Concepts in the Anthropological Study of Irrigation

William W. Kelly

American Anthropologist, New Series, Volume 85, Issue 4 (Dec., 1983), 880-886.

mayel. Norman: University of Oklahoma Press.

Sackett, James R.
1977 The Meaning of Style in Archeology: A General Model. American Antiquity 42: 369-380.

Sanders, William T.
1960 Prehistoric Ceramics and Settlement Patterns in Quintana Roo, Mexico. Contributions to American Anthropology and History, Vol. 60. Pub 606, pp. 155-264. Washington, D.C.: Carnegie Institution of Washington Publication.

Sanders, William T., Jeffrey Parsons, and Robert Santley
1979 The Basin of Mexico: Ecological Processes in the Evolution of a Civilization. New York: Academic Press.

Sejourne, Laurette
1970 Arqueologia del Valle de Mexico, I. Culhuacan. Mexico: INAH.

Sharer, Robert J., and Arlen F. Chase
1976 New Town Ceramic Complex. *In* Prehistoric Pottery Analysis and the Ceramics of Barton Ramie. Peabody Museum Memoirs, Vol. 18. Cambridge: Harvard University.

Smith, Robert E.
1971 The Pottery of Mayapan. Papers of the Peabody Museum of Archaeology and Ethnology, Vol. 66.

Thompson, J. Eric S.
1970 Maya History and Religion. Norman: University of Oklahoma Press.
1981 The Itza of Tayasal, Peten. *In* Ancient Mesoamerica, Selected Readings. J. A. Graham, ed. pp. 297-303. Palo Alto, Calif.: Peek Publications. (Orig. 1951.)

VonDaniken, Erich
1974 Chariots of the Gods? New York: Bantam Books.

Von Winning, Hasso
1961 Teotihuacan Symbols: The Reptile's Eye Glyph. Ethnos 26:121-166.

Wauchope, Robert
1970 Protohistoric Pottery of the Guatemala Highlands. *In* Monographs and Papers in Maya Archaeology. W. R. Bullard, ed. pp. 90-243. Papers of the Peabody Museum of Archaeology and Ethnology, Vol. 61.

Wobst, H. Martin
1977 Stylistic Behavior and Information Exchange. *In* For the Director: Research Essays in Honor of James B. Griffin. C. E. Cleland, ed. pp. 317-342. Anthropological Papers, No. 61. Ann Arbor: Museum of Anthropology, University of Michigan.

Wolfe, Alvin W.
1969 Social Structural Bases of Art. Current Anthropology 10:3-44.

Wonderley, Anthony W.
1981 Late Postclassic Excavations at Naco, Honduras. Latin American Studies Program Dissertation Series, No. 86. Ithaca, N.Y.: Cornell University.

Woodbury, Richard B., and Aubrey S. Trik
1953 The Ruins of Zaculeu Guatemala. Vol. 1. Richmond, Va.: United Fruit Company.

Concepts in the Anthropological Study of Irrigation

WILLIAM W. KELLY
Department of Anthropology
Yale University

Irrigation is a fundamental strategy for ensuring and increasing agricultural production in many societies, and it represents one of the most significant technical achievements in the human use of natural resources. But irrigation is more than an act of hydraulic engineering. It requires institutional arrangements for the construction and maintenance of physical facilities and procedures for the movement and distribution of water. Irrigation is economically important as the disposition of a critical input of agricultural production; it is politically significant as a source of power and leverage in local, regional, and national political arenas; and it is of considerable social consequence because it defines patterns of cooperation and conflict in irrigated agricultural regions.

In the last 30 years, the many studies that have followed the early work of Steward, Wittfogel, and Childe have demonstrated with increasing sophistication the varieties of irrigation practices and organization in a broad range of historical and contemporary societies (e.g., the numerous cases in Downing and Gibson 1974 and Coward 1980). Nonetheless, there are several persisting conceptual difficulties in our efforts to describe and explain these variable forms of irrigation organization. Among the most serious are the following four:

1. The widely used concept of an "irrigation system" typically conflates three distinct dimensions of agricultural water use: natural water

flow patterns, physical networks of facilities and environmental modifications, and organizational configurations of irrigation roles.

2. In identifying patterns of irrigation organization, there is a tendency to focus exclusively on water delivery roles, overlooking roles dealing with three other, often equally complex phases of agricultural water use: water source control, application to crops, and drainage.

3. "Centralization," a key concept for those concerned with the relationship of irrigation to political power, is often used loosely to refer both to the internal configuration of authority among the various irrigation roles and to the external articulation of irrigation roles to general state authority.

4. Finally, forms of irrigation organization are all too frequently attributed directly to "natural facts of water" like aridity and flow stochasticity and/or to the scale of the physical network rather than to the variable cultural meanings of those natural and technical "facts" for the social actors in a given setting.

My intention here is to outline the difficulties and ambiguities in each of these positions and to suggest how we might more usefully specify our concepts. Thus, this is a methodological exercise, not in laying out rigid procedures for irrigation case study, but in attempting to identify and clarify the central conceptual issues for analyzing how people have organized to exploit water resources for food production.

HYDROLOGICAL, TECHNICAL, AND SOCIAL UNITS OF IRRIGATION

The frequency with which studies refer to "the irrigation system" would recommend this as our master analytic concept, although like most master concepts it is usually left undefined. An explicit statement has been offered by Canute VanderMeer, and it is a formulation that many others implicitly share:

> An irrigation system is an arrangement by which water is conveyed from a source to an area needing water to facilitate the production of desired crops. As such a system involves four elements: (1) one or more sources of water; (2) fields; (3) physical structures such as canals and ditches which can carry water from its source to the fields; and (4) a functioning set of principles and techniques adopted by humans to create a water-flow pattern within the physical structures related to the amount of water available from the source, the characteristics and locations of the physical structures, and the varying needs of the fields. [VanderMeer 1968:720-721]

The first difficulty with such a postulated "irrigation system" of hydrology, topography, engineering, and management is an unwarranted isomorphism of three analytically distinct and, more often than not, empirically incongruent "systems": natural water flow patterns, physical facility networks, and irrigation role configurations. It should in fact be a fundamental task of irrigation ethnography to isolate these hydrological, technical, and social levels of irrigation, to determine their relative scale, and to study how they may be mapped on to one another.

For describing natural water flow patterns in a landscape, geomorphologists and other natural scientists have settled on the concept of the drainage basin, "the 'source area' of the precipitation eventually provided to [a selected] stream channel by various paths" (Leopold et al. 1964:131). The drainage basin concept has proven fruitful to those social scientists who have adopted it as a unit of observation in their irrigation research (e.g., Lees 1973; Mitchell 1976; Conklin 1980), but most studies of irrigation organization are still not grounded with careful descriptions of water flow patterns by drainage basin.

It should be emphasized, however, that the drainage basin concept cannot itself establish the boundaries of one's inquiry. It is an arbitrary unit, defined by selecting an "outflow point" along a stream, and can be expanded or contracted simply by selecting another outflow point. Thus it is one's research problem that must suggest how best to incorporate the drainage basin concept. For example, certain historical and ecological considerations led Flannery to focus on the Valley of Oaxaca (that is, the upper basin of the Atoyac drainage basin) rather than just one of the valley arms or the entire Atoyac drainage basin (Kirkby 1973:7-23). For my own study in Japan (1982), I sought a small river basin with alluvial fan topography and branching, river-source canal networks of medium historical depth because preliminary research indicated that such a setting would be both historically and geomorphologically representative of a major type of Japanese agricultural water use.

THE FOUR PHASES OF IRRIGATION

VanderMeer's definition of "an irrigation system" also reflects a second weakness in many ethnographic accounts of irrigation—an exclusive focus on water delivery and water delivery roles. In fact, as the controlled application of water to crops, irrigation potentially poses four distinct problems:

1. Water source control. Either a surface or subsurface water source must be exploited. Utilizing stream flow, for example, can entail watershed forest conservation, headwaters dam storage, river channel stabilization, and embankment construction. Capturing hillside runoff requires collection channels and storage ponds.

2. Water delivery. Water must be delivered from the source to the use area, typically through a canal network (though not necessarily, for example, some forms of the Chinese well-field or Mesoamerican pot irrigation).

3. Water use. The many techniques for actual water application to crops include bunding, furrowing, flooding, and borderstrip watering.

4. Water drainage. Drainage can be a complex and serious problem both prior to cultivation (in the conversion of wetlands into arable fields) and in the disposal of excess water during and after cultivation. In each case, channeling, pumping, river training, and levee construction may be necessary.

In the broadest sense, then, we must speak of four distinct phases of irrigation. To be sure, the importance and elaboration of each in a given setting will depend on crop requirements and cultivation practices. The need for a multiphase definition of irrigation is probably most obvious in wet-rice cultivation, where, for example, field watering strategies and drainage techniques are typically as intricate as source control and delivery. Elaboration of these four phases will also vary with the technical and organizational level of the irrigators; actual physical facilities and environmental modifications do not necessarily represent comprehensive, even adequate, solutions. I would suggest, though, to the extent that such facilities and modifications constitute a connected series, we can speak of a physical network of irrigation. In my Japanese study basin, even by the 18th century there was such a physical network that included, conceptually, the headwaters forest, an alluvial fan embankment, nine canal networks, and downstream river works—however incomplete and ineffective these early efforts were. It bears reiterating that physical networks of irrigation are often *not* isomorphic with natural water flow patterns. There may be several distinct networks within a basin, or through interbasin transfers, networks that extend over several basins. In all cases, though, an arbitrary focus on water delivery is indefensible; one must determine empirically the extent of irrigation facilities in all four phases.

Given a multiphase irrigation cycle, we can move from physical facilities to the level of social organization by noting that in each phase there are certain tasks performed; that is, in a selected setting, there will be procedures and arrangements by which water is controlled, delivered, used, and drained. These may be described in several ways, although irrigation studies commonly speak of four types of tasks: (1) the construction of irrigation facilities, (2) their maintenance and operation, (3) the allocation of water, and (4) the resolution of conflicts that arise. Again, the importance and elaboration of these tasks will vary with the setting, but that too is a matter for empirical determination. Analytically, we should consider irrigation organization to be based on the performance of these four types of tasks in the four phases of irrigation.

We can express task performance in terms of roles, behaviors, and norms. That is, one can identify the roles with rights and duties to perform these tasks—such as ditch tenders, irrigation cooperative officers, corvée laborers, water judges, etc. One can detail the actual practices of irrigation with descriptions of turn-taking along a branch canal, repair of a diversion weir, conflict resolution cases, and so on. And, one can explicate the normative principles that inform task performance—the body of rules, laws, and customary procedures by which irrigation tasks should be performed. To be sure, the concept of role and the relations of roles, behavior, and norms are disputatious issues of central importance in social theory. In my own work, I have generally used "role" to refer to named social positions with identifiable rights and duties and have treated role behavior and normative expectations as complementary though seldom congruent features of role descriptions. This is not the place to defend such an approach; I do wish to argue here that however formulated, a description of roles, behaviors, and norms associated with the irrigation cycle must be generated from a broad framework of potential tasks.

CENTRALIZATION AND ARTICULATION

A persistent issue in social science studies of irrigation has been its relationship to state authority and political power. Many of these studies tend toward one of two polar positions. Some have emphasized the frequency of local autonomy in irrigation management, the tendency of cultivator-water users to generate procedures and form associations for operating water works, such as the Valencian *comuna* (Glick 1970) and the Balinese *subak* (Geertz 1973). Others have found a propensity for elite control of irrigation, stressing that there are often important linkages between control of irrigation roles and political power. The Hunts (1974), for example, have argued for a canyon basin town of the Mexican Cuicatec that de facto control of all area irrigation is exercised by the few wealthy families that compose the town's upper class and perform crucial conflict resolution tasks. In short, the debate about irrigation and political power tends to contrast local autonomy with elite control as a simple dichotomy or as opposite ends of a single continuum of organizational possibilities.

Moreover, this contrast is usually phrased in terms of "centralization"; in most cases in the literature, local water-user autonomy is characterized as "decentralized," in contrast to "centralized" elite control. For example, Glick's description of Valencian irrigation as "cellular and decentralized" (1970:94) is apparently meant to indicate that there were eight separate *comuna* main canal organizations on the plain, each independent of the others, the town, and the crown. This is true enough, yet it is clear from his data that in terms of *internal* structure, each *comuna* was itself scarcely a decentralized organization. There was a governing council of deputies and an executive officer with a subordinate staff. To be sure, these roles were filled by election at an annual meeting of all main canal irrigators—in contrast to the elite's assumption of authority roles in the Hunt's Cuicatec case. Nonetheless, in the *comuna* a hierarchy of executive, legislative, and judicial roles was vested with very substantial powers. Indeed, in terms of internal structure, most of the referents of both local autonomy and elite control would appear to be rather "centralized," including the Balinese *subak* and role configurations controlling many of the small networks in Oaxaca sampled by Lees (1973).

The Hunts addressed these ambiguities of centralization when they differentiated two different "contexts" in which authority is centralized: instances in which authority in irrigation matters is concentrated in several irrigation-specific roles and instances in which irrigation authority is concentrated in and exercised by roles embedded in the general political system (1974:132). I have found it preferable to cast such a distinction as one between separate variables rather than between different "contexts." I would propose that it is useful to discriminate between the *internal* configuration of authority among roles performing irrigation tasks and the *external* relationship or connection of these irrigation roles to those in other social systems, most notably the general political system (the state). To call both variables "centralization" is unnecessarily confusing. When used unambiguously in the irrigation literature, the second variable, external linkage to the state, is usually termed "centralization," but this ignores the long-standing usage of centralization in political science as the distribution of authority *within* a bounded system such as governmental administration or bureaucracy. For this reason, centralization/decentralization is more logically the variable of internal organization: the degree to which irrigation roles are hierarchically configured and authority in irrigation task performance is concentrated. I have found articulation/autonomy, by distinction, to be appropriate terms to characterize the degree to which irrigation organization is linked to or is independent of the state (or general political authority in the absence of state organization, as among the Sonjo [Gray 1963]).

This suggests that we must often make several assessments of irrigation organization. An inspection of irrigation task performance in the four phases of irrigation and a judgment about the relative authority among roles yields a broad, initial division into decentralized and centralized patterns. In the former, there is a fragmentation of authority functionally and areally among many roles and a minimal body of regulations and customary procedures; there is no cumulation of authority into a pervasive pattern of control (e.g., Kelly 1982). With centralized irrigation organization, there is a concentration of authority through a nesting areal and functional hierarchy of irrigation roles, with explicit and codified procedures.

Yet, irrigation organization may be centralized either in terms of strong water-user organization or in terms of elite control. In the former instance, water users themselves mobilize and maintain an effective and independent organizational framework and generate a body of self-regulating procedures. Elite control is a pattern by which a political, economic, or social elite assumes those irrigation roles decisive enough to control irrigators and irrigation. The elite may themselves be water users, as in the Hunts' case, or they may be "outsiders," as with the Iraqi government irrigation engineers described by Fernea (1970).

Finally, self-regulating water-user organization is by definition autonomous of general political authority. But where irrigation is elite controlled, the elite may be articulated to state authority by virtue of exercising formal or informal political roles, or it may be independent of and possibly competitive with state authority.

Taken together, such distinctions define four potential "states" of irrigation organization: decentralization; autonomous, local water-user organization; control by an elite articulated to state authority; and control by an elite independent of state authority. Of course as ideal types, these distinctions offer only a first-order framework to guide one's assessment of a particular situation, which will most likely fall somewhere between these states. It is in fact the shifting tensions among and between local water users and elites in the four phases of irrigation that should be at the center of our investigations.

THE NATURAL FACTS OF WATER?

A fourth problem, which recurs in explanations of irrigation organization, is the tendency to posit certain characteristics of water flow or a certain "scale" of physical facilities as operating directly and mechanically to determine organizational form. For example, the conclusions of Maass and Anderson's study of six irrigated areas rest on a rather direct line of reasoning: the unpredictability of water flow creates psychological insecurity and social conflict (or at least the threat of conflict) among those who would use it; for successful irrigation, water users must overcome this insecurity and insure predictability by cooperating to form and maintain a strong collective water user organization (1978:2, 366, 399-400). Others suggest the scale of physical facilities as an alternative stimulus to centralized irrigation organization. Netting, for example, has proposed that:

> Hierarchical authority may be a necessity only when (a) the scope of irrigation works requires for its construction and maintenance greater capital investment or technological skill than can be provided by individual cultivators or local associations, or (b) when a growing scarcity of water threatens disorder and conflict which will seriously reduce the utility of the system. [1974:33]

The error of an explanation that begins with the scarcity and unpredictability of water or the scale of hydraulic engineering lies in its implicit but false opposition of nature and culture. "Scarcity," "stochasticity," and "scale" are not variables that operate directly on water users. They do not, as environmental absolutes, pose "organizational requirements of irrigation" (ibid.). They are not prime movers, as Cowgill (1975) has cogently demonstrated for population pressure, often elevated to a similar explanatory status. To question the causal primacy of hydrology and engineering in shaping forms of irrigation organization is not to deny the play of natural forces on human behavior. But it is to insist that the constraints of nature are just that: broad constraints, a range of tolerance, within which specific instances of social organization are given meaning by cultural distinctions and given form through social action. As there are no territorial imperatives, so there are no hydrological imperatives.

Rather, we must see irrigation organization as a social expression of culturally defined water resource needs and characteristics. Glick (1972) has shown, for example, that San Antonio River water in Texas has been exploited in a framework of Islamic-Hispanic concepts about water use and distribution that he traced to the Canary Island origins of many of the earliest European settlers. The work of Zuidema (1978) and Urton (1980:38-65) has demonstrated that one cannot explain historical or contemporary forms of irrigation organization in the Cuzco region of Peru without reference to the Incaic cosmological integration of celestial space and terrestrial space (including topography and hydrology). To be sure, if patterns of social organization are not derivative of environmental absolutes and engineering scale, nor are they easily reflexive of internally consistent cultural systems. Hobart (1978) has criticized Geertz's evaluation of the nine-stage Balinese cycle of agricultural/hydrological rituals on just these grounds. He observed that the ritual calendar fits rather badly with actual cultivation practices; he contended that instead of representing and so smoothly regulating field work and water use in a basin, the rituals in fact "misrepresent" and "obscure" certain social relationships (ibid.:80). In attributing crop success and failure to the gods, they deflect attention from significant administrative deficiencies of *subak* organization and inter-*subak* mediations and from the disparity between economic concentration among cultivators and a cultural norm of equality among water users.

CONCLUDING REMARKS

I have suggested here several refinements in concepts that are widely used in the analysis of the social organization of irrigation. I have argued for (1) distinctions between hydrological, physical, and social units of irrigation; (2) a multiphased conceptualization of irrigation, including source control, delivery, crop application, and drainage; (3) differentiation between internal centralization of irrigation roles and external articulation to political authority; and (4) a formulation of irrigation organization as a social expression of culturally defined water resource needs and characteristics.

The issues of how and why people come together in various patterns to exploit water resources for agriculture are not only central to any theoretical understanding of the extensive irrigated regions of the world, they are critical to the pressing needs in much of the developing world for increasing food production and for ensuring equitable control over productive resources. Future contributions by anthropologists must proceed on a less ambiguous conceptual base, and the discussion here has been an effort at such clarification.

NOTES

Acknowledgments. I would like to thank Harold C. Conklin for his helpful comments on an earlier version of this paper.

REFERENCES CITED

Conklin, Harold C.
1980 Ethnographic Atlas of Ifugao: A Study of Environment, Culture, and Society in Northern Luzon. New Haven: Yale University Press.

Coward, E. Walter, Jr., ed.
1980 Irrigation and Agricultural Development in Asia: Perspectives from the Social Sciences. Ithaca: Cornell University Press.

Cowgill, George L.
1975 On Causes and Consequences of Ancient and Modern Population Changes. American Anthropologist 77:505-525.

Downing, Theodore E., and McGuire Gibson, eds.
1974 Irrigation's Impact on Society. Tucson: University of Arizona Press.

Fernea, Robert A.
1970 Shaykh and Effendi: Changing Patterns of Authority among the El Shabana of Southern Iraq. Cambridge: Harvard University Press.

Geertz, Clifford
1973 The Wet and the Dry: Traditional Irrigation in Bali and Morocco. Human Ecology 1:23-39.

Glick, Thomas
1970 Irrigation and Society in Medieval Valencia. Cambridge: Belknap Press of Harvard University Press.
1972 The Old World Background of the Irrigation System of San Antonio, Texas. Southwestern Studies Monograph No. 35. El Paso: Texas Western Press.

Gray, Robert
1963 The Sonjo of Tanganyika: An Anthropological Study of an Irrigation-based Society. London: Oxford University Press.

Hobart, Mark
1978 Padi, Puns, and the Attribution of Responsibility. *In* Natural Symbols in South East Asia. G. B. Milner, ed. pp. 55-87. London: School of Oriental and African Studies.

Hunt, Eva, and Robert C. Hunt
1974 Irrigation, Conflict, and Politics: A Mexican Case. *In* Irrigation's Impact on Society. T. Downing and M. Gibson, eds. pp. 129-158. Tucson: University of Arizona Press.

Kelly, William W.
1982 Water Control in Tokugawa Japan: Irrigation Organization in a Japanese River Basin, 1600-1870. East Asia Papers Series. Ithaca: Cornell University China-Japan Program.

Kirkby, Anne V. T.
1973 The Use of Land and Water Resources in the Past and Present Valley of Oaxaca. Memoir No. 5. Ann Arbor: Museum of Anthropology, The University of Michigan.

Lees, Susan
1973 Sociopolitical Aspects of Canal Irrigation in the Valley of Oaxaca. Memoir No. 6. Ann Arbor: Museum of Anthropology, The University of Michigan.

Leopold, Luna B., M. Gordon Wolman, and John P. Miller
1964 Fluvial Processes in Geomorphology. San Francisco: Freeman.
Maass, Arthur, and Raymond L. Anderson
1978 . . . And the Desert Shall Rejoice: Conflict, Growth, and Justice in Arid Environments. Cambridge: MIT Press.
Mitchell, William P.
1976 Irrigation and Community in the Central Peruvian Highlands. American Anthropologist 78(1):25-44.
Netting, Robert M.
1974 Agrarian Ecology. *In* Annual Review of Anthropology, Vol. 3. pp. 21-56. Palo Alto: Annual Reviews.
Urton, Gary
1980 At the Crossroads of the Earth and the Sky: An Andean Cosmology. Austin: University of Texas Press.
VanderMeer, Canute
1968 Changing Water Control in a Taiwanese Rice Field Irrigation System. Annals of the Association of American Geographers 58:720-747.
Zuidema, R. Tom
1978 Lieux Sacres et Irrigation: Tradition Historique, Mythes et Rituels au Cuzco. Annales: Economies, Societies, Civilisations 33(5/6):1037-1056.

Topical Sorting: A Technique for Computer Assisted Qualitative Data Analysis

AARON PODOLEFSKY
Department of Sociology and Anthropology
West Virginia University

CHRISTOPHER McCARTY
Department of Anthropology
University of Florida

This paper addresses issues in the management and systematic analysis of qualitative field research data. Although problems in the analysis of qualitative data are common to both individual and team research efforts, they become most apparent when research involves extensive data collection. In the applied setting, researchers may be asked to provide an ethnographic or comparative analysis of a large data set comprising field notes collected by one or more field-workers in each of a number of sites and to coordinate these with data collected through other strategies, survey research, for example. While the richness and detail of field notes, in-depth interviews, and other forms of narrative or textual data provide insight from a unique perspective, the abundance of information, in the absence of an adequate data management system, tends to confound the analysis and obscure important information.

The increasing use of qualitative research in large-scale, multimethod, multisite projects has highlighted the need to develop our sophistication in the management and analysis of field notes.

QUALITATIVE ANALYSIS: THE LIMITS OF TRADITIONAL METHODS

Typically, qualitative data resulting from participant-observation or in-depth interviewing are a series of typewritten pages in narrative format. Analysis begins with the field-worker's intimate familiarity with his or her data. A simple index may be constructed or multiple copies of the data set may be produced allowing particular pages to be filed under several headings. As the size of the research team (or length of fieldwork) increases, with a concomitant increase in the volume of material, these data management strategies become severely deficient.

In contrast to qualitative data, problems inherent in manipulating large quantitative data sets have been overcome through the evolution of sophisticated software. "Packaged programs" (e.g., SPSS, SAS, BMDP) and increased storage capacity have eliminated many difficulties in quantitative data management. Advances in qualitative data analysis have not been as quick to appear. Reasons include the lack of technology for manipulating narrative or textual data, as well as the way in which qualitative research has been conceptualized and carried out by practitioners.

Recently, however, several researchers have applied computer technology to the analysis of textual data. Although information scientists (Bamford 1972) and anthropologists (Bernard 1980; Werner 1982) have for some time used computer programs to search texts for specific words or phrases and to accomplish the technical management of field data (Chambers and Bolton 1979; Kirk 1981; Sproull and Sproull 1982; Agar in press), only within the last two years has there been any development of