of common range overlap." He then (1960:1700) "determined the climate" in the site area at the time the fossil fauna lived based on "the climate of the area in which the extant forms are all living today." Stephens (1960:1698) suggested the prehistoric annual average temperature and precipitation on the basis of the "common distribution" of the taxa in the assemblage. None of these early researchers used the term *sympatry* or *area of sympatry* (AOS, hereafter).

Semken (1966:169) was the first analyst to use the term when he determined the AOS for 11 extant species of mammals in an Illinoian assemblage "in the manner described by Stephens (1960)." He also determined the AOS for 10 and the AOS for 9 of the species represented in the assemblage he studied. In all cases, the AOSs Semken mapped all indicated a cooler and moister climate than the site presently experienced. Guilday et al. (1964) had earlier plotted what can be thought of as an isopleth map showing how (not surprisingly) the AOS became larger as one progressed from 17 to 7 included species (see also Rhodes, 1984; Schultz, 1969). Guilday et al., however, had little to say about the paleoclimatic implications of the AOSs other than that they all indicated more northern latitude locations than the site location, and thus they inferred that the climate at the site was likely cooler at the time that the faunal remains were accumulated and deposited than today. They named their AOS map a "center of abundance map" (Guilday et al., 1964:182), a label I have not otherwise encountered. They say little else about their map, and do not provide details about how the map was generated or the abundances to which the name referred, though I suspect "abundance" refers to taxonomic richness.

The AOS technique has been used in the 1960s (e.g., Schultz, 1967, 1969), 1970s (Holman, 1971; Jenkins and Semken, 1972), 1980s (Foley, 1984; Hudak, 1984; McMillan and Klippel, 1981; Rhodes, 1984; Rhodes and Semken, 1986; Semken, 1980, 1983, 1984; Semken and Falk, 1987; Walker, 1982), 1990s (Baker et al., 1991; Falk and Semken, 1990; Souders, 1994; Woodman et al., 1996), and more recently (Cruz-Muñoz et al., 2009; Jans-Langel and Semken, 2003; Lyman, 2008; May et al., 2008; Wallace, 2008). It always involves a map showing the geographic location and shape of the AOS and the location of the site that produced the remains of animals that were stratigraphically associated and whose overlap in modern species-specific ranges defines the AOS (Fig. 1). The modern climate of the AOS is typically (but not necessarily) derived from isopleth maps of climatic variables such as average coldest temperature in mid-winter and average warmest temperature in mid-summer (e.g., Visher, 1954). The