also that supports are lodged in ongoing social relationships that vary over time and entail sequential linkages.

Part 2 of the collection examines social support through the life cycle. There is much evidence that unexpected or off-schedule life events are more stressful than those that are normatively scheduled; Schultz and Rau suggest that members of social networks are less likely to have the appropriate abilities or knowledge to provide support in the case of unexpected events and losses. Boyce suggests that for children the most crucial aspect of support is permanence in close ties. In the middle years, work and family roles entail both stresses and supports. Kasl and Wells give a good overview of what is known; they recommend as basic strategies a sharper focus on specific work settings, longitudinal studies set up around important transitions, and the elaboration of the causal network to include other influences on health outcomes (prior health status, biological risk factors, health-related behaviors, and medical care data). Viewing social support and health of the elderly, Minkler concludes that, contrary to widespread opinion, social support does not seem to play a different or more important role in influencing the health of the elderly than it does with younger adults.

Part 3, on social support and disease etiology, contains systematic assessments of what we know about social support and mental health from community samples and about the relation of social supports to morbidity and mortality and an examination of how styles of coping with stress may be influenced by social supports and resource mobilization. Kessler and McLeod assess the effects of social support by first evaluating the design adequacy of the various studies and then confining attention to the studies deemed adequate. From those they conclude that membership in affiliative networks is modestly associated with mental health, independent of stress, and that stress-buffering effects most often derive from emotional support. But mental health or social competence may influence support, so the direction of causation is moot. Kessler and McLeod conclude that evidence for the health-promoting potential of supports will require targeted interventions in specific high-risk crisis situations.

Berkman focuses on both methodological and conceptual issues in assessing the evidence for effects on mortality and morbidity. She notes the importance of cultural features that may influence response to questions about networks and supports in population surveys, sometimes leading to drastically wrong inferences from the responses. More than most authors, she emphasizes the need for examining pathways leading to effects on health—the consequences of seeking help and of receiving care, the biological effects of shared modes of living, and the biological sequelae of stressors themselves.

Part 4 focuses on social support interventions and health policy. Wortman and Conway note that health status may influence perceived support, support may enhance the following of medical regimes, or support may directly act upon a person's sense of well-being and self-mobilization. Negative interactions may also occur as a consequence of misconceptions of the illness by significant others, overprotectiveness, the patient's rejection of dependency, or stigmatization. Potential negative influences are seldom assessed adequately in studies focused on social support. Gottlieb describes in some detail a number of interventions that seek to mobilize social networks or primary group supports to get alcoholics into treatment, to minimize intrusive critical interaction in families of schizophrenics, to aid children whose parents are divorcing, or to facilitate coping with other stresses and mental health problems. Here emphasis is more on approaches than on effectiveness, but many of the approaches could be incorporated in sharply focused research.

Fleming, Baum, and Singer draw upon a vast literature dealing with ways in which the physical environment and architectural design can affect stress levels and impose limits on or enhance interpersonal contacts. In the final chapter, Keisler reiterates the need for clearer delineation of causal ties before research findings can be made the basis for public policy decisions. He notes instances in which increasing support for those very low in support may actually be counterproductive.

Again and again the authors note that we must have more specificity, specificity in delineating facets of networks or relationships that are particularly consequential in buffering particular kinds of stressful experience and specificity in the examination of temporal sequences. Population studies almost never permit the disentanglement of processes and sequences of closely related developments. Studies of programs that provide supports are much more promising in this respect.

A topic that needs elaboration and further research is the interaction between persons' attributes and the social ties they establish and maintain. We know from longitudinal research that aloof or negativistic adolescents tend in adulthood to have fewer friends, to become divorced, and to be relatively dissatisfied in their work lives. The social supports that they can call upon as resources are, then, clearly not the same as those of more positively oriented persons. We need to know what other consequences derive from such personal attributes in order to be certain that the relationship between supports and health is not a spurious one.

This is a book primarily for workers in the field seeking to learn how better to contribute to the production of further knowledge or to understand the questions that must be raised in interpreting research results. Some of the chapters touch so briefly on so many studies as to leave a reader who does not know the literature well with insufficient detail to understand the issues. But to an unusual degree this collection combines high-quality analysis with breadth and coherence. It is encouraging to note that increasingly the workers in this general field are reading beyond their own disciplines; although each discipline has its preferred literature, collections like this one and an increasing number of journals with a truly interdisciplinary orientation are combatting provincialism.

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Four-Dimensional Topology

Instantons and Four-Manifolds. DANIEL S. FREED and KAREN K. UHLENBECK. Springer-Verlag, New York, 1984. x, 232 pp., illus. $15. Mathematical Sciences Research Institute Publications, vol. 1.

This book exposes the beautiful confluence of deep techniques and ideas from mathematical physics and the topological study of the differentiable structure of compact four-dimensional manifolds, compact spaces locally modeled on the world in which we live and operate. The volume is the outcome of a seminar on the work of Simon Donaldson, who utilized results in gauge field theory to prove the nonexistence of differentiable structures on certain compact 4-manifolds. This work is in sharp contrast to the earlier remarkable results of Michael Freedman, who completely classified (simply connected) compact topological 4-manifolds. As a result of these two lines of work there are at least two distinct calculuses available on Euclidean 4-space; that is, Euclidean 4-space R^4 admits an exotic differentiable structure. It is only in dimension four that this remarkable phenomenon occurs. In all other dimensions Euclidean space possesses a unique differentiable structure. (Further refinements of Donaldson's work by Clifford Taubes imply that there is at least a continuum's worth of exotic differentiable

structure on $\boldsymbol{R}^4$, and further work by Donaldson implies that such an exotic structure resides as an open subset of ordinary $\boldsymbol{R}^4$.)

Differential geometers have long been aware that four-dimensional space does have some remarkable properties that distinguish it from spaces of other dimensions. In four-dimensional space the rotation group $SO(n)$ is a simple Lie group for all $n = 4$ and $SO(4)$ is locally isomorphic (double covers) $SO(3) \times SO(3)$. As the six-dimensional space $\Lambda^2(\boldsymbol{R}^4)$ of 2-forms on the inner product space $\boldsymbol{R}^4$ can be viewed as the Lie algebra of $SO(4)$, $\Lambda^2(\boldsymbol{R}^4)$ decomposes as the sum of the three-dimensional spaces $\Lambda^2(\boldsymbol{R}^4) = \Lambda^2{}_+ \oplus \Lambda^2{}_-$. This decomposition is significant in Riemannian geometry, for if a 4-manifold M admits a Riemannian metric and P is a principal $SU(2)$ bundle over M, a connection ($SU(2)$-gauge potential) ∇ in P has a curvature (gauge field) R^∇, which is a 2-form (with values in a Lie algebra). Thus R^∇ decomposes as $R^\nabla{}_+ + R^\nabla{}_-$. It is only in dimension four that the curvature decomposes. A connection whose curvature satisfies the equation $R^\nabla = R^\nabla{}_+$ ($R^\nabla{}_-$) is called self-dual (anti–self-dual). Such solutions minimize the Yang-Mills functional (that is, they minimize the field strength) and are sometimes referred to as instantons.

Physicists have also long been aware of the special nature of four-dimensional space. Yang-Mills theory was developed by physicists to give a classical model of strong interactions, which because of their range are known to be quantum phenomena. It is quite remarkable that in the development of this theory many of the concepts of modern global differential geometry and topology, such as bundles, connections, curvature, and Chern-Weil theory of characteristic classes were reinvented by physicists. After acceptance of the relevance of non-Abelian gauge theories—that is, bundles with structure groups more interesting than $U(1)$—it was recognized that Yang-Mills theory gave a renormalizable theory of the coupling of electromagnetic and weak interactions. The focus became the understanding of these minimal solutions on the special manifolds $\boldsymbol{R}^4$ or $\boldsymbol{S}^4$. This description was made possible by concurrent developments concerning stable vector bundles on complex projective 3-space that were made possible by an innovative tool, the Penrose twistor construction adapted to this theory by Richard Ward. The work of Atiyah, Hitchin, and Singer, Atiyah and Bott, and Atiyah and Jones began to place this work in a more differential geometric context. Very recently solutions to the Yang-Mills equations over more complicated manifolds were obtained by Taubes, who utilized a strong implicit function theorem technique and the preliminary work of Uhlenbeck. The situation took a 180-degree turn when Donaldson made the space of these minimal solutions of inherent mathematical interest and showed that it contains information concerning the topology of the manifold over which the solutions were defined. After being mainly motivated by the questions of physicists, Donaldson showed that Yang-Mills theory can be utilized as a powerful tool to solve mathematical problems.

This book is designed for a mature mathematical audience with some background in topology and geometry. It presents Donaldson's work together with the foundational work in gauge field theory done by Uhlenbeck, Taubes, Atiyah, Hitchin, Singer, and others upon which Donaldson's arguments are based. The book is filled with insightful remarks, proofs, and contributions that have never before appeared in print. For anyone attempting to understand the work of Donaldson and the applications of gauge theories to four-dimensional topology, the book is a must. Although not for the weak at heart, the volume will pry open the door to the mathematical aspects of Yang-Mills theory. The door is just ajar. The field is extremely active, and the times are exciting. Donaldson has handed the topologists a tool that has applications that are still being discovered. The frontiers of four-dimensional topology—what a breathtaking place to be!

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Mate Choice

The Túngara Frog. A Study in Sexual Selection and Communication. MICHAEL J. RYAN. University of Chicago Press, Chicago, 1985. xvi, 230 pp., illus. $33; paper, $14.95.

The idea of Darwin's that met with most skepticism among other biologists was his theory of sexual selection, in particular the suggestion that conspicuous male "adornments" and behavior patterns may have evolved because females prefer highly adorned or active males as mates. This idea was opposed by most of Darwin's colleagues, including Wallace, partly because it seemed to require too much of an aesthetic sense in female animals.

For about a century, except for laboratory studies of *Drosophila* showing that females sometimes discriminate among males, not much happened in the way of testing Darwin's suggestion. Finally, sexual selection has become a subject of realistic field studies, following recent advances in quantitative recording, experimentation, and statistical analysis of animal behavior. This progress has coincided with an upsurge of interest and theoretical development in behavioral ecology and population biology, relevant for the understanding of sexual selection. As a result, there are now a number of field projects that address Darwin's theory.

Michael Ryan's clear, well-written book presents a particularly fine example. Its hero, the túngara frog, *Physalaemus pustulosus*, offers unique possibilities for testing crucial aspects of sexual selection theory. This is partly because the advertisement call of the male, in contrast with the simple calls of most other anurans, consists of two different components: *whines* and *chucks*. Ryan's study at Barro Colorado Island in Panama centers on the function and evolution of these two components, but it also deals with other aspects of reproductive behavior in an integrated fashion, combining approaches from several disciplines. The study demonstrates the remarkable explanatory power of field observations combined with incisive, controlled experiments and comparative analyses; it provides broad understanding of the species' biology as well as detailed answers concerning selective mechanisms.

Female túngara frogs often appear to sample several calling males before making contact with one of them; the male then clasps the female, and the pair goes off to mate and deposit the eggs in a floating nest, a sort of protective meringue house that the male builds by beating the jelly matrix of the eggs into foam. As the calling male does not defend any resource of importance to the female, she seems to choose her mate on the basis of his own characteristics.

What, then, makes for male mating success? The best predictor of a male's success is the number of nights he spends at the pond. The causes behind variation among males in this respect are not known; differences in their ability to procure surplus energy for spending time at the pond is one possible but untested reason.

In addition, male mating success increases with body size; it is here that the advertisement call comes in. Experiments by Ryan and Stanley Rand showed that the whine component is important for species recognition; females do not approach a speaker broadcasting only chucks. They are more attracted by calls containing both whine and chuck than by whines alone. Ryan suggests this is because females can better judge the size of the male from the chuck than the whine; females tend to approach chucks with low fundamental frequency, typical of