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INTRODUCTION TO THE SYMPOSIUM ON SOIL CRUST COMMUNITIES

Larry L. St. Clair¹ and Jeffrey R. Johansen²

ABSTRACT—Soil crust communities in semiarid and arid lands around the world have received increasing attention in the past two decades. A symposium on their ecology was presented at the annual meeting of the American Bryological and Lichenological Society held in 1991 in San Antonio, Texas. An introduction to the topic and an overview of the papers appearing in the proceedings volume are given in this prologue.

Key words: cryptogamic crusts, microbiotic crusts, microphytic crusts, semiarid ecosystems, algae crust, lichen crust, moss crust.

In many arid and semiarid regions of the world the surface soil is consolidated into a thin crust by microorganisms, lichens, and bryophytes. Soil crusts have varying microtopography. Some are flattened, polygonal, and possess a rough, undulating surface; others are pedicled. All soil crust communities contain a microflora of cyanobacteria, bacteria, eukaryotic algae, and fungi. Well-developed soil crusts also contain lichens and/or bryophytes.

Soil crusts of biotic origin have been known under a variety of names. Raincrust was one of the first terms used (Fletcher and Martin 1948) but has been abandoned because of confusion with raincrusts of nonbiotic origin. Many researchers designate the crust by its dominant life form, i.e., algal crust, lichen crust, or moss crust. Cryptogamic crust, a term coined by Harper (Kleiner and Harper 1972), has been the most widely used term during the last 20 years. Some researchers have been dissatisfied with the term cryptogamic crust because cryptogams are plants without seeds, a group that includes ferns and fern allies (not components of soil crusts) and excludes cyanobacteria and fungi (not plants). Microfloral crust (Loope and Gifford 1972), microphytic crust (West 1990), microbiotic crust, and cryptobiotic crust (Belnap 1993) are other epithets that have been proposed. Cryptogamic crust will likely persist for some time because of its wide usage and historical precedence. Of the more recent terms, we feel that microbiotic crust is the most accurate and recommend its usage.

Increasing evidence indicates that microbiotic crusts play several vital roles in arid and semiarid rangeland ecosystems. The most important role likely is stabilization of soil surfaces and consequent reduction of soil erosion. Support for this hypothesis has been gathered by several workers (Blackburn 1975, Booth 1941, Fletcher and Martin 1948, Loope and Gifford 1972, MacKenzie and Pearson 1979). In some instances, microbiotic crusts improve seedling establishment by providing moist sites in the cracks and complex topography of the crusts

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(Eckert et al. 1986, St. Clair et al. 1984). Soil 
crusts have varying effects on infiltration, and it 
is unclear whether they improve or worsen 
water relations in the soil (Harper and Marble 

Probably the second most important role 
microbiotic crusts play is the improvement of 
soil fertility. Both the free-living and lichenized 
cyano bacteria fix atmospheric nitrogen in sig-
nificant amounts (Jeffries et al. 1992, Klubek 
and Skujins 1980, Rychert et al. 1978, West and 
Skujins 1977). Furthermore, the crusts con- 
tribute to soil organic matter through primary pro-
ductivity of the cyanobacteria and algae (Jeffries 
et al. in press). Through contributions of organic 
material and reduced erosion of silts and clays, 
cation exchange capacity may be higher in 
crusted soils.

Microbiotic crusts in North America are most 
prevailent in the semiarid steppe regions in the 
Great Basin, Colorado Plateau, and Columbia 
Basin. They also extend into the hotter, more 
arid deserts in the southwestern regions of the 
United States. These regions differ distinctly 
from semiarid regions east of the Rocky Mount-
in s in that they developed without the pres-
sure of large herds of grazing ungulates (i.e., 
bison). Antelope, mule deer, and elk grazed the 
semiarid steppes before the arrival of European 
settlers, but these herbivores did not graze in 
large herds and grazed semiarid areas only dur-
ing the colder months of the year. The domi-
nance of bunchgrasses, shrubs, and microbiotic 
crust communities in the Intermountain West 
reflects the historical grazing pressures present in 
the region (Mack and Thompson 1982).

With the introduction of grazing cattle and 
sheep, vascular and microbiotic communities 
have both been impacted. Evidence indicates 
that domestic grazing animals seriously damage 
the integrity of the microbiotic crust through 
trampling of the crust, particularly during dry 
periods of the year (Anderson, Harper, and 
Holmgren 1982, Anderson, Harper, and Rush-
forth 1982, Brotherson et al. 1983, Harper and 
Marble 1988). Destruction of microbiotic crusts 
by off-road vehicles and backpackers has 
recently become a concern in many areas. 
Rangelores also damage microbiotic crust com-
munities by killing most of the lichen, moss, and 
algal constituents (Johansen et al. 1982, 1984).

Factors influencing the development of 
microbiotic crusts were studied by Anderson, Har-
er, and Holmgren (1982). They found that silty 
soils with high electrical conductivity were more 
likely to develop visible crust features. A few 
workers have studied recovery of cyanobacteria, 
lichens, and mosses following disturbance (An-
derson, Harper, and Rushforth 1982, Johansen 
These studies indicate that algal recovery occurs 
before lichen and moss recovery; and that the 
process of full recovery takes many years. St. 
Clair et al. (1986) demonstrated that recovery 
can be accelerated through addition of cryp-
togamic amendments. Despite these studies, 
our current understanding of recovery of micro-
bio tic crusts is very limited.

Microbiotic soil crusts of arid and semiarid 
rangelands have received considerable atten-
tion in the literature. They have been the subject 
of no fewer than six reviews in the past four 
years (Dunne 1989, Harper and Marble 1985, 
Ischei 1990, Johansen 1993, Metting 1991, 
West 1990). In the past 50 years over one hun-
dred papers have been published on various 
aspects of the composition, distribution, physi-
ical properties, and ecology of arid/semiarid soil 
crusts. There is a growing consensus among 
researchers that these crusts play an important 
beneficial role in the ecosystems in which they 
occur. However, unanimity does not exist. In 
particular, West (Gutknecht 1991, West 1990) 
has questioned the ecological value of micro-
bio tic crusts and called for more rigorous studies 
of their ecology, physical properties, and re-
sponse to disturbance.

Because of the interest in microbiotic crust 
communities and the current debate over their 
role in semiarid and arid ecosystems, a sym-
poium on soil crust communities was held at the 
annual meeting of the American Bryological 
and Lichenological Society in San Antonio, Texas, 5 
August 1991. This issue of the Great Basin 
Naturalist contains the proceedings of that sym-
poium as well as other related papers on micro-
bio tic soil crusts.

The first part of the volume contains various 
papers dealing with floristics and distribution of 
various crust components. St. Clair et al. (1993) 
review the distribution of soil lichens in the arid 
and semiarid regions of the Intermountain West 
of the United States, and address the impact of 
disturbance on soil lichen communities in this 
region. A report on the bryophytes of calcareous 
soils of a semiarid region of south central Aus-
tralia is given by Downing and Selkirk (1993). 
Grondin and Johansen (1993) give a preliminary
species list of soil algae from Colorado National Monument and discuss the spatial heterogeneity of cyanobacteria and coccolid eukaroytic algae in crusts of the monument. Wheeler et al. (1993), in a companion paper to the work by Grondin and Johansen (1993), report on the spatial heterogeneity of bacterial populations in microbiotic crusts. Finally, Belnap and Gardner (1993) present an electron microscopical study of Microcoleus vaginatus (Vauch.) Gomont, which elucidates the role that Microcoleus plays in the microstructure of microbiotic crusts.

The second part of the volume addresses the ecology of the microbiotic crusts. Our understanding of the relationship between microbiotic crusts and soil hydrology is furthered in a study of semiarid woodlands of Australia by Eldridge (1993). Contributions of microbiotic crusts to soil fertility are discussed by Harper and Pendleton (1993), who present data indicating that cyanobacteria and cyanoabacterial li­chens may enhance the availability of several essential minerals for higher plants. Johansen et al. (1993) present the results of a study of the impact of rangefire on soil algal communities in the Columbia Basin and the degree of recovery during the two years following fire. In the final paper, Belnap (1993) discusses the use of inoculants in speeding recovery of microbiotic crusts.

LITERATURE CITED


