A COMPARATIVE STUDY OF IMPACT OF OPEN CAST COAL MINING ON AVAILABILITY OF SOIL MICRO-ORGANISMS LIKE BACTERIA, ACTINOMYCETES AND FUNGI IN BOTH MINING AREAS OF JHARIA COALFIELD AND NON-MINING AREAS (BALIAPUR AND SINDRI) OF DHANBAD, JHARKHAND ALONG WITH SIGNIFICANCE OF STRATEGIES NEEDED FOR THE MANAGEMENT OF DEGRADED LAND TO HAVE IDEAL SOIL ENVIRONMENT AND IMPROVED BIODIVERSITY OF SOIL INSECTS

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ABSTRACT
Coal is very important fossil fuel resource which fulfills the ultimate energy requirements. Jharia coalfield is known for its prime coking coal resources in the world. For effective coal extraction open cast mining is done on large scale in JCF. Due to blasting, drilling and excessive use of explosives the top most layer of the soil gets severely damaged. The availability of soil nutrients gets completely disturbed by open cast mining activities due to which presence of soil micro-organisms like bacteria, actinomycetes and fungi also gets affected. Availability of soil micro-organisms like bacteria, actinomycetes and fungi etc. is very significant because such organisms play major roles in promoting effective soil ecosystem. This paper presents the results of the study carried out in both mining and non-mining areas. The availability of soil micro-organisms like bacteria, actinomycetes and fungi etc. in both mining (Lodna and Bastacola) and non-mining areas (Baliapur and Sindri) was assessed and compared. It has been observed that in non-mining areas the stable and effective soil environment have excellent availability of organic matter and all other physico-chemical parameters due to which micro-organisms like bacteria, actinomycetes and fungi are found in good numbers whereas mining areas do not have similar soil environment and hence due to degraded soil ecosystem, poor availability of organic matter the soil micro-organisms remain in lowest number. The present comparative study of soil are very vital to understand that how open cast mining activities are damaging the ideal soil environment. The obtained results are also very beneficial for planning the rehabilitation programmes for Jharia coalfield so that degraded land can have ideal soil environment and improved Biodiversity of soil insects.

Keywords: Fossil fuel, Open cast mining, Top soil, JCF, Environment, Ecosystem, Biodiversity, Rehabilitation

INTRODUCTION
In recent years increasing emphasis on open cast mining has resulted in an unprecedented increase in waste dumps. Prime coking coal in Jharia coalfield is also being extracted by mainly opencast mining. In open cast mining due to heavy blasting and excess use of explosives the most valuable fertile top layer of soil which is the natural resources of feeding zone of plant is spoiled. Several ecological problems like changes in land use pattern, land degradation, modification of topographical features, disturbance to plant and animal communities are being caused by surface mining activity. Surface mining activities increase the soil erosion leading to the formation of depleted topsoil and subsequent loss of wild life, livestock productivity and may create biological deserts. Odum (1971) included soil erosion as a part of soil pollution and Rama Rao (1962) called soil erosion as creeping death of the soil. All such problems are existing in throughout the Jharia coalfield but the eastern side of Jharia coalfield like Lodna and Bastacola are heavily disturbed.

Due to opencast mining the fertile soils get lost which ultimately cause adverse ecological impact. The opencast mining damages the original vegetation due to which the flora as well as fauna population get depleted. Opencast mining disturbs the soil profile sequences very badly. In the abundance sites natural vegetation succession is much slower than areas where soil layers are in the natural sequence (Bradshaw and Chadwick 1980, Marss et al 1981 and Roberts et al 1981). It has been observed that due to the impact of overburden materials the soil usually have great deficiency of major nutrients. So, all such factors are affecting the presence of soil micro-organisms like bacteria, actinomycetes and fungi etc in mining areas of JCF.

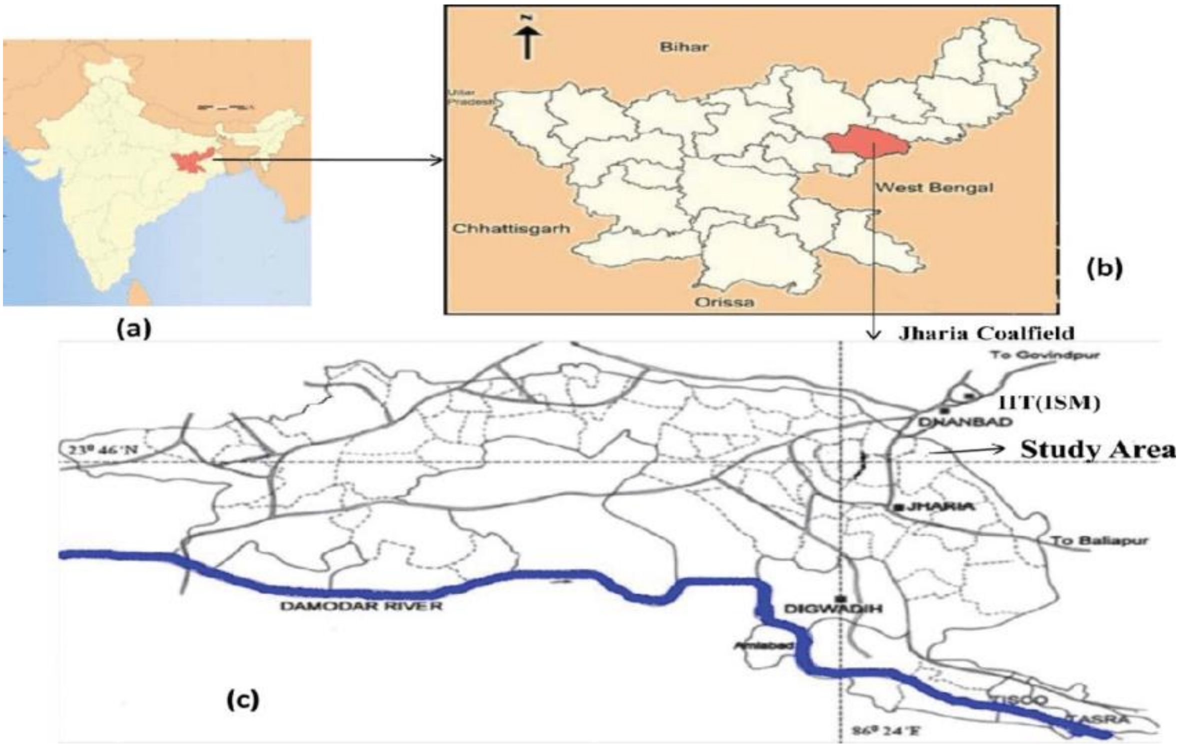
MATERIALS AND METHOD

SAMPLING SITES

To study the impact of open cast coal mining Bastacola and Lodna areas of Jharia coalfield were selected prominently. From Bastacola five different sites i.e Kuiya Open cast, Golakdih Open Cast, Bera Open Cast, Ghanuadih Open Cast, and Kusunda Open Cast of Area No. IX of JCF were selected. Similarly, from Lodna again five sites i.e. Ginagora Open Cast, South Tisra Open Cast, North Tisra Open Cast, Kujama Open Cast and Central Surunga Open Cast of Area No. X of JCF were selected. Bastacola and Lodna are heavily mining affected areas of JCF.

Baliapur and Sindri are non-mining areas. From Baliapur five samples were taken from D.A.V.,School, Rangamati, Baghmara Village, Krishi Vigyan Kendra, Samalapur Village and Hawaipatti Baliapur. Similarly, from Sindri again five sites i.e Rohrabandh F.C.I. Hospital, Manohartand Village, S.P.M. College Domgarh, PDIL Sindri Saharpura Gate and Sindri Basti Sindri were selected to collect the soil samples.

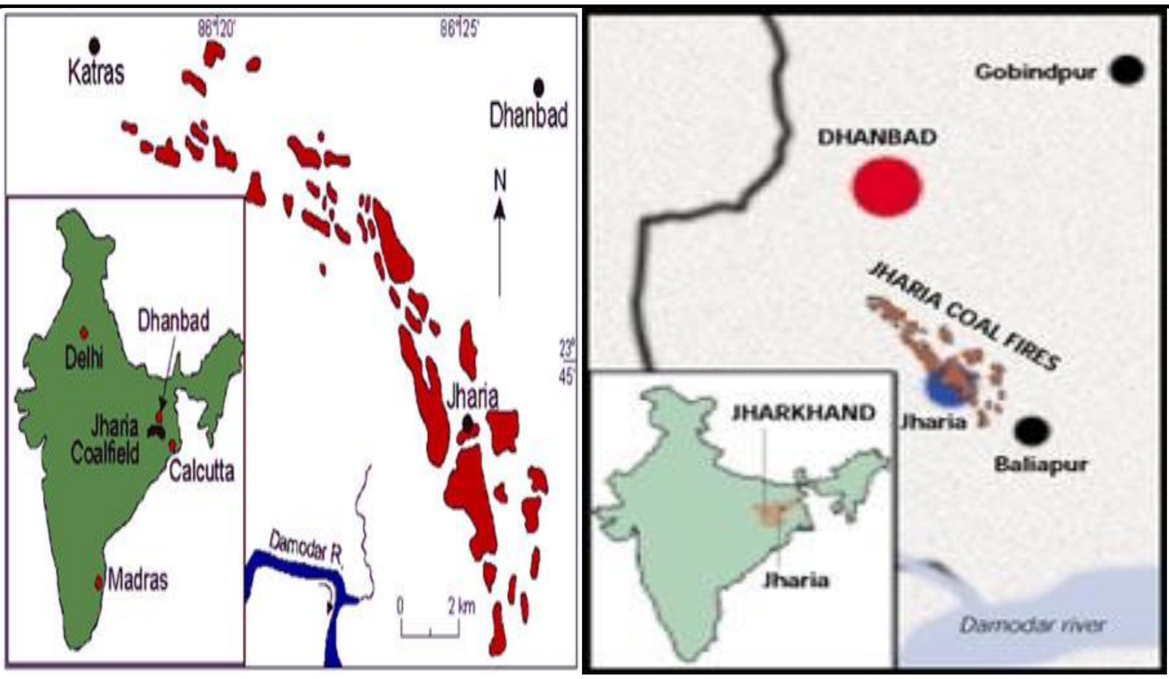
LOCATION OF STUDY AREAS



LOCATION MAP OF STUDY AREA
(The Geological Survey of Jharia Coalfield was done in 1930 by C.S. Fox.)

GEOGRAPHY

Jharia is located between the co-ordinates 23.7516^0 North latitude and 86.4203^0 East longitude. This coalfield is located at the heart of the Damodar Valley. The altitude of Jharia is about 77 meters and area about 450 km^2. The field is roughly sickle shaped. The coal basin extends for about 38 km in an east-west direction and a maximum of 18 km in north-south direction. Jharia is known for abundant reserves of coal. Jharia is a major contributor to Jharkhand's economy as it is considered as the only source of coking coal in our country.



GEOGRAPHICAL STATUS OF STUDY AREA

ENUMERATION OF BACTERIA, ACTINOMYCETES AND FUNGI

Soil was collected from the upper or outermost layer usually the top 2 inches (5.1 cm) to 8 inches (20 cm) from both mining and non-mining areas.

ESTIMATION OF BACTERIA AND ACTINOMYCETES

I.SAMPLE COLLECTION

To study the presence of bacteria and actinomycetes samples of soil were collected from the rhizosphere zone from both mining and non-mining areas . To check the presence of these soil micro-organisms 'Plate Count Spread Method' was adopted. Preparation of media for bacteria and Peptone-yeast Agar was done very carefully. Peptone 5 g, yeast extract-3 g, agar-15 g were added in 1 L of deionized water. The process of autoclaving was allowed at 15 mm pressure for a period of 15 minutes and after that it was cooled to 45°C. 10 ml of 0.1 $CaCl_2$ was added to the hot solution. The pH was adjusted to 7.0 with conc. HCl after the process of autoclaving.

II PREPARATION OF MEDIA FOR ACTINOMYCETES:

These are the gram positive bacteria which form branching hyphae usually 0.5-1 µ diameter. Williams and Wellington Medium was used for the actinomycetes starch-casein agar.

CHEMICAL COMPOSITION OF STARCH CASEIN AGAR

S.NO.	CONSTITUENTS	AMOUNTS
i.	Starch (Soluble)	10.0 g
ii.	Casein (Vitamin free)	0.3 g
iii.	Sodium Chloride (NaCl)	0.2 g
iv.	Potassium Nitrate (KNO_3)	0.2 g
v.	Potassium dihydrogen phosphate (K_2HPO_4)	0.2 g
vi.	Magnesium Sulphate ($MgSO_4$,$7H_2O$)	0.05 g
vii.	Calcium Carbonate ($CaCO_3$)	0.02 g
viii.	Ferrous Sulphate ($FeSO_{4,}7H_2O$)	0.01 g
ix.	Agar	18 g
x.	Cyclohexamide (Heat Stable)	50 mg
xi.	Distilled Water	1000 ml

The pH was adjusted to 7 after autoclaving with 0.1 N HCl.

III. PROCEDURE

STEP 1: PREPARATION OF DILUTION SERIES

a. 10 g of soil was dissolved in 95ml of dilution water in a dilution bottle and the bottle was shaken in horizontal position for 10 minutes with the help of mechanical shaker.
b. 1 ml of suspension from the bottle was removed by sterile pipette and it was added to a tube containing 9 ml dilution water. After this the three most diluted suspensions were plated.

STEP 2: PREPARATION OF PLATES : For each dilution three replicates were prepared. Thus total 9 plates were required.

STEP 3: INOCULATION OF THE PLATES

a. Three spread plates were prepared for the bacteria of dilution 10^{-3}, 10^{-4},10^{-5}.
b. Dilution 10^{-2},10^{-3},10^{-4} were used for the actinomycetes.
c. 0.1 ml of each dilution was put for bacteria on three separate lebelled peptone-yeast agar plates and for actinomycetes on starch casein plates.
d. A spreader was taken and dipped into ethanol then a burner was flamed to ignite the ethanol. After cooling of the spreader the drop of inoculum was spread around the surface of the agar until all traces of free liquid got disappeared.
e. The same procedure was repeated with next plate.
f. The bacteria and actinomycetes plates were incubated at room temperature for one week and two weeks respectively.

STEP 4:COUNTING OF BACTERIA AND ACTINOMYCETES

The total number of bacterial colonies and actinomycetes colonies were counted.

CALCULATION

$$\text{No. of microbes of dry soil/g} = \frac{\text{Average no. Of colonies X Dilution Factor}}{\text{Dry Weight of the Soil}}$$

ESTIMATION OF VESICULAR ARBUSCULAR MYCORRHIZA (VAM) FUNGI

VAM Fungi are widespread and significant root symbiants of all mycorrhizal association. About 80 % of all land plants form this type of mycorrhiza. Most families of leguminosae are host of these fungi. Mycorrhiza (Pleural mycorrhiza) means fungus root which is formed by the association between a plant and a fungus. Majority of plants remain involved in these association. Endomycorrhiza are known as VAM fungi which are Zygomicotina and Asomycotina group. They form vesicles and arbuscules within the cell (intracellar) of root cortex. They serve as organ of storage and transfer of carbon compounds and mineral nutrients between the fungal hyphae and host plant.

I. COLLECTION OF FUNGI

Approximately 500 g of rhizosphere soil was taken along with feeder roots and collected in polythene bags from both mining and non-mining areas.

MATERIALS

a). Spade b). Sampling Bottle (filled with 50 ml of fixative solution) for collection of feeder roots c). Plastic Bag and Stickers d). Refrigerator e). Fixative Solution : Formaldehydrade 37%, glacial acetic acid and ethanol in the ratio of 5:5:90 (13 ml formalin was mixed with 5 ml glacial acetic acid in 200 ml 5% ethyl alcohol).

METHOD

a. First few cm of soil surface was removed to eliminate plant debris.
b. 25-30 cm of soil was dig to have plant roots.

c. The feeder roots were kept in sampling bottle.
d. Soil sample was kept together with roots in a plastic bag.
e. The bottles and bags were numbered.
f. The sample was stored in a refrigerator at 4°C until analysis.

II.PROCEDURE FOR ASSESSING THE PRESENCE OF VAM
REQUIRED CHEMICALS AND REAGENTS

a. H_2O_2 Solution (3%)
b. KOH Solution (10 %)
c. Tryphan Blue Solution: 0.5 g of Tryphan Blue was dissolved in 500 ml of glycerol and 450 ml of distilled water along with 50 ml of 1% of HCl solution were added.
d. Destaining Solution: Lactophenol (20g Phenol, 20g Lactic acid, 40 g Glycerine)
e. Mounting Medium: Having acetic acid and glycerol (1:1).

METHOD

a. The feeder roots were washed and immediately put in FAA solution.
b. The root pieces were washed with water and the attached soil particles were removed.
c. The roots were cut into 1 cm pieces.
d. Roots were put in 10% KOH solution and boiled at the temperature of 90°C for 1-2 hours.
e. The roots were allowed to cool and after that washed with water twice or thrice.
f. The roots were acidified with 5 N HCl for a few minutes and then rinsed thoroughly with distilled water for twice or thrice.
g. The root segments were stained with 0.05% trypan blue and excess stain was removed by Lactophenol (20g Phenol 20 g Lactic acid 40 g Glycerin).
h. The root segments were mounted on slides containing acetic acid : Glycerol (1:1).
i. The mounted root segments were examined under microscope at 100 and 400 magnification.

RESULT AND DISCUSSION

ENUMERATION OF MICRO-ORGANISMS (BACTERIA, ACTINOMYCETES AND FUNGI)

SITE	AREA	NO. OF BACTERIA ($X10^5G^{-1}$)	NO. OF ACTINOMYCETES ($X10^5G^{-1}$)	NO. OF FUNGI ($X10^5G^{-1}$)
MS1	MINING AREA	8.2-16.3	5.1-11.4	3.2-9.4
MS2	MINING AREA	8.9-16.8	5.7-11.8	3.6-9.9
MS3	MINING AREA	6.2-13.1	3.3-8.6	2.1-6.6
MS4	MINING AREA	5.1-12.4	3.0-8.1	2.1-6.2
MS5	MINING AREA	6.5-14.4	3.9-9.8	2.4-7.9
MS6	MINING AREA	6.9-14.8	4.0-10.1	2.6-8.1
MS7	MINING AREA	7.3-15.4	4.2-10.3	2.8-8.9
MS8	MINING AREA	7.6-15.7	4.8-10.7	3.0-9.1
MS9	MINING AREA	9.1-17.0	6.2-12.1	4.1-10.3
MS10	MINING AREA	9.8-17.4	6.5-12.6	4.4-10.8
NMS11.	NON-MINING AREA	44.6-69.0	40.3-58.1	36.2-56.3
NMS12.	NON MINING AREA	46.1-70.2	42.9-59.4	37.7-57.6
NMS13.	NON MINING AREA	46.8-70.3	43.2-60.3	38.2-58.3
NMS14.	NON MINING AREA	49.0-72.1	44.7-61.5	39.3-59.8
NMS15.	NON MINING AREA	47.2-71.0	43.5-60.6	38.7-58.6
NMS16.	NON MINING AREA	45.2-69.1	41.6-58.7	36.6-56.9
NMS17.	NON MINING AREA	48.1-72.3	45.1-62.2	40.1-60.2
NMS18.	NON MINING AREA	47.5-71.8	44.1-61.2	39.1-59.2
NMS19.	NON MINING AREA	45.9-69.7	42.2-59.0	37.2-57.3
NMS20.	NON MINING AREA	49.4-73.8	45.9-62.8	40.8-60.7

A) AVAILABILITY OF MICRO-ORGANISMS IN MINING AREAS

In Kuiya Open Cast of Bastacola Area No. IX the number of bacteria, actinomycetes and fungi were found 8.2-16.3, 5.1-11.4 and 3.2-9.4 respectively. In Golakdih Open Cast the number of bacteria, actinomycetes and fungi were found 8.9-16.8, 5.7-11.8 and 3.6-9.9 respectively. In Bera Open Cast the number of bacteria, actinomycetes and fungi were found 6.2-13.1, 3.3-8.6 and 2.1-6.6 respectively. In Ghanuadih Open Cast the number of bacteria, actinomcetes and fungi were found 5.1-12.4, 3.0-8.1 and 2.1-6.2 respectively. In Kusunda Open Cast the number of bacteria, actinomycetes and fungi were found 6.5-14.4, 3.9-9.8 and 2.4-7.9 respectively.

In Ginagora Open Cast of Lodna Area No. X the number of bacteria, actinomycetes and fungi were found 6.9-14.8, 4.0-10.1 and 2.6-8.1 respectively. In South Tisra Open Cast the number of bacteria, actinomycetes and fungi were found 7.3-15.4, 4.2-10.3 and 2.8-8.9 respectively. In North Tisra Open Cast the number of bacteria, actinomycetes and fungi were found 7.6-15.7, 4.8-10.7 and 3.0-9.1 respectively. In Kujama Open Cast the number of bacteria, actinomycetes and fungi were found 9.1-17.0, 6.2-12.1 and 4.1-10.3 respectively. In Central Surunga Open Cast the number of bacteria, actinomycetes and fungi were found 9.8-17.4, 6.5-12.6 and 4.4-10.8 respectively.

B). AVAILABILITY OF MICRO-ORGANISMS IN NON-MINING AREAS

In D.A.V. School, Rangamati of Baliapur Area the number of bacteria, actinomycetes and fungi were found 44.6-69.0, 40.3-58.1 and 36.2-56.3 respectively. In Baghmara Village the number of bacteria, actinomycetes and fungi were found 46.1-70.2, 42.9-59.4 and 37.7-57.6 respectively. In Krishi Vigyan Kendra the number of bacteria, actinomycetes and fungi were found 46.8-70.3, 43.2-60.3 and 38.2-58.3 respectively. In Samlapur Village the number of bacteria, actinomycetes and fungi were found 48.0-72.1, 44.7-61.5 and 39.3-59.8 respectively. In Hawaipatti of Baliapur Area the number of bacteria, actinomycetes and fungi were found 47.2-71.0, 43.5-60.6 and 38.7-58.6 respectively. In Rohrabandh Near F.C.I. Hosp. of Sindri Area the number of bacteria, actinomycetes and fungi were found 45.2-69.1, 41.6-58.7 and 36.6-56.9 respectively. In Manohartand Village the number of bacteria, actinomycetes and fungi were found 48.1-72.3, 45.1-62.2 and 40.1-60.2 respectively. In S.P.M. College, Domgarh of Sindri Area the number of bacteria, actinomycetes and fungi were found 47.5-71.8, 44.1-61.2 and 39.1-59.2 respectively. In P.D.I.L., Saharpura of Sindri Area the number of bacteria, actinomycetes and fungi were found 45.9-69.7,42.2-59.0 and 37.2-57.3 respectively. In Sindri Basti of Sindri the number of bacteria, actinomycetes and fungi were found 49.4-73.8,45.9-62.8 and 40.8-60.7 respectively.

The highest number of soil micro-organisms like bacteria, actinomycetes and fungi was found in Sindri Basti of Sindri 49.4-73.8, 45.9-62.8 and 40.8-60.7 respectively which is a non-mining site whereas the lowest number 5.1-12.4, 3.0-8.1 and 2.1-6.2 respectively was found in Ghanuadih Open Cast of Bastacola Area No. IX which is a mining affected area **.**

In non-mining areas the stable and effective soil environment have excellent availability of Nitrogen, organic matter and all other physico-chemical parameters due to which micro-organisms like bacteria, actinomycetes and fungi are found in good numbers whereas mining areas do not have similar soil environment and hence due to degraded soil ecosystem, poor availability of Nitrogen and organic matter the soil micro-organisms remain in lowest number. The present study shows that the availability of total nitrogen in mining areas was less as compared to non-mining areas due to excellent growth of some medicinal and leguminous plants like Dalbergia sissoo, Melia azedarach, Polyalthia longifolia, Tectona grandis, Alstonia scholaris in non-mining areas as these plants have strong association with VAM fungi which help the soil to maintain ideal quantity of Nitrogen. The Nitrogen activity in the root nodules have been reported by Pokhriyal et. al (2003) . The ideal quantity of Nitrogen and other nutrients available in the soil positively affect the growth of plants which promote the ideal survival of micro-organisms like bacteria, actinmycetes, fungi and several soil insects as well. Fassi et.al (1972) have also reported that high humified organic matter is beneficial for the establishment of bacteria, actinomycetes, mycorrhiza and several other soil organisms. The plants like Neem, Babool, Ashoka, Eucalyptus, Sisum, Teak etc. in abundance have efficient colonization of VAM (Habte and Manjunath, 1991) due to which absorption of nutrients become very effective. So such factors contribute a lot in maintaining excellent vegetational condition for the ideal growth and survival of soil micro-organisms like bacteria, actinomycetes, fungi and soil insects in non-mining areas. The micro-organisms like bacteria, actinomycetes and fungi along with several soil organisms are playing very significant roles in maintaining the soil ecosystem and ideal microbial activities as they are making the soil nutrients easily available to the plants for ideal vegetation**.** According to Brown and Lugo (1994) degraded ecosystem returned to productivity with the help of bacteria, fungi mycorrhiza and they improve the soil fertility. The interaction of microbes with various other soil animals like beetles and different soil insects were studied by microbial ecologist **(**Davidson et.al 2002), which showed the importance of food web interaction in determining the structure and activity of soil microbial communities. It proved that soil microbial communities have great significance in ecosystem.

SIGNIFICANCE OF STRATEGIES NEEDED FOR THE MANAGEMENT OF DEGRADED LAND CREATED DUE TO OPENCAST MINING TO HAVE IDEAL SOIL ENVIRONMENT & IMPROVED BIO-DIVERSITY OF SOIL INSECTS

As opencast mining activities are responsible for damaging the topmost layer of the soil therefore, the soil insects and various micro-organisms are bound to live in acute stressed conditions. Hence, to check harmful effects and sustainable development of mining affected regions environmental management plan is of great significance (Jha, A. K. & J. S. Singh. 1993).

In the barren overburden dump soil temperature and other physical factors do not allow growth of soil insects and other soil organisms in the absence of grasses and biomass. Therefore, efforts need to be done so that grasses can be grown to have biomass. Thus, the soil organisms will appear and sustainable development of a disturbed site would take place. As it is clearly known that biodiversity leads to stability of ecosystem . Higher the level of biodiversity lesser is the time required for reaching the stability of the ecosystem.

In mining areas land degradation and the formation of overburden dumps are important environmental concerns. In transforming a disturbed mined land into economically usable land form, time, money and good geological fortune are required. The degraded land of mining areas must be restored to productive and aesthetic uses.

The overburden dump rock mass must be used in reclamation of mined out areas for developing effective post mining land uses. The available dumps in mining areas must be scientifically made reclaimed and rehabilitated. To accelerate the process of natural recolonization of restored mined land suitable species of plantation is needed .

For effective reclamation of mining affected areas all the efforts should be made to have ideal vegetation. Soil insects and several micro-organisms play significant roles in keeping the natural soil ecosystem in excellent condition naturally but to have ideal population of these soil insects in mining areas efforts should be made to provide favourable growing conditions hence, herbs, shrubs and trees should be allowed to grow in mining affected areas in large numbers. This will modify the physico-chemical properties of the mining soils through constant litter production which will also increase the microbial activity of the soil. With such efforts the soil environment which was very harsh just after mining will improve and change gradually to hospitable condition through natural succession.

Soil insects need to be promoted in mining areas because these insects enhance the productivity of overburden dumps by increasing draught tolerance of plant and Phosphorus availability which are limiting factor for plant establishment.

The soil insects along with several other micro-organisms are very essential for our ecosystem but they are dependent on effective vegetation directly or indirectly for their natural growth and survival. Therefore, plantation of variety of plants for example babool, neem , eucalyptus, teak, sisum etc. need to be promoted with great sincerity in mining affected areas. This will lead to the formation of a diverse and stable ecosystem.

For effective biological reclamation of degraded mine site grasses & bamboo species must be planted on slopes and the ideal pattern of herbs, shrubs and tree species plantation should also be followed.

NEED TO GROW CERTAIN SPECIES OF PLANTS ON DEGRADED LAND OF MINING AREAS TO IMPROVE SOIL ENVIRONMENT AND BIO-DIVERSITY OF SOIL INSECTS

To have ideal soil environment, improved biodiversity of soil insects and effective rehabilitation in open cast mining affected areas mixed species of following plants must be selected to grow on degraded land as such plants remain colonized with VAM fungi which facilitate them to survive even in stressed soil environment (Singh, A. N., A. S. Raghubanshi & J. S. Singh. 2002) :

S.N.	COMMON NAME	SCIENTIFIC NAME	GENERAL USE
01	Babool	Cassoa seamea	Medicinal
02	Ashoka	Polyalthia Longifolia	Medicinal
03	Neem	Azadirachta indica	Medicinal
04	Acacia	Acacia auriculoris	Medicinal
05	Aakash Neem	Melia azedarach	Medicinal
06	Teak	Tectonia grandis	Wood
07	Siris	Albijja lebbek	Medicinal & Timber
08	Shisham	Dalberjia sissoo	Timber
09	Sal	Shorea robusta	Timber
10	Arjun	Terminalia arjuna	Medicinal & Timber
11	Imli	Tamarinuds indica	Medicinal & adible fruit
12	Palas	Butea monssperma	Fuel wood & erosion
13	Gulmohar	Delonox regia	Aesthetic
14	Eucalyptus	Eucalyptus tereticornis	Timber
15	Katha	Acacia catechu	Erosion mestigatory

CONCLUSION

The availability of organic matter was excellent in non-mining areas due to higher accumulation of leaf litter and their rapid decomposition to form humus. The availability of total Nitrogen in mining areas was found lesser as compared to non-mining areas because organic matters get accumulated in the soil of non-mining areas by roots and leaching of Nitrogen from heavy vegetation. In non-mining areas the growth of medicinal and leguminous plants like Dalbergia sissoo, Melia azedarch, Polyalthia longifolia, Tectona grandis , Alstonia scholaris takes place very ideally. These plants have great association with Vesicular Arbuscular Mycorrhiza (VAM) due to which total Nitrogen get accumulated in ideal quantity so due to the presence of higher amount of mineralizable matter growing plants get essential amount of Nitrogen which ultimately influences the soil fertility. The lack of ideal plantation in mining areas results lesser accumulation of total Nitrogen.

The ideal quantity of Nitrogen and other nutrients along with high humified organic matter available in the soil of non-mining areas positively promote the survival of micro-organisms like bacteria, actinmycetes, fungi in large number whereas due to less availability of Nitrogen and organic matter in the soil, mining areas have poor availability of such micro-organisms. The present study reveals that soil micro-organisms like bacteria, actinomycetes and fungi etc. are found in maximum number in non-mining area (Sindri Basti, Sindri 49.4-73.8,45.9-62.8 and 40.8-60.7 respectively) whereas these soil micro-organisms are found in least number in mining area (Ghanuadih Open Cast of Bastacola Area No. IX 5.1-12.4, 3.0-8.1 and 2.1-6.2 respectively). Availability of soil micro-organisms like bacteria, actinomycetes and fungi etc. is very significant because such organisms play major roles in making the soil nutrients easily available to the growing plants for effective vegetation. Thus the availability of soil micro-organisms in large number promote ideal habitat for soil insects as such insects are directly or indirectly dependent on effective vegetation of the concerned area. The availability of soil insects and other micro-organisms in large population in non-mining areas have improved the structure, nutrient cycling and biological process of the soil so well whereas the poor availability of these soil fauna in mining areas have resulted the degraded soil ecosystem so the excellent availability of all such micro-organisms supported natural habitat as well as ideal growing conditions for the soil insects.

The soil insects along with micro-organisms living in mining areas are the most suffering organisms. As open cast mining activities involve heavy blasting, drilling and excessive use of explosives due to which removal of earth crust of several feet depths takes place and thus the top soil vegetation, nutrient quality and fertility of the soil all get severely damaged in mining affected areas.. The top most layer of the soil is not only responsible for providing shelter to soil organisms but it is also responsible for the establishment of ideal biological circumstances for effective growth and survival of soil insects. So, the environmental impacts of open cast coal mining must be assessed periodically and to have improved environmental conditions the available overburden dumps must be levelled to make a plan area and the selected plant species should be planted to make it a green land suitable for the growth of soil insects which play vital role in food chain. By doing this the mining area will turn into a green field vegetation with ideal bio-diversity which is the need of the time for the life of the earth.

Generally, the plants growing over barren land of mining areas are under severe stress due to poor availability of essential soil nutrients and moisture contents which hamper the ultimate vegetation of the mining affected areas but when the above mentioned plant species will be allowed to grow in large number then due to constant litter production organic matter of the soil will be improved which will promote microbial activites of the soil and thus the physico-chemical characteristics of mining soil will also get improved.

Thus, the improved vegetation condition will allow the soil insects and several other soil micro-organisms to appear in large number which would be very beneficial to maintain the natural soil environment and ideal bio- diversity status of the soil insects in open cast mining affected areas.

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