Current Status of Korean Lichen Research –Beginning and Prospect

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Abstract

Lichen is one of the most widely distributed eucaryotic organisms in the world. Lichen is the result of a symbiotic association between two unrelated organisms - a fungus and an alga (or cyanobacterium). Researches in Korean lichens were mainly focused on investigation of Korean lichen flora and most of them were primitive and short-term based projects until 1990's. In this communication, current status and prospect of Korean lichen research are briefly discussed with emphasis of KoLRI (Korean Lichen Research Institute) activities and roles in national research projects on bioresource development in Korea.

I. What lichens are

Lichens are unique in the world of vegetation in that they cannot be neatly classified into any of the ordinary categories we think of as "plants". The reason is simple: a lichen is not a single entity, but a composite of a fungus and an organism capable of producing food by photosynthesis. Lichen fungi can associate with green algae or cyanobacteria, or sometimes both. The special biological relationship found in lichens is called symbiosis. The resulting composition of a fungus and its photosynthetic symbiont (photobiont) has been such an evolutionary success that there are close to 14,000 species of lichens in the world, tremendously diverse in size, form, and color. They are found from the poles to the tropics, from the intertidal zones to the peaks of mountains, and on every kind of surface from soil, rock, and tree bark to the backs of living insects.

Lichenization is one of the most successful methods by which fungi fulfill their requirement of carbohydrates from a photosynthetic partner. The fungus produces a thallus or body, within which the photobionts are housed and protected from adverse stresses such as UV and dryness. The fungi that form lichens belong, for the most part, to the Ascomycetes. There are almost 30,000 species of ascomycetes, almost half of which form lichens. A large and diverse variety of ascomycetes, including 13 major groups (orders) out of 43, are represented among the lichens. Because such a large number of unrelated fungi are involved in lichen formation, biologists know that lichens have not evolved from a common ancestor. There are about 25 genera of green algae, a few golden algae, one brown alga, and 12 genera of cyanobacteria that become associated in lichens as photobionts. Another few are algae of other kinds. Only a dozen genera, however, represent the photobionts in the

vast majority of lichens.

The appearance of each lichen is determined almost entirely by the genetic information contained in the fungus, which, in most cases, determines the lichen's structure. Evidence of various kinds suggests that every recognizable lichen is derived from a different species of lichenized fungus. For this reason, the name we give to a lichen is actually the name of its fungal component. When we say, "This lichen is *Cladonia cristatella*", we mean that the fungus of the lichen *is Cladonia cristatella*; the photobiont has its own name, in this case, the green algae *Trebouxia erici*.

Lichens play a significant role in nature, influencing soil fertility, the growth of surrounding plants, and the formation of soil over bare rock or sand, as well as providing food, nesting materials and shelter for mammals, birds, and invertebrates. Lichens also have any commercial or practical values. People have used lichens over the centuries as food and decoration, and as a source of dyes, medicines, poisons, and fiber. More recently, they have been employed mainly in the manufacture of perfumes and antibiotics, and as pollution monitors and indicators of old growth forests. In Asian countries such as Japan, Korea and China, one kind of rock tripe, called rock mushroom (*Umbilicaria esculenta*; 石耳), has been used as medicine and food for a long time. During the past 20 yr there has been a resurgence of interest in fungi and other microorganisms as source of novel, pharmacologically active molecules. Lichen-forming fungi produce a wide range of natural products among which approximately 350 secondary metabolites have been identified; many are unique to lichens and appreciable number have been shown to have several biological activities of potential economic values.

II. Researches on Korean lichens during the last few decays

Since Korean lichens were first reported by Hue on 1915, Japanese researchers mainly investigated flora of Korean lichens until 1945. Few Korean researchers have investigated the flora of Korean lichens from early 70's to 90's. According to Kim's report, there were 28 families, 52 genera and 217 species of Korean lichens. Many specimens of Korean lichens were supposed to be prepared and conserved at that time, but most of them are not available at this moment. Park (1990) also reported 17 families, 46 genera and 189 species of macrolichens in Korea. Her specimens were deposited at the lichen herbarium of Duke University. There were 248 species of lichens reported in North Korea.

Researches on Korean lichens until early 1990 were mainly focused on investigation of Korean lichen flora. However, most of the works were not submitted to international community and thus, were not approved internationally. Because there has been no research core for lichen study in Korea during the last 50 year, official specimen, data and information on Korean lichens have not been accumulated. Application of lichens to air pollution monitoring study was launched in Korea at early 1990. Recently, isolation of lichen-forming fungi and investigation on polysaccharides of Korean lichens were attempted.

III. Future works on Korean Lichens

Although Korean lichen flora has been investigated for the last few decays and some reports were worth of scientific citation, systematic classification of Korean lichen and proper organization of

Korean lichen flora are still far from the standard of international lichen societies. For identification of Korean lichens, systematic classifications of North American lichens, Japan lichens and European lichens are practically used because of no established systematic classification of Korean lichens. With use of these classifications, most of Korean lichens can precisely be identified at the level of order, family and genus, but hardly be identified at the level of species. Establishment of systematic classification of Korean lichens is the most fundamental and prerequisite work for Korean lichen research. Therefore, the information of individual lichens should be prepared, accumulated, and integrated into the whole frame requiring establishment of Korean lichen systematic classification. For example, characteristics of morphology and their description should be completed with visible evidences such as photos and drawings. Recently, KoLRI (Korean lichen Research Institute) at Sunchon National University started to collect the information and to construct D/B system accessible on-line by internet. In addition to morphological characteristics, information on spot tests, chemical compounds, and nucleotide sequence of 5.8S rDNA have also been prepared and accumulated. Molecular works on 5.8S rDNA of Korean lichens will provide with new features of Korean lichen classification and allow comparative study of Korean lichens with the lichens in other countries. Furthermore, long-term programs for raising researchers and expert groups (associations) should be established and continuously supported by national-base organizations.

Lichen specimens are usually deposited and conserved at specialized herbarium of university and national institute in USA, Japan, UK, and several countries. Unfortunately, there is no official lichen herbarium and special curators in Korea, so far. Establishment of Korean lichen herbarium is also needed in the near future. The herbarium will take charge of all specimens of Korean lichens and join the international exchange program of lichen specimens. Recently, the Japanese Society of Lichenology launched far-east Asian network of lichenology. Lichenologists in Korea and China were invited to participate the network for collaborate works. KoLRI is now ready to join the network to share information and natural bioresource.

Intact lichens cannot be cultivated readily and large-scale collection programs are likely to conflict with conservation interest. Laboratory cultures of lichen-forming and lichenicolous fungi provide a means by which lichen secondary metabolites can be produced for the purpose of evaluation in programs to discover microbial products. There have been several methods to isolate lichen-forming fungi from intact lichens. Although ascospore or intact thallus is mainly used to isolate the fungi, it is very difficult to obtain pure isolate of the lichen-forming fungus because of high rates of contamination, and low rates of germination and/or cultivation on artificial media. It is also difficult to distinguish lichen-forming fungal isolate from lichenicolous fungal isolates originated from the same lichen. Currently, isolation of lichen-from fungi from Korean lichens has intensively been attempted with several novel techniques such as micromanipulation and differential centrifugation. Molecular work on 5.8 S rDNA was also employed to identify the real lichen-forming fungal isolate from contaminated fungi. Few lichen-forming fungi of Korean lichens were successfully isolated. These isolates will be registered and deposited at KCTC as a type culture. Screening, isolation and chemical identification of their compounds having biological activity against pathogens and diseases will proceed in the near future.