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THEORY AND RESEARCH IN ORGANIZATIONAL ECOLOGY

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Abstract

Major theory and research in organizational ecology are reviewed, with an emphasis on the organization and population levels of analysis and processes of organizational foundings, mortality, and change. The main approach to organizational foundings examines the roles of density dependence and population dynamics. Six approaches to studying organizational mortality are fitness set theory, liability of newness, density dependence, resource partitioning, liability of smallness, and the effects of founding conditions. Research on organizational change is just beginning to appear in the literature. The convergence between ecological and institutional research is discussed, especially the role of legitimacy in population dynamics, and the effects of institutional variables on vital rates. Some key criticisms of organizational ecology are addressed, and some suggestions for future research are proposed.

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INTRODUCTION

Organizational ecology focuses on the study of organizational diversity. Its key concerns are to investigate how social conditions influence (*a*) the rates of creation of new organizational forms and new organizations, (*b*) the rates of demise of organizational forms and organizations, and (*c*) the rates of change in organizational forms. The emphasis is on the evolutionary dynamics of processes influencing organizational diversity. And, in contrast to the predominance of adaptation in the study of organizations, organization ecology investigates the role of selection processes.

Although differences exist among individual researchers, one significant premise underlies thinking in organizational ecology. Under specific conditions, processes of change in organizational populations parallel processes of change in biotic populations. This similarity invites investigation of population biology ideas and models to see how they illuminate organizational processes of interest. Often, though, this is misunderstood by critics as the use of biological theory to explain organizational change or the use of biological metaphors to study organizations.

In its classical form, the principal tenet of organizational ecology can be stated succinctly: once founded, organizations are subject to strong inertial pressures, and alterations in organizational populations are largely due to demographic processes of organizational foundings (births) and dissolutions (deaths). Most research in organizational ecology has dealt either with tests of the selectionist tenet or with demographic processes in organizational populations.

Although the first substantive discussion of a selectionist approach to organization-environment relations appeared in the *Annual Review of Sociology* over a decade ago (Aldrich & Pfeffer 1976), the only comprehensive review of organizational ecology to appear here was more recent (Carroll 1984a). Following Hannan & Freeman (1977:933–34), Carroll distinguished between three different levels of analysis in organizational ecology: the organizational level, the population level, and the community level. These three levels of analysis are characterized respectively by developmental, selection, and macroevolutionary approaches to study evolution. Carroll's review comprehensively placed the development of organizational ecology in a broader theoretical perspective, tracing its intellectual roots to human ecology (Hawley 1950, 1968), and building links with disparate fields like urban sociology and business policy.

Since this first review, when the first few empirical studies in organizational ecology had just begun to appear, research in organizational ecology has blossomed. Some of the recent events that symbolized the coming of age of organizational ecology are the publication of a key text, *Organizational*

Ecology (Hannan & Freeman 1989), and two collections: *Ecological Models of Organization* (Carroll 1988), and *Organizational Evolution: New Directions* (Singh 1990).

Because research in organizational ecology now constitutes a large body of work, our review is limited primarily to work that has appeared since Carroll (1984) and to the organization and population levels of analysis.

In this review, consistent with Hannan & Freeman (1989:7), we argue that the evolution of populations of organizational forms can best be studied by examining how social and environmental conditions influence the rates at which new organizations are created, the rates at which existing organizations die out, and the rates at which organizations change forms. The next three sections of the paper review the current literature on foundings, disbandings, and changes in organizational forms. The fourth section reviews the growing convergence between ecological and institutional research. The fifth section reviews and evaluates some of the main criticisms that have been leveled against organizational ecology research. The final section concludes with some significant unanswered questions and some speculations about what new directions may usefully be pursued.

ORGANIZATIONAL FOUNDINGS

Compared with the extensive literature on organizational mortality, there are fewer studies of organizational foundings in the ecological literature. As Delacroix & Carroll (1983) suggest, this may be due in part to the conceptual and methodological peculiarities of studying foundings. Since there is no organization prior to founding, the population or environment itself needs to be treated as the level of analysis. Another difficulty concerns determining the specific point when a founding occurred and distinguishing between all organizing attempts and those that successfully culminate in an operating organization. Researchers usually do not treat organizing attempts as foundings, preferring to focus instead on creation of an operating entity that acquires inputs and provides outputs (Delacroix & Carroll 1983) or its formal incorporation (Tucker, Singh, & Meinhard, 1990), although some theoretical treatment of emerging organizations does exist (Katz & Gartner 1988). Most of the recent literature on organizational foundings has concentrated on density dependence and population dynamics explanations of foundings. This section reviews the underlying theory and empirical evidence.

Density Dependence and Population Dynamics

Delacroix & Carroll (1983) argued that the cyclical patterns of organizational foundings over time that are typically observed may be explained by the effects of prior organizational foundings and failures on the availability of resources. Thus, the disbanding of an existing organization may create free-floating resources which could be reassembled into new organizations. An upper limit exists to this positive effect of prior failures on current foundings, however, since an even larger number of deaths would signal an environment noxious to potential entrepreneurs, which would thereby discourage foundings. This effect would lead to a curvilinear relationship between current foundings and prior failures. Similarly, the effect of prior foundings should also be curvilinear. At first, prior foundings would encourage potential entrepreneurs to create new organizations by signalling a fertile niche. But as the number of foundings increases further, this imitation process would lead to so many foundings that competition for resources would discourage further foundings.

Hannan's (1986) synthesis of institutional and ecological ideas also dealt with density dependence of organizational founding rates. The early range of density legitimates the organizational form itself and helps increase the founding rate. But as density increases further, the legitimacy process begins to be dominated by the competitive process, and this decreases the founding rate. Like its influence on mortality rate, density has a nonmonotonic effect on founding rate, except that the effect is first positive and then negative. And this model can be extended to include competition between populations of organizational forms, by modeling cross-population density effects (Hannan & Freeman 1988a).

We think the evidence in support of the hypothesized nonmonotonic pattern of density dependence of foundings is strong (see Table 1), particularly from studies designed specifically to test the model (Carroll & Swaminathan 1989a, Hannan & Freeman 1987). Of course, it is important to model density and population dynamics arguments together, because it seems that population dynamics effects are related to both density dynamics and changes in density levels (Tucker et al 1988:151). When the two are modeled together there is some evidence that population dynamics effects may be weaker than density dependence effects. It would be useful to study the generalizability of these results and to explore the causes for population differences, if any are observed.

ORGANIZATIONAL MORTALITY

We have identified at least six different themes in how ecologists have approached the study of mortality—fitness set theory, the liability of newness, density dependence and population dynamics, resource partitioning theory, the liability of smallness, and the impact of founding conditions on organizational mortality. This section reviews both theoretical arguments and empirical evidence for each of these approaches.

Fitness Set Theory

In an influential paper in which they persuasively argued the case for a selection approach to organizations, Hannan & Freeman (1977) suggested two broad starting points. The first was competition theory, which would specify the process of optimization by which forms become isomorphic with their environments. The second was niche-width theory, which specified whether, and under what conditions, specialist or generalist strategies provided organizations with an evolutionary advantage. In carrying out an empirical test of these niche-width arguments, Freeman & Hannan (1983) also elaborated and refined the theory. Building on work by Levins (1968) in bioecology, Freeman & Hannan focussed on two features of environmental variations—*levels of environmental variability* and *grain*. Whereas variability refers to the variance in environmental fluctuations about their mean, grain refers to the *patchiness* of these variations, with many small periodic variations being *fine grained* and a few large periodic variations being *coarse grained*. Levels of variability and grain could vary independently of each other. The predictions based on niche-width theory (for concave fitness sets, in which typical environmental fluctuations are large relative to the tolerances of organizations for these fluctuations) were that in fine-grained environments, the specialist strategy would be favored, i.e. specialist organizations would have a lower mortality rate regardless of the level of environmental variability because they would ride out brief tough times. And in the case of coarse-grained environments, a specialist strategy would be favored for low levels of environmental variability, but a generalist strategy would be favored for high levels of variability (Freeman & Hannan 1983:1126–29).[1] In contrast, received organization theory predicts that generalism is favored only for high levels of environmental variability, since diversified organizations spread out their risk.

This question, though interesting and important, has not been researched enough (see Table 2 for summarized empirical evidence). Although the available data are in agreement with fitness set theory predictions, particularly the Freeman & Hannan (1983) study designed specifically to test these ideas,

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[1] Herriott (1987) commented that in the case of high temporal variability and coarse grain (and a concave fitness set), the prediction of fitness set theory should be a polymorphic population which is generalist, but is composed of specialist forms. In their reply, Freeman & Hannan (1987b) pointed out that restaurants, contrasted with, say, multinational conglomerates, are simpler organizations in which polymorphism is unlikely, so, generalists prevail over specialists under these conditions.

Table 1 Organizational foundings

Approach	Population	Key[a] Variable(s)	Concordance	Reference
Density dependence and population dynamics	Argentine newspapers, 1800–1900	Births, deaths	+ +[1,2]	Delacroix & Carroll (1983)
	Irish newspapers, 1800–1925	*same as above*	+ +[2,3]	
	Local newspaper industry, 125 year period	*same as above*	+[3,4,5]	Carroll & Huo (1986)
	Metro Toronto VSSOs, 1970–82	Births, deaths, institutional changes	+ +[6]	Tucker et al. (1988); Singh, Tucker & Meinhard (1990)
	same as above	*same as above* (separate analysis for specialists and generalists)	+ +[7]	Tucker, Singh & Meinhard (1990)
	US national labor unions, 1836–1985	Population density	+ +[8]	Hannan (1986)
	same as above	Population density, births	+[9] (industrial unions) + +[9] (craft unions)	Hannan & Freeman (1987)
	California wineries, 1941–84	Births	+ +[10]	Delacroix & Solt (1988)
	9 19th/20th century newspaper populations	Population density, births, deaths	+ + (6 pop.)[11] + (3 pop.)	Carroll & Hannan (1989)
	US brewing industry, 1633–1988	Population density, births, deaths	+ +[12, 13]	Carroll & Swaminathan (1989a)
	US and German breweries,	Population density, births	+ + German + US[14]	Carroll et al (1989)

US semiconductor companies, 1947–84	Population density, entries	+	Hannan & Freeman (1989)
PA telephone firms, 1877–1933	Population density, population mass	–[15]	Barnett & Amburgey (1989)
Worker cooperatives in Atlantic Canada, 1940–1987	Population density, births, deaths	+[16]	Staber (1989a)

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[1] Quadratic effects of prior births were insignificant in some models, but in the right direction.

[2] Quadratic effects of prior births or deaths were insignificant in some models, but in the right direction.

[3] Periods of political turmoil significantly increased newspaper foundings.

[4] Predicted curvilinear effects of prior failures not found, quadratic effect of prior births not significant in some models.

[5] Stronger effects of institutional environment on foundings than task environment effects.

[6] Significant independent effects of population dynamics and institutional changes; some evidence that institutional changes significantly altered population dynamics.

[7] Population dynamics, institutional changes and their interaction influence specialist foundings more strongly than generalist foundings.

[8] Results for industrial union foundings marginally significant; density of industrial unions depresses foundings of craft unions, but not vice versa.

[9] More complex models than Hannan (1986) estimated that controlled for prior density and births.

[10] Density dependence and population dynamics not estimated, strong effects of prior foundings.

[11] Political turmoil raises foundings; population dynamics effect of prior foundings, failures do not appear stable.

[12] Quadratic effect of density not significant but in right direction in more complex models.

[13] Curvilinear effects of failures significant and in wrong direction, effects of foundings in right direction in complex models.

[14] Curvilinear effects of foundings not significant, and in wrong direction for US breweries.

[15] Curvilinear effects of density in predicted directions when modeled alone; become significant but in wrong directions when mass modeled together.

[16] Predicted curvilinear effects of births and deaths for worker cooperatives but not for consumer or marketing cooperatives; predicted density dependence for consumer and marketing cooperatives, but wrong direction for worker cooperatives.

[a] *KEY:* + + *refers to* statistical significance, agreement with theory; + *refers to* right direction, non-significant; – *refers to* wrong direction, non-significant; — *refers to* statistical significance, disagreement with theory

more studies are needed that explicitly contrast predictions from received organization theory and fitness set theory in other populations. The question of organizational polymorphs needs particular attention.

Liability of Newness

In the investigation of regularities that underlie patterns of organizational mortality, an influential and productive issue has been the liability of newness, the propensity of young or new organizations to have higher failure rates. Stinchcombe (1965) argued that this happens for several reasons, some internal to the organization and others external. Young organizations and the individuals in them have to learn new roles as social actors. A significant amount of time and effort has to be expended to coordinate these new roles for the individual actors and in their mutual socialization. And in dealing with external clients, customers and other relevant actors, new organizations are forced to compete with existing organizations that have well-established client groups who are familiar with the organization. The failure to attract business away from an established competitor is one of the key factors contributing to failure of a new organization.

A complementary treatment of the liability of newness comes from Hannan & Freeman's (1984) elaboration of their earlier theoretical statement (Hannan & Freeman 1977). They argued that in modern societies organizational forms that have high levels of reliability and accountability are favored by selection processes. Reliability and accountability of organizational forms require that the organizational structure be highly reproducible. Due both to processes of internal learning, coordination, and socialization within the organization and to external legitimation and development of webs of exchange, the reproducibility of organization structure increases with age. Because greater reproducibility of structure also leads to greater inertia, however, organizations become increasingly inert with age. And since selection processes favor organizations with inert structures, organizational mortality rates decrease with age—the liability of newness.

Even though the burden of the evidence supports the liability of newness (see Table 2), we think two issues bear further examination. One—it seems clear from several studies that explicitly modeling covariates can alter patterns of age dependence. Methodologically, one alternative explanation to age dependence of mortality is population heterogeneity (Tuma & Hannan 1984, Freeman et al 1983, Carroll 1983), and the findings may simply reflect this—although Hannan (1988a) estimated models containing effects of unobserved heterogeneity and still found negative age dependence. Age can also be seen as a surrogate for multiple underlying constructs that vary with age; for example, specific survival related competencies or external institutional support. Thus, there is a need to model relevant covariates explicitly in multiple populations and to examine the cumulative results of such studies. Two—it also appears that population differences exist in age dependence patterns. It is important to ask what factors distinguish populations with monotone and nonmonotone age dependence patterns. The Levinthal & Fichman (1988) work (which is also a special case of unobservable heterogeneity) shows how endowments can lead to nonmonotone age dependence patterns.

Resource Partitioning Theory

Compared with Hannan & Freeman's theory of the dynamics of niche width (Hannan & Freeman 1977, Freeman & Hannan 1983) in which they drew upon insights from fitness set theory, Carroll (1985) proposed a model for the dynamics of niche width which applies to markets characterized by strong economies of scale. He asked whether it is better for an organization to be a specialist or a generalist, given a high market concentration in the environment.

In a geographically dispersed market, with high, concentrated demand in the core, and heterogeneous pockets of demand in the periphery, each organization attempts to capture the center of the market. This is true when there are only a few organizations; but as the number of organizations increases, large, powerful generalists push other organizations from the center of the market. When generalists become numerous, some are pushed to the periphery, and outcompete specialists for resources, based on their size. Thus, when the number of generalists in the market increases in a dispersed market, the life chances of specialists deteriorate vis-á-vis generalists. But when a few generalists dominate the core of the resource space—i.e. the concentration of generalists is high—specialists can thrive on the periphery and outcompete generalists. The process by which this happens is called resource partitioning, because it makes specialists and generalists appear to operate in distinct resource spaces. Resource partitioning predicts that when concentration in the generalist mass market is high, the mortality rate of generalists increases and the mortality rate of specialists decreases. The evidence seems to support resource partitioning ideas (see Table 2). However, their generalizability and competing theoretical views need further examination. For example, illuminating the relationship between fitness set theory and resource partitioning and their relative contributions to mortality can bring about a better understanding of form-environment relations.

Liability of Smallness

Related to the discussion above of the liability of newness, another important stream of research has addressed how organizational size may systematically influence mortality rates. In their discussion of selection and inertia in organizational populations, Hannan & Freeman suggested that the level of structural

Table 2 Organizational mortality

Approach	Population	Key[a] variable(s)	Concordance	Reference
Fitness set theory	Restaurants in 18 California cities, 1974–1977	Variability, grain, form	+ + coarse-grained + fine-grained	Freeman & Hannan (1983)
	US semiconductor firms, 1948–1984	*same as above*	+ + coarse-grained — fine-grained, low variability + fine-grained, high variability	Freeman & Hannan (1987a; 1989)
Liability of newness	Argentine newspapers, 1800–1900	age	+ +	Carroll & Delacroix (1982)
	Irish newspapers, 1800–1975		+ +	
	52 data sets on retail, manufacturing and other enterprises	*same as above*	+ +	Carroll (1983)
	US national labor unions, 1800–1980	*same as above*	+ +[1,2]	Freeman, Carroll & Hannan (1983)
	7 US metro newspapers, 1800–1975	*same as above*	+ +[1,2]	*same as above*
	US semiconductor firms, 1957–1979	*same as above*	+ +[1,2]	*same as above*
	Restaurants in 18 California cities, 1974–1977	*same as above*	+ +	Freeman & Hannan (1983)
	Metro Toronto voluntary social service organizations (VSSOs) 1970–1982	*same as above*	+[3]	Singh, Tucker & House (1986)
	Local newspaper industry, 125 year period	*same as above*	+ +	Carroll & Huo (1986)
	All Finnish newspapers, 1771–1963	*same as above*	+ +	Amburgey, Lehtisalo & Kelly (1988)
	US national labor unions, 1836–1985	*same as above*	+ +[4]	Hannan (1988a)

SE Iowa telephone companies, 1900–1917	*same as above*	+/−[5]	Barnett & Carroll (1987)
US state bar associations, 1870–1920	*same as above*	+[6]	Halliday, Powell & Granfors (1987)
California wine industry, 1940–1985	*same as above*	+[5]	Delacroix, Swaminathan & Solt (1989)
Finance units in 3 US cities, 1890–1975	*same as above*	−[6]	Meyer, Stevenson & Webster (1985)
Business interest associations, 1936–1983	*same as above*	−[7]	Aldrich & Staber (1983)
Metro Toronto VSSOs, 1970–1982	*same as above*	−[7]	Tucker, Singh & House (1984)
Knights of Labor local assemblies, 1869–1900	*same as above*	−[7]	Carroll & Huo (1985; 1988)
Dyadic auditor-client attachments, 1973–1986	*same as above*	− −[7]	Levinthal & Fichman (1988)
Worker cooperatives in Atlantic Canada, 1940–1987	*same as above*	−[7]	Staber (1989b)
Child care organizations in Metro Toronto, 1971–1987	*same as above*	− −[7]	Baum (1989a)

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[1] Initial size at founding controlled.

[2] Death rates did not appear to reflect only the (potentially confounding) factor of historical variations in mortality rates.

[3] Modeling external legitimacy covariates explicitly made age dependence of mortality rate insignificant.

[4] Disbanding, absorption and merger showed strong, monotonic, negative age dependence.

[5] More complex models in which other variables modeled explicitly.

[6] Negative age dependence disappeared after controlling for other covariates.

[7] Age dependence of mortality rates showed significant non-monotonic patterns.

[a] *KEY:* + + *refers to* statistical significance, agreement with theory; + *refers to* right direction, non-significant; − *refers to* wrong direction, non-significant; − − *refers to* statistical significance, disagreement with theory

Table 2 (*Continued*)

Approach	Population	Key variable(s)	Concordance	Reference
Resource partitioning	Newspapers in 7 US metro areas, 1800–1975	Conc. of circulation, specialism/generalism	+[1]	Carroll (1985)
	Music recording industry	Conc. of advertising, specialism/generalism	+	Carroll (1987)
	US microbreweries and brew pubs, 1975–1988	Founding and mortality rates, market conc.	+ +[2]	Carroll & Swaminathan (1989b)
Liability of smallness	7 US metro newspaper populations, 1800–1975	Log membership at founding	– –[3]	Freeman, Carroll & Hannan (1983)
	US labor unions, 1800–1980	Log circulation at founding	+ +	*same as above*
	Metro-Toronto VSSOs, 1970–1982	Size of board at founding	+ +[4]	Singh, Tucker & House (1986)
	California restaurants, 1974–1977	Log sales	+ +	Freeman & Hannan (1983)
	US semiconductor firms, 1946–1984	Numbers of employees	+	Freeman (1989)
	US national labor unions, 1836–1935	Log size	– –[5]	Hannan (1988a)
	SE Iowa telephone companies, 1900–1917	Log number of telephones	+ +	Barnett & Carroll (1987)
	California wineries, 1940–85	Storage capacity	+ +	Delacroix, Swaminathan & Solt (1989)
	SE Iowa telephone firms, 1900–1917	Log number of telephones	+ +	Barnett (1989)
	PA telephone firms, 1877–1934			
	US state bar associations, 1870–1930	Number of workers	+ +	Halliday, Powell & Granfors (1987)

Founding conditions	Argentine newspapers, 1800–1900 Irish newspapers, 1800–1975	Creation during peak or trough years of business cycle	− −Argentine[6] + Irish	Carroll & Delacroix (1982)
	same as above	Creation during politically turbulent years	+ + Argentine + Irish	*same as above*
	Local US newspaper industry, 125 year period	*same as above*	+ +	Carroll & Huo (1986)
	US national labor unions, 1836–1985	Population density at founding	+ +[7]	Carroll & Hannan (forthcoming)
	Argentine newspapers, 1800–1900	*same as above*	+ + Argentine[7]	*same as above*
	Irish newspapers, 1800–1970		+ Irish	*same as above*
	San Francisco region newspapers, 1840–1975	*same as above*	+ +[7]	*same as above*
	US breweries, 1633–1988	*same as above*	+ +[7]	*same as above*
	Metro Toronto VSSOs, 1970–1982	Population density at founding	+ +[8]	Tucker, Singh & Meinhard (1989)
	same as above	Form	+ +[8]	*same as above*
	same as above	Concentration	+ +[8]	*same as above*
	same as above	Institutional change	+ +[8]	*same as above*

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[1] Not all coefficients significant; population size of local environment controlled.
[2] Founding rates increased and mortality rates decreased as market concentration rose.
[3] Large member of missing cases.
[4] At VSSO founding, board members are the only people available to do the organization's work.
[5] Larger unions had a higher mortality rate, contrary to Freeman, Carroll & Hannan (1983).
[6] Being created in a peak year raised mortality.
[7] Liability of scarcity and tight niche packing, the latter marginalizing newcomers, makes density at founding positively correlated with mortality.
[8] Time varying environmental conditions—concentration, density and favorable and unfavorable institutional change—were controlled for in complex models.

KEY: + + *refers to* statistical significance, agreement with theory; + *refers to* right direction, non-significant; − *refers to* wrong direction, non-significant; − − *refers to* statistical significance, disagreement with theory

Table 2 (*Continued*)

Approach	Population	Key variable(s)	Concordance	Reference
	US trade associations, 1900–1983	Population density at founding	+	Aldrich et al (forthcoming)
	same as above	Number of predecessors	+ +	*same as above*
	same as above	Founded through mergers	+ +	*same as above*
Density dependence and population dynamics	US national labor unions, 1836–1985	Population density	+ +	Hannan (1986) Hannan & Freeman (1988b)[1]
	US semiconductor firms, 1946–1984	*same as above*	+ +	Freeman (1989)
	9 19th/20th century newspaper populations	*same as above*	+ + (3 pop.) + (3 pop.) − (3 pop.)	Carroll & Hannan (1989)
	US brewing industry, 1633–1988	*same as above*	+ +[2]	Carroll & Swaminathan (1989a)
	Metro Toronto VSSOs, 1970–1982	*same as above*	—[3]	Singh, Tucker & Meinhard (forthcoming); Tucker et al. (1988)
	SE Iowa telephone firms, 1900–1917	*same as above*	–[3]	Barnett & Carroll (1987)

PA telephone firms, 1877–1934 SE Iowa telephone firms, 1900–1930	*same as above*	—[4]	Barnett (1989)
PA telephone firms, 1877–1933	Population density, population mass	–[5]	Barnett & Amburgey (1989)
US and German breweries, 1900–1982	Population density	+ +US – –German	Carroll et al. (1989)
Bavarian breweries, 1900–1981	National and state level population density	–	Swaminathan & Wiedenmayer (1989)
California wineries, 1940–1985	Population density	–[6]	Delacroix, Swaminathan & Solt (1989)
Cement industry, 1886–1982 Glass container industry, 1899–1984 Window glass industry, 1890–1984 Minicomputer industry, 1964–1980	Population density, major technological changes	+[7]	Anderson (1988)

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[1] Model controlled for age, features of national, political and social environments.

[2] Model controlled for linear effects of prior foundings and failures.

[3] Mortality rate increased at low densities, decreased at higher densities.

[4] Density showed competitive effects when only the linear term was modeled; quadratic term not significant for Iowa, significant for Pennsylvania.

[5] Predicted curvilinear effects when density modeled alone; when curvilinear density and mass dependence modeled together, no effects significant, but in expected directions; when only linear mass and density effects modeled, density has only competitive effects.

[6] Effects of density sensitive to model specification. Some evidence of lateral migration of firms to neighboring niche to escape overcrowding.

[7] Linear effects of density were modeled alone and were competitive; era of ferment following technological change increased mortality.

KEY: + + *refers to* statistical significance, agreement with theory; + *refers to* right direction, non-significant; – *refers to* wrong direction, non-significant; – – *refers to* statistical significance, disagreement with theory inertia increases with size (1984, p. 158). According to Hannan & Freeman, since selection processes in modern societies are such that they favor organizations with greater structural inertia (i.e. inert organizations have lower mortality rates) larger organizations must have lower mortality rates. This propensity of smaller organizations to have higher mortality rates is known as the liability of smallness (Aldrich & Auster 1986, Freeman et al 1983).

Aldrich & Auster (1986) have suggested some of the reasons underlying the liability of smallness. Smaller organizations have several disadvantages, compared with large organizations. They have greater difficulty in raising capital. Tax laws, in particular the favorable tax treatment of capital gains, create incentives for small-firm owners to sell out to large firms, whose borrowed funds for acquisition purposes have tax-deductible interest. Governmental regulations have more impact on small organizations as they attempt to deal with city, county, state, and federal levels of government. Finally, in competing with large organizations for labor input, small organizations are at a major disadvantage, since they cannot offer the long-term stability and internal labor markets that large organizations are thought to have.

Although the liability of smallness is an important substantive question in its own right, another significant reason it has been pursued is one related to the liability of newness. Most new organizations tend to be small. If small organizations have higher death rates, as the liability of smallness suggests, liabilities of newness and smallness are confounded and need to be separated out. Thus, many studies of liability of newness also focus on the liability of smallness.

With few exceptions, there seems to be strong empirical support for the liability of smallness (see Table 2). Extending the findings to other populations and formulating more complex models should help to establish the results more firmly.

Founding Conditions

Although the impact of founding conditions, whether organizational or environmental, on mortality rate has usually not been treated as a separate topic for investigation—often it is appended to discussion of liability of newness—we think it has sufficient theoretical importance to warrant separate treatment. The key theoretical concern dates back to a paper by Stinchcombe (1965). In an influential paper that investigated links between organizations and social structure, Stinchcombe proposed a relationship between the historical time at which an organization is created and the social structure in existence at the time. Some of the features of the social environment at the time of founding influence (or *imprint*) the organizational processes that subsequently get institutionalized and then resist alteration. Thus, some of the features acquired at founding are carried by organizations throughout their life cycles. A systematic exploration of the impact of these conditions at founding informs this broader theoretical concern.

Tucker et al (1989) suggested another important reason to study the influence of founding conditions on mortality. Selection processes are known to operate on variations that exist in populations of organizations (Aldrich 1979, Aldrich & Pfeffer 1976, Campbell 1969, McKelvey & Aldrich 1983). One way to reinterpret, for example, evidence on the liability of newness, or on organizational form-environment fit, is that both provide variations in populations of organizations; some of these enhance life chances, whereas others do not. Thus, individual organizations in a population differ from one another both by organizational age and by fit between form and environment. One important implication of imprinting arguments is that the behavior of contemporary organizations continues to be influenced by differences in founding conditions, and these differences are another way in which organizations differ from each other. In other words, differences in founding conditions and their impact on mortality rates are another way in which selection processes operate in organizational populations.

Carroll & Hannan (1990) have suggested that density at founding may increase the mortality rate for at least two reasons. First, a liability of scarcity; intense competition at founding means new organizations face stronger selection pressures. Surviving organizations cannot devote necessary resources to formalizing structures and routines and this makes them inferior competitors at every age. Second, tight niche packing occurs because when density is high, new entrants find themselves pushed to the margins of the resource space, since they can't compete directly with established organizations. As they adapt to the thinner resources at the margins, they also get committed to persisting there, which results in higher mortality.

The evidence strongly suggests that variations in founding conditions are systematically related to mortality rates, even after accounting for, in some studies, age dependence and environmental conditions (see Table 2). Some issues useful to explore further are processes of imprinting in organizations and the question of whether founding conditions affect organizational foundings and mortality in similar or different ways.

Density Dependence and Population Dynamics

Hannan (1986) synthesized ideas from the institutional approach to organizations (Meyer & Rowan 1977, Meyer & Scott 1983, DiMaggio & Powell 1983) and organizational ecology (Hannan & Freeman 1977) in a novel modeling framework to study how organizational mortality and founding rates are related to density, the number of organizations in the population. Underlying the usual Lotka-Volterra model of population growth from bioecology is the assumption that mortality rate increases approximately linearly with population size. In incorporating sociological mechanisms into models of population growth, Hannan argued that population density captures both legitimation and competitive forces. In the early stages of the development of a new organizational form, growth in numbers legitimates the organizational form itself, thereby decreasing the mortality rate. But as density continues to increase, competitive pressures overwhelm the legitimation effects, increasing mortality rates. Thus, mortality rate is related nonmonotonically to density, decreasing initially and then rising again as density continues to increase. This model can also easily be extended to include competition between populations by asking whether the mortality rate of one population increases as the density of the other population increases through explicitly modeling cross-population density effects. These arguments were presented in a more formalized manner by Hannan & Freeman (1988a).

The evidence in favor of the Hannan (1986) model of density dependence is strong (see Table 2), particularly the Hannan & Freeman (1988b) labor union study and the Carroll & Swaminathan (1989a) brewery study, both designed specifically to test the model. But we think the discrepant findings need to be considered further.

One weakness of density-dependence arguments has been that, implicitly, each organization in the population is assumed to have an equivalent impact on mortality rates, although some studies do control for total population size. In contrast to density-dependence arguments which relate density to mortality rate, mass dependence arguments (a plausible alternative view) use a measure of population mass, the density with each organization weighted by its size (for example, Barnett & Amburgey 1990). Thus, larger organizations exert more influence on the population in this model. However, the findings for density from such models are very sensitive to the details of the model specification (Barnett & Amburgey 1990), suggesting that the covariates needed for robust description of mass versus density dependence are not yet fully understood.

Carroll & Hannan (1989), in an attempt to reconcile the differences in results that various studies have turned up, suggest that the studies that don't provide consistent evidence do not have data on the complete history of the population, especially including the early period. Excluding this early period in the history is particularly problematic for the facilitative legitimacy effect in the density dependence model which occurs early on. Thus, the Tucker et al (1988) study which examines a population of voluntary social service organizations during 1970–1982, and the Delacroix et al (1989) study, which lacks data on the California wine industry during the post-Prohibition years, 1934–1939, are both potentially subject to this problem.

The Carroll & Hannan conjecture may not explain all the inconsistent results for density dependence of mortality rates. Two caveats come to mind. One is that studies of the telephone organization populations (Barnett & Carroll 1987, Barnett 1989, Barnett & Amburgey 1990) do appear to have some data on the early history of the population, yet do not display the early legitimacy-enhancing, mortality-reducing effects of density. Instead, the effects are competitive. But it may still be argued that data for the earliest post-Bell patent period are unavailable here, except for Barnett (1989). The second caveat is that, although this explanation accounts for why the negative linear effect of density on mortality rate may not be as predicted, it does not explain why the quadratic effect (density squared) also goes against predictions of the model (Tucker et al 1988, Carroll et al 1989). We think the Carroll & Hannan explanation may be partly true, but it does not explain all of the results. An alternative possibility is that there may be systematic differences across populations in patterns of density dependence of mortality areas. For example, in some populations legitimacy may have a nonmonotonic relationship with density, first increasing and then decreasing. It also seems to be the case that such models produce density results that are rather sensitive to model specification (Barnett & Amburgey 1990).

ORGANIZATIONAL CHANGE

In this section we review the theoretical arguments and empirical evidence that deal with questions of change in *individual* organizational forms. As we had pointed out above, change in populations of organizational forms, the central focus of organizational ecology, needs to be studied by the systematic examination of mortality rates of organizations, founding rates of organizations, and rates of organizational change (Hannan & Freeman 1989:7). The previous two sections of this paper demonstrated that compared with the extensive literature on organizational mortality, few studies have dealt with foundings. Even less work has been done on rates of organizational change or transformation (Aldrich & Marsden 1988:377). Most ecological thinking maintains that the larger part of population change occurs through the population level demographic processes of organizational founding and mortality, and change in individual organizations contributes considerably less to population change (Hannan & Freeman 1977, 1984).

We think there are at least three key reasons for this inattention to organizational change. First, ecological theorists have argued persuasively that, due to both internal structural arrangements and external environmental constraints, organizations are subject to strong inertial pressures which severely inhibit organizational capacities to change (Hannan & Freeman 1977:930–33).

This has been argued to be particularly true of core organizational features such as the stated goals, forms of authority, core technology, and marketing strategy of the organization (Hannan & Freeman 1984:156). Second, ecological theorists argue for an explicit focus on populations of organizations (Hannan & Freeman 1977, 1989, Staber & Aldrich 1989). As such, organizational level phenomena are of only secondary interest. Third, empirical, ecological studies tend to rely on data gathered from historical archives over long periods of time. Even if the theory were to accommodate a specific interest in organizational change, internal organizational data may typically be difficult to obtain. However, despite all of the above, there exist both theoretical and empirical approaches to this question of organizational change.

Inertia and Rates of Organizational Change

Hannan & Freeman (1984), building upon their earlier argument (1977), hypothesized that some kinds of organizational changes occur frequently in organizations, and sometimes these may even be radical changes (1984, p. 149). But the nature of selection processes is such that organizations with inert features are more likely to survive (p. 155). And as they age, they become progressively more inert (p. 157).

Aldrich & Auster (1986:168–70) argued for a *liability of aging* in older organizations, a process that severely limits the possibility of organizational transformation, and that arises from a combination of internal and external factors. This liability of aging manifests itself in the reduced propensity of older organizations to undergo changes or transformations. Among the internal factors, vested interests harden with age, because power distributions get institutionalized, and organizations become more internally homogeneous which lowers their sensitivity to external changes and, thereby, their propensities to change. The main external reason is that older organizations get embedded in their surroundings and develop exchange relationships that curtail their autonomy and ability to change.

Singh, Tucker & Meinhard (1988) point out one difficulty with the liability of aging argument, that it does not distinguish between change processes and their consequences for mortality. Instead, Singh et al developed a rigidity-of-aging thesis, based in the literature, which specified that rates of change in organizational features decline as organizations age. Whether this rigidity of aging poses a liability for organizations is a separate question and is probably best addressed separately. But in addition to this rigidity-of-aging view, they also developed a competing theoretical view, the fluidity-of-aging thesis, which specified that rates of change in organizational features increase as organizations age. Whereas the rigidity-of-aging view is generally consistent with ecological views of structural inertia (Hannan & Freeman 1984) and related to the liability of aging (Aldrich & Auster 1986), the fluidity of aging is based on a view of boundedly rational organizational decisionmakers attempting to adapt to constantly changing, uncertain environments. They tested these competing theoretical models of how rates of change in organizational features vary with organizational age, using data from a population of voluntary social service organizations. Initial results seemed to indicate that for all organizational features studied, rates of change monotonically increased with age, after controlling for organizational form and size of board of directors at founding, and institutional environmental conditions and population density over time. This suggested strong support for the fluidity-of-aging thesis. However, when the time since the last change was also modeled explicitly—because the longer this period, the greater the probability of a change occurring—the results changed substantially. These results seemed more consistent with the position that for changes in core features (e.g. sponsor), rates of change declined with age, and for changes in peripheral features (e.g. structure, chief executive), rates of change increased with age. Thus, the rigidity-of-aging thesis appeared to hold true for core features, but the fluidity-of-aging thesis seemed most descriptive of peripheral features of organization.

In other relevant studies, the evidence has been mixed. In an analysis of strategic domain changes in a cohort of daycare centers, Baum (1989b) did not find support for the rigidity-of-aging thesis. Instead, the rates of strategic change first reached a maximum during an adolescent phase, then declined, reached a peak during an obsolescent phase, and declined again. Ginsberg & Buchholtz (1989) studied conversion from nonprofit to for-profit status by health maintenance organizations (HMOs) following a radical environmental shift. Their results showed that older HMOs took longer to convert than younger ones, which was consistent with the rigidity-of-aging thesis. Kelly & Amburgey (1989) found that in the US airline industry, rates of change in core features, such as business level changes to specialism or generalism, and corporate level changes to generalism, all declined with age. This lent support to the thesis of Singh, Tucker & Meinhard's (1988) concerning the rigidity of aging. In a study of changes in strategy by semiconductor companies Boeker (1987) found that the difference between initial strategy and current strategy increased significantly with age, which was generally consistent with the fluidity-of-aging thesis. And Amburgey & Kelly (1985), in a study of transformations in a population of US business periodicals, found that rates of change in features studied all declined with age.

We think this question is rather underinvestigated, given its importance. There is some contradictory evidence, but some evidence also suggests that the distinction between core and peripheral features (Hannan & Freeman 1984, Scott 1987b) is useful to the study of rates of change in organizations.

Thus, rates of change in core features may decrease with age, and rates of change in peripheral features may increase with age. It is important, first of all, to see if these findings generalize to other populations. A broader theoretical issue is to specify more clearly the role that inertia plays in organizational change and, following Hannan & Freeman (1984), to explicate how inertial forces apply respectively to core and peripheral features of organization.

CONVERGENCE OF ECOLOGICAL AND INSTITUTIONAL RESEARCH

During recent years, organizational ecology and the institutional approach to organization (DiMaggio & Powell 1983, Meyer & Rowan 1977, Meyer & Scott 1983, Scott 1987a, Zucker 1987) have been two of the more actively researched areas. Whereas they were initially seen as separate theoretical views, a significant recent trend suggests convergence of these ideas, which may be viewed as an exciting research development in organization theory. In this section, we review aspects of this convergence.

In relating ecological and institutional theories of organization, two questions can be raised. One, how do changes in the institutional environment influence ecological dynamics. Two, how do ecological dynamics culminate in institutional change. We think there has been a greater convergence of ecological and institutional ideas around the first question (but see Hannan 1988b for a discussion of how ecological dynamics more generally influence social change). Two important ways in which this convergence has occurred are in the effects of institutional variables on vital rates in organizational populations, and the role of legitimacy in population dynamics.

Effects of Institutional Variables on Vital Rates

The general approach adopted is examining the effects of exogenous institutional variables on founding, disbanding, and change rates in organizations (see, for example, Singh, Tucker and Meinhard, forthcoming).[2] Carroll & Huo (1986) distinguished between the effects of task and institutional environmental variables on foundings and failures in a local newspaper industry. They found that task environmental variables related to customers, competitors, suppliers, and regulatory groups influenced newspaper performance (as measured by circulation) more than foundings and failures. On the other hand, institutional variables, especially political turmoil, influenced foundings and failures significantly, but not newspaper performance.

Tucker et al (1988) asked whether changes in the institutional environment significantly altered the ecological dynamics of founding and mortality in a

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[2] Hannan & Freeman (1989; Chapter 3) also devote considerable attention to the interaction of competitive and institutional processes in creating and eroding boundaries between organizational populations.

population of voluntary social service organizations. Singh, Tucker & Meinhard (forthcoming), in a study of broader scope, dealt more elaborately with issues of multicollinearity and autocorrelation in the earlier study and also examined the effects of institutional changes on rates of organizational change. The results showed strong evidence for the independent influence of ecological dynamics (curvilinear effects of prior foundings and failures) and institutional changes (favorable and unfavorable programs and policies of the state) on current foundings and mortality. And results also showed strongly that both favorable and unfavorable institutional changes significantly raised rates of change in organizational features. This idea, while central to institutional theory (Meyer & Rowan 1977) had, to the best of our knowledge, not been studied empirically earlier.

Tucker, Singh, & Meinhard (1990) further studied whether the interactive effects of institutional changes and ecological dynamics on voluntary organization foundings described above also held for subpopulations of specialists and generalists. Consistent with expectations, the results showed that the founding patterns of specialist and generalist organizations were significantly different. For specialist foundings, the curvilinear effects of lagged foundings, disbandings, and density, and the effects of institutional changes were all significant, but they were insignificant for generalist foundings. Further, although institutional changes altered the density dynamics of specialist foundings, there was no effect on generalist foundings. Thus, the interactive effects of ecological and institutional variables may vary by organizational form.

In a different vein, Barnett & Carroll (1989) have examined competitive patterns among different organizational forms in the early American telephone industry (1902–1942), and different institutional environments created by legal constraints and how these shaped the competitive patterns. The results showed that, consistent with their expectations, there were more telephone companies in states that had greater internal local political differentiation, an indicator of institutional (political) constraint. With regard to regulatory changes, the evidence was that state-level interconnection laws intensified the symbiotic relationship between large and small telephone companies. The other regulatory change, the Kingsbury Commitment, fundamentally changed the relationship between large and small companies from a symbiotic to a competitive one. Thus, particularistic constraints intended to reduce competition from a dominant organization led to an unintended increase in competition among other organizations.

Legitimacy and Population Dynamics

In addition to how institutional variables, particularly those related to the role of the state, influence founding, disbanding, and change in organizations, another significant convergence between ecological and institutional ideas concerns legitimacy and the role it plays in population change. Because we have already reviewed above some of the relevant literature, we deal with it briefly here.

Legitimacy features in population dynamics through how external institutional support reduces selection pressures on organizations. This idea is, of course, central to institutional theory (Meyer & Rowan 1977, Meyer & Scott 1983) because the isomorphism of an organization with the institutional environment enhances legitimacy and so provides greater access to resources, which reduces mortality rates. In organizational ecology one of the important reasons young organizations have a liability of newness is that they lack external legitimacy and institutional support (Hannan & Freeman 1984). Acquisition of external legitimacy and institutional support significantly reduced the death rate in a population of voluntary organizations (Singh, Tucker & House 1986).

The other argument which puts legitimacy at the core of organizational ecology is the density dependence of founding and mortality rates, reviewed in greater detail above (Hannan 1986, Hannan & Freeman 1987, 1988b). In the early range of density, it is argued that the growth in numbers of organizations legitimates the organizational form itself, decreasing the mortality rate and increasing the founding rate. Although some studies do not demonstrate the common pattern of results, these ideas are strongly supported by data from multiple, diverse organizational populations.

SOME CRITICISMS OF ORGANIZATIONAL ECOLOGY

Organizational ecology has attracted its share of critical attention (see, for example, Astley 1985, Perrow 1985, Young 1988), and some of the criticisms are currently being actively debated (Freeman & Hannan 1989, Brittain & Wholey 1989, Young 1989). The main criticisms relate to the supposedly deterministic nature of ecological ideas, the lack of attention to adaptation and change, the nature of the key constructs and the units of study, the nature of the organizational populations studied, and the divergence between theoretical constructs and their measures, particularly in the density-dependence arguments.

Strategy researchers in particular (see Bourgeois 1984) have been vocal about the seeming determinism of organizational ecology. We think there are enough variations on this theme to warrant separating out the main arguments. Three stand out, their interpretations depending on what is meant by determinism. The most commonly shared belief is that ecological thinking is deterministic, as opposed to voluntaristic, and that managerial agency and free will are denied in this approach (Astley & Van de Ven 1983). Another related interpretation of the criticism is that ecological ideas are monocausal and make the case for a new form of environmental determinism. A third interpretation is that the arguments are deterministic in that they are nonprobabilistic and, given low levels of fitness to environmental conditions, suggest the inevitability of organizations being selected out.

Organizational ecology is not deterministic in any of these senses. Hannan & Freeman acknowledged that leaders of organizations formulate strategies and help organizations adapt (1977, p. 930). In fact, they consider the environment as consisting mainly of other organizations, so environmental effects reflect, in part, the effects of actions of other organizations. However, their main interest lay in a selectionist approach which emphasized the population level of analysis instead of the adaptation of single organizations. There is little disagreement between approaches to strategic change in organizations initiated by managerial actions and selection ideas—they are simply at different levels of analysis (Burgelman & Singh 1989). Even though some empirical studies are focused more narrowly, most ecological research takes the view that selection in organizational populations is multicausal, not monocausal. For example, selection pressures, and, hence, mortality rates, are highest for young organizations. But, in addition to the effects of age, the economic and political conditions at founding (Carroll & Delacroix 1982), the acquisition of external legitimacy (Singh, Tucker & House, 1986), and initial organizational size also influence mortality rates (Freeman et al 1983). Ecological ideas are, moreover, probabilistic as opposed to deterministic. Since the instantaneous transition rates (of founding, disbanding, or change) are the object of study, even an organization with relatively low fit with environmental conditions has some probability, though admittedly small, of surviving for a long time. If anything, pre-ecological organizational research has tended to take the deterministic view of organizational evolution (for example, the contingency theory of the 1960s and 1970s), and ecological research has attended more to its probabilistic and dynamic nature. The criticism of ecological ideas as deterministic is simply wrong.

A second related criticism is that ecological thinking is not sufficiently attentive to organizational change and adaptation (Astley & Van de Ven 1983, Fombrum 1988, Perrow 1986, Young 1988). There is validity to this criticism, although the current provisos need refining. Their genesis dates back to Hannan & Freeman (1977). Hannan & Freeman (1977) noted that a full treatment of organization-environment relations covers both adaptation and selection, and that they are complementary processes (p. 930). They chose to focus on selection, arguing that selection rather than adaptation would explain change in organizational populations. But, as long since noted, change in organization per se is quite another matter.

Indeed, on this question of organizational change, some other early theorizing focused directly on organizational transformations (Aldrich & Pfeffer

1976, Aldrich 1979, Aldrich & Auster 1986, McKelvey & Aldrich 1983). In a revision and extension of their earlier arguments, Hannan & Freeman (1984) tried to deal substantively with organizational change. They acknowledged that organizations do make changes, sometimes even radical changes, but that inert organizations were favored by selection processes. In their core features, organizations become progressively more inert as a consequence of selection processes.

Clearly, however, some prominent views in organizational ecology maintain that the primary manner in which populations of organizations change over time is through differential foundings and disbandings of organizational forms (Carroll 1987, 1988:2, Hannan & Freeman 1989). This view follows from the assumption that inertial pressures severely constrain the extent to which organizations can change forms. Interest in populations as the unit of analysis need not necessarily preclude attention to organizational change. It is at the population level that the selectionist tenet is empirically testable. Recent empirical evidence indicates that organizational changes are systematically related to organizational mortality (e.g. Carroll 1984b, Singh, House & Tucker, 1986). Consequently, improved treatments of organizational populations will have to address foundings, disbandings, and change in organizational forms. Thus, for example, researchers have been engaged in some empirical studies examining rates of change in organizations (Kelly & Amburgey 1989, Singh et al 1988).

Another critical argument relates to the nature of the units being studied and some key constructs of the theory. For instance, Young (1988) has argued that concepts such as organizational birth and death are problematic. Only a facile argument would claim that these problems are specifically related to organizational ecology. We think it less useful to search for definitions of birth and death that are workable in all contexts, since none may exist. More to the point is examining whether births and deaths have been defined and measured reasonably in specific settings. For example, one way to define these events is to tie them to the notion of an organization as a legal entity—a substantively meaningful step, because legal entity status means an organization is legally liable and can incur legal obligations. We are inclined to dismiss Young's global claim that the lack of concepts generalizable to all contexts is a fatal flaw in ecological thinking.

A fourth criticism heard frequently is that organizational ecologists study only trivial organizations, not the giant corporations that have tremendous economic impact (Astley & Van de Van 1983:254; Perrow 1986:211). The larger and more powerful organizations are able to exert more influence on their environments and, the critique goes, are not subject to selection pressures in the same way that small, numerous organizations are (Scott 1987b). Although some ecological studies have focused on small organizations (e.g.

Freeman & Hannan 1983), several have addressed a much broader range of size. Thus, both large and small organizations have been included in the populations studied (for example, Hannan & Freeman 1988, Carroll 1987, Freeman et al 1983). Moreover, large organizations are not immune to selection pressures, although the time spans needed to study them may be longer. Even the Fortune 500 is a very mobile group. In the last five years well over 100 departures have occurred from this prestigious group, mainly through acquisitions, mergers, leveraged buyouts or declines in size (Fortune 1989). However, in the mix of adaptation and selection processes that influence organizational evolution, the relative role of selection is probably less profound for these large organizations.

The final criticism we address here relates specifically to the density dependence of founding and mortality rates of organizations (Hannan 1986, Hannan & Freeman 1987, 1988b, Carroll & Hannan 1989a). An early objection to density-dependence ideas was that the simple count of the number of organizations contained in the density measure assumes an equal competitive impact of each organization. Although this may be useful in a bioecological context, since the assumption is roughly true there, in organizational populations it seems likely that larger organizations have a stronger competitive impact. This is an important criticism and has been addressed by Barnett & Amburgey (1990) in a recent study of the density dependence of founding and mortality rates in the early telephone industry. Population mass dependence of founding and mortality rate, in which each organization is weighted by its size, was explored as an alternative to density dependence. When mass and density dependence were modeled simultaneously, the predicted nonmonotonic density dependence patterns were not obtained. This alternative approach holds promise and provides one of the most plausible alternatives, one that may establish the density dependence findings more firmly.

In a recent interchange (Carroll & Hannan 1989a, b, Zucker 1989), Zucker has argued that density dependence ideas are problematic because the underlying processes of legitimation and competition are, in fact, not studied directly even though they are central to the theory. Instead, models of density dependence are tested. This is problematic because the link between legitimacy and density has not been demonstrated. In their reply to Zucker, Carroll & Hannan (1989b) argue that their indirect use of legitimacy is quite consistent with how institutional theorists themselves have treated it, and that they do not think it is necessary to observe legitimation directly.

The most critical aspect of Zucker's point is that the gradual rise of legitimacy in relation to density in the early range of density may not be appropriate, and that reduced legitimacy, rather than increased competition, may account for increasing mortality in the late range of density (e.g. the fur industry in the Netherlands). Zucker's argument may inappropriately be interpreted as disproving Carroll & Hannan. But we think the more crucial issue concerns alternative interpretations of their empirical findings. Thus, in the semiconductor industry, it may be argued that the early range of density reflects more the learning and copying of technological skills and is probably indistinguishable from legitimacy. A fruitful way in which to pursue this debate is to devise alternative interpretations of the current findings, and test the competing hypotheses with new data. A key question that deserves investigation is whether legitimacy rises monotonically in the early years of an organizational form.

A currently unresolved aspect of density-dependence ideas concerns studies which give the predicted results for organizational foundings but show discrepant findings for mortality (Barnett 1989, Carroll et al 1989, Tucker et al 1988, Delacroix & Solt 1988, Delacroix et al 1989). As discussed above, the discrepant mortality findings may result because data on the early history of the population are not available. If that is so, the question is, how are the supportive results for foundings to be interpreted, since they too are based on data from these incomplete observation windows. A reconciliation of these findings is currently an open question in need of further explanation.[3]

FUTURE DIRECTIONS

As an intellectual enterprise, organizational ecology has been fruitful in recent years. Yet some important unanswered questions remain, a few of which we address below (see also Hannan & Freeman 1989:336–41 for a related discussion).

Community ecology, the study of the evolution of patterns of community structure, promises to be an important domain in the future. An organizational community is a collective of interacting organizational populations. Hitherto, community ecology has been insufficiently researched by ecologists, as a consequence of which critical questions dealing with the emergence and disappearance of organizational forms have not been addressed (Astley 1985, Carroll 1984a). Recently, though, there is a trend toward more work on community level problems. Barnett & Carroll (1987) studied mutualism and competition between organizations in the early telephone industry and showed that mutualism existed between individual organizations, while communities of organizations showed indirect evidence of competition. This supported the view that environment can be studied by examining the interdependencies between organizations. Beard & Dess (1988) proposed two ways of operationalizing and applying the community ecology concept, using input-output analysis. One way is to define the niche of each organizational species in terms of other species and directly interacting environmental elements. The

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[3] This argument is based on a personal discussion with Paul DiMaggio who pointed this out.

other is to model the resource dependence of an organizational species using a Leontief input-output model. Staber (1989c) studied interdependencies between populations of worker, marketing, and consumer cooperatives in Atlantic Canada. Whereas results showed mutualism between and within the worker and marketing cooperative populations, consumer cooperatives showed competition within the population but commensalistic relations with worker and marketing cooperatives. McPherson (1990) has developed an ecological model of community organization based on how organizations compete for members. This model emphasizes the crucial role of social networks in processes of recruitment and generates hypotheses about stability and change in niches, and growth, decline, origin, and death of voluntary groups.

The question of organizational speciation, the creation of basically new forms of organization, is also fundamental and open, although some work has been done on niche formation in the wine industry (Delacroix & Solt 1988) and on the emergence of new industries (Van de Ven & Garud 1987). We think that entrepreneurship plays a key role in creating new organizational forms, each of which spawns a population of similar forms as imitators rush in to copy the innovation. These new populations become members of the community of organizational populations. Certain consequences of their appearance are therefore ecological in nature, but the mechanism of speciation and its community dynamics goes well beyond the usual boundaries of ecological analysis. Recently, we have shown (Lumsden & Singh, 1990) that one may begin to model such speciation steps in a manner that relates entrepreneurial thinking to the large-scale structure of the organizational community. The results of such models begin to quantify the rates and time courses of organizational speciation without drawing heavily on analogies to biological speciation. Although the initial results are promising, critical discussion of the species concept in organizational theory has just begun.

Speciation is a particularly dramatic instance of micro events (entrepreneurship) altering macroscopic structure (the appearance of a new organizational form, with subsequent alterations in community dynamics, and the evolution of other populations). It is not, however, an isolated instance: Heretofore, organizational ecology has been concerned mainly with populations (and how their vital rates create demographic change) and, to a lesser extent, the community; the internal workings of individual organizations are of secondary significance. Organization theorists point out that it is necessary to focus on intraorganizational evolution, and relate these patterns of behavior and decision to organizational demography (Burgelman & Singh 1988). Although the critical issue of organizational adaptation and change has been a hotly debated rationale for incorporating micro analyses into organizational ecology (Astley & Van de Ven 1983, Perrow 1986, Young 1988), the recent evidence that intraorganizational change alters mortality per se (Carroll 1984b, Singh et al 1986) suggests that it may not be appropriate to ignore internal organizational change in ecological models.

Organizations, of course, are not simply hierarchical systems in which individual acts of choice and behavior determine population dynamics. People constitute, and are acted upon by, organizations and interactions among organizations. Their understanding of, beliefs about, and attitudes toward organizations help shape the decisions from which the organizations themselves take form. Systems of this type, in which underlying constituents comprise and react to the overall organization, are termed *heterarchies* (Hofstadter 1979). They are hierarchical forms with feedback. An outstanding problem is to incorporate heterarchical thinking into organizational ecology, allowing inferences about individual behavior to be deductively related to the demographic measures of population change (and vice versa). Similar interests in evolutionary biology have led recently to the introduction of modeling methods to do just this—i.e. expose the reciprocal contact between individual and community to quantitative analysis (Lumsden & Wilson 1981, Findlay & Lumsden 1988). This approach, called gene-culture theory, provides tools and a pertinent metaphor through which organizational ecology can begin to synthesize individual and demographic thinking into one system.

In biological heterarchies (gene-culture populations) of any complexity, there is no fixed environment. Other populations, communities, or assemblages of propagating genes change in response to changes in the population we are observing. Under the organizing influence of natural selection, an adaptive response in one population may result in adaptive counter-responses in others. This is coadaptation, a consequence of the evolutionary relationship between the populations linked together in biotic ecosystems. In the place of immutable, exogenous conditions, an evolving population experiences a complex array of other populations that react to it (Roughgarden 1979, Grene 1983).

In some ways, we think, communities of organizational populations are similar. Particularly in the case of powerful organizations (Perrow 1986) that are agents for change and are central within their societies, the appropriate ecological metaphor is coevolution, in which the demography (and evolution) of multiple populations is considered simultaneously through coupled, generally nonlinear, demographic equations. Intriguingly, the biological literature on coevolution and coadaptation has been growing rapidly over the past decade and now provides a rich selection of models (Roughgarden 1979, Feldman 1989). In the spirit of earlier developments in organizational ecology, we think it would be useful to examine how such models can improve our understanding of organizational evolution.

A final direction that holds considerable promise is more critical examination of the nature of organizational evolution. For biological organisms, evolution is fundamentally genealogical and based ultimately on the propagation of genes, and for a few species, social learning along lines of descent. Organizations do not replicate in this manner. Organizational evolution begins with the appearance of a new form, the product of entrepreneurial thought, and ends with the extinction of the last members of the population that imitation creates around the founding member. It makes sense to speak of organizational founding and failure, together with selection, adaptation, learning, populations, and communities. It is less sensible to seek analogues of genes and genealogies when in fact there may be none close to what exists in the biological world.

The latter is a problem only if one expects organizational ecology to resemble, in its generalizations as an evolutionary science, evolutionary biology itself. But the alternative is more interesting and, in view of what we have said thus far, more plausible. Although the evolution of organizational populations parallels that of biotic entities in some ways, in others it is strikingly different. There is speciation without genealogy, and a preponderance of Lamarckian (social learning) rather than Mendelian inheritance (Nelson & Winter 1982, Winter 1990). Evolution, however, is a meaningful, even essential, concept through which change in populations of organizations is to be understood. The details of these new steps in the future development of organizational ecology provide organization theorists with fundamental challenges.

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