Stone tobacco pipes found among grave goods at the Hill Pawnee site, around A.D. 1800. The Reverend John Dunbar, in his *Letters Concerning the Presbyterian Mission*. . . (1918) made reference, "unfortunately without description or other elaboration, to the use of the 'big pipe' by his hosts on ceremonial occasions." [From *Central Plains Prehistory*]

Drainage spans two of the three, yet, because the work was done before water screening and flotation were common recovery practices, we have little evidence for Woodland Stage plant or animal use in either.

The elegance of Wedel's ecologically focused presentation falters a bit in the chapter on Early Village Indians. After a paragraph comparing the Kofyar of Nigeria with Upper Republican cultivators of the North American Plains he wonders "just why the comparison was made" (p. 129). I do too. I believe Wedel has mistaken a previously published reference to wood ash fertilizer for a comparison of farming practices. His discussion of the radiocarbon dates for Upper Republican complexes in the region is equally puzzling. To paraphrase him, the available dates indicate a 12-century span. Nevertheless, he contends, we should assume a restricted period of occupation, purge the sample of assays considered too early or too late (that is, 25% of those available), then average those from sites with more than one determination. If we manipulate the evidence in this way then the Upper Republican occupation of the region need not have been much longer than the two or three centuries originally assumed. Unfortunately, such manipulations leave a five-century gap between the region's Woodland and Upper Republican occupations. It therefore becomes necessary to explain the Woodland vessel found on an Upper Republican house floor, which Wedel does by creating a new, and implausible, version of the curation effect.

Wedel reviews the White Rock and Dismal River remains in the first of two chapters on Late Village Indians. He handles the pertinent explorers', travelers', and traders' accounts with the care and precision of a good ethnohistorian, and his treatment of the material remains meets the highest trait- and object-oriented standards of cultural historical description. The second chapter on Late Village Indians describes historic Pawnee subsistence practices and material culture but deals far too briefly, albeit lucidly, with Pawnee social organization. The penultimate chapter of the book provides a balanced and sympathetic view of the events and processes that led to the removal of the Pawnees from Nebraska. In concluding Wedel reviews the issues and ideas that have guided his work in the Plains and makes interesting suggestions for those who might wish to continue in the same vein.

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The Ecology of Plant Disease

Plant Virus Epidemics. Monitoring, Modelling and Predicting Outbreaks. GEORGE D. MCLEAN, RONALD G. GARRETT, and WILLIAM G. RUESINK, Eds. Academic Press, Orlando, FL, 1986. xxii, 550 pp., illus. $71.50.

Modern advances in the molecular biology of plant viruses have not been paralleled by equally striking advances in the ecology of plant virus diseases. Detailed understanding of how viruses replicate, move, and cause disease within plants on a molecular level is unlikely to be a panacea in the control of plant virus diseases because many factors outside of the plant influence disease spread. *Plant Virus Epidemics* calls attention to the importance of understanding the complex interactions among viruses, vectors, plants, and environment and of describing these interactions in quantitative models.

General epidemiological principles for plant virus diseases have yet to be established with the clarity and confidence J. E. van der Plank and others have brought to the understanding of fungal diseases since 1960. Three international conferences on the epidemiology of plant virus diseases held since 1982 have confirmed that the field dynamics of virus diseases differ sufficiently from those of fungal diseases to require new and different approaches. The book that resulted from the First International Workshop of Plant Virus Epidemiology, held in Oxford, England, in 1982 (*Plant Virus Epidemiology*, Blackwell Scientific, 1983) presented numerous interesting but brief accounts on a wide variety of topics. *Plant Virus Epidemics*, which follows the second international workshop, held in Australia in 1984, focuses instead on the theme of its subtitle: "Monitoring, Modelling and Predicting Outbreaks."

R. G. Garrett's prologue outlines the rationale for predicting outbreaks. Lacking therapeutic methods, we can at best prevent virus spread. But prophylactic control measures are often applied when not needed because the incidence of disease cannot be predicted. Moreover, the scope for modeling "seems so wide, and the approach so direct, that it is surprising how little has been attempted" (p. 10). The disciplinary isolation of scientists working on the multifaceted subject of plant virus epidemiology probably explains why modeling has been used so seldom.

Encouragingly, *Plant Virus Epidemics* illustrates a variety of applications of models to plant virus systems and points the way to major steps that must be taken to improve current models. The editors have included a diversity of viewpoints, but these are generally well integrated toward the volume's central theme. For example, chapters on migration of aphid vectors (L. R. Taylor), plant growth models (M. Stapper), and simulation modeling (N. Carter) provide broad but succinct coverage of essential background material written by capable specialists for interested nonspecialists. In this regard, only a few chapters on insect population regulation and modeling fall short of clearly establishing their relevance to plant virus epidemiology.

The most instructive contributions are those that provide detailed and updated case studies and explanations of model development and application. The work of Kiritani and colleagues on rice dwarf virus resulted in a series of research reports that spanned more than a decade. Now Miyai, Kiritani, and Nakasuji explain the key details of this work in a clear and coherent retrospective, pointing out the weaknesses as well as the strengths of their approach. Most important, they indicate where new work should lead. Other classical, long-term studies of virus diseases such as barley yellow dwarf (R. T. Plumb) and beet yellows (G. D. Heathcote) are reviewed in the context of predicting disease spread. In the case of beet yellows, a scheme that emphasizes simple measures of winter severity has provided surprisingly accurate predictions of regional disease severity in Britain. In contrast, the most recent models of the aphid-borne soybean mosaic virus (Ruesink and Irwin) require far more detailed inputs such as data on aphid trap catches and levels of seed transmission of virus, but they also provide far more detailed predictions of virus incidence and effects on yields. Better yet, they provide new insights to guide plant breeding efforts and to adapt different control strategies to local conditions. For example, their models indicate that reducing the rate of seed transmission of soybean mosaic virus relative to plant age at inoculation should greatly reduce virus spread where aphid vectors do not colonize soybean. This is a trait that breeders should have little trouble incorporating into commercial varieties.

Plant Virus Epidemics should itself serve as a model for future references and reviews of plant virus epidemiology. As such, it will be a reference for years to come. Its scope is comprehensive and varied, but the presentation is clear and coherent so that researchers from diverse fields such as plant pathology, entomology, agronomy, ecology, mathematics, and operations research should be able to understand the material outside their specialties and identify common ground on which they can integrate their efforts toward the new directions this volume suggests.

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Insect Chemoreception

Mechanisms in Insect Olfaction. T. L. PAYNE, M. C. BIRCH, and C. E. J. KENNEDY, Eds. Clarendon (Oxford University Press), New York, 1986. xviii, 364 pp., illus. $69. Based on a seminar, Oxford, U.K., Aug. 1984.

As the editors of this volume note, the use of olfactory signals as an alternative to pesticides in the control of insects has been slow to be implemented, in part because many fundamental questions, such as how insects recognize and locate odor sources, remain unanswered. This book summarizes our current understanding of some of the behavioral and physiological processes that underlie this emerging technology.

Its title notwithstanding, the book is not a general review of insect olfaction, although the 35 short contributed papers span an array of topics. An opening presentation by Dethier extolling the virtues of a comparative approach to understanding the chemical senses is particularly appropriate since research in insect chemoreception often parallels related studies on other species. The next 19 papers treat the behavior of insects locating odor sources. This area of investigation has a rich and controversial history. Although the question of how flying insects actually locate an odor source remains unanswered, it increasingly appears that the odor serves to trigger upwind flight and that directed locomotory movements are the result of internal steering guided by multimodal sensory input, including visual cues from surrounding vegetation. Among the important new findings are that spatial discontinuities inherent in odor fields, which flying insects apparently detect as temporal discontinuities, are critical for odor orientation, as are spatial and temporal perturbations of the odor field induced by the microhabitat in which the odors are released. Moreover, no single pattern of flight behavior, or therefore presumably of orientation strategy, necessarily characterizes all species of flying insects. Clearly, more remains to be learned, in spite of important and exciting progress.

The remaining 15 papers are physiological. Among the important new findings in this area is that pheromone receptor cells can follow odor pulses up to at least 10 hertz. Temporal sensitivity appears to be enhanced by inactivating enzymes that rid the receptor lymph of odorant molecules and that somehow coexist with other, soluble binding proteins, hypothesized to protect and carry pheromone molecules to dendritic receptors. Descending interneurons that "flip-flop" to different output states in response to changes in odor concentration offer further evidence of neural tuning to the spatiotemporal parameters of odor fields. The question of quality coding, how one odor is distinguished from another, remains elusive. It is increasingly clear that "silver bullet" chemical signals, single molecular species detected by dedicated neural circuitry in lock-and-key fashion, are not the general case. Multicomponent odors prevail, and interactions at the receptor cells, if not among other coactivated elements of the olfactory pathway, complicate the issue of quality coding. One consolation is that the neural substrate for quality coding continues to elude workers using other animal models. A particularly bright hope is the prospect of unraveling quality coding at higher levels of the insect olfactory pathway where one can begin to analyze the response spectra of interneurons with identifiable patterns of branching in olfactory neuropil.

This volume is not intended for general reading. Indeed, mastering the subtleties of orientation theory, not to mention the associated terminology, is no easy task. The editors give us a well-organized, timely overview that should provide advanced students of science easy access to the literature and to current ideas about how insects recognize and locate odor sources.

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Neutrino Mass

'86 Massive Neutrinos in Astrophysics and in Particle Physics. O. FACKLER and J. TRÂN THANH VÂN, Eds. Editions Frontières, Gif-sur-Yvette, France, 1986. xviii, 704 pp., illus. $69. Moriond Workshop 6 (Tignes, Savoie, France, Jan. 1986).

There is today no compelling evidence that neutrinos, the weakly interacting particles emitted in nuclear beta decay, have a nonzero mass. The implications of neutrino mass for particle physics and astrophysics are sufficiently intriguing, however, that large numbers of experimentalists and theoreticians study this subject. In fact it is believed that there are three different varieties of neutrinos, ν_e, ν_μ, and ν_τ, associated with the three charged leptons, the electron, the muon, and the τ particle. As a result there are three possible values of neutrino mass, and the neutrinos emitted in weak decays, like the ν_e, may be mixtures of mass eigenstates.

Measurements of the electron spectrum from the beta decay of tritium provide the best method for finding a small mass of the electron neutrino ν_e. The latest of a series of experiments in Moscow is reported here by Valentine Lubimov; since 1980 these experiments have indicated a nonzero mass of about 30 electron volts. The present volume provides the first reports of new experiments on the tritium spectrum by groups at SIN (near Zurich), Tokyo, and Los Alamos. None of these find a nonzero value, and the Zurich group reports an upper limit of 18 eV.

Even if experiments indicate that ν_e does