Proceedings of the 7th Annual British Columbia Mine Reclamation Symposium in Victoria, BC, 1983.
The Technical and Research Committee on Reclamation

THE SOIL FAUNA OF HIGH ELEVATION RECLAIMED SITES IN SOUTHEASTERN BRITISH COLUMBIA

Paper prepared
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INTRODUCTION

The soil community is a complex organization of interdependent species which process dead organic material and convert it into mineral soil. The soil microflora is responsible for mineralization, wherein the decomposed organic matter is broken down into its chemical constituents and made available for uptake by plants. The soil fauna greatly accelerate the decomposition process by ingesting and breaking down organic matter, thus making it more available to bacteria and fungi. Soil fauna stimulate fungal growth by cropping, and serve to disperse bacterial and fungal spores. They may also condition dead organic material in other ways that facilitate microfloral action. These animals improve soil aeration and water status by burrowing, and by opening passages occupied by decaying roots. Their role as decomposers is critical in Canadian Soils, because of the scarcity of macrofauna, such as earthworms (Marshall et al 1982).

Mine spoil initially lacks such a biological community of soil flora and fauna. It is therefore desirable to understand the functioning of these disturbed ecosystems, to determine whether a soil environment conducive to vigorous and sustained plant growth is being established, and to determine how this soil development may be enhanced.

This research project is currently underway at an open pit mine in southeastern British Columbia, owned and operated by B.C. Coal Limited. Previous research undertaken at B.C. Coal during the period of 1979-1981 indicated that soil microarthropods may play a significant role in the rate of organic matter turnover and subsequent nutrient cycling and soil development on high elevation reclaimed mine spoils (Fyles, 1980; Lawrence, 1981). Their abundance and ecological importance make them an immediate concern where management activities depend on soil fertility.

The objectives of this study are threefold:

1. To investigate in detail the succession of soil fauna on high elevation reclaimed land.
2. To determine wherever possible, the effects of these species on the rate of organic matter turnover.
3. To investigate methods of ameliorating the disturbed site, to improve the turnover rate of organic matter, nutrient cycling, and subsequent soil development.

SITE LOCATION

The study site is located on the property of B.C. Coal Limited, in the Rocky Mountains of southeastern British Columbia (Figure 1). The nearest village is Sparwood, which is located 20 kilometres west of the B.C./Alberta border. The study area itself is located near the crest of a high sandstone ridge at an elevation of approximately 2000 metres. The growing seasons are short, cool and moist, with the ground snow-free for five months of the year and only 40-70 frost-free days per year.

The disturbed areas which form the basis for this study are the end product of open pit coal mining. The mine is a truck and shovel operation, and overburden rock is deposited in extensive waste dumps.

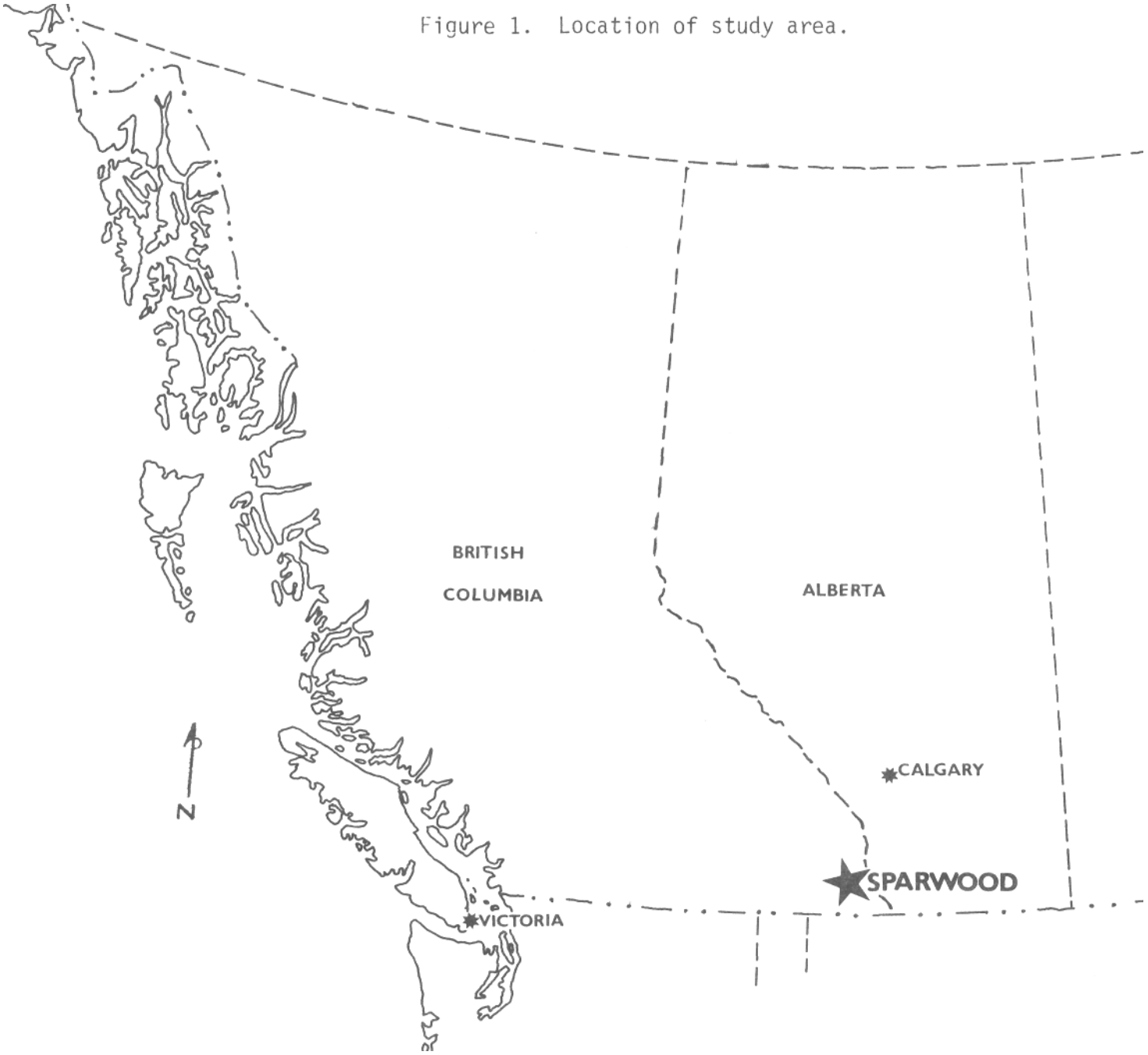
The first step in reclaiming these spoils is the resloping of the dumps to an angle of 28 degrees or less. This also lessens the compaction problem. An agronomic seed mixture of grasses and legumes is broadcast by hand or by helicopter, usually in the fall. The sites are then fertilized, and the dump harrowed to ensure seed burial and incorporation of the fertilizer. The reclaimed areas receive an annual maintenance application of 13-16-10 fertilizer, at a rate of roughly 200 kg/hectare.

STUDY SITE SELECTION

Three reclaimed sites ranging in age from two to nine years were chosen to study the recolonization of soil fauna onto reclaimed mine spoils. Each of these sites were chosen so as to minimize environmental variables between the sites such as slope, aspect, and elevation. Age should be the only major difference between the reclaimed sites, as each site received the same seed mixture and annual fertilizer applications, and is composed of roughly the same parent material.

The fourth site chosen for study was a nearby natural subalpine meadow, which differed from the reclaimed areas in a number of respects. The site was steeply sloping, and the vegetation was composed entirely of native grasses, forbs and shrubs, as opposed to agricultural species on the reclaimed areas. Soil types between the natural grassland and the reclaimed areas were significantly different, although the original parent material of the grassland soil was probably similar to that of the reclaimed areas. The natural grassland was included in the sampling as an example of a well established community which had developed under conditions similar to those of the reclaimed areas.

Figure 1. Location of study area.



METHODS AND MATERIALS

Work to date has concentrated on three major areas of research:

EXTRACTION OF SOIL FAUNA FROM SOIL CORES

Core samples subdivided into two different depths, were taken from each of the study sites at monthly intervals over the 1982 field season.

Two methods of extraction were used. One-half of the samples were extracted for soil-dwelling nematodes and enchytraeids (a small family of earthworms), using a modified Baermann funnel (O'Connor, 1970). The organisms in the remaining samples were collected using a high-gradient Lusenhop extractor, a technique which establishes a temperature gradient in the soil sample (Edwards and Fletcher, 1970). Major taxa extracted here include mites, Collembola (small wingless insects), and other soil-dwelling insects.

EMERGENCE TRAPS

A second major area of research involved the continuous bio-monitoring, through the use of emergence traps, of those organisms which spend the majority of their life cycle in the soil, and emerge as adults to breed. Major insect orders include Diptera (flies), Coleoptera (beetles), and Hymenoptera (wasps and bees).

The trap itself consisted of a pyramid-shaped frame, $1m^2$ at the base, which was covered with a fine mesh cloth. The trap was set into the ground at a depth of approximately 20 centimetres, so that no insects could escape. Emerging insects flew upwards towards light coming through a jar at the top of the trap, and dropped into a suspended collection vial. Vials were changed weekly, and the sites monitored continuously over the entire field season.

The method is useful in that it provides a quantitative estimate of the number of organisms emerging from a square metre of soil. It also provides a valuable supplement to the determination of soil fauna through the extraction of whole cores because the taxonomy of the soil fauna, particularly larval forms, is very poorly known.

DETERMINATION OF ENVIRONMENTAL PARAMETERS

The third and final area of study involves the determination of environmental parameters, specifically:

a) production of above-ground vegetative biomass,
b) detrital decomposition rates,
c) soil temperature and moisture conditions, and
d) soil particle size distributions.

As mentioned previously, it is desirable to establish a soil environment on these waste dumps which is conducive to vigorous and sustained plant growth. This is most conveniently measured through biomass production and decomposition rates, and will be directly influenced by the soil fauna. The composition of the soil faunal communities will in turn be influenced by such soil parameters as particle size distributions, temperature and moisture levels.

Soil extraction results will be analyzed using a computer ordination technique, and the resultant community information correlated with environmental parameters to determine which factors may be most important in influencing the abundance and distribution of the soil fauna.

RESULTS

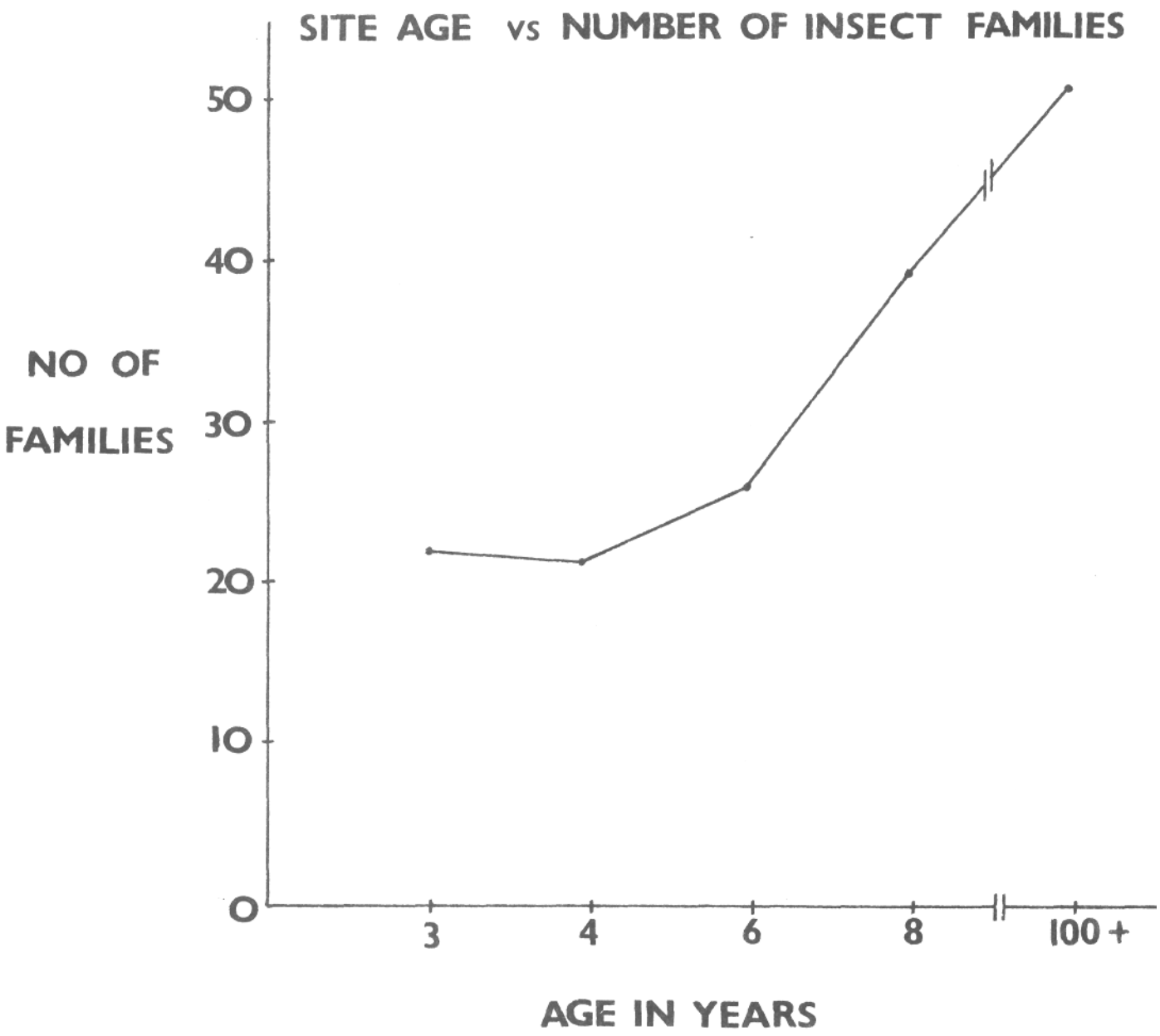
Results are currently being analyzed and are showing some interesting trends.

As expected, species diversity increases with site age (Figure 2). Figure 2 is based on preliminary insect sampling done in 1981, and indicates that the number of different insect families found on a reclaimed site increases with site age. The natural grassland, of course, shows the greatest degree of family diversity.

It appears from the samples assessed to date, that Collembola, mites, and certain Diptera are among the early colonizers of reclaimed mine spoil. Mites are much more abundant on the intermediate-aged site, and all three groups are well represented on the oldest reclaimed site.

Nematodes are present on the two older reclaimed sites, but very rare on the two year old site. They are very abundant on the natural grassland.

FIGURE 2


SITE AGE vs NUMBER OF INSECT FAMILIES
NO OF FAMILIES
50
40
30
20
10
0
3
4
6
8
100 +
AGE IN YEARS

Enchytraeids are also present on the natural grassland, but have not been found on any of the reclaimed sites. Like all terrestrial earthworms, enchytraeids have a beneficial influence on the soil, increasing soil drainage and aeration, and mixing and churning the soil through burrowing.

Workers in Ohio have been able to successfully introduce the earthworm Lumbricus terrestris on to mine spoils, with beneficial results (Vimmerstedt, 1973). During their five year study, earthworms survived, and buried or consumed the equivalent of five metric tons of leaf litter/hectare. The levels of available phosphorus and exchangeable cations in the mineral spoil were also increased.

A similar introduction will be undertaken this summer on one of the older reclaimed study sites, to investigate survival rates of three different earthworm species. If this earthworm trial is successful, it may prove to be a valuable means of improving the rate of organic matter decomposition, along with improving certain soil characteristics on these reclaimed sites.

CONCLUSION

A study such as this is not only useful from a scientific point of view, but provides practical knowledge in a field which definitely needs a lot of work. It is certainly desirable to establish a good vegetative cover, but it is also very important to ensure that the dead organic material is broken down and recycled through the system. It is this recycling that ensures the development of improved soil characteristics, an important step in the re-establishment of viable ecosystems on lands disturbed by mining activities.

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