migrants continue to pass over those islets all day long, whereas Paximada is located so that migrants are likely to pass over only in the morning hours.

Using assumed figures for mortality—56 percent in the first year, 22 percent in the second, and 19 percent in subsequent years—Walter claims that the lesser availability of prey and the lower rate of reproduction place the Paximada and other eastern Mediterranean populations in jeopardy in terms of replacement. This is true only if breeding does not begin until the third year; but recent banding studies on Mogador show that breeding begins in the second year, and even the lowest annual rate of production reported by Walter, 1.26 young per pair, will yield 216 potential recruits for each 190 needed to maintain a stable breeding population.

Among several problems of evolutionary ecology discussed, two are worth special notice: Territoriality and sociability among species of the genus *Falco*, and the "reversed" sexual size dimorphism in raptors. Walter depicts (fig. 57) ten models of territoriality among falcons, grading from the purported mutually exclusive, all-purpose territory of *F. sparverius* to the extremely social condition in *F. naumanni*, in which there is group defense of a colonial nesting area but apparently little defense of specific nesting sites by individual pairs. Eleonora's falcon differs from the latter only in that pairs do defend a small area around their nests. Fieldworkers who have been studying the approximately 200 pairs of prairie falcons (*F. mexicanus*) nesting along just 130 kilometers of canyon in the Snake River Birds of Prey Study Area of Idaho will be surprised to discover that Walter has included this species in his territory model 2, representing species in which the pairs are so dispersed that they are not in "periodic contact" with each other. Walter has tried to relate his models of dispersion to the geography of suitable nesting sites and to temporal and spatial patterns of prey availability, but such an effort is perhaps premature for the genus *Falco*.

Why female falcons and other birds of prey have evolved a larger body size than the males of their species has been much discussed in recent years, but no one has come up with an explanation that satisfactorily accounts for all of the relevant facts, including the fact that some female raptors are actually smaller than their males. Walter usefully calls attention to the likelihood that many variables act in concert to influence the *degree* of sexual size dimorphism in raptors. Students of this subject will be particularly interested in table 24 and figures 58 and 59, in which five degrees of size dimorphism are compared against ten variables: prey dispersion, prey size, prey character, resident status of raptor, home-range defense, size of nesting territory, social status, nesting sites, division of labor between the sexes, and nest type. Walter shows that for 14 species of falcons R. W. Storer's dimorphism index based on wing length ranges from 0.6 for *F. naumanni* (least dimorphic) to 14.4 for *F. peregrinus* (most dimorphic). Eleonora's falcon, with an index of 3.4, ranks only third from *F. naumanni* and is less dimorphic than the species of kestrels. There does seem to be some association between an increase in the dimorphism index and increasing prey size, time and energy invested in capture, division of labor between the sexes, and size of nesting territory or home range for these 14 species, but other species, such as the small, highly size-dimorphic *F. rufigularis*, introduce exceptions. Walter's own hypothesis about why the female is the larger sex in raptors—that her large size has evolved as a mechanism to protect her developed follicles when she strikes against prey in her hunting attacks—would seem to be negated by the fact that the females are entirely sedentary during gonadal maturation and ovulation and are fed by the males.

As far as the extreme reversed size dimorphism of the bird-eating falcons and accipiters is concerned, the hypothesis first set forth in detail by C. M. White and T. J. Cade (*The Living Bird*, 1971) still has merit. Because the smaller males are better adapted to catch small birds and the larger females, which hunt late in the breeding season, are better adapted to catch large birds, the size difference maximizes the hunting capability of a pair during the breeding season, when there is a high demand for food by the adults and young and dispersed, resident prey must be taken from a circumscribed hunting area around the nest. In the case of Eleonora's falcon, the prey is constantly being replenished by the flow of migrants, and there is no advantage in the female's hunting or specializing on species different from those taken by the male; hence there has been little selection for a difference in size between male and female.

Sometimes digressing from its main theme and even abstruse in places, this book is nevertheless an instructive attempt to relate the social organization and individual behavior of a colonial nesting raptor to the spatial and temporal characteristics of its migratory prey and to the geographic and topographic features of its nesting habitat. The study poses more questions than it answers, as it should. It provides an important body of information on which future students of Eleonora's falcon will be able to build a more quantitative and analytical autecology.

TOM J. CADE
A. LUDLOW CLARK
Section of Ecology and Systematics, Division of Biological Sciences, Cornell University, Ithaca, New York 14850

Celestial Mechanics

Instabilities in Dynamical Systems. Applications to Celestial Mechanics. Proceedings of a NATO Advanced Study Institute, Cortina D'Ampezzo, Italy, July 1978. VICTOR G. SZEBEHELY, Ed. Reidel, Boston, 1979 (distributor, Kluwer Boston, Hingham, Mass.). xxiv, 314 pp., illus. $39.50. Nato Advanced Study Institutes Series C, vol. 47.

This volume consists of 20 research and survey papers, together with another 19 brief seminar reports. Unfortunately, the title of the book is somewhat misleading: for the most part, the only types of dynamical systems considered are those arising in mechanics (usually celestial mechanics). Nevertheless, the inclusion of the word "instability" in the title is most welcome. It underlines the recent resurgence of interest among dynamical astronomers in nonlinear, unstable behavior. In the past, researchers in celestial mechanics have often concentrated on stable phenomena, aiming to prove, for example, the stability of the solar system. But, as Szebehely remarks in his contribution to the book, the prediction of instabilities may be the first step in research on stability and is often the most important.

Two main themes emerge from the book: the stability or instability of periodic solutions in the n-body problem and the problems of instability in the large, or global instability. Among authors dealing with the former, J. D. Hadjidemetriou details the evolution of stability along families of periodic solutions that bifurcate away from known circular or elliptic Keplerian solutions of a restricted problem. Generally, he finds that such orbits maintain their stability, losing it only at resonances. V. Markellos contributes a numerical study of certain families of symmetric and nonsymmetric periodic orbits of the full three-body problem that bifurcate away from planar solutions. Building on the basic work of Zare and Szebehely and McKenzie, A. E. Roy extends the idea of a surface of critical stability to certain nonplanar many-body problems and uses this to find empirical stability criteria for several important three-body systems. And F. Nahon discusses orbits in the vicinity of the small mass in the restricted problem. Some of these orbits are collision orbits, and these seem to be a fruitful subject for further research in instability theory.

In related work, J. Waldvogel extends the pioneering work of R. McGehee on triple collision in the collinear three-body problem to the planar case and C. Simó shows why triple collisions introduce a nonregularizable singularity into the equations of motion.

Gobal questions of instability are addressed by several authors. R. Broucke describes the well-known Henon-Heiles problem, as well as three other nonintegrable problems of mechanics. Numerical studies of these and similar problems often provide pictures of islands of stability surrounded by "ergodic seas." That is, the phase space of the system breaks into regions where motion is more or less regular and regions where orbits wander around randomly, and perhaps even densely.

No adequate theoretical description of ergodic seas exists in the literature, though questions about their structure seem to be among the most important questions in instability theory. Are they really ergodic? Is there a dense orbit? As Szebehely remarks, the age-old tools of dynamical systems—power series methods, integrability, and numerical techniques—are not sufficient to answer these questions. Only the qualitative theory has a chance of succeeding.

This approach is admirably described in two papers in the volume, one by R. W. Easton and the other by G. Contopoulos. Easton offers his explanation of the numerically found ergodic seas: they are there and are caused by homoclinic behavior. He backs his contention with a simple model, the highly perturbed twist mappings. Contopoulos discusses a related phenomenon, Arnold diffusion, which occurs only in higher-dimensional problems but which possibly destroys any hope of stability in nonintegrable problems.

This collection presents several different and useful viewpoints of unstable phenomena in mechanics. Not only dynamical astronomers, but other scientists interested in nonlinear phenomena will find it useful.

ROBERT L. DEVANEY
Department of Mathematics, Tufts University, Medford, Massachusetts 02155

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