International Journal of Pure and Applied Zoology
Volume 4, Issue 1, pp: 12-17, 2016
http://www.alliedacademies.org/international-journal-of-pure-and-applied-zoology/

ISSN (Print) : 2320-9577
ISSN (Online): 2320-9585

Review Article

SOIL EXPLORATION: FAUNA AND FLORA VERSUS MACHINE

Aliyu Umar Mohammed*

Department of Biology, Federal College of Education Katsina, PMB 2041, Katsina, Katsina State, Nigeria

Article History: Received 4th January 2015; Accepted 3rd June 2015

ABSTRACT

This paper highlights the utilization of biotechnology embedded in fauna and flora for the detection, exploration and monitoring of surface and underground water and mining of minerals; which is much cheaper than using electronic equipments and gadgets. The examples are the biotechnology embedded in Stygobites (in relation to stygophiles and stygoxenes) is utilized in the detection of contamination of the interstitial zone by heavy metals in some sectors of the Rhone River (France), which has surpassed that of electronic pollution monitoring systems. Coal deposits were detected in Sweden from the presence of *Viscaria aplina* flower in fields and plants such as *Stackhouse tyronii* and *Hybanthus floribundus* were used in Australia to identify lead and nickel respectively. Plants that were found to have high levels of Selenium are used to locate Uranium. Professional water locators use special electroseismic equipment and ground penetrating radar to detect underground water. These are very expensive, high tech and require a lot of skill and training to operate the equipments. These can be substituted by biotechnology e.g. a well-developed termitarium is usually built around an underground spring. Furthermore, the biotechnology embedded in aquatic insects of the family *Heteroptera*, e.g. *Sigara* (which needs water for its reproductive cycle), and Elephants (that use infrasound to detect underground water), has led to the development of a water vapor detection device. In addition, geologists have for long been able to cheaply conduct soil exploration to detect minerals by simply analyzing the soil beneath termitariums. This same technique lead to the identification of the Vila Manica copper deposit in Mozambique in 1973 as well as the Jwaneng Diamond mine. The biotechnology in Marmots is also utilized to explore unearth gold. German Shepherd dogs have been used to locate nickel sulphides and gold orebodies. The least money needed for an upstream mechanized exploration in Africa is about $45.32 million while the highest investment needed for the same mineral exploration using biological means is about only $10,000. Consequently the biotechnology embedded in fauna and flora should be considered as cheap replacements for machines for the sustainable development of Nigeria.

Keywords: Biotechnology, Fauna, Flora, mechanized exploration, biological exploration, minerals, monitors.

INTRODUCTION

Animals, plants and microbes utilize chemical signaling which enable them to explore their environments, recognize food and detect the presence of toxins. Other functions of chemical signaling include recognition of prey, predators, pathogens, etc. besides identifying family and friends and the recognition of reproductive mates (Garvey, 2012). Therefore such signals could be used as biotechnology to subsidise various fields of human endeavors in the field of science and technology especially the areas of water monitoring and mineral prospecting in Nigeria and around the world.

Nigeria is currently in dire need of huge income and revenue in order to carry out the much needed developmental projects such as portable water and exploration of minerals that will bring in the much needed revenue to governments at all levels. Unfortunately, the exploration of these resources requires the use of sophisticated machines and gadgets, which cost hundreds of million dollars. Consequently, Nigeria has for long been hindered from reaping the benefits that lies in the exploration of its natural resources. Fortunately, all hope is not lost as research have shown that the biotechnology embedded in fauna and flora can facilitate the

*Corresponding author e-mail: wooddust.comp@yahoo.co.uk,

exploration of Nigeria's natural resources quickly and at minimal costs.

Fauna and Flora in Water Monitoring

Before the 1960s, determining the quality of ground water was only possible through the assessment of hydrological, hydrogeological and hydrochemical variables. However, thereafter numerous agencies started utilising the invertebrate fauna present in ground water to detect sources of water pollution e.g. of such agencies are The US Environmental Protection Agency, the French Water Agency and so on (Malard *et al*., 1996).

Ground water ecology initiated the use of invertebrates as biomonitors of ground water quality. And it has been beneficial in the detection of heavy metal contamination in the interstitial zone of some sectors of the Rhone River (France). Water pollution is confirmed whenever the population of *Stygobites* becomes scarce in relation to that of *stygophiles* and *stygoxenes*. This innovation provided data that are much more reliable than that of electronic monitoring systems of pollution (Malard *et al*., 1996). And these biotechnologies can promote the monitoring of water pollution in Nigeria at a much cheaper rate than the use of expensive machines and gadgets.

Many professional water locators use special electroseismic equipment that sends seismic waves through the ground to detect the movement of any existing water below the ground surface. The seismic waves are monitored with a computerized device and a ground penetrating radar, both of which come at a high cost of $3.5 m UD dollars (Jain, 2012; USGS, 2012). However the same job of locating water can be done cheaply using biotechnology. For example, according to Wilderness Survival Skills website, insects can be utilized to locate water, because insects are usually found in areas with water and that animals tend to stay near water sources. Therefore animal tracks or presence of insects are signs of water near the surface. This technique will make it possible to find spring water without having to waste many resources to dig hundreds of feet into the ground (Jain, 2012).

Similarly, insects like gnats and mosquitoes need water for nourishment, therefore they will be highly active in areas having water near the surface soil. In addition, birds that feed on insects usually congregate around a water body to seek for food (insects) and water during early morning and late evening. This is also true for worms, snakes and other invertebrate species (Waverly, 2012). Animal tracks, regularly leading to and from a particular area, from different directions, indicate animal migration to water sources. Usually areas where such animals congregate are close to surface and or underground water bodies.

Furthermore, a particular land area with much more dense vegetation than its surrounding (which may be normally dry or sparsely populated) is a sign of the presence of underground water. The presence of brighter and more vibrant colored plants in a particular area is also a confirmation of water availability therein (Waverly, 2012).

Aquatic insects such as the *Heteroptera* (true bugs), e.g. *Sigara*, use the polarization pattern in order to find water habitats which it needs for its reproductive development. Similarly, Elephants utilise infrasound to detect underground water. These techniques have led to the development of water vapor detection devices such as the Mars Time Domain Electromagnetic Sounder (MTDEM), which uses induction to detect groundwater, located 5 km deep from the Marsian surface (Futterknecht *et al*., 2012).

Termites need water to protect themselves against drying and death. Available literature indicates that the Relative Humidity within the nest is between 99 - 100 % so as to keep the termites alive and kicking. Whenever a part of a termite nest is damaged, the workers immediately rush to that point and repair it with wet soil, which has been previously stored in the nest. The wet soil can only come from a wet section of the nest located near an underground water body. Therefore a well-developed termitarium is found only where there is adequate underground water (Krell, 1996).

Fauna and Flora in prospecting for minerals

The hardest part of mining has always been finding where the ore deposits are located. In the olden days there were few techniques of processing soil to detect ore deposits e.g. historical records of old mines, magnetic surveys, geo-morphology and advanced laboratory techniques. These are very expensive, high tech and require a lot of skill and training to operate the equipments involved. However, currently fauna such as insects and other animals are being considered as a first port of call for miners (Latimer, 2012).

According to Latimer (2012) people in northern parts of India and Pakistan have for long been able to collect gold from soil brought to the surface when ants dig their burrows and tunnels.

Insects have for long been used for soil prospecting, particularly for gold and nickel. In Africa, ancient African civilisations used termitariums as a starting point for mineral exploration. In their quest for water, termites often dig down to about 70 m and in some cases more (Latimer, 2012). The author added that, geologist can cheaply determine the types of minerals present below and around a termite mound by examining the soil samples brought to the surface by the termites. The information gathered will determine whether further exploration will be economically beneficial or not. A similar technique was utilized to establish the Vila Manica copper deposit in Mozambique and a DeBeers geologist discovered a piece of limonite (a classic diamond indicator) in a termite mound, and which lead to further exploration and to the discovery of the Jwaneng Mine (Latimer, 2012).

An interesting report by Robert Brooks in Episodes, indicated that metal deposits were discovered after it was noticed that animals became sick from metal poisoning, after browsing on land located on old mines (Latimer, 2012). For example, about 200 µg/g of lead were discovered from a farm close to a Roman lead workings, after the death of numerous cattle and horses at the same area, which was confirmed to be as a result of lead poisoning. Similarly, Uranium was also discovered in a field when some animals browsing in the same field fell sick after eating plants containing high levels of selenium. And since selenium is often associated with uranium, it was easy to determine the location of the uranium from the distribution of such plants (Latimer, 2012).

In Sweden, Russia, Finland, and Norway, the mining industry have taken advantage of the biotechnology in dogs such as the German Shepherds, Australian Koolies and Belgian Shepherds and trained such dogs to find ore bodies, so as to meet the requirement for nickel sulphides by their steel industries. For example, when a dog named Lari was made to compete against a human in the mid 60s, it discovered 1330 sulphide bearing boulders in a field while the man discovered only 270 surface traces. Later that same year Lari discovered a very high amount of copper ore (Latimer, 2012).

Many floras have also been utilized in mining. The technique has been recorded as being used in China since the 5th century BC. For example the *Viscaria aplina* flower was used to discover copper deposit such as the Viscaria copper mine in Sweden, because it grows in association with copper deposits. Similarly, the plants Stackhouse *tyronii* and - *Hybanthus floribundus* were used as lead and nickel indicators in Australia (Latimer, 2012). Bloodwoods were similarly utilized to discover a geobiological pattern over the Coyote mineralization (Latimer, 2012).

A probable economic model to calculate monetary gain of the biological exploration usage in a large scale analysis

From Table 1 above it is obvious that the cost of exploration through biological means is much cheaper than through mechanized exploration. The least money needed for an upstream mechanized exploration in Africa is about $45.32 million (USEIA, 2012) while the highest investment needed for exploration in Africa is about $45.32 million (USEIA, 2012) while the highest investment needed for the same mineral exploration using biological means is about only $10,000.

For the Biological exploration (BE) method, to be considered better than the Mechanized exploration (BE), difference between the total cost of ME and BE most be higher than the total cost of BE. Therefore,

Comparative benefit (CB) =

Total expenditure of ME - Total expenditure of BE = $45,320,000 million - $10,000

CB = $45,310,000

Therefore the comparative benefit of using biological exploration method over mechanized exploration method is $45,310,000, which means that the annual gain when BE is utilized is equivalent to $45,310,000.

Why Flora and Fauna are not widely used for exploration

Unfortunately, inspite of the above stipulated gain that will be accrued from utilizing biotechnology in soil exploration, BE is yet to gain the much popularity it deserves because it is a new field and there are very few experts in the field currently. However it will gain more patronage in the near future when universities around the world start offering BE as a course on its own.

Negative Impacts of Biological Exploration

- ✓ BE is slow
- ✓ It not as precise as ME
- ✓ Profit level cannot be easily determined
- ✓ It is difficult to determine at the onset whether the quantity of mineral deposit present is viable

Negative Impacts of Mechanized Exploration

Human, socio-economic and cultural problems of mechanized exploration: Exploration and production operations lead to economic, social and cultural changes (UNEP IE/PAC Technical Report 37, 1997).

How land is used in agriculture e.g. fishing, hunting and logging. In addition to poorly planned settlement and poor exploitation of natural resources. Others are poor housing, education, healthcare, water, fuel, electricity, sewage and waste disposal, and consumer goods preparations; besides weaknesses in recreational use, tourism, and historical or cultural resources etc.

Table 1. Comparison of Machine-based versus Bio-based exploration.

Activity	Machine- based exploration requirement	Bio-based exploration requirement
Desk study: identifies area with favourable geological conditions	Requires a lot of review Cost- $ 150,000	Requires some review Cost - $ 100
Aerial survey	Low-flying aircraft over study area Cost - $ 3,100,000	Not required
Seismic survey	*Access to onshore sites and marine resource areas *Possible onshore extension of marine seismic lines *Onshore navigational beacons *Onshore seismic lines *Seismic operation camps Cost - $ 18,000,000	Not required
Exploratory drilling	*Access for drilling unit and supply units *Storage facilities *Waste disposal facilities *Testing capabilities *Accommodation Cost - $ 5,500,000	Not required
Appraisal	*Additional drill sites *Additional access for drilling units and supply units *Additional waste disposal and storage facilities Cost - $ 6,000,000	Monitoring and evaluation Cost - $ 2,000
Development and production	*Improved access, storage and waste disposal facilities *Wellheads *Flowlines *Separation/treatment facilities *Increased oil storage *Facilities to export product *Flares *Gas production plant * Accommodation, infrastructure *Transport equipment Cost - $9,000,000	Cost - $7,000
Decommissioning and rehabilitation	*Equipment to plug wells *Equipment to demolish and remove installations *Equipment to restore site Cost - $ 1,000,000	Not necessary

Sources: UNEP IE/PAC Technical Report 37 (1997).

Air pollution

Various gasses are emitted and they pollute the air e.g. carbon dioxide, carbon monoxide, methane, volatile organic carbons and nitrogen oxides. Others include sulphur dioxides and hydrogen sulphides. The UNEP IE/PAC Technical Report 37 (1997) reported that the primary sources of atmospheric pollution emissions from oil and gas operations arise from: Gas flaring, venting and purging of gases; in addition to poor combustion processes in diesel engines and gas turbines; others include release of fugitive gases from loading operations and tankage and losses from process equipment; in addition to the emission of airborne particulates during construction, from vehicle traffic; and well testing.

Water Pollution

During explorations activities mud and cuttings are released into the ocean and this increase the levels of hydrocarbons that are harmful to a large number of aquatic organisms (UNEP IE/PAC Technical Report 37, 1997). These water pollutants include inorganic salts, heavy metals, solids, production chemicals and hydrocarbons. Others include benzene, PAHs, and radioactive materials (NORM) (UNEP IE/PAC Technical Report 37, 1997).

Terrestrial impacts

Terrestrial impacts arise activities related to construction e.g. spillages, leakages and disposal of solid waste activities. These leads to disruption of soil structure and that lead to erosion. In addition it leads to changes in surface hydrology and drainage patterns allowing for siltation and habitat damage and these reduces vegetation and wildlife (UNEP IE/PAC Technical Report 37, 1997).

Ecosystem impacts

Changes in the quality of water, air and soil and sediment quality, noise, extraneous light and changes in vegetation cover changes ecological factors such as habitat, food, nutrient supplies and breeding areas in addition to migration routes, vulnerability to predators and weaknesses in herbivore grazing patterns. Erosion, siltation and poor vegetation weaken the soil nutrients and activity of microorganisms and eventually leads to loss of fauna and flora (UNEP IE/PAC Technical Report 37, 1997).

Potential emergencies

Many unwanted incidents can occur e.g. fuel, oil, gas, chemical spills. Others include fires, explosions, flood, earthquake, thunder, war etc., as spelled out by UNEP IE/PAC Technical Report 37 (1997).

The better possibility of the usage of machine-based exploration

Vegetation (especially endangered, protected and commercial species) and all water sources such as aquifers should be preserved using shot-hole method in place of vibroseis (onshore). There should be adequate drainage systems e.g. segregated and contained drainage, sumps, oil traps, drip pans etc. to handle spills and leakages of hazardous chemicals. In addition oils, fuels and other explosive materials need to be stored properly before eventual disposal. All waste materials e.g. oily water, oil sumps, litter, waste pits, in fills etc. should be properly treated, containerized or buried at a depth of 1m. Before discharge, sewerage must be properly treated to prevent discolouration and visible floating matter. Low toxicity water-based drilling mud should replace oil-based muds (OBM) and mud pits should be dried. In addition exhausts materials e.g. Carbon (iv) oxide, Hydrogen Sulphide etc. handled appropriately. The exploration site should be restored to its original state at the end of exploration exercise.

CONCLUSION

The enormous natural resources present in Nigeria and around the world can be quickly and cheaply explored by utilizing the biotechnology embedded in fauna and flora. Biotechnology should also be considered as cheap replacement for the expensive machines and gadgets used currently for mineral exploration, because that will lead to the sustainable development of Nigeria and other underdeveloped countries around the world.

ACKNOWLEDGMENT

The author is thankful to the Head of the Department of Biology, Federal College of Education Katsina for the facilities to carry out the work.

REFERENCES

Futterknecht, O., Macqueen, M.O., Karman, S., Diah, S.Z.M. and Gebeshuber, I.C., 2012. Inspiration from functional biomaterials in honeybees and elephants: Development of Miniaturized devices for navigation and water detection. Biomaterial symposium, 19-21, November 2012, Wien, Vienna, Austria.

Garvey, K.K., 2012. Professor honored for chemical ecology. University of California. www. university of California.edu/news/articl /28112.

Jain, H., 2012. How to find Land with Spring Water. eHow Contributor. www.ehow.com.

Krell, R., 1996. Value-added products from beekeeping. Food and Agriculture Organization of the United Nations Rome, pp. 7-8.

Latimer, C., 2012. Working like a Dog. Australian mining. www.miningaustralia.co m.au.

Malard, F., Plenet, S. and Gibert, J. 1996. The use of Invertebrates in Ground Water Monitoring: A Rising Research Field. 16(2): 103-113.

UNEP IE/PAC Technical Report, 1997. Environmental management in oil and gas exploration and production. An overview of issues and management approaches. A joint Oil Industry International Exploration and Production Forum (E&P Forum) and the United Nations Environment Programme Industry and Environment Centre (UNEP IE) Technical Production. UNEP IE/PAC Technical Report 37.

USEIA, 2012. How much does it cost to produce crude oil and natural gas? Frequently Asked Questions. A United States Energy Information Administration (USEIA).

USGS, 2012. How Do Hydrologists Locate Groundwater. United States Geological Survey (USGS): http://ga.water.usgs.gov/ed u/gwhowto find.

Waverly, J.S., 2012. Detecting Underground Springs in Your Yard. eHow Contributor, www. ehow. Com.