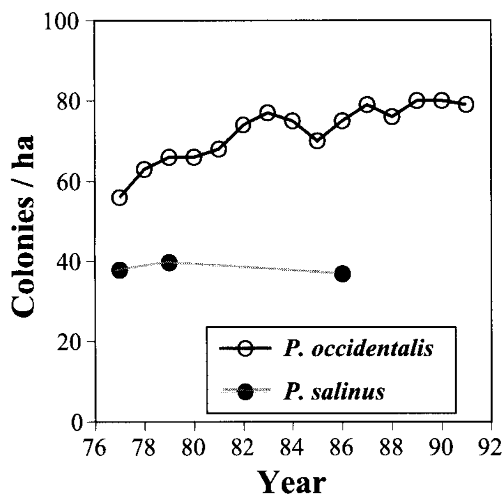


Figure 7.2. Abundance of two harvester ants, *Pogonomyrmex occidentalis* and *P. salinus,* over 15 and 9 years, respectively, in North America. *P. salinus* shows no discernible trend, but *P. occidentalis* appears to have increased in numbers. Data from Porter and Jorgensen (1988) and Keeler (1993).

### Two Studies from the Chihuahuan Desert

Two more long-term studies reflect how different investigators focusing on different species may achieve complementary results. Chew and De Vita (1980) studied three species (*Aphaenogaster cockerelli, Myrmecocystus depilis,* and *M. mexicanus*) in Chihuahua desert scrub. A 9.3-ha cattle exclosure was censused six times over 23 years. One species, the diurnal *M. depilis,* varied in density about 50%, while the numbers of its congener *M. mexicanus* increased 11-fold (Fig. 7.3a). *A. cockerelli,* in contrast, was locally extirpated over the same time period. The increase of *M. mexicanus,* given its negative association in space with the other two species, suggested competitive release from *A. cockerelli,* but there was little to suggest why the assemblage had changed.

A second experiment nearby found evidence for major reorganization of species composition over 18 years (Brown et al. 1997). Brown and colleagues followed the responses of plants, rodents, ants, and birds to various experimental treatments on a set of 0.25-ha plots. On the site's control plots, the numbers of two harvester ants, *Pogonomyrmex rugosus* and *P. desertorum,* decreased over the 18 years (Fig. 7.3b). *P. rugosus,* like *A. cockerelli* in the previous study, went locally extinct. A third species, *Pheidole xerophila,* though showing threefold variation in density, had no downward trend. These changes in ant composition occurred at the same time as a threefold increase in shrub cover and shifting abundance of a number of dominant rodent species. Changes in ant and rodent densities appeared to ramify throughout the desert community, affecting horned lizards (which prey on *P. rugosus*) and burrowing owls (which nest in rodent burrows).

Brown et al. (1997) link these community changes to an increase in winter rainfall from four El Niño years. The increased winter rainfall favors shrubs at the expense of desert grasses, and it may wet and ruin the stored seeds of harvester ants such as *Pogonomyrmex* and *Aphaenogaster.* As in Wolda's study of Panama light traps, such profound changes in species composition in this ecosystem yielded little change in species richness (Valone and Brown 1995). In both cases, the loss of some species may be compensated by the arrival of others.

## Recovery from Perturbation: Inertia, Resilience, and Nonlinearities

We now turn to studies of ecosystems recovering from stressors. For our purposes, a stressor is anything that alters the ecosystem properties of a site relative to a control site. Stressors create a perturbation; the site recovers to some degree once the stressor is removed. Given the inherent variability of ecosystems (as we have seen previously), monitoring site recovery