Report on Kanmantoo Cryptogams September 2015

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Introduction

Very little is known about the type and diversity of cryptogams (lichens, liverworts and mosses) at Hillgrove mining lease south of Kanmantoo. A survey was conducted during June and August 2015 to collect and identify the dominant species that occur on rocks and soil in the remnant mallee vegetation. A comparison survey was also conducted in Frahns scrub approximately 7 km east of Kanmantoo.

Beneficial role of cryptogams

Lichen cryptogams colonise bare rock surfaces, soil and vegetation and once established tend to facilitate soil formation by weathering rock structure physically and by penetrating the surfaces with fungal filaments. These structures chemically erode the substrate with the acids they produce. The lichens upper surface also traps wind-blown dust and plant material that forms a substrate for their development and further facilitates the establishment of liverworts, mosses and small herbs.

In the low rainfall area around Kanmantoo, lichens, liverworts and mosses can colonise soil surfaces and protect them from wind and water erosion e.g. the lichen *Diploshistes thumbergiannus* (Figures 1 & 2). This lichen forms a calcium rich crust on the soil that resembles bird droppings with some reaching 20 cm in diameter. Lichens, liverworts and mosses support a rich assemblage of small animals and many live in channels and burrows that aerate the soil allowing water to penetrate to lower levels (Edridge et.al. 1997 p13).

Lichens, liverworts and mosses can undergo desiccation and intermittent drying. On moistening they rapidly recover their normal form. Lichens and mosses growing on soil or rock tend to become covered with grains of sand or dust. During dehydration and rehydrating, the leaves tend to throw off the grains, this reduction in size and expansion enables them to survive from being buried in the soil (Catcheside 1980 p21). Dried cryptogams can survive adverse conditions and their spores in the soil can rapidly grow and pass to maturity when moisture is available (Catcheside 1980 p 20). This ability means that in their dehydrated form, they can be harvested, and after reconstitution, used to re-inoculate barren areas of soil in mine rehabilitation sites.

Aim

The area of this study involves the identification and abundance of lichens, liverworts and mosses and their potential to be used as a soil inoculum. This process will facilitate the mine

site soil rehabilitation process and allow the succession and growth of native plants species. It has been proposed that harvested collections of lichen, liverwort, and moss propagules could be incorporated with native grass seed along with a hydrated-polymer sicking agent and sprayed onto soil after mining is completed (John Crocker, pers.comm. 2015).

To gain a comparison of what the vegetation at Hillgrove mine site was once like, a second native stand of mallee vegetation was examined for cryptogams at Frahns scrub. This remnant vegetation is located 8 km east of the mine site and may be a reservoir of cryptogams for revegetation of Hillgrove mine site. A number of collections were identified from this area with the possible aim of using them for re-inoculation.

Methods

Transects were made along tracks and vegetation stands and cryptogams were photographed, GPS records taken and voucher specimens stored in envelopes. An assignment number and date of collection, type of substrate and elevation for each specimen were noted.

Specimens were later examined microscopically and sketches made of the whole plant form, leaf structure, midrib presence or absence, cellular structure and presence and of sporophytes capsules, spores and vegetative structures recorded. These features were them used to key out the relevant species noted in Tables 1 and 2.

Results

In the Hillgrove remnant vegetation the lichen species; *Diploschistes thumbergiannus* is established and forms a calcium rich crust which holds the soil together (Figures 1, 2). A similar crustose lichen species *Lecidea* spp. with black fruiting structures was also found at Frahns scrub (Figure 3, 4).

The thallose liverwort; *Asterella drummondii* was found amongst mosses on the access track near Gate 3; north of the main excavation pit. It was also found in Frahns scrub colonising sheltered soil microsites (Figure 5). It prefers well drained hill slopes where moisture concentrates after rainfall (Eldridge and Tozer 1997 p67).

At Frahns scrub the uncommon moss species *Goniomitrium enerve* was found on bare soil near crustose lichen colonies (Figure 6). A mature moss species at Frahns scrub; *Bryum torquescens* was identified with spore bearing structures (sporophytes), see Figure 7.

The majority of cryptogams identified at Hillgrove mine site were growing on soil (8 species) while one lichen species; *Neofuscelia* spp. (Figure 9) was found growing on rock. One unidentified green algal species north of the mine site found was forming a dense mat on a soakage pond (Table 1).

The number of cryptogams growing on soil at Frahns scrub was 12 with one lichen species; *Teloschistes sieberianus* growing on bark (Figure 9).

Many of the lichen species in Frahns scrub were growing on bare soil and liverwort and moss species were growing in semi shade near grass clumps or the shaded areas under trees and shrubs (Figure 10).

Figure 1. The location at Hillgrove mine site where the crustose lichen *Diploschistes thumbergiannus* occurs (white areas in foreground). Date 2-7-2015

Figure 2. The thallose lichen *Diploschistes thumbergiannus* at the Hillgrove mine site

Figure 3. Frahns scrub near road, 2 km from Frahns Homestead. Date: 31-7-2015

Figure 4. Crustose lichen *Lecidea* spp. with black fruiting structures, Frahns scrub

Figure 5. *Asterella drummondii* growing on access track near Gate 3. Hillgrove mine site (developing spore bearing structures can be seen as green spherical swellings).

Figure 6. The rare moss species *Goniomitrium enerve* at Frahns scrub

Figure 7. Spore bearing structures of the moss *Bryum torquescens* at Frahns scrub

Figure 8. The lichen; *Neofuscelia* spp. growing on rock at Hillgrove mine site

Figure 9. The lichen; *Teloschistes sieberianus* growing on bark at Frahns scrub

Figure 10. Dense colony of moss growing at Frahns scrub in semi shade

Table 1. ***Numbers of Lichens, Liverworts, Mosses and Algal species found at Hillgrove mine site in remnant vegetation and on soil and rocks.***

Organism	**Number Name**	**Substrate**	**Comments**
Crustose lichen	1 *Parmelia* spp.	On soil	Soil binding
Crustose lichen	1 *Diploschistes thumbergiannus*	On soil	Common
Foliose lichen	1 *Neofuscelia* spp.	On rock	Common
Thallose liverwort	1 *Asterella drummondii*	On soil	Amongst other mosses
Leafy liverworts	1 *Fossombronia* spp.	On soil	Common
Moss	1 *Triquetrella* spp.	On soil	Common
Moss	1 *Barbula hornschuchiana*	On soil	Loosely attached to soil
Moss	1 *Phaseum* or *Pottia* spp.	On soil	Sessile, capsules rare
Moss	1 *Hypnum cupressiforme*	On soil	Very common
Green algae	1 (Filamentous unknown spp.)	Mud	Large mats

Table 2. ***Numbers of Lichens, Liverworts and Mosses found at Frahns scrub 7 km east of Hillgrove mine site.***

Organism	Number Name	Substrate	Comments
Crustose lichen	1 *Heterodea beaugleholei*	On soil	Soil binding
Crustose lichen	1 *Aspicilia* spp.	On soil	Soil binding
Crustose lichen	1 *Lecidea* or *Diploschistes* spp.	On soil	Soil binding
Foliose lichen	1 *Heterodea muelleria*	On soil	Soil binding
Foliose lichen	1 *Teloschistes sieberianus*	On bark	Common
Thallose liverwort	1 *Asterella drummondii*	On soil	Amongst other mosses
Moss	1 *Pottia* spp.	On soil	Common
Moss	1 *Goniomitrium enerve*	On soil	Uncommon
Moss	1 *Phaseum* or *Pottia* spp.	On soil	Common
Moss	1 *Bryum torquescens*	On soil	With capsules
Moss	1 *Phascopis rubicunda*	On soil	Amongst other mosses
Moss	1 *Triquetrella* spp.	On soil	Common
Moss	1 *Archidium* spp.	On soil	Perennial

Discussion

Soil Crusts as Environmental indicators

Lichens, liverworts and mosses and other cryptogams bind soil particles together to form a crust which protects the soil from wind and water erosion. "Well developed, diverse soil crusts indicate that soils are in good condition" (Eldridge and Tozer 1997 p66).

Some lichens, liverworts and mosses can be useful indicators of soil types. For example several lichen species are associated with soils having high calcium content while others indicate high salinity levels and pH greater than 8. Other lichen species fix atmospheric nitrogen and release it into the soil (Filson and Rogers 1979 pp 23-26).

Little is known about the effect of air borne pollutants on soil lichens, however some lichens are highly sensitive to air pollution i.e. the gas sulphur dioxide and toxic pollutants. Generally lichens growing on trees are affected, this was not apparent at the mine site and their species diversity in the two study sites suggests they are not susceptible.

Losses of soil crust forming lichens occur when their habitat is damage by vehicle movement and high stocking rates of hard hooved animals; particularly goats, sheep and cattle (Eldridge and Tozer 1997 pp 64-65). At Hillgrove mine site the only stock are Kangaroos which are relatively low in density and their tracks showed no signs of lichen destruction?

Conclusions and recommendations

The harvesting of lichens, liverworts and mosses when dehydrated on the soil may be achieved by soil surface vacuuming using a leaf sucker. The spores and microscopic particles may be separated using a micro-pore filter. The bulk of cryptogam plant matter can be collected in a bag for later re-hydration.

Alternatively strips of native soil with various populations of lichens, liverworts and mosses may be scraped from native sites and spread over sites to be rehabilitated. It has been proposed that hydro-suspensions of various cryptogams and native grass seed, along with a polymer sicking agent could be used to spray and rehabilitate large areas of the mine site. After the application assessments would then be made in winter to determine the species that rapidly colonise soil or rock.

Artificial techniques to manually replace patches of crust have been tested interstate and overseas, i.e. "the use of both wet and dry slurries of salvaged crust to regenerate areas where the crust has been destroyed" (Eldridge and Tozer 1997 p 65). One method is to harvest the top few centimetres of soil which contain the beneficial soil inoculum. The soil-crust salvage method needs to have a minimum storage time and be done when dry, since many of the organisms photosynthesise and are only active when wet.

Soil harvesting can best be achieved with minimum damage to the site by scaping the top 2 cm of soil:

> "In long discontinuous strips which run perpendicular to the prevailing wing direction. These strips should be separated by well-developed soil crusts which will ensure that the scalped areas have the greatest chance of re-establishing" (Eldridge and Tozer 1997 p 66).

The lack of sporophyte (spore) bearing structures on liverworts and moss species identified at both Hillgrove mine site and Frahns Scrub may be indicative of soil type, climatic conditions and colonisation to new sites (Glime, 2005 Chapt. 4-5) the findings suggest a limited reserve of propagules for re-establishment and vegetative material may be needed in the rehabilitation process at Hillgrove mine site.

Re-establishment is encouraged by free-living cyanobacteria in the crusts and can enhance the production of soil nitrogen and promote the establishment of lichens and mosses. This can be achieved by amendment of the wet slurry of cryptogams and seed with starch (Eldridge and Tozer 1997 p 66). A 10% molasses solution has also been shown to encourage the cyanobacteria development.

Dry harvesting of cryptogams e.g. lichen, liverwort and moss mats along with spore material in the upper 2 cm soil layer may also be achieved using a portable leaf vacuum. The dry friable mat of cryptogams and soil microbes can then be rehydrated with a starting seed inoculum diluted 1:8 or less, and after one hour sprayed thinly over the site to be rehabilitated. It is recommended that rapid growing herb and grass seed be used in this mixture to create a shade barrier for the cryptogams.

References

Catcheside D.G. 1980. Mosses of South Australia. Government Printer, South Australia.

Eldridge D. and M.E. Tozer 1997. A practical guide to Soil Lichens and Bryophytes of Australia's Dry Country. Department of Land and Water Conservation, Star Printey Sydney.

Filson R.B. and R.W. Rogers 1979. Lichens of South Australia. Government Printer, South Australia

Glime, Janice M. 2008 *Bryophyte Ecology*. Volume 5. Uses. Ebook sponsored by Michigan Technological University and the International Association of Bryologists. http://www.bryoecol.mtu.edu/ .