The nurturers, in contrast, seek to work with this new knowledge to encourage "optimum" productivity in the field, implicitly recognizing ecological interconnectedness. They suggest that breeders attempting to develop improved nitrogen fixing alders, for instance, should work toward "optimal symbioses" with plant, frankia and mycorrhiza as an integrated whole. Such nurturing microbiologists are beginning to work with mixed species cultures, selected from native strains. They use the living plant itself as the propagation media, collecting nodules, mushroom fruitbodies and soil from the plant roots for inoculum.

Progress has been slow in genetically engineering nitrogen fixing organisms and mycorrhizal fungi, while the effectiveness of propagating natural symbionts through plant passage is proving itself in many sectors. The outcome of these conflicting camps of symbiosis application remains to be seen, but it will probably be determined by socio/economic factors as much as by ecology.

Finally, the nature and limitations of knowledge itself exhibits close similarities between that of symbiosis research and the deeper ecology perspective. The soil microbial community, and its relation with plant and soil, is seen more as a multidimensional process than mechanistic cause and effect. It is felt that more is to be learned from a study of the whole symbiotic system in soil than from isolated symbionts in the laboratory.

As we ask questions, the answers laboriously acquired present yet deeper questions. On a single actinorhizal plant, research has shown as many as nine organisms symbiotically cocreating, as it were, one single tree.* Inoculating nodulated plants with mycorrhizal fungi increases number of nodules. If the same nodulating plant is artificially kept mycorrhizal only, inoculation with the nodule causing symbiont increases percent mycorrhizal infection. We have a synergy at play here beyond our wildest dreams. The axiom that "the environment is not only more complex than we think, it is more complex than we can ever think" is particularly evident in symbiosis. The more we learn, the more we see what we may never know.

Heidegger says: Let being be. We do not need to rush out and inoculate our native forests. The symbionts are already at work. But in our chemical, monocultural agriculture and tree farms, and in our nurseries with their sterile soils, we are creating conditions positively hostile to these symbiotic relationships. We need to much increase our research into the living soil and develop new technologies, new cultures to nurture it. We are in the position of having to do more to learn to do less.

*The Casuarina genus comprises a group of about 80 species of often actinorhizal shrubs and trees mostly native to Australia. There is great interest in their use in Third World countries to halt the spread of desert and develop sustainable forestry systems. One tree can have nitrogen fixing nodules, several species of ectomycorrhizas, several species of endomycorrhizas, and dense, mat-like proteoid roots caused by an unknown microorganism which increase nutrient absorption. Various Psuedomonas bacteria have been shown to be involved in both the frankia and endomycorrhiza infection process. This gives us nine organisms in all, counting the plant.

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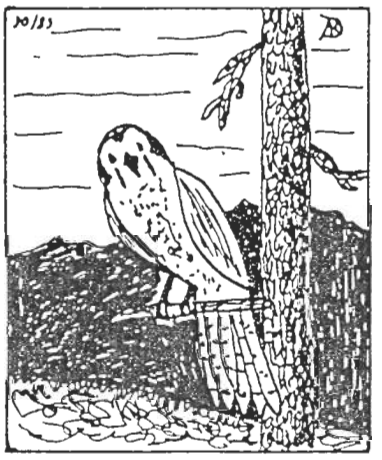
GALE
by Stephen Lewandowski

in midwinter
chicken eggs
freeze in the nest

the wind shrieks
outside while
we crouch
in the chicken house
nailing tar paper
over the windows

tree pruning wind
works all night
testing each branch--
some spring back,
some crash to the ground--
little by little
getting the trees
the world into shape



HOOKED
by Stephen Lewandowski

Hayfield mowd
slick as a mirror--
alfalfa laid out in long parallel lines.
A machine blows it
into the wagon for
the Holstein dairy herd--
big milk producers
waiting in the barn--
hooked on high
protein feed.

Stephen Lewandowski is with the Ontario County (US) Soil and Water Conservation District. He has published several books including **Honey and Ashes** from Tamarack Press and **Inside and Out** from Crossing Press.

TOWARD A SUSTAINABLE AGRICULTURE*

By Wes Jackson

Nowhere is the split between humanity and nature more dramatic than in the differing ways with which people and nature cover the land with vegetation. To maintain the ever-normal granary, agriculturalists have favored the monoculture of annuals. Nature has for the most part, favored the polyculture of perennials. This is not to say that perennials are excluded from agricultural endeavors, nor that nature excludes the annual plant as part of her strategy to keep the ground safely covered. Certainly the numerous nut and citrus trees, grapes and berries (be they blue, black, rasp or straw), along with other perennial plants including cotton and sugar cane are important to agriculture. And no naturalist need remind us that annuals are widely dispersed in natural ecosystems.

What are the implications of these opposite tendencies and how seriously ought we work to heal the split? Nature is both uncompromising and forgiving, but we do not yet know when to count on compromise and when on forgiveness. I doubt that we ever shall. But we can say with a rather high degree of certainty that if we are to heal the split, it is the human agricultural system that had better grow more toward the ways of nature.

On a limited scale nature rewards enterprise. A weedy annual is enterprising. Not only will it cover bare ground quickly, but it will also store an excess of energy besides. This is probably the reason our most important crops are weedy annuals. During a growing season, a small amount of annual vegetative biomass promotes the production and survival of a rather large number of seeds. This is usually assured by one of three ways or even a combination of all three: (1) the storage of plenty of food in the seed, (2) the set of many seeds and (3) the ability to colonize a disturbed area. Many perennials may have these three characteristics, but it is less critical for them to be expressed in a particular season for there is always another year. For that matter, there is another year for annuals too, for some of their seeds will remain viable for more than one year. But overall, the colonizing annual relies on **enterprise.** The ancestors of our current crops may well have been camp followers --colonizers of the disturbed ground around the campsite. They were available for human selection, and usable because they could produce an excess of potential energy.

We don't know whether the early agriculturalists were faced with famine, but when they began to plant annuals in fields, they were beginning to **reward** enterprise. The monoculture of annuals was a big new thing. The face of the earth was changed.

It is amusing to look at the process teleologically--on the general thesis, for example, that plants are a device invented by soil to prevent its own destruction.

By and large, the patient earth has rewarded patient ecosystems more generously, but enterprise has probably been rewarded too. It would seem to be a good strategy for an ecosystem to have enterprising species present, for quick colonizers could rapidly cover the ground made naked by a migrating buffalo, which had wallowed and dusted himself, or an excessive flood, or an insistent wind. The ecological capital which had been sucked from parent rock material or borrowed from the air could be retained to promote more life for future generations of all species in the system.

The selection of enterprising plant species has rewarded all humans bent on enterprise in food production. But there is a second consideration. Humanity also has long been armed with a tendency to take without thinking. After all, life and sustenance itself have forever been gifts of nature. Combining these two characteristics--enterprise and the taking--has produced a result now to be reckoned with after the four hundred or so generations since humanity started concentrating on seed time and harvest.

To maintain any system, agricultural or natural, bills must be paid eventually. In nature's prairie, the bills are paid automatically and with amazing regularity. The wild forms have evolved methods for dispersing seed, recycling minerals, building soils, maintaining chemical diversity, promoting new varieties and even controlling weeds. Most biologists believe that natural selection alone was up to these tasks, and that purpose was not necessary. In a sense, nevertheless, the prairie