cooperation functioned very effectively until the various colonies withdrew on achieving independence. The loss of South Africa for other reasons was a major setback, which has continued to the present.

After writing a report on these activities in London, Worthington had a choice of three jobs—to become director of fishery research of Britain's Ministry of Agriculture and Fisheries, to return to Cambridge as a senior tutor, or to become deputy director-general (scientific) of the British Nature Conservancy. He chose the last, presumably because of its greater environmental challenges and involvement. His activities at this time (1957–1964) reflect the environmental unrest around the world. He gives three examples of the kinds of disputes he was involved in, two of which were decided in favor of industry but only with major concessions from them and with their awakening to some of the realities of ecology. The other major effort was in establishing national, local, and forest nature preserves, wildfowl reserves, and "sites of special scientific interest." Management plans were needed for every reserve.

But although these activities were in England, Worthington was still involved in specific projects outside the country—in East and Central Africa, Jamaica, and Ethiopia. He became a member of the executive board of the International Union for Conservation of Nature and Natural Resources, and later as vice president he launched an African Special Project, which held a conference at Arushan in Tanzania in 1961. Worthington considered this conference together with a telegram from President Nyerere as a turning point in the direction of regarding wildlife as a resource rather than as a hindrance to development.

In 1964, nearing retirement but with no intention of doing so, Worthington became the scientific director of the International Biological Program (IBP). In the chapter devoted to this enterprise he presents a reasonable summary of what the IBP was all about, of some of its major successes, and of its nonsuccesses. As these were turbulent times politically, many scientific activities were impeded by such events as the conflict between Arab and Jew, wars in Biafra and between India and Pakistan, and the isolation of Cuba and Mainland China. Worthington was responsible for establishing the Man and Biosphere Program in 1972, which involves governments in an IBP-like program, and was involved in the Scientific Committee for Problems of the Environment.

The steamer tugboat S.S. *Kavirondo*, used as a research vessel in the 1927 Lake Victoria fishery survey, with a split-prowed canoe in the foreground, papyrus to the left, and reed swamp to the right. [From *The Ecological Century*]

A Committee of Water Research (COWAR) was begun in 1968, with Worthington representing biology. In 1972 he became president. COWAR sponsored a large international symposium on man-made lakes in Knoxville, Tennessee, in 1971 and another on the environmental effects of irrigation in arid lands in Alexandria, Egypt, in 1976. The approach of both symposiums was ecological. Significantly, COWAR has since been reorganized to include the Union of International Engineering Associations.

In 1976, now 71, Worthington was again looking forward to years of leisure on his farm in Sussex. He was not involved officially in any governmental or international activities, but he consented to be a part-time environmental adviser to Halcrow and Partners, consulting engineers. This obviously has involved him in a number of projects, only two of which are mentioned—the construction of a reservoir in Tanzania for producing rice and the construction of two seaports in Thailand. In both he helped prepare the environmental impact statements that were used in decision-making.

Worthington suggests that if one-tenth of the money being spent on defense were allocated instead to the study and conservation of natural resources we would be more likely than we now are to enjoy environmental harmony in the next century. In the two partnerships that must be realized for effective survival, that of humans with nature is coming along well, whereas that among humans still has a long way to go.

Thus, in 11 short chapters Worthington gives us a glimpse of the development of ecology, based mainly on his experiences in East Africa, modified at the end by wider international activities. Much information the reader would like to have is not given, although likely it is available in the various reports and books cited in the references. Worthington himself is not really a scientist, although he has been a very effective science administrator. Through much of his life he has been concerned with Africa south of the Sahara and its underdevelopment. The new underdeveloped nations there are having many problems, not the least of which is the management of their renewable resources. For this they need a scientific cadre of their own citizens, supported by funds from the countries themselves.

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Primate Adaptations

Five New World Primates. A Study in Comparative Ecology. JOHN TERBORGH. Princeton University Press, Princeton, N.J., 1984. xiv, 261 pp., illus. $40; paper, $13.50. Monographs in Behavior and Ecology.

Deep in the neotropical forests of southeastern Peru lurk the monkey watchers of Manu. Their alpha male is John Terborgh. His chosen mission is to describe and explain the variation in ecology and social organization of an extraordinarily diverse primate community. Surrounding his field site are natural populations of 13 primate species, a situation most nearly paralleled in the West African and Southeast Asian equatorial forests. The 13 species span an 80-fold weight range from the tiny pygmy

marmoset to the black spider monkey, one individual of which is the heaviest recorded South American wild monkey (it was a male from Brazil).

Terborgh's working hypothesis is that many of the behavioral differences between the species can be understood "as adaptations for exploiting food resources with distinct spatial and temporal patterns of abundance." To test his hypothesis it was necessary to accumulate data on activity patterns, ranging and feeding behavior, and species interactions throughout the year. But the study area is heterogeneous to say the least—it contains areas of both riparian and lacustrine successional vegetation, including a fig swamp, as well as tall high-ground forests of various ages. Individual monkeys cannot be identified, and sometimes it is not possible to distinguish among different troops of the same species. Therefore, to make his task manageable Terborgh concentrated his effort on a preliminary but nonetheless intensive study of just five species that range in size from 0.4 to 3.0 kilograms and have similar diets. Fleshy fruits provide their calories and small animal prey their protein requirements. The five species provide challenge enough. There are two tamarins that live in small family groups and defend joint territories (one family of each species per territory), two capuchins that live in larger groups of a dozen or so individuals, and the squirrel monkey, which lives in groups of about 35 individuals that range over enormous undefended and unadvertised areas. To add to the complexity, the squirrel monkeys frequently join with groups of either capuchin species for periods from a few hours to ten days or more.

The rainfall is seasonal, resulting in periods of abundant and scarce fruit supplies. In response to the shifting availability of food both within and between habitats, the monkeys change their feeding, ranging, and social behavior. Terborgh's research team logged about 540 contact hours per species between August 1976 and August 1977. Their observations form the quantitative base for most of this book, though more recent supplementary data are used to test various ideas.

A monkey's body size is an important determinant of its diet. For example, small species cannot subsist on foliage alone. On the other hand, using stealth, the smaller monkeys at Manu catch larger animal prey—the exact opposite of the usual optimal foraging assumption. During the wet season, from about November to April, fruit is widely available and the monkeys' diets are quite similar. But during the dry season the feeding habits of the different species diverge considerably. When searching for animal prey, the larger of the two capuchins (3 kilograms) uses its strength as a destructive forager, breaking hollow twigs and ripping off bark to expose the prey beneath. At the other extreme, the smaller of the tamarins (0.4 kilogram) has great agility and can garner exposed food while clinging to vertical surfaces. However, in general the larger species have a wider range of potential feeding options: they can use their strength to forage, they are less susceptible to predation by raptors and so can feed in the exposed high canopy, and having lower metabolic rates they can use leaves or unripe fruit as protein sources.

Despite different techniques for catching animal prey, it seems likely that fruit eaten during the dry season is the factor most closely associated with the species-typical social behavior. The small tamarins crop a variety of fairly uniformly distributed and predictable fruiting trees. As a consequence they defend territories. Why two species should share a territory is unexplained, but, given that they do, their joint use of the territory by traveling in parallel around it ensures that return times to fruiting trees are maximized. In sharp contrast, the squirrel monkey is a fig specialist *par excellence* and the fruits on a fig tree ripen as a large, concentrated, non-predictable, non-renewable, non-defendable patch. Several groups of squirrel monkeys may descend on a single tree at any one time, together with other primates and several bird species. The resource cannot be defended against the dominant capuchin species, which is also partial to figs. The large group size of squirrel monkeys can have little to do with improving foraging success. It is more likely to be a selfish-herd antipredator defense mechanism, as are the squirrel monkeys' attachments to the capuchin groups whose home ranges they travel through in their incessant search for fruiting fig trees.

There are no similar studies from the New World, and, as with others that have been reported on simian primates from elsewhere (notably Gautier-Hion's from Gabon, Chivers's from Malaysia, and Struhsaker and Leland's from Uganda), it is surprising how much can be achieved with the intelligent interpretation of basic observational data. Very little is known about primate communities in general and New World primate communities in particular, and Terborgh's book is a notable contribution toward furthering our understanding. He may be correct that optimal group sizes result from a balance between predator pressure on the one hand and the spatial and temporal variation in food patch qualities on the other. If he is correct, it should be no surprise that broad interspecies studies have failed to identify ecological correlates of variation in group size—the relevant measures have not been quantified in any single case. Terborgh presents us with a series of preliminary observations. Many of his tentative conclusions and working hypotheses will eventually prove incorrect, as he is the first to admit. Nevertheless, he has already brought us a long way. His useful fusion of natural history observations with carefully argued interpretations derived from a firm matrix of theory provides a substantial foundation for further studies.

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A Biota and Models

Island Biogeography in the Sea of Cortéz. TED J. CASE and MARTIN L. CODY, Eds. University of California Press, Berkeley, 1984. xii, 508 pp., illus. $55. Based on a symposium, Los Angeles, 1977.

Biogeography has never been a field short on controversy, and throughout its history attempts to explain the distribution of plants and animals on islands have figured prominently. Land bridges, continental drift, sea-level fluctuations, dispersal capabilities of organisms, and the evolutionary roles of competition and resource availability all have been debated. Within the last 15 years, now that plate tectonics is better understood, vicariance biogeography has been revived. Also, the dynamic equilibrium model has brought more quantitative ecological thinking to the forefront and set the stage for controversy on the role of species turnover, stochastic processes, and balanced immigration and extinction rates on the one hand and more deterministic processes and historical legacies on the other. In the middle of the current fray is a growing group that criticizes anyone who does not build quantifiable null models against which to test hypotheses.

It is with this background that Ted Case and Martin Cody have edited an empirically and theoretically well-rounded book on the Gulf of California. The work is important for a number of reasons. It provides information about a