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ALGAE ASSOCIATED WITH ALLUVIAL GOLD OF INDUS AT ATTOCK

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ABSTRACT

Soil algal flora from auriferous alluvials of the river Indus in the vicinity of Attock Fort were studied. In all 31 species belonging to 18 genera were found. The blue green genera were Aphanocapsa (1 sp.), calothrix (1 sp.), Chroococcus (3 spp.), Gloeothece (1 sp.), Lyngbya (1 sp.), Merismopedia (1 sp.), Nostoc (1 sp.), Oscillatoria (8 spp.), Phormidium (3 spp.), Stichosiphon (1 sp.) and Symploca (2 spp.). The Chlorophyceae found belong to 6 genera viz., Gloeocystis (1 sp.), Microspora (1 sp.) and Ulothrix (1 sp.). Xanthophyceae was represented by a single plant, Heterococcus. This is the first study of algae found in relation with gold and may help in gold prospecting.

INTRODUCTION

The prime object of this work is to determine and explore the algal flora which has some degree of correlation with the presence of gold in the soil. This work is a new approach to the geobotanical prospecting of the minerals and the first step to carry out a preliminary exploration of algae in this direction. Some work has been done in this field on the higher plants.

The soil samples used in this work were collected from the alluvials of the Indus river in the vicinity of Attock Fort. The extraction of gold from the alluvials of the Indus river has been in practice for centuries. This practice has also been reported from the alluvials of the Hunza, Gilgit and Chitral rivers. The distribution of gold in these alluvials is erratic. According Tahirkheli (1974), most of the favourable localities containing washable auriferous alluvials may roughly be located north of Attock, 34° North, and between 71° 31′ E and 76° E.

The Indus river originates at an elevation of 17,000 feet on the northern flank of Kilash mountain in Tibet and before it joins the Indian ocean near Karachi, it flows for about 2,000 miles. The upper reaches of the Indus, upstream of Attock, are mountainous and its alluvials are gold-bearing (Tahirkheli, 1974).

The Indus bed in the vicinity of Attock is about 900 feet above sea level, which culminates to over 3,500 feet and 6,500 feet elevations upstream around

Chilas and Skardu, located in Diamir and Baltistan Agencies respectively (Tahirkheli, 1960).

In 1973, Geolgical Survey of Pakistan undertook a project to examine the mineral deposits of parts of the Indus, Gilgit, Hunza and Chitral rivers. During the survey it was observed that gold washing activity has been confined mostly to the stretch between Attock and Skardu. The maximum and minimum gold contents in the vicinity of Attock Fort was determined to be 0.0038 and 0.0086 oz/ton (Ahmad *et al.*, 1975).

In general gold concentration is 0.001 ppm in igneous rocks, 0.002 ppm in soils and 0.005 ppm in plant ash (Hawks and Webb, 1962; Brooks, 1972).

In the early 1930, Goldschmidt, a pioneer in Geochemistry was the first to make the suggestion that analysis of plant material might be an effective method of prospecting for minerals. In later years this method of exploration came to be known as the biogeochemical method, following the terminology of Vermadsky, the Russian geochemist, (Hawks and Webb, 1962).

Nemec *et al.* (1936) reported 610 ppm of gold in the ash of *Equisetum palustre*. Later workers also found gold in *Equisetum arvense* as 63 ppm (Brooks, 1972). Cannon *et al.* (1968) however, did not find gold exceeding 0.5 ppm in 40 species of *Equisetum* found in the United States. In a grass *Lagochilus intermedius* gold was found to be 36 ppm. In general gold is 0.005 ppm in plant ash but relatively higher percentage of gold has been observed in *Salsola rigida, Haplophyllum robustum* and *Girgensohnia* and in upper branches of *S. arbuscula, S. carinata,* and *Cryptodiscus didymus* (Brooks, 1972). Toxicity of gold is small (Hawks and Webb, 1962; Brooks, 1972).

The present study is only a preliminary exploration of the algal flora. Due to lack of analytical facilities, the quantity of gold in the plants obtained was not determined and left out for future study.

MATERIALS AND METHODS

Soil samples were taken from the upper 6" depth of the Indus alluvials in the vicinity of Attock Fort. The soil was from the original site from when gold was reported. Samples were cultured in petridishes containing soil extract (Faridi, 1971). On the visible growth, algae was observed microscopically. All the diagrams made by camera lucida are original.

DISCUSSION

From the very early times it has been recognized that plants are often indicative of the type of substrates upon which they grow and that a number of plant species have a preference for certain types of elements and that this factor can be used for prospecting of minerals (Brooks, 1972).

The use of vegetation as guide to mineralization includes two fields of study: biogeochemistry and geobotany. Biogeochemical methods of exploration depend on the chemical analysis of plants or humus to obtain evidence of mineralization in the substrate, whereas geobotanical methods involve a visual survey of the vegetation cover in order to detect mineralization by means of plant distributions, the presence of indicator plants, mutational or morphological changes induced by excess of certain elements in the substrate (Brooks, 1972; Hawks & Webb, 1962).

Biogeochemical methods of prospecting which depend on the chemical analysis of the vegetation are based on the assumption that an element in the soil or bed rock will be accumulated by the plant in reporducible manner and that consequently anomalous amounts in the vegetation will indicate anomalies in the substrate (Hawks & Webb, 1962).

A universal characteristic of the indicators is that they will have a high element content in their ash (Brooks, 1972).

Indicator plants are divided into two main classes according to their distribution. The first group comprises the universal indicators which will not grow in non-mineralized regions and can be used in any region in which they occur. These indicators are valuable in prospecting since their presence almost always indicates a high soil concentration of the element being sought, however, they do suffer from the disadvantage of limited distribution range. Great success has been obtained with their aid. Examples are the discovery of copper in Zambia by use of *Becium homblei,* and the use of *Astragalus* for discovering Uranium in Colorado plateau (Brooks, 1972; Hawks & Webb, 1962). Another group of plants comprise the local indicators which are species adapted to tolerating mineralized ground but which will grow elsewhere provided that competition from other species is not too great. Such indicators are usually considerably more common than universal indicators but have the disadvantage that they are often only useful in a limited area (Brooks, 1972).

The use of vegetation as a guide to mineralization is a field of research which is essentially multidisciplinary in scope and which involves diverse subjects such as botany, geo-botany, biochemistry, biogeochemistry, biogeography, chemistry, geochemistry, geology, soil science and statistics. These multi-disciplinary aspects have tended to discourage research in this field since today is the age of specialization where workers skilled in "General Science" are becoming increasingly rare.

The role of microorganism, particularly algae, as indicators of minerals is completely unknown. Therefore the present study is the first move in this direction.

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PLATE I

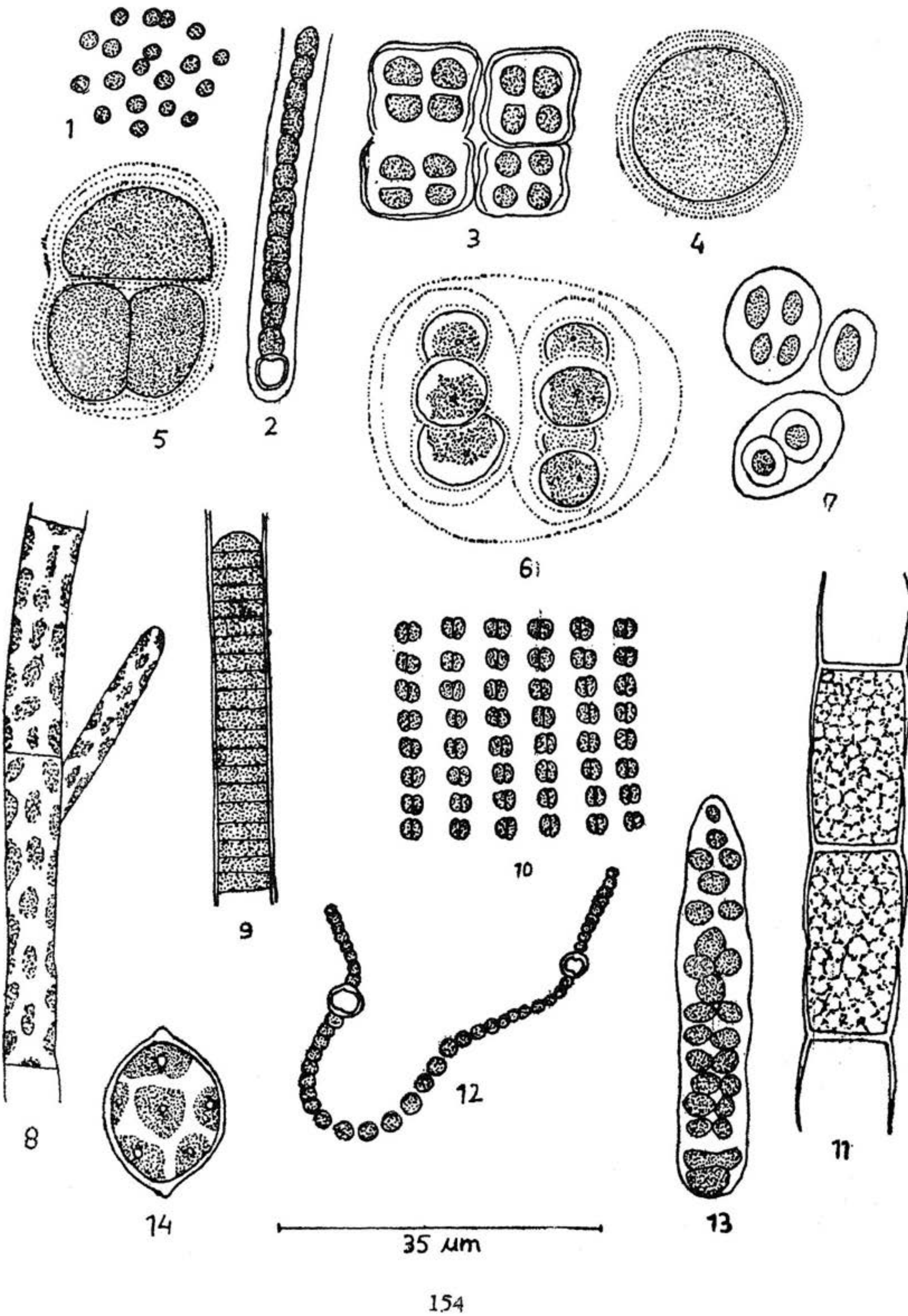

PLATE 2

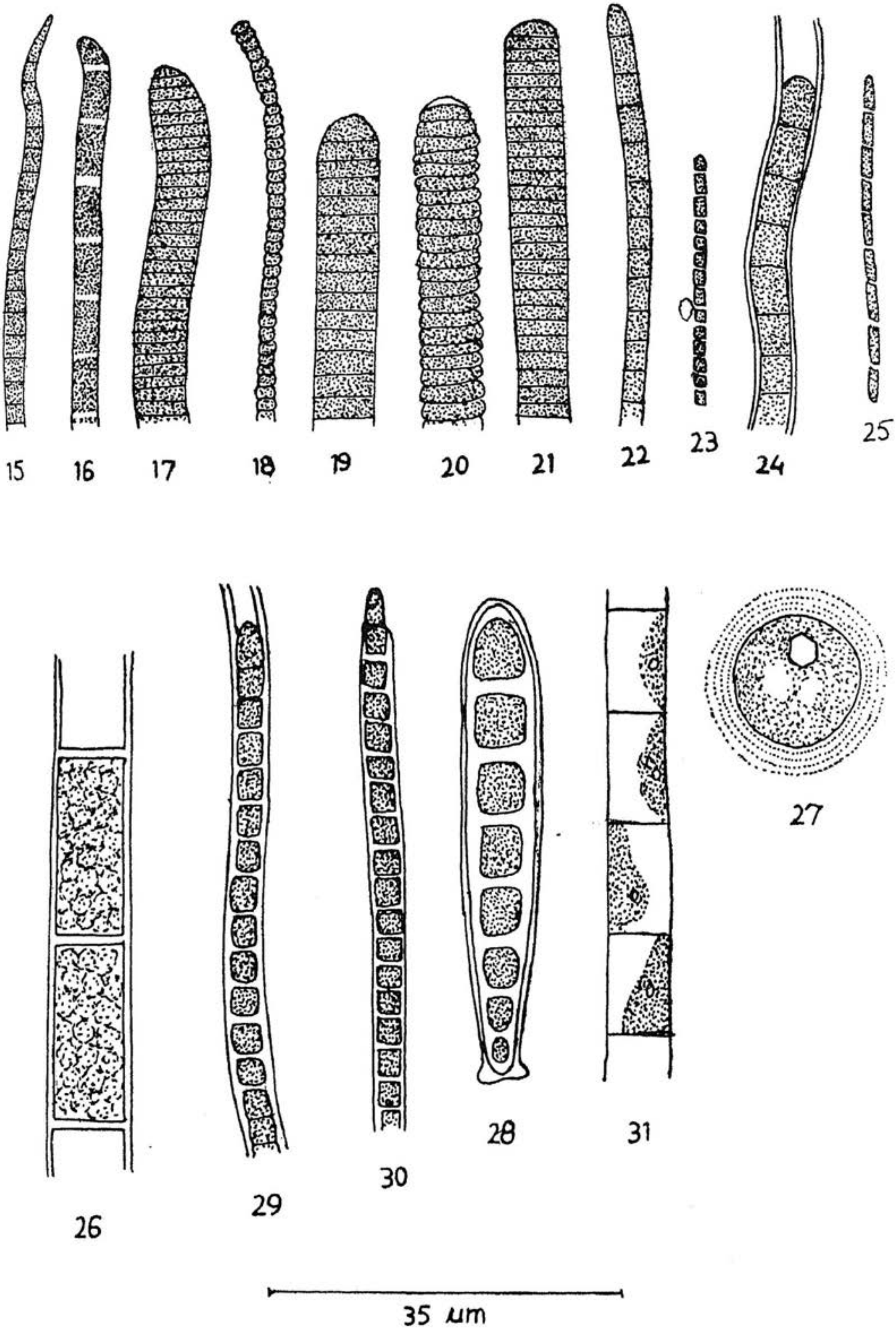

PLATE 1

SPECIES	FIG. NO.
Aphanocapsa montana	1
Calothrix brevissima var. moniliform	2
Chroococcus cohaerens	3
C. macrococcus	4
C. turgidus	5
Gloeocystis gigas	6
Gloeothece rupestris	7
Heterococcus longicellularis	8
Lyngbya hieronymusii	9
Merismopedia tenuissima	10
Microspora crassior	11
Nostoc calcicola	12
N. punctiforme	13
Oocystis crassa	14

PLATE 2

SPECIES	FIG. NO.
Oscillatoria animalis	15
O. chlorina	16
O. curviceps	17
O. foreaui	18
O. limosa	19
O. sancta	20
O. subbrevis	21
O. tenuis	22
Phormidium fragile	23
P. tenue	24
P. purpurascens	25
Rhizoclonium hieroglyphicum	26
Spongiochloris lamellata	27
Stichosiphon sansibaricus	28
Symploca cartilaginea	29
S. muscorum	30
Ulothrix variabilis	31

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