

The Community Concept in Community Ecology

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We argue that ecologists have conceived of the community concept in at least three ways (typological, functional, and statistical), and that ecologists have used "community," as indicated by ecological terminology, in two main ways (type and group). The typological conception emphasizes phenomenological descriptions of co-occurring species, the functional conception emphasizes mathematical relationships among co-occurring species, and the statistical conception emphasizes the frequency of species' co-occurrence. The type usage emphasizes idealized "types," and the group usage emphasizes quantitative boundaries and/or mathematically precise interactions. We further argue that all of these senses of "community" are problematic. Ecologists seem unable to say precisely what a community is, in part because of the difficulty of (a) measuring community properties, (b) determining the temporal and spatial scale for various communities, and (c) evaluating the different meanings attributed to community terms. We suggest that although (a) and (b) appear to be difficulties that are heuristically useful for future ecological theorizing, (c) does not.

Introduction

In the preface to his recent *Toward a New Philosophy of Biology: Observations of an Evolutionist* and in his earlier *Growth of Biological Thought*,

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Ernst Mayr emphasized that recent progress in evolutionary biology is a result of conceptual clarification, not a consequence of improved measurements or better scientific laws (Mayr 1982, 1988). We likewise believe that conceptual clarification is perhaps the most important key to theoretical progress in community ecology. In this essay, we offer a historical and philosophical analysis of perhaps the most important foundational concept in community ecology, namely, "community." We show that the concept has changed throughout the twentieth century. We argue that (1) ecologists sometimes conceived of communities as groups defined primarily in a *typological* way, that is, largely through *phenomenological descriptions* of co-occurring species. At other times, (2) ecologists thought of communities as groups defined in a *functional* way, that is, largely through *mathematical relationships* among co-occurring species. Yet at other times, (3) ecologists have understood communities as groups of species defined primarily in a *statistical* way, that is, largely through the *frequency* of their co-occurrence in certain environments. We further argue that ecological terminology suggests ecologists have used "community" in two main ways: to refer either to an idealized "type" or to a group of species with quantitative boundaries and/or mathematically precise, interactive components. We argue that all of these senses of "community" are problematic. Ecologists seem unable to say precisely what a community is, in part because of the difficulty of (a) measuring community properties, (b) determining the temporal and spatial scale for various communities, and (c) evaluating the different meanings attributed to community terms. We argue that although (a) and (b) appear to be difficulties that are heuristically useful for future ecological theorizing, (c) does not.

We have chosen to review the community concept because of its primacy throughout the history of ecology. Indeed, ever since the earliest days of the discipline, ecologists have focused on why particular groups of species are found together, how they are interconnected, and whether or not these aggregations of species manifest any sort of order or balance. In other words, some of the most basic questions of ecologists have concerned what constitutes a community and what causes communities to remain stable or unified "wholes" through time.

Questions about community are important beyond the realm of ecological theorizing. They are important in part because, unless we know what an ecological community is and what promotes and maintains its structure, responsible conservation will be impossible. Without taking a position on whether communities are natural kinds, we wish to assess the utility of various community concepts for scientific progress. Because of our emphasis and because of space limitations, we shall not

discuss any purely stipulative definitions of 'community' (MacArthur 1972; Underwood 1986). If our account of the evolution of the community concept is correct, then it may provide a step toward both conceptual clarification and consensus about the ecological nature of communities.

Community Concepts

Clements (see 1905; 1928, p. 140), perhaps the most influential ecologist of the early twentieth century, used three "community" terms, 'community', 'association', and 'formation'. The 'community' he defined as "a mixture of individuals of two or more [plant] species" (Clements 1905, p. 316). The 'association' he defined as "the arrangement of individuals in vegetation" (Clements 1905, p. 315). The 'formation', following Griesbach, he defined as "a group of plants which bears a definite physiognomic character" (Clements 1905, p. 3; see also Moss 1910). We believe the key word in the first definition (of 'community') is "mixture." By using this word, Clements conveys the impression of an entity recognized by simple juxtaposition of species in space and time, an entity that could be characterized, therefore, by a listing of the species comprising it (Clements 1905). Likewise, we think the second definition (of 'association') also has a key word, "arrangement." By using this word, Clements conveys the impression of an entity recognized by some discernible pattern among the coexisting species. This pattern appears to arise from various distributions of species within the list, such as numerical dominance of certain taxa or the relative abundance of each of the species. For example, Clements says that associations "are recognized chiefly by floristic differences. Associations are marked primarily by differences of species, less often by differences of genera. At the same time, their organic relation to each other ... rests upon floristic identity to the extent of one or more dominants" (Clements 1928, p. 129). The key to the third definition (of 'formation') is the phrase "physiognomic character." Clements's definition of this term suggests that we recognize a formation the way we recognize a face, for example, largely by the form or appearance of the whole. Thus, we suggest that at least three distinct conceptions of the community were afield early in the present century.

Decades after Clements, Macfadyen (1963) recognized three important properties that ecologists used in conceiving of communities. The first property was simple species co-occurrence, which was, in the view of many, the only well-established characteristic of communities. The second property was dynamic stability, which requires that the "normal" species composition be restored after perturbation. The third

property was constancy of species composition, which forms the basis for recognizing idealized community "types." These three properties correspond, respectively, to the three community concepts (community, association, formation) that Clements used 30 years earlier.

There is evidence that Clements conceived of the formation as the fundamental "unit of vegetation" (1928, p. 127). Others viewed the association in this way (e.g., Braun-Blanquet and Furrer 1913; see Daubenmire 1968). If ecologists wished formations, associations, or any other "units" to be identifiable, however, then they would have needed to supply clear operational definitions. Even some contemporaries of Clements realized that classification on the basis of community concepts is not easy in practice, however. For instance, Warming, who was more reductionist and mechanistic than Clements, noted that communities, in the sense of co-occurring individuals, hardly ever are sharply separated from one another geographically (Warming 1909; see McIntosh 1985). He was convinced, nonetheless, as was Clements, that different plant communities could be grouped comprehensively on the basis of their responses to climate and soil. Because ecologists did not provide precise criteria for confirming the presence of "units" in nature, terms like 'formation' and 'association' would seem to be of limited practical value. Even if such a comprehensive grouping as Clements and Warming and others envisioned were possible, and even if fundamental vegetational units could be identified, all community-classification problems would not be solved, however. One reason is that vegetational units cannot easily accommodate communities that include other components of the environment, such as animals (see Daubenmire 1968; Underwood 1986); hence, ecologists needed to devise additional classification schemes. In response to this difficulty, community ecologists resurrected the term 'biome' to accommodate animals as well as plants (Carpenter 1939; Clements and Shelford 1939). They also created the term 'ecosystem' to include nonliving components of the environment (Tansley 1935). (Clements and Shelford [1939, p. 20] defined 'biome' as "the plant-animal formation; the basic community unit." Tansley [1935, p. 306] defined 'ecosystem' as "the fundamental concept appropriate to the biome considered together with all the effective inorganic factors of its environment.") These additional classification schemes were no more, perhaps even less, rigorous than the ones used for vegetation alone.

Beginning in the 1920s, critics attacked the attempts of many plant ecologists to classify groups of plants into fundamental vegetational units—the formations of Clements and others (Cain 1947; Curtis 1959; Curtis and McIntosh 1951; Gleason 1926, 1939, 1952; Ramensky 1926;

Whittaker 1951, 1953, 1957). These critics reasoned that if the formation—or other ecological units, for that matter—were valid, then various “types” of formations, or communities, could be separated from one another according to objective empirical criteria, such as species composition. On the contrary, however, their field results showed that species of plants tended to be distributed independently along gradients and, therefore, that community groupings such as formations usually could not be bounded in a nonarbitrary way. Several ecologists suggested that a conception of the community as any kind of idealized “type” probably was best relegated to duty as what Cain called a “metaphysical approximation” (see Cain 1947; Curtis and McIntosh 1951; Ovington 1962).

The inability of ecologists to document the existence of certain idealized vegetation “types” within the association or the formation framework meant that the physiological, typological, and phenomenological classification schemes of Clements and others had failed to provide much insight into the mathematical aspects of ecological organization. A more mathematical way of thinking about community interactions and concepts began to gain broad acceptance in the 1950s, although its roots go farther back in time (e.g., Elton 1927). Taylor has suggested that a 1948 paper by G. E. Hutchinson may have established the “cybernetic” (i.e., self-regulating feedback system) conception of the community that predominated for the next several decades (Taylor 1988; see also Haraway 1981–82; Margalef 1968). Two of Hutchinson’s students, Robert MacArthur and Howard Odum, played key roles in elaborating this conception of the community (see Fretwell 1975; Taylor 1988).

Other mathematically precise, “feedback” conceptions of the community also came into prominence in the 1950s, probably in part because of the organic and physiological emphases of Clements’s earlier typological views. Several well-known ecologists built on the notion of feedback and developed a concept of the community as a highly structured, functionally interacting unit (Allee et al. 1949). In describing this concept of the community, Kendeigh asserts, first of all, that a community is “an aggregation of organisms which form a distinct ecological unit.” He says that “major communities” are “those which, together with their habitats, form more or less complete and self-sustaining units or ecosystems, except for the indispensable input of solar energy.” “Minor communities” (“societies”), on the other hand, are “secondary aggregations within a major community and are not, therefore, completely independent units as far as circulation of energy is concerned” (Kendeigh 1961). Although these definitions are not pre-

cise, they illustrate the conception of communities as highly structured units of interacting species and habitats. But what does it mean to say that communities are "systems" or have structure? Caswell gives one account (1976, pp. 327-28):

Function and structure (physiology and morphology, growth and form, operation and pattern) are dual aspects of any system. A system, by any of the commonly encountered definitions, is (1) a collection of entities which, (2) influence each others' behavior. A structural approach to the study of a system emphasizes the components, examining their nature, number, distribution, arrangement, and pattern of interaction. A functional approach, on the other hand, focuses on the dynamics of behavior and development of the system or selected subsystems. . . . Species diversity, the number and relative abundance of the constituent species, is one of the most commonly examined structural aspects of biological communities. The relationship between diversity and the dynamic functioning of communities is the subject of a large body of ecological theory. This theory has developed along three major lines. . . . The three are not totally independent, but some mixture of them covers most of the commonly encountered theorizing about diversity.

The three interactive conceptions of the community that Caswell distinguished—one based on cybernetics, another on control theory, and a third on niche theory—presuppose that interactions among species develop mathematically describable feedback loops that determine community structure (Caswell 1976).

Despite Clements's influential physiological or organic model of idealized community "types" (already discussed), Macfadyen (1963) noted that emergent and organismal properties of communities were rarely mentioned in the ecological literature written in the middle of the twentieth century. At least part of the reason for this infrequency may have been the attacks on group selection during the 1960s, attacks that seemed to render community ecology—of the superorganism variety—inconsistent with evolutionary theory (see, e.g., Weins 1966; Williams 1966). Interest in the emergent and organismal properties that might be associated with the community, however, increased in the second half of the century. This interest arose largely because of the conception of the community as a self-regulating feedback mechanism, with concomitant emphasis on interactions among component species and dynamic stability (Macfadyen's second property). Again, the mainspring may have been Hutchinson (1948). As we already mentioned,

under his cybernetic view of ecology, ecologists have envisioned the community as a self-regulating entity. Taylor (1988, p. 217) confirmed the importance of Hutchinson's (1948) views in this regard: "For Hutchinson, . . . ecology was . . . united by a theoretical proposition: groups of organisms are systems having feedback loops [among species] that ensure self-regulation and persistence [of the system]." Hutchinson himself says (1948, pp. 221–22): "When a circular causal system is described in terms of the variation in numbers of biological units or individuals . . . the mode of approach is characterized as *biodemographic*. In general, the biodemographic [approach is appropriate] to more complex cases, some of which might be regarded as involving teleological mechanisms." Emergent characteristics, properties that are not simply collective properties (see Salt 1979; Underwood 1986), therefore, were seminal to the conception of community encompassed by this cybernetic view (see Oksanen 1988). Because of these emergent characteristics, persistence of the cybernetic or community system could not necessarily be predicted from anything known about the component species. Nevertheless, ecologists were able to theorize about system characteristics, recognizing that if the community is an organism, as Clements claimed, then it should be possible to study its metabolism. Hence Lindemann (1942) studied, for example, the metabolic transfer of energy through communities or ecosystems. Likewise, Eugene Odum provides an excellent example of how energy transfers might be emergent properties of organismic communities. In his discussion of research with his brother Howard at Eniwetok Atoll in 1954 (1977, p. 1290), he writes: "We theorized that the observed high rate of primary production for the [coral] reef as a whole was an emergent property resulting from the symbiotic linkages that maintain efficient energy exchange and nutrient recycling between plant and animal components."

In the 1960s, many ecologists postulated that certain emergent properties might be part of a "superorganism" (see McIntosh 1976, 1980; Simberloff 1980). The resurrected superorganism concept became especially evident in the 1960s in the blossoming field of ecosystems ecology (McIntosh 1985; see Evans 1956). Odum (1969, pp. 262, 266), for example, claimed that "the 'strategy' of long-term evolutionary development of the biosphere . . . increased control of, or homeostasis with, the physical environment in the sense of achieving maximum protection from its perturbations. . . . The intriguing question is, Do mature ecosystems age, as organisms do?" We see a very short logical path from this ecosystemic conception of nature to the currently popular idea of Gaia, perhaps the ultimate in "superorganisms" (see Ram-

bler, Margulis, and Fester 1988; Odum 1989). Moreover, although the evolution of Hutchinson's cybernetic perspective into a revitalized organicist perspective may seem incongruous, it might have been anticipated from the fact that both perspectives so strongly embrace self-regulation. As Taylor notes (1988, p. 220): "Hutchinson's self-regulating systems constituted a small step from the homeostatic communities of his contemporaries; circular causal paths were likewise a small step from groups of interspecies populations acting, reacting, and coacting to ensure coordination within the community."

The view of the community as a self-regulating feedback mechanism—as both equilibrium ecologists like Hutchinson and ecosystems ecologists like Odum emphasized—went largely unchallenged in the ecological mainstream throughout most of the 1960s and 1970s. In fact, Eugene Odum (1977, p. 1290) was touting this view of communities as the "new ecology" well into the 1970s—as he had done in the mid-1960s (Odum 1964). Beginning in the mid-to-late 1970s, however, a challenge began to develop, one which centered on the lack of convincing evidence in favor of some of the basic premises of the feedback view of community structure (see Dayton 1979; Simberloff 1980; Strong et al. 1984).

One premise of the self-regulation view, that feedbacks from interactions among community components were important in maintaining the community, came under particular attack. Critics charged that, even though interdependencies clearly exist among species, ecologists had not demonstrated that communities have any precise, uniform, or recognizable interactive community "structure." They said that ecologists had been no more successful in classifying groups of species by the ways in which they interact than by any other means (e.g., the "community matrix" approach; Vandermeer 1981). A second criticism was that ecologists had not shown that ecological interactions, such as competition, are responsible for whatever "structure" may be thought to exist. See, for example, the "null models" debate (Connor and Simberloff 1978; Quinn and Dunham 1983; Schoener 1988; see also Shrader-Frechette and McCoy 1993; Peters 1991). Finally, no one had established that whatever community "structure" may be thought to exist is stable in the way a self-regulating feedback system should be (McCoy and Shrader-Frechette 1992). As a result of these failures of the feedback view, ecologists called into question foundational community concepts, particularly in the field of ecosystems ecology (Underwood 1986).

Although the self-regulation or interaction view is alive and well in the work of many ecologists, particularly ecosystems ecologists, they

seem to have moved away from the mechanistic cybernetic approach (e.g., Allen and Starr 1982). Other ecologists have moved away even from the self-regulation or interaction view. What conception of community organization can fill the vacuum, even a partial one, left by the decline of the self-regulation or interaction view of persons like Hutchinson and Odum? Simberloff (1980) and others have suggested that a probabilistic account—which also has roots that go well back in time (e.g., Gleason 1926)—may serve this function (see, e.g., Whittaker 1967, 1973). Indeed, clashes between self-regulating and probabilistic approaches underlie many current controversies in ecology, for example, the "null models" debate just mentioned. Only time will reveal the outcome of these conflicts and their impact on ecological studies (see Cody 1989; Roughgarden 1989; Ulanowicz 1990; Vadas 1989). It is interesting to note, however, that the probabilistic conception of ecological organization brings with it a partial return (some ecologists see it as a retreat) to one aspect of an earlier conception of the community. The turn-of-the-century notion of "community" as a "mixture of individuals" (i.e., co-occurrence of species) (Clements 1905, p. 316), which was still by mid-century "the only well established . . . property [of communities]" (Macfadyen 1963, p. 179), obviously is the key characteristic of the probabilistic view (see Simberloff 1980; Strong et al. 1984). This partial return to an earlier conception of the community as a co-occurrence of species in time and space—but without the notion of interaction—means that according to some ecologists (e.g., Gilbert and Owen 1990), the community has no structure. Whatever structure has been thought previously to exist is (in the words of Gilbert and Owen) merely "a biological epiphenomenon, a statistical abstraction, a descriptive convention without true emergent properties but only collective ones" (Gilbert and Owen 1990, p. 33). Other ecologists maintain that if co-occurrence of species in time and space produces no structure, in the sense of self-regulating feedback, then no community exists at all (e.g., Hengeveld 1989). This latter viewpoint stems, of course, from a particular conception of the community. So as not to beg any questions about how to define communities, we have chosen to include co-occurrence as one of the possible conceptions.

Terminology Associated with the Community Concept

What does the terminology that ecologists use reveal about the community concept? As the previous review illustrates, a complete listing of the terms related to the community concept would be extensive. We have selected five terms which, because they are relatively common and long-lived, are of central importance to the development of the

concept during the present century. The five terms are 'association', 'biome', 'community', 'ecosystem', and 'formation'. To begin to sort out the various meanings and terms associated with the community concept, we attempted to employ computer searches of databases to uncover books and articles in which definitions of these five terms appeared.¹ Faced with a massive amount of material and no apparent way of circumscribing it in a wholly rational way, we compiled a list of explicit definitions of the five terms from a variety of sources. Moreover, for the reasons described earlier, we used materials (from these sources) containing definitions of at least two of the five community terms. These sources include (1) ecological textbooks and dictionaries (Begon, Harper, and Townsend 1986; Brewer 1979, 1988; Cain 1947; Clements and Shelford 1939; Colinvaux 1973, 1986; Collier et al. 1973; Ehrlich and Roughgarden 1987; Gleason 1926, 1939, 1952; Hanson 1962; Knight 1965; Krebs 1972; Lederer 1984; McNaughton and Wolf 1979; Odum 1963; Pianka 1978; Pielou 1974; Ricklefs 1973; Shelford 1963; Smith 1980, 1986; Whittaker 1970); (2) collections of readings in ecology (Kormandy 1965; Boughey 1969; Hazen 1970; Ford and Hazen 1972); and (3) "citation classics" of ecology listed by McIntosh. (These classics are eighty of the most highly cited publications in ecology between the years 1947 and 1977, as identified by the Institute for Scientific Information [ISI]. The ISI publishes *Current Contents* and is a leader in developing methods to judge the impact of scientific publications on future research in their fields [McIntosh 1989].) We also used (4) other books and papers known in advance to contain explicit definitions of one or more of the terms (Cowles 1901; Clements 1905, 1928; Tansley 1935; Whittaker 1957; Curtis 1959; Strong 1983; Diamond and Case 1986; Williamson 1987). Although we anticipated that this large sampling would yield an accurate representation of how the five community terms have been employed, nevertheless unknown biases may have arisen as a result of data selection (see Ferson et al. 1986), as well as from our representation of what authors intended their definitions to mean.

1. This effort proved not to be workable, for three reasons. First, the most important database, BIOSIS, originated in 1969. Using it would mean that we had no information on scholarship done in the first sixty-eight years of the century, and that we were forced to focus only on work of the last twenty years. Second, even during the years 1969-89, the number of books and articles listed in BIOSIS as specifically addressing our five terms was too large to be examined. For example, potential sources in which the word "ecosystem" appeared either in the title or in the abstract numbered 22,504. Even restricting the search to publications written in English yielded 18,140 potential sources. Similarly, potential sources for "formation" numbered 180,538, and for "community"

Based on an analysis of wording used in the definitions we have compiled, and ignoring the chronology of those definitions, we suggest that twentieth-century ecologists have had two basic ways of writing about communities. These are as "types" or "kinds" without precise specification of boundaries or interactions among components (type way), and as groups of species with quantitative boundaries and/or interactive components (group way). Definitions of three of the five community terms generally reflect the type way of writing, and definitions of the remaining two terms seem to show the group way of writing. 'Association', 'biome', and 'formation' appear to seek typification of the biota according to a set of more or less specified criteria, largely related to form or appearance: their definitions suggest that some natural or idealized community "type" exists. Cain, for example, says that an association is a "community type which is based upon a knowledge of a series of separate individual . . . stands which are more or less similar" (Cain 1947, p. 192). Whittaker and Colinvaux, for instance, say that an association is a community "unit" recognized by species composition (Whittaker 1957; Colinvaux 1973, 1986). Many authors speak of associations being recognized by "index species" (Shelford 1963), by "uniformity of species" (Krebs 1972), or by a "characteristic combination of species" (Brewer 1979, 1988). An association, therefore, appears to be conceived as a community type or category recognized through the form or appearance—as is a gestalt—of its composing species. It seems reasonable to think of associations as recognized in gestalt fashion because they are defined in terms of the appearance of a *kind*—rather than by some quantitative criterion. Similar conclusions can be shown to hold for the definitions of 'biome' and 'formation'. Biomes, for example, are "units" (Clements and Shelford 1939), "kinds" (Whittaker 1970), or "types" (e.g., McNaughton and Wolf 1979; Ehrlich and Roughgarden 1987), recognized by species composition (e.g., Pianka 1978; Brewer 1979, 1988). If these definitions are representative, and we think they are, then 'association', 'biome', and 'formation' refer to idealized types or kinds, recognized in gestalt fashion, by means of the physiologically or organically organized species composing them.

'Community' and 'ecosystem', on the other hand, are defined in terms of a set of more or less specified biotic criteria largely related to space, time, and mathematically describable interactions (i.e., interrelationships among species). Their definitions suggest that communities

numbered 22,504. Third, there were no database entries for terms like "community, concept of" or "community, definition of."

must have spatial and temporal boundaries and/or measurable interactions. Note that, by "spatial boundaries," we do not mean those that are obvious *a priori*, such as the boundaries of the "community" of a lake, an island, or a cornfield (Roughgarden and Diamond 1986). Rather, we mean those boundaries that can be set *a posteriori* by differentiating one group of species from another in some way, perhaps where boundaries are identified by searching for greater and lesser than expected similarities in species composition among locations. The locations are grouped or separated according to the outcome of the similarity analysis (see, e.g., McCoy, Bell, and Walters 1987). Cain (1947), Collier et al. (1973), and Ricklefs (1973), for example, speak of communities as having definite spatial boundaries. Shelford (1963), Whittaker (1970), Ricklefs (1973), Collier et al. (1973), Pielou (1974), Brewer (1979, 1988), and Smith (1980, 1986) all speak of the species in a community as interacting, such as through predation or competition. Much the same can be said to be true for ecosystems. In other words, 'community' and 'ecosystem' appear to denote "groups" (e.g., Cowles 1901; Hanson 1962; Brewer 1979, 1988; Strong 1983) or "aggregates" (Shelford 1973; Colinvaux 1973, 1986) of species, rather than a type. These groups appear to be recognized, not primarily by the gestalt appearance of component species, but by quantitatively definable boundaries and/or *interactions* of their component species.

The Epistemological Status of the Community Concept

Despite the fact that the uncertainty surrounding the concept of community typically results in theoretical confusion, there are good reasons for believing that the concept nevertheless may have some heuristic value for future ecological theorizing. To see the precise ways in which some of the conceptual problems we have outlined may lead to progress in ecology, we need to have an account of when a conceptual difficulty is useful versus when it is useless. Following Wimsatt's analysis of how and why some false models can often help us to find better ones (Wimsatt 1987, see also Wimsatt 1980; see finally Shrader-Frechette and McCoy 1993), we might argue that just as there are epistemological roles for false models, so also there are epistemological roles for imprecise concepts. After all, every science is uncertain, and neither the concepts nor the evidence in community ecology (or anywhere else) are unassailable. Given this unavoidable uncertainty, it may be that the problems we have uncovered in the community concept are not so much evidence of obstacles to scientific theorizing but instead are somehow heuristically useful for the progress of community ecology.

On Wimsatt's scheme, there are at least seven ways in which models can be false, four of which sometimes produce useful insights for error-correcting activity and three of which are rarely helpful in such situations. Useful types of falsity, for Wimsatt, are cases in which the model may be only locally applicable, an idealization never realized in nature, incomplete in leaving out causally relevant variables, or misdescriptive of the interactions of some variables. Rarely useful or not useful types of model falsity, for Wimsatt, are those in which the model is a totally wrong-headed picture of nature, purely phenomenological, or erroneous in its predictions, that is, inconsistent with states of affairs specified by the model. If one assumes (as seems reasonable) both that Wimsatt's (1987) categorization of "useful" and "rarely useful" false models is approximately correct, and that this categorization yields analogous insights for distinguishing between "useful" and "rarely useful" conceptual imprecision in science, then his analysis provides one vehicle for interpreting the epistemological significance of the problems with the community concept. Following these two assumptions, do the problems associated with the community concept fit into analogous categories of useful or rarely useful instances of imprecision? In order to answer this question, we must have a clear idea of the main difficulties with the community concept. These are (*a*) problems associated with measuring community properties, (*b*) problems with determining the temporal and spatial scale over which a community is to be judged, and (*c*) problems with the variety of meanings ecologists attribute to community terms. What is the epistemological significance of each of these difficulties?

The problem (*a*) that community properties are hard to measure may be epistemologically useful. Although measurement difficulties may be indicative of conceptual problems of varying degrees of seriousness, the measurement problems associated with the community concept appear to be difficulties related to idealization in science. In the case of the community concept, we have idealized notions of the concept associated either with particular community "types" or with groups of species that either interact or are merely within a spatial or temporal boundary. We can remove some of the measurement problems associated with the idealization of the community concept by operationalizing community terms. For example, one could search for ways to group species in some nonarbitrary way, to attempt to set community boundaries *a posteriori* (see, e.g., Legendre, Dallot, and Legendre 1985; McCoy et al. 1987; Whittaker 1967, 1973).

Problem (*b*)—that a community may be judged present or absent, depending on the chosen spatial and temporal scales—similarly is ar-

guably an instance of conceptual imprecision that could be useful in achieving greater precision. This difficulty is, in large part, that the community concept alleged applicable at one level or scale is not clearly applicable at another level or scale (see Allen and Hoekstra 1992). Wimsatt appears correct, that such problems of applicability typically are problems that can provide a basis for further scientific progress, because often we can localize applicability problems, and hence we can use what he calls "piecemeal engineering" to improve the concept or model. For example, one could look for density independence or density dependence at different spatial scales, and then use the findings to determine the precise concepts that were applicable or inapplicable to different communities. Hence, problem (b) does not appear to be a *prima facie* obstacle to theorizing in community ecology; indeed, it may well aid it because we are able, at least, to pinpoint the precise areas in which applicability of a particular concept of community or stability is problematic.

The variety of meanings attributed to community terms, problem (c) discussed earlier, however, appears to be a difficulty that is unlikely to be useful for further theorizing in community ecology. First, the meaning variability of the term is a manifestation of conceptual incoherence and perhaps even inconsistency. Sometimes communities are said to be identifiable on the basis of interaction, or on the basis of how similar they are, *a priori*, to some idealized grouping, or on the basis of co-occurrence of species. Indeed, there is currently no universally applicable specification of the characteristics that describe a community, no set of necessary and sufficient conditions for defining a community. What, in practice, is often described as a "community" is a disjunction of relationships, none of which is essential for all instances of communities. There is no homogeneous class of processes or relationships that define a community, and there is no single, adequate account of what community is. Because there is not, the conceptual incoherence surrounding community terms and meanings appears more to block heuristic power and scientific progress rather than to aid it. As a result, the more plausible meanings associated with the concept do not appear to be isolable. Hence, it is difficult to pinpoint problematic aspects of the community concept and to correct them. Also, at some minimal level, scientists' meaning the same things when they talk about the same concepts appears to be a necessary condition for progress in clarifying those concepts. Scientific progress seems to presuppose the ability to isolate semantic from nonsemantic problems. Yet, such isolation does not appear possible, given the degree of variability of meanings associated with the community concept.

Yet another difficulty is that the apparently dominant current meaning associated with the community concept—that of species co-occurrence—is compatible with virtually any model for the possible structures underlying the community. Indeed, the apparent evolution of the community concept, away from emphasis on interactions among component species and toward emphasis on persistence or co-occurrence of species, may provide little basis for explaining patterns of communities or stability. The current community concept appears merely to focus on presence/absence or co-occurrence/non-co-occurrence of species, independent of mechanisms that might account for such presence or absence, occurrence or non-co-occurrence. Crawley (1986), for instance, argues this position when he claims (p. 1) that the community is an "abstraction . . . which an ecologist has circumscribed for the purposes of study" and (p. 4) that "the issue is not whether there are identifiable . . . kinds of communities . . . the question is to what extent biological interactions . . . influence community structure."

While we agree with the essence of Crawley's argument, we think it tends to confuse two separate roles of community classification. Whether or not there are identifiable kinds of communities may not be a very important concern for current theoretical arguments about communities, but it is an important concern for practical ecology. Field ecologists need to recognize differences among vegetation (or habitat) "types," even if specifying precisely what accounts for the differences they perceive is largely a pointless exercise (see Daubenmire 1968; Eiten 1992; Hanson and Churchill 1961; Oosting 1958). Once they are agreed upon, these differences can be used as indicators of variation in the sum of ecological conditions. Without such indicators, the detection of ecological variation might prove prohibitively difficult. Logic, convenience, and experience determine, in large part, how much use ecologists make of particular vegetation "types" to indicate ecological conditions.

The evolution of the community concept—toward the current emphasis on persistence and co-occurrence—does not seem to provide a fertile ground for theorizing about what explains possible community characteristics. And if not, the current community concept, with its emphasis on persistence and co-occurrence, tells us very little about alleged community structures and interactions. Hence, the current community concept may be approaching heuristic bankruptcy. Nevertheless, the exercise of discovering and devising rules of thumb (for grouping species in alleged communities) has significant operational power for solving practical problems of ecology.

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