FINAL REPORT

A COOPERATIVE PROGRAM FOR ECOSYSTEM RESEARCH IN KOREA

October 1966 – September 1968

Office of Ecology
Smithsonian Institution
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ECOLOGICAL STUDY IN KOREA

FINAL REPORT

by

Helmut K. Buechner

Edwin L. Tyson

Ke Chung Kim

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Foreword

The present planning study was prompted by Harold J. Coolidge, Executive Director of the Pacific Science Board of the National Academy of Sciences, who saw in the Demilitarized Zone of Korea, and the adjacent unoccupied strip, an unusual opportunity to determine the responses of vegetation and animal life to release from the impact of centuries of human activity. He also envisioned the possibility of converting the DMZ into a national park, if and when North Korea and South Korea reunite. In addition to familiarizing Korean scientists with the DMZ Study Area (outside the restricted zone) and initiating research projects, a 5-year plan was developed for a Korean Center for Environmental Studies involving a program of ecological research and education as an initial phase in an endeavor to broaden the biological bases for harmonious relationships between Korean society and its total environment. The plan accompanies this report. It is being reviewed by private foundations, government agencies in the U.S. and Korea, university faculty, scientists, and administrators with a view toward revision. It is already evident that the educational component requires further strengthening, the administrative structure needs further consideration, and the proposed projects must be more carefully selected in terms of relevance to the critical ecological problems in Korea.

The current military situation in Korea and financial austerity have militated against an immediate follow-up of the planning study.

However, the proposed program of ecological studies in Korea is not being abandoned. A revised 5-year plan will be ready when financial support and conditions in Korea are propitious for implementing a Korean Center for Environmental Studies.

The following document is composed of three parts: (1) the final program report of Edwin L. Tyson, Smithsonian Institution Field Representative in Korea and program manager; (2) review and recommendations by Ke Chung Kim, Department of Entomology, Assistant Professor and Curator of Insects, Pennsylvania State University (Consultant to the Smithsonian Office of Ecology on the Korean project); and (3) individual project reports.

Helmut K. Buechner

Helmut K. Buechner

Head, Smithsonian Office of Ecology
Principal Investigator

PART ONE

by

Edwin L. Tyson

Smithsonian Field Representative

and Program Manager

Introduction and Summary

The program of "Ecological Study in Korea" that was sponsored by the Smithsonian Institution and the Air Force Office of Scientific Research was initiated with the following objectives: (1) to provide a general description of the vegetation, animal life, soils, physiography, and climate of the study area; (2) to prepare appropriate vegetation and physiographic maps to accompany the descriptions; (3) to carry out a series of research projects of a preliminary nature on the physical characteristics, flora, and fauna of the study area by Korean scientists; and (4) to prepare a sound proposal for a long-range program to be submitted to granting agencies.

The program encountered the frustrations common to research conducted in developing countries. The major problems stemmed from the disparity of cultural background that exists between Korean investigators and their American colleagues. One view of the Korean attitude that is compatible with my own experience is expressed in a recent book by Paul S. Crane (1967. Korean Patterns, Hollym Corp. Seoul, Korea, 239 pp.). Koreans involved in scholarly pursuits are at or near the top of the status system, and all the influential positions are held by the older and less well-trained individuals, often at the expense of the younger, foreign-trained scientists.

Korea is rapidly moving forward in all areas of development under its present government. One of the most recalcitrant institutions to date, however, has been higher education. The young, foreign-trained scientists who find themselves relegated to minor positions in the less prestigious universities and colleges have started in recent years to move into government service. It is from their positions in the ministries, and especially the Ministry of Education, that change is being wrought today.

The consequences of overestimating the level of research sophistication of the Korean investigators is evident in the results of the program. The effort to develop maps of the vegetation and physiography of the study area was abandoned --partially as a result of increased military pressure in the area and partially because the scope of the project was too ambitious in terms of the time and manpower that were available.

A series of projects were launched by Korean investigators in an effort to develop information on the physical characteristics, flora, and fauna of the study area. The results of these studies are reviewed briefly in the body of the following report. While there are many flaws in both the objectives and methodologies of the individual projects, all of which has its roots, in my opinion, in the inadequacy of the educational system, they do represent, when taken as a whole, a considerable increase in our knowledge of the area and a contribution towards upgrading the biological sciences in Korea.

On this last point, the Smithsonian representative was able to ascertain the improvements being implemented by the Ministry of Education and support was quietly offered to him in most contacts with members of the scientific community. Many discussions were held with scientists who were translating textbooks into the Korean language and with investigators who were working on the research projects of this program. On the basis of these informal contacts, together with the formal, routine work of project administration, the contributions of this program during its 21 months of operation to the development of Korean science can be stated as follows:

1. For the first time scientists from several universities worked together in relative harmony on a simple unified project.
2. University scientists discovered they could work with various governmental agencies, especially the Ministries of Defense, Education, and Science and Technology with mutually beneficial results. It was forcefully brought out that the ministries would support research if its significance to the country could be illustrated.
3. The younger, more progressive scientists were introduced to the possibility of obviating the conservatism that impedes progress in the development of Korean science. Many were surprised, for example, that some of the proposals submitted

by established but untrained professors were rejected, while the proposals of many of the younger men were accepted.

In summary, the greatest contribution to Korean scientists has been in exposing the general scientific gap that exists between Korea and the Western countries, and in demonstrating, through the experience of this program, the reforms that are necessary in both research and education before any substantial progress can be made. The long-range proposal, which was prepared well in advance of this final report, will represent, once the necessary administrative and organizational readjustments have been made, a mechanism capable of dealing with the basic problems at their source. Its emphasis on intensive education combined with a research orientation towards the basic studies that must necessarily underlie more complicated questions of ecosystem structure and function, will provide the Koreans with a competence that is badly needed and almost completely neglected at the present time.

SECTION ONE

Background and General Observations

Introduction

This brief description of the major environmental elements of Korea, north of Seoul, is based primarily on observations, impressions gained from reading many brief papers and reports, and on conversations with specialists in the various fields of research. Little mention is made throughout on sources of materials because of the rather informal nature of the descriptions.

Only one comprehensive bibliography of publications by Korean scientists is available (Korean Scientific and Technological Information Center, 1966.) Most of the fields of science have organized societies that publish journals devoted exclusively to each field and these journals publish current research reports.

Prior to 1945, most of the research in Korea was published by Japanese scientists. Before 1910, there were only a few research reports concerning Korea. Most of these were published by various Russian, German, Japanese, and French scientists who stopped in Korea for periods ranging from a few days to several months, usually as part on an overall trip to China, Manchuria, or eastern Siberia. These early workers laid a solid foundation for many in the environmental sciences, but in most instances, their work has not been continued by later Japanese or Korean scientists. Early Korean scientific achievements are reviewed in the UNESCO Korea Survey (1960).

Numerous scientists from many institutions in Korea and from outside organizations that have various research and development programs in Korea contributed to the impressions stated in this report. I wish to thank these people for their information. At the College of Liberal Arts and Sciences, Seoul National University, Drs. Kang Yung Sun and Hong Soon Woo, Mr. Yoon II Byung and Mr. Chung Yung Ho assisted me most. At the College of Education, Drs. Choi Ki Chul and Kim Choon Min have contributed, especially in the fields of icthyology and soils. Dr. Lee Tchang Bok, College of Agriculture and Forestry, Seoul National University, contributed ideas in plant taxonomy and general ecology. Dr. Won Pyung Oh, Kyung Hee University, discussed with me the vertebrate fauna, especially birds and mammals, and conservation in general. At the College of Medicine, Seoul National University, Dr. Rim Han Jong contributed information on human parasites and epidemiology of environmentally related diseases of man. Dr. Lee Yung No, Ewha Womans University, discussed plant taxonomical problems many times and Dr. Oh Ke Chil, Sogang Jesuit College, contributed in plant ecology. Persons from several other institutions contributed from time to time. Most assuredly, more help would have been forthcoming in most cases, but communications were hampered by my inability to understand the Korean language.

In my report I will list only a few of these institutions. In most instances several individuals were involved. Korea University, Dong Guk University, Yonsei University, Korea Union College, and the Asia Foundation are all examples.

Finally, I wish to thank the many members of the U. S. Forces in Korea and the Republic of Korea's Army who aided, protected, and helped in ways too numerous to mention. Persons from other non-Korean organizations often gave invaluable aid, namely J. T. Callahan, U. S. Operations Mission, and Joram Ekstein, State of Israel Aid Mission (on geological matters), and R. R. Shepherd, agronomist-entomologist, U. S. Eighth Army. Several people at both the U. S. Embassy and the British Embassy in Seoul were also helpful.

Location and Maps

The Republic of Korea (ROK) is a peninsula jutting southward from North Korea, and is separated from it by the military demarcation line that was established in 1953. On each side of the demarcation line there is a demilitarized zone (DMZ) two kilometers in width. Korea is bounded on the west side by the Yellow Sea, on the east side by the Sea of Japan, and on the south by the Korea Strait. It is located between 34°30' and 38°40' north latitude and 126°10' and 129°50' east longitude, with maximum distances of approximately 300 miles in a north-south direction and 200 miles in an east-west direction. It includes 38,000 square miles of land.

Contour maps of Korea, scaled at 1:50,000, may be purchased at most of the good stationery stores in Seoul. Road maps are provided by the Korea Tourist Bureau and are also on sale at the stationery stores and most of the large hotels. The Republic of Korea (ROK) Army Map Service also publishes a map scaled at 1:100,000, but it is not available for general distribution. U. S. Army maps of both 1:50,000, 100,000, and 250,000, with English names, can be obtained through the U. S. Army Map Service, Far East, or they may be acquired through the Engineer, U. S. Eighth Army, Yongsan, Seoul. Maps of the DMZ and adjacent areas scaled at 1:25,000 have been made, but they are not available for general use through Seoul sources.

Mapping has been developed into a fine art by the ROK Map Service as can be seen by the quality of the available maps. Data for these and other maps were obtained from undated Japanese sources, field reconnaissaince by the ROK teams, and by study of aerial photographs taken by the U. S. Forces in Korea.

Aerial photographs of the DMZ have been made from time to time since 1950 by the U. N. Command and the U. S. Forces in Korea, but these are not available for general use. Specific photos may be acquired by request to the U. S. Forces in Korea at Yongsan.

Meteorology

Korean climate and weather are dominated by two external factors, the first of which is the high pressure area that forms in the region of Lake Biakal, Siberia, and pushes cold air to the south and east in winter. The second is the warm, moist air from the middle Pacific Ocean that moves up the east coast of Asia in the form of typhoons and cyclones in summer, Thus, Korea has cold, dry winters and warm, moist summers. Temperatures are usually extreme for the latitude in both summer and winter, but mild and pleasant during spring and fall.

Korea has an ideal annual precipitation cycle for agriculture. Most of the 20 to 40 inches of rainfall occurs during the summer growing season for plants, with the heaviest rainfall being in July and August.

The Korean Central Meteorological Office maintains sixteen well equipped weather stations throughout ROK south of a line from Inchon on the Yellow Sea and Kangnung on the Sea of Japan. No well equipped station is within thirty miles of the DMZ. The Republic of Korea's (1966) economic development plan for the 1967-1971 proposes establishment of several more complete stations and it is hoped that some of these will be in the vicinity of the DMZ.

Meteorology in Korea in the past has been primarily aimed at forecasting. Future interests of Korean meteorologists will possibly be directed toward subjects of a more academic character, such as the effects of mountains on mass air movement, the effects of elevation on rainfall, and the distribution of organisms in relation to climatic elements. It is also expected that the presently developing interest in ecology will create an interest in micrometeorology in the future.

Geology

The ROK and the whole of the east Asia mainland may be described as a new world geologically (Kabayashi, 1953). The first geological report was by Gottsche (1884); his information was gained during an eight-month trip to Korea. Following this, little geological work was done until the Japanese began their systematic explorations of the mineral resources soon after 1910. Their publications became numerous in the 1930's and they reported more than 200 minerals. It was not until after the Korean Conflict ended in 1953 that Korean geologists became active in publishing.

The geology of South Korea at the DMZ is generally homogeneous in lithology and structure (J. T, Callahan, personal communications). Most of the rocks are quartz rich, and most of the materials have the chemical and mineral composition of granite. The most common minerals are quartz, orthoclase, feldspar, and biotite mica.

The rocks in the mountainous eastern half of South Korea near the DMZ consist of Granite gneiss of Precambrian age, granite of Createaceous age, and alluvium of the Quaternary age. In most of the mountainous areas, including those near the west coast, schists, gneisses, and other metamorphic rocks have been intruded by the younger granite. All the rocks have been metamorphosed as a result of earth movement both before and after intrusion of the granite.

In the valley of the Imjin River and its prominent tributaries, basalt flow-layers occupy a large part of the area. Basalt is at least 30 feet thick in places, and it appears to have flowed over alluvial sands of former river beds. The basalt flows appear to have been falted in places subsequent to emplacement.

Alluvium occupies the main river valleys and their tributaries. It consists of sands, gravel, cobbles, and minor amounts of clay and silt. The mineral content is mostly quartz, feldspar, and mica derived from the parent mountain. Alluvium deposits may be up to 40 feet deep in places, but it is usually much less than this. Depths of deposits decrease toward the headwaters of the rivers and streams to the point where little is found in much of the mountain area.

In general, alluvial valleys are broad and flat, and only slightly sloping toward the adjacent stream. The broad valleys are a result in part of the rapid siltation of river valleys that occured when Korea tilted in recent times (J. T. Callahan, personal communications) toward the Yellow Sea, and in part of hundreds of years of a rice paddy cultural practice of fertilizing paddies with rich clay soils which accumulate on the hillsides.

Geological studies by Korean scholars have extended the basic investigations of the Japanese, especially in exploration of oil and mineral resources. Numerous geological maps have been produced, especially of mineral-rich areas (Geological Survey of Korea, 1963-1967). The Geological Society (1956) published a map of both North and South Korea, made from current researches, Japanese reports, and sometimes simply by connecting lines between study areas. Mineral and oil explorations are accelerating; yet, some of the geologists are branching out into fields of academic interest.

Hydrology

The streams of Korea drain the peninsula from east to west, into the Yellow Sea, and the axis of drainage is from six to ten miles from the Sea of Japan. When the Korean peninsula tilted toward the Yellow Sea, the criginal drainage pattern was interrupted. Stream piracy is evident everywhere in the peninsula. This reversal of stream flow resulted in what appears to be abnormal thickness of alluvium along the streams and valleys of the interior and western Korea.

Ground water occurs in the crystalline rocks (granite, gneiss, schits, and other metamorphic rocks) in the cracks and fracture zones. These rocks generally have a low porosity. In many places extensive mineral alteration has taken place to depths of 100 feet or more. Only on the tops of bare ridges and cliffs, and in some cuts, is bed rock exposed. The weathered rock materials have a porosity of as much as 50 percent and contain ground water, usually below depths of five to fifteen feet. The depth of ground water is controlled by topography, water being found closer to the surface in the valleys.

Ground water occurs in the alluvium in the pore spaces of the uncemented sediments. The porosity of these sediments ranges from 50 percent in the clay and silty-clay layers to about 25 percent in the sand-gravel beds. Gravel beds have the highest permeability.

Intermittent and perennial springs flow from the crystalline rocks. Springs at the higher elevations are most likely to be intermittent because the water drains from the rock fissures constantly, and those at the highest levels stop flowing first, when the water table drops following the summer rainy season. Springs at the lower elevations and at or near the valley floor will most likely be perennial. The flow fluctuates from rainy (summer) to dry (winter) season as the rock fissures are drained, the water table drops, and the hydrologic gradient lessens.

Within abandoned rice paddies in the DMZ, the water table should be at or near the surface during the rainy season, and recede to depths of as much as ten feet during the dry season. With respect to land surface, the depth of the water table will be greatest in the higher parts of the paddy fields. Most of the rice paddies are underlaid by alluvium, but the upper few feet consists of clay and silt - partly due to natural deposition and partly because it has been brought in by the farmers as fertilizer and as a stopper to retard percolation of water through the porous alluvium.

With the continuing search for water for irrigation and hydroelectric power, it is inevitable that considerable emphasis will be placed on the development of water resources of the major rivers of Korea. Studies are being conducted on the Han River basin, and plans for future studies include all the major rivers. These large-scale studies are utilizing many geologists and as the program expands, more will be needed. Few geologists are available for programs of greater academic interest.

Vegetation

The vegetation of Korea near the DMZ is characterized by, first, a total lack of mature vegetation, and second, excessive human disturbance in most of the regions. Because of this, there is a continuous struggle by both native plants and animals for survival in their competition with man. In general, there is an area that ranges from a few yards to several miles in width along the south side of the DMZ where indigenous peoples are not allowed to live. However, most of this area is not truly abandoned since thousands of soldiers occupy the area and many of them are required to obtain wood for fuel and fortifications from the forests. In some places succession has been allowed to progress unhampered by man for up to 18 years. It is in these areas that the effects of man can best be studied in an effort to understand the biotic communities of Korea and to learn how to manage the vegetation for the benefit of man.

The abandoned areas extend across Korea along the DMZ and range from sea level on both coasts to over 1200 meters in the Hangnobong Mountains neat the east coast. The abandoned rice paddies in the western lowlands provide the best examples of lands undisturbed for 18 years. Most other areas, even though abandoned as far as farmers are concerned, continue to be set back in their successional stages from time to time by military activities. The highest peaks, which are often used as observation posts and were once covered with forests, have been cleared to improve visibility, and in most cases even the regenerating shrubs and small trees are cut anew each fall and winter. These annual disturbances of the vegetation have most certainly induced changes in the fauna as well.

This situation is not restricted to the DMZ. Most of the forests of South Korea have been denuded. The process was well advanced by 1900, and destruction of the vege ation is inversely proportional to its distance from a town or village. Citizens in quest of winter fuel for the cold winters go into the forests and cut and harvest all the undergrowth. Thus, no forest regeneration is taking place on millions of acres of land. Furthermore, leaves, straw, fallen limbs, grass, and any other materials that may be used for fuel are gathered and carried to the towns and villages. This practice leaves the forest with trees, sometimes, but without any understory or organic matter to hold water or to imp ove fertility or texture of the soils. Thus, much of the water that falls during the torrential summer rains runs off directly, causing devestating floods and siltation in the rice paddies and streams. Tree-planting programs initiated by the government probably do not reforest nearly as fast as the citizens destroy the forest in their quest for fuel.

This annual destruction of understory vegetation is reaching the point of becoming a national disaster. As a result, floods and erosion are wide-spread and accepted by the general population as unavoidable natural disasters. Reservoirs in farming districts silt up in a few years, rice paddy damage is wide-spread and sometimes irreparable, roads and bridges are continuously being carried away by floods, and millions of man days are expended each year on repairs. Large scale terracing operations are carried out each year on hillsides that should be in forests, and miles of stone works are built by the ROK Army in an effort to control floods and protect roads. To a casual observer, it appears that little effort is being made to attack the problem at its source, by revegetating the denuded hillsides.

The only trees which are commonly left by the fuel gatherers are the pines, perhaps because it is a crime to cut a pine tree. Pinus densifolia, the most common pine, produces a very poor quality of timber and grows slowly, yet many hillsides are beginning to be covered with pure stands. This widespread interference with the forest ecosystem by growing single-species forests is creating problems unanticipated by the planners, such as the spread of the destructive pine moth, Dendrolimus spectabilis, which causes widespread damage by eating pine buds and needles. Along with this moth, perhaps numerous other species are spreading in the wake of the destruction of mixed forest stands. Other problems, perhaps brought on by the ecosystem damage, which are still unrecognized and unanticipated, may be more costly to the economy of ROK than is realized by anyone at the present time.

Chung (1962) recognized three major plant zones in Korea, the frigid, temperate, and warm zones. For purposes of this report, however, the vegetation may be best be delimited by describing the patterns most common in the ROK. These can be divided into four main zones: the east coast, the mountainous middle region, the western lowlands, and the sandhills.

East Coast Vegetation

East coast vegetation is found only along a narrow strip between the mountains and the Sea of Japan. Most of the area has been nearly denuded by the people of the fishing villages along the coast. The valleys, when not too rocky, are in rice paddies, and the lower hillsides are often planted to produce crops such as cabbage, radishes, lettuce, tomatoes, etc., including perhaps up to 50 percent of the area. The common plants along the entire coast appear to be weeds and grasses which are common to disturbed areas. On the hills, native forest species are common and the ubiquitous Pinus densifolia covers many of them. Soils are primarily granitic sands, and for that reason, this coastal zone may be classified with the sand hills.

Mountain Vegetation

The mountain vegetation is composed of native forest species in the various seral stages of succession except on some of the highest peaks such as Sorek Mountain (1708 meters). Many of the mountain tops that may have been covered with old original forest stands up until the time of the Korean Conflict (1950-1953) are now cleared of all tall vegetation. The mountain forest extends from approximately ten miles from the Sea of Japan westward for about sixty miles in a massif with many peaks above 1000 meters elevation. Even the western lowlands are interspersed with mountains that appear to have the same general vegetation as is seen on the massif. However, many of the isolated mountains have been denuded, and seral stages on all of them are earlier than in the mountains proper.

The forests are made up predominantly of pines and oaks interspersed in a mosaic of patterns that appear to be associated with past farming practices, fire, slope direction, slope steepness, and other physiographic features. No mature forests have been seen in the ROK, assuming that oaks and associated plants will be the climax species. Perhaps no more than ten percent of the mountain region is used for agricultural purposes.

Western Lowlands

Due to the tilting of Korea to the westward, the western region is characterized by having broad, flat valleys surrounded by mountains of up to 1000 meters elevation. These isolated mountains appear to have similar vegetation to the massif. In areas presently inhabited by indigenous people, all the valleys are terraced. The rice paddies, and the lower slopes of the hills are in farm lands, and almost all vegetation is disturbed annually. More than 50 percent of the area is used for agricultural purposes. The only vegetation which is annually undisturbed is located in the DMZ, namely in the area north of the Imjin River. Most of these abandoned paddies are grass covered, primarily by species of Miscanthus. However, there is a distinct difference in appearance (and perhaps species) between the grasses which are present in the various paddies, a result of water table differences, among other things.

Some of the abandoned paddies are being invaded by woody species of plants such as willow, Salix spp. on the wetter areas, and black locust, Robinia pseudoacacia on the drier sites. In general, woody vegetation, mostly the oaks and pines, is not invading paddies as rapidly as might be expected. Perhaps this is due in part to the length of time the land has been in use (over 4000 years in some places) and to the dearth of native woody species on the surrounding hills at the time of abandonment.

Sand Hill Vegetation

Throughout main areas of the ROK there are vast sandhills which are sparsely covered with vegetation. Erosion is a serious problem that in many places threatens the rice paddies in the valleys with silt. On many of these granitic sand areas the dominant plants are usually shallow-rooted grasses and herbs. On others where the vegetation has been allowed to develop, *Pinus*, *Robinia*, and *Alnus* are the common tree species. These are seldom over eight inches in diameter. Sandhill plants grade into areas of better soils where it appears that the same species are present, but the trees are larger and the grasses and herbs are more vigorous. If the sands are moist from underground waters, *Larix*, may be a common tree. Erosion is less serious where the soils are better, and if the hillsides do not slope too much, the land is usually used for agricultural purposes. In spite of the deep sands there seems to be no moisture problem with farm crops because most of the rainfall is in the summer.

Most recent studies on plants have been limited to species lists on limited areas such as those of I. K. Lee (1965), W. S. Hong (1962), W. S. Hong and B. T. Kim (1960), S. H. Kim (1959), and W. C. Lee (1963), to mention only a few. Complete listings of Korean plants can be found in T. H. Chung (1962) and Nakai (1952) where each author reports more than 3000 kinds of plants. In recent years some definitive type studies have been done on various groups, namely Y. N. Lee's (1966) book on grasses, T. B. Lee's (1965) paper on Lespedeza and Y. H. Chung's (1956) publication on Euglena. Ecological studies have been few, but some scientists such as I. K. Choi, I. K. Lee, K. C. Oh, and B. L. Park have contributed worthwhile publications. Agricultural and forestry studies have been the most common, followed by physiological studies.

Fauna

The ecosystems in Korea have been disturbed to such an extent and for such a long time that in most places only those species associated with seral stages are able to thrive in abundance. To the casual observer there is a scarcity of birds and mammals except for a few species of rodents. Few fish can be observed in the streams, and insects do not appear numerous in the fields or forests; however, there are several insect-associated diseases prevalent.

On the hillsides where the vegetation is harvested each winter, only certain rodents and shrews appear to thrive well. However, their populations are probably greatly modified, and their relative abundance altered. Species that are common in the inhabited western lowlands are scarce or absent from the DMZ. A good example is the common house mouse, *Mus musculus*, which is also a field mouse in Korea. This mouse is common in all the agricultural regions stidued, but not one single individual was caught in the DMZ. *Apodemus agrarius* is common in both places. Jones and Johnson (1960 and 1965) have published on the shrews, rodents, and lagomorphs of Korea. Won and Woo (1958) list 70 species of land mammals, including 22 species of bats, in all of North and South Korea.

Bird life in and around towns, villages, and even individual farm houses is scarce. Many farmers trap all kinds of birds for sale or for food, especially the more common buntings. It is not uncommon to see these species offered for sale in restaurants in Seoul. Large birds, except the ubiquitous magpie, and hawks in winter, are scarce in most areas. The only place where many species (such as herons, cranes, and ibis) can be seen in numbers, is in the DMZ. Ducks and geese are not common in the northern part of ROK, except as migrants. Won and Woo (1958) list 366 species of birds including birds of the neighboring seas.

In the mountainousregions, the mammal species and especially the birds are much more common than in the lowlands along the coast. Perhaps bird populations in the high mountains have been greatly disturbed by the activities of man, primarily along the DMZ. The Tristan's woodpecker, a species of the high mountains, is rapidly being deprived of its primary habitat by the activities of the military forces in their quest for fuel and fortifications. Mammals that may be threatened are the large cats, namely the Korean tiger which may already be extinct, and the Manchurian goral, Naemorheudus goral, a small member of the cow family. These species and perhaps others are inhabitants of the central massif and they may need special protection for their survival. The goral at the present time supplies supplementary food in the diet of the ROK soldiers at the high, isolated outposts. Goral hides are common in the Seoul fur and hide markets.

The water snakes and the common viper appear to be enhanced by the rice paddy cultural practices. The vast water-filled paddies afford ample space for numerous frogs, a common source of food for the watersnakes, Natrix and Agkistrodon. On the hillsides in the vicinity of the rice paddies there is an abundance of rodents upon which the viper, Vipera, feeds.

The taxonomy of the freshwater fishes is well known. The larger fish in the major streams such as the Imjin and Han Rivers are important economically. Cold-water fish of the family Salmonidae are found in the clear cold mountain streams and they are utilized by the indigenous people. Few fish can be seen in the smaller streams, except in the DMZ where they may be seen up to 15 inches in length. Large fish are uncommon except in the rivers, perhaps a reflection of the fishing pressure. The freshwater fish fauna of Korea includes approximately 175 species (Chung, 1961), with only a few species common to streams of both coasts.

Generally, streams appear to be more or less sterile, especially those above the farm lands in the mountains. Lower down the water courses, the streams appear to be more fertile yet more polluted by waters running out of night-soil fertilized rice paddies. Human waste of all types is dumped into the rivers and streams by cities, towns, and villages; and before a stream reaches the sea it is usually too polluted for any kind of safe human use. Further, the tremendous erosion problems brought on by the denudation of the hillsides allows huge volumes of silt to settle into the streams and rivers, thus making them less valuable for fish production. No fisheries management work has been done on the freshwaters of Korea. Nothing is known about the tonnage of freshwater fish consumed annually or the fisheries potential. Several reservoirs in use or under construction warrant some kind of fisheries studies in an attempt to develop lake fisheries. This special field is neglected except by a few indigenous people that live near the lakes.

Not much information is available concerning the status of arthropods in general. Several of the economically important species of insects and crabs are well known, especially the agricultural and forest pests and those of medicinal importance. Best known are the silk worm, pine moth, mosquitoes, and members of the fly family Drosophilidae. Of the well known pests, nothing is being done for their control beyond local control by individuals.

Little work has been done on many of the other invertebrate groups such as the leaches, free-living nematodes, planarians, and many others. There are a few studies, mostly taxonomic in nature, on such groups as the snails, clams, earthworms, spiders, myriopods, etc. Perhaps the best known are the human parasitic flukes. Even here, the life cycles and all the intermediate hosts are not well authenticated.

In general, work on Korean animals has been concentrated on taxonomic studies and faunal lists of limited areas. In recent years, a few definitive type taxonomic studies have been published, such as the mammal papers by Jones and Johnson (1960 and 1965). A few ecological papers of note have been published, including C. W. Kim's (1965 and 1966) work on the pine moth, P. H. Won's (1961 and 1965) on mammals, and P. O. Won's (1961) on birds.

Studies presently in progress include a wide variety of projects on insects, birds, mammals, fish, snails, and many other small under-financed, individual projects on a wide variety of organisms.

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SECTION TWO

Individual Project Reviews and List of Publications

Introduction

The environment of the Republic of Korea is unique in East Asia in that there is an undisturbed area contiguous to and south of the Demilitarized Zone that has not been cultivated since 1950, and which has been abandoned since 1953. The DMZ extends from the Sea of Japan on the east cost to the estuary of the Han River near the west coast. Elevations range up to 1200 meters near the east coast, and mountains extend across half the peninsula. Approximately the western half of the DMZ, a lowland area, had been intensively cultivated prior to the Korean War for thousands of years; whereas the eastern portion, which is hilly to mountainous, was covered in large part with pine forests and cultivated only in suitable valleys.

Crops formerly cultivated in the DMZ included rice, grown in paddy fields, and vegetables such as potatoes, cabbage, cucumbers, radishes, corn, and tomatoes grown along with grains other than rice in well-drained fields. Since these fields were well-fertilized with manure, the soils were not impoverished at the time cultivation was abandoned. During the past 15 years, grass, forbs, shrubs and some oaks, pines, and black locust have grown up in the former vegetable fields; the paddy fields are now covered with grasses together with some willows, black locust and a few pines and shrubs. Seemingly, the former pine forests of the mountainous areas are changing to oak forest, but this may be due to uncontrolled exploitation by nearby natives and by soldiers who cut the trees for their numerous fortifications.

As might be expected, the abundance of birds and mammals feeding on grains dropped sharply, and other birds, primarily insectivores and their predators, the hawks increased. Small mammals appear to be few in number while the large mammals such as the wild boar, the Korean deer, and the red fox have markedly increased. Among the conspicuous birds present are the Korean crane, white-naped crane, the Japanese crested ibis, the black stork, and the spoonbill. The ring-necked pheasant and the magpie are very common while the Tristram woodpecker has probably decreased due to destruction of its preferred habitat in the forests on high mountain peaks. It is probable that other groups of animals may have changed considerably in terms of population levels.

The initial Study Areas included all the general habitat types found across the peninsula, including the western lowlands, the central volcanic plateau, the granitic high mountains and mountain valleys. Later the sandy east coast was included. In all these areas, the majority of people derive their livelihood entirely from the natural resrouces of the land and water. Modern science and technology has hardly reached most of the people even though it has been on the periphery of their lives for many years. The people are obviously an integral part of web-like ecosystem complex, and it is anticipated that a systems approach can best be used in the future in which the human population will be considered a component of the environment and not an extraneous complex superimposed on the ecosystem.

Data presented by the research reports cannot in any way be considered final, but it does represent additional data in the overall effort to enumerate the components of the environment and how they function in Korea. Monographic reports may eventually emerge, including most of the plant and animal groups found in Korea, while more scientists are being trained to perform the more complex ecosystem analyses. The number and kinds of benefits accruing to the Republic of Korea and to the rest of the world from studies as proposed here will depend entirely on the ingenuity and experience of the scientists and administrators associated with the long-range program. These benefits can be tremendous and can be of inestimable value in adjusting human populations to the natural resources of the country. Faulty judgments and actions can be disastrous to the environments of Korea and irreparable damage can be done to the future productive potential of the country.

The DMZ, including the abandoned lands immediately to its south, provides a unique opportunity to study an ecological baseline that had been developing for 13 years at the beginning of this program. By comparing the dramatic changes in vegetation and in animal life occurring in the DMZ with areas heavily influenced by man, ecological principles can be investigated. During the first year of the program it was expected that some fundamental differences in these two areas could be pointed out and it was hoped that initial studies would serve as a guide in planning for a 5-year proposal.

During project planning, which began in October 1966, the Smithsonian Institution representative held weekly meetings with the Korean scientists in an effort to develop satisfactory work plans. Conferences were constantly being held during this period and throughout the entire duration of the project. Rapport appeared to be excellent. Everyone said he understood the aims of the research program and the importance of developing good research projects in support of the proposed 5-year plan. However, it soon became obvious that most of the scientists did not know how to plan and initiate field research. For cultural reasons, they appeared to be unable to ask for, accept, or act on outside advice. The written plans which were submitted within 4 to 6 months after the date of request were unsatisfactory. Generally, they were grandiose and did not show a sound understanding of the problems to be studied, or they were incomplete to the point where the problem was not stated. Cost estimates were always unrealistic. Efforts to revise these plans proved futile, as revisions often did not represent improvements. Yet, it was with these plans that the program was begun in earnest in the spring of 1967. Within a few months most of the scientists proceeded to wor areas of their own special interests without prior consultation.

Project Titles and Personnel

1. On the fishes of the northern part of the Republic of Korea.
   Scientist: Choi, Ki Chul, Ph. D., Professor, Department of Biology, College of Education, Seoul National University
   Assistants: Sang Lin Chun and Shin Sok Choi

2. A preliminary study of the phytoplankton of the Han River estuary.
   Scientist: Chung, Yung Ho, Ph. D., Professor, Department of Botany, College of Liberal Arts and Sciences, Seoul National University
   Assistants: Young Moo Kang and Jae Hyung Shim

3. Some effects of fire on vegetation.
   Scientist: Hong, Soon Woo , D. Sc., Dean and Professor, Department of Botany, College of Liberal Arts and Sciences, Seoul National University
   Assistants: Yong Keel Choi

4. Microbial populations in the Han River estuary.
   Scientist: Hong, Soon Woo, D. Sc., Dean and Professor, Department of Botany, College of Liberal Arts and Sciences, Seoul National University
   Assistants: Yung Chil Hah

5. Drosophilid fauna of six areas of Korea.
   Scientist: Kang, Yung Sun, D. Sc., Professor and Head, Department of Zoology, College of Liberal Arts and Sciences, Seoul National University
   Assistants: Kwang Woung Moon and Sun Ok Yoon

6. Some geological investigations in northern part of the Republic of Korea.
   Scientist: Kim, Bong Kyun, D. Sc., Professor, Department of Geology, College of Liberal Arts and Sciences, Seoul National University
   Assistants: Yong Ahn Park

7. Insect host-parasite relationships with emphasis on the pine moth.
   Scientist: Kim, Chang-Whan, D. Sc., Professor and Dean, School of Engineering and Science, Korea University
   Assistants: Jin Il Kim and Jin Kook Oh

8. Plant succession in abandoned fields.
   Scientist: Kim, Choon Min, D. Sc., Professor, Department of Biology, College of Education, Seoul National University
   Assistants: Young Deuk Rim and Nam Kee Chang

9. The dispersion ratio and soil nutrients of eroded soils.
   Scientist: Kim, Choon Min, D. Sc., Professor, Department of Biology, College of Education, Seoul National University
   Assistants: Young Deuk Rim and Nam Kee Chang

10. The relationship between forest types and soil nutrients.
   Scientist: Kim, Choon Min, D. Sc., Professor, Department of Biology, College of Education, Seoul National University
   Assistants: Young Deuk Rim and Nam Kee Chang

11. On the ecology of Pinus densiflora.
   Scientist: Lee, Il Koo, D. Sc., Professor, Kow Kuk University
   Assistant: Ho Joon Lee

12. The composition and distribution of mammal populations.
   Scientist: Won, Pyong Hoci, D. Sc., Professor, Department of Biology, Dong Guk University
   Assistants: Hai Poong Lee and Yun San Kim

13. An investigation of some bottom fauna of some rivers.
   Scientist: Yoon, Il Byung, B. S., Instructor, Department of Biology, Woo Suk University
   Assistant: Kun Kim

14. Check-list of the birds of the Republic of Korea (with E. L. Tyson and M. E. J. Gore.)
   Scientist: Won, Pyong Oh, D. Sc., Professor, Department of Biology, Kyung Hee University
   Assistants: Han Chung Woo and Mi Za Chun

15. Some bird observations near the demilitarized zone.
   Scientist: Won, Pyong Oh, D. Sc., Professor, Department of Biology, Kyung Hee University
   Assistants: Han Chung Woo and Mi Za Chun

16. A list of plants collected in Korea.
   Scientists: Chung, Young Ho (see #2 above)
   Lee, Il Koo (see #8 above)
   Lee, Yong No, D. Sc., Professor, Department of Biology, Ewha Womans University
   Park, Man Kyu, Professor, Department of Biology, Catholic Medical College
   Assistants: Ho Joon Lee, Yoo Sung Lee, In Soo Chung and Young Moo Kang

Review of Research Projects

The purpose of this section of the report is to review the individual research effort of each of the 13 scientists and their 21 student assistants employed on the program. All scientists continued to work on their projects throughout the entire period of the program while some of the assistants were changed. All the scientists except one have either a Doctor of Science, Doctor of Philosophy, or an Honorary Doctor's degree. They were reputed to be among the leading scientists in Korea, and were selected by Yung Sun Kang as the experts in their respective fields. The list of Korean scientists includes two university deans, six department heads, two professors, and one instructor with a Bachelor of Science degree. These men range from 32 to 64 years of age with only two men under 40 years. Seven scientists were from Seoul National University, which is reputed to be the best and most prestigious university in Korea; of the other six, each is from a different university.

Each of these reports represents more than 35 days of work for the scientist in charge and approximately 1 year for each of his assistants. Assistants did most of the work both in the field and in the laboratory, usually with little, if any, supervision. The major contribution of the Smithsonian representative has been in minor editing of language and in attempting to make ambiguous statements meaningful.

Reviews

Choi, Ki Chul. On the fishes of the northern part of the Republic of Korea.

This report gives a rather long list of fishes captured from a large number of collecting stations in the Han and Imjin River systems and on the east coast of Korea. The report shows a decided lack of planning and little or no editing. For example, the summary indicates 40 species of fish captured in streams along the east coast, whereas, Table 4 gives only 15. In general, the author did not organize his results and discussion as he rambled along on distribution, dominance, numbers and habits. He obviously has a wealth of data, but it is presented in such a way as to be all but meaningless.

Chung, Yung Ho. A preliminary study of the plankton of the Han River estuary.

Professor Chung has done a very good job of collecting data on the phytoplankton of the Han River. He planned his collections well. However, he does not appear to understand estuaries and shows little evidence of having read much of the literature on the subject. This is understandable as his represents the first study of its kind in Korea.

The author assumes that the reader will understand the analytical methods used without going into any detail. Physical data in the discussion simply points out what the graphs indicate and biological data only lists species encountered. Table 2 does not relate organisms to locality and only indirectly with the physical records obtained.

In general, the report shows promise and it appears likely that a wealth of information that may have been obtained on the study is not presented here.

Chung, Yung Ho, Yong No Lee, Il Koo Lee, and Man Kyu Pak. A list of plants collected in Korea.

This report is a listing of plants collected by these four scientists during the summer of 1967 and through May, 1968. The list of families is arranged according to Engle (1924), and the species are listed alphabetically by families. It is hoped that these plants will be made available to competent taxonomists throughout the world.

Identifications were apparently made through consulting the publications in the reference list. It would be interesting to have these identifications checked by taxonomists in the Smithsonian Institution.

Hong, Soon Woo. Some effects of fire on vegetation, and Microbial populations in the Han River estuary.

In the paper on the effects of fire on vegetation, the author stated reasonable objectives. Then in the methods, he lists ten specific things he did, none of which were done in a satisfactory manner. This paper is a study in poor planning; it indicates a lack of knowledge on the subject by the author; and it shows no understanding of the scientific method.

In the report on microbial populations, Hong redeems himself somewhat. This report shows a reasonable amount of planning; however, the reviewer suggest that this is probably a reflection of the ability of the assistant. This program was obviously carried out according to a plan, and the results are meaningful in their entirety. Even the conclusion stated in the results and discussion is valid-- Seoul does need a new sewage system as any casual visitor can attest.

Kang, Yung Sun. Drosophilid fauna of six areas in Korea.

This project was designed to survey the species of Drosophilidae found in the general area of the DMZ. Collections were made by standard methods considering several environmental factors when setting traps. These factors were seldom mentioned later in the paper. A reasonable number of flies were captured, but there is no data on which to judge relative trapping success by areas as the writer attempts to do. The author notes that it is remarkable that the numbers of flies caught at one site was less than at another, but gives no data to support this thesis. Perhaps more field work was done in one area than in the other?

The paper shows a general lack of planning as well as carelessness in writing, as the field researcher must have recorded more ecological data than is presented here. There are several discrepancies between the numbers of flies used in the discussion and in Table 2. For example, there are 168 members of Drosophila brachynephros shown in the table, and 166 are recorded in the discussion.

Kim, Bong Kyun. Some geological investigations in the northern part of the Republic of Korea.

Kim appears to have planned his project well in that he selected several discrete areas for study. These represent perhaps all the geological formations found along the DMZ; thus, he was able to get a good picture of the entire uninhabited area. He stated that these data will be used in planning more comprehensive studies, then he explained what these studies would be.

General geology of two areas has been published (see literature cited) and he frankly stated that tabulation of field data had not been completed at the time of this report; therefore, most of this paper appears to be a summary of his findings.

Kim shows that he has an understanding of geological methods and the work appears to have been well planned.

Kim, Chang-Whan. Insect host-parasite relationships with emphasis on the pine moth.

The title and introduction of this report indicate that the diversity of insects in abandoned and adjacent inhabited lands would be studied, along with some predator-prey relationships. Both are worthy projects and should have been pursued. However, his last statement in the introduction indicated that they only collected insects to see what was present. Again, an excellent study, but why such an elaborate introduction?

This project presumably utilized 35 days of field work for the major investigator and for his two assistants plus half time for the assistants for almost 2 years. Yet their collections were no more extensive than that required of a graduate student in a general entomology course. What did these men do with their time? The only results is a list of families and the numbers of species found in each with some very general comments on the vegetation types from which they were collected.

Kim, Choon Min. Plant succession in abandoned fields. The dispersio ratio and soil nutrients of eroded soils. The relationships between forest type and soil nutrients.

Three reports are reviewed here. Two of them appear to be only tabulations of data collected without interpretation. The data may be useful for a broader study of soils, but nothing is stated concerning this. The report on plant succession as stated in the title shows some promise.

Kim appears to understand how to study a plant community as he established transects and plots for obtaining quantitative data. However, there is nothing in the paper indicating that he understood plant succession. He does not give any data on succession beyond the fact that he selected what he supposed to be old fields, so what he found was assumed to be 16 years of vegetation development. He suggested that plants invade old fields much slower in Korea than in

Tennessee but offered no reasons for this.

In general, the project appears to have been a simple data gathering operation with no real aims beyond this.

Lee, Il Koo. On the ecology of Pinus densiflora.

Professor Lee believes that pine trees have vanished from the DMZ so he sets out to prove that fire killed them. This may or may not be true, and the data presented in this paper are not satisfactory to explain either hypothesis. Most of the report is concerned with observations made over a period of time plus three ill-conceived experiments that have nothing to do with fire.

The subject of the growth of pine forest is pertinent to Korea today, but some quantitative and qualitative data are needed to establish tolerances of the trees. Nothing was learned along these lines. Finally, 15-year old observations by two army generals were used to prove the point that fire killed all the pines in the DMZ. Data concerning other species of pines was assumed to be relevant to the Korean pine.

Tyson's observations in the same areas of the DMZ where Lee studied indicate that the pine has not disappeared but that it simply has not invaded the old fields as fast as might have been expected following the war in 1950-1953.

Won, Pyong Hooi. The composition and distribution of mammal populations.

This report is an account of mammals captured or present in several study areas near the DMZ, including 180 specimens of 12 species and 9 other species confirmed as present. This collection represents approximately three specimens per day for three people, or one specimen per person per day. What did the investigators do with their time?

Nothing is said in the paper about composition of mammal populations, yet this was one of the main purposes of the research. Distribution is considered only to the extent that specimens were taken at certain localities and not at others. In the description of study areas, Yanggu-Gari was omitted. Why?

The paper is a tragic example of poor planning. The author stated that work was limited because of trying to work in "army operation zones". This may have limited collections somewhat. He went on to state that with more time to improve methods, success would have been improved. Would this have helped a person with 35 years of rodent experience?

Won, Pyong Oh. Some bird observations near the demilitarized zone.

The author proposed to study the seasonal distribution of birds, yet all the tables give only numbers without indicating seasons. In the section on noteworthy species, the dates birds were seen is usually given, but nothing is said as to why the record is noteworthy. The long list of birds observed indicates a general weakness in note-taking or very poor observational techniques. For example, Buteo buteo is a very common resident, yet only eight were reported. ' many were often seen by Tyson at one time in several of the same places and times that Won was making his observations. There appears to be a complete lack of planning the field work and report writing, and the data herein reported are no better than the usual Christmas bird count in the U.S.

Yoon, Il Byung. An investigation of some bottom fauna of some rivers.

This study attempts to identify the stream bottom fauna, mostly insects, in relation to substrate and surrounding vegetation. Yoon apparently planned is program so as to arrive at these relationships, but he frankly admits that he has not finished identifying the specimens. It is perhaps for this reason that he makes no effort to discuss these relationships. Of the 54 genera and species shown in Tanle 3, only 34 have been identified to species, indicating a lack of reference material essential for taxonomic or classification studies, or a lack of experience on the part of the investigators. This paper shows promise but does not go far enough to give a reviewer sufficient information for a critical review.

Publications

1. Choi, K. C. 1968. Studies on the fresh-water fishes distributed on the east side area of Taiback Mountain chain. Korean Zool. 2: (in press).

2. Kang, Y. S. and K. W. Moon. (1967). Drosophilid fauna in the vicinity of the demilitarized zone in Korea. Drosophila Info. Serv. No. 43, p. 148.

3. Kim, B. K. and Y. A. Parl. 1967. The origin of the so-called Punch Bowl. J. Geol. Soc. Korea. 3:61-66.

4. Kim, B. K. and Y. A. Park. 1968. Outlines of geology of the Kanghwa Island. J. Geol. Soc. Korea. 4:31-39.

5. Lee, Y. N. 1967. Chromosome numbers of flowering plants in Korea. J. K. C. R. I. 2:455-478.

6. Tyson, E. L. 1967. Small mammals in relation to Korean hemorhagic fever. Korean J. Zool. 10:35-38.

Proposed Publications

1. Choi, Ki Chul
   On the micro distribution of fresh water fishes in the Han River.
   Studies on the ecology of the Sooib, Suwha and the Hanke Rivers with special reference to the niche of Brachymystax lenox.
   The microhabitat and management of the salmonid fish, Brachymystax lenox.

2. Chung, Yung Ho
   A study of the phytoplankton of the Han River estuary.

3. Hong, Soon Woo
   Microbial populations in the Han River estuary.

4. Kang, Yung Sun
   Drosophilidae of Korea: their distribution and chromosomal characertistics.

5. Kim, Bong Kyun
   Sedimentation of the Whajinpo beach sands.
   On the meaning of the term "Ignounconformity".
   Geology of the east coast of Korea.
   Geology of Mt. Daesung and vicinity.
   Geological maps of Myojang Dong and Mt. Kumhak area.

6. Kim, Choon Min
   The dispersion ratio of soil nutriments of eroded soils.
   The relationship between forest types and soil nutrients.

7. Lee, Il Koo
   On the ecology of Pinus densiflora.

8. Lee, Yong No
   Chromosome numbers of indemic plants to Korea.

9. Tyson, Edwin L.
   An evaluation of rat control methods.

10. Won, Pyong Oh
    Check-list of the birds of Korea.

SECTION THREE

Prospects and Recommendations

At the end of 21 months of Smithsonian Institution involvement in the Korean program, we have reviewed progress for the purpose of determining how best to improve and implement the attached 5-year proposal for developing a Center for Environmental Studies. This proposal concentrates on education and research as they relate to Korean society.

To date 13 research projects have been initiated, each utilizing approximately the equivalent of one man-year. The initial studies were designed to describe the physical aspects of the DMZ Study Area and to compare biological phenomena in the DMZ with the inhabited areas to the south. These research projects, even if not as productive as initially planned, do contribute something to a better understanding of nature and how it relates to man. They were concerned with many of the problems confronting Korea today: environmental pollution, misuse of natural resources, and man's need to adapt to a changing world.

The input from the Smithsonian representative to these research projects was minimal, due primarily to cultural differences. This lack of a suitable channel through which to advise is reflected in the quality of the research accomplished. The inability of the older Korean scientists to see the need for, to ask for or to accept advice suggests that major changes should be made in the 5-year plan.

To develop a long-term program of research and scholarship which will be a credit to the Smithsonian Institution, it is imperative that the 5-year plan be reconsidered in view of the Korean scientist's ability to do research or to train graduate students. Therefore, the large sums proposed for research should be reduced to more realistic proportions and should be allotted to younger scientists and graduate students who are more willing to cooperate with and profit by associations with outside scientists. The education commitment of the 5-year plan should remain large but more emphasis should be placed on direct association between Korean students and outside scientists and graduate students. A large reduction in research funds to Korean scientists should be countered balanced by increased funds for US scientists to do research in Korea. Korean students who are working as assistants should be supported for degree work only, and a time limit should be placed on support. Initially all commitments to individual scientists and students should be on a short-term basis within the long-term project. Progress reports should be presented often, and US scientists should be required to inspect all projects several times each year.

Ideally, the program should begin rather small and build as quickly as satisfactory personnel can be located in both the US and in Korea. US scientists should work in Korea, using Korean assistants of their own choosing. As their research programs develop, they can offer research support on a short-term basis to those scientists, especially the younger ones, who are considered willing and capable of improving their abilities through mutual association. Within 10-15 years, as satisfactory scientists and students are located, trained, and instilled with the necessary moral qualities for rational environmental observations, these men can act as a cadre for a Korean Center for Environmental Studies.

The Biological survey, as presented in the 5-year plan, is ideally suited for a developing program which stresses the ecosystems. It provides specific goals while at the same time it can be broken up into many small but manageable units which can be contracted to scientists or to students for theses or short-term research. By the widespread use of these contracts, the U.S. scientists will have excellent opportunities to recruit only those scientists that have proven ability and those who are willing to profit by outside contacts. These are the men who should be encouraged to continue their training in the more complicated aspects of ecosystem science. Within 10-15 years, These scientists, trained on the program, will be capable of initiating, promoting, and managing a Korean institute of high quality.

The immediate goals of such a modified program would be to catalog the biotic and physical components of the Korean environments, while the younger scientists are being trained in the more complex ecosystem relationships. The program should aim toward the ecological orientation of scientists, and collectors of all kinds of specimens should be ecologically orientated in order to obtain the maximum benefit from collections. All collections should be placed in both the National Science Museum in Seoul and the Smithsonian Institution in Washington, where they will be available for the world scientific community. Collections should be available for use in exhibits at the museum and throughout Korea in an effort to orient Korean citizens toward the biological aspects of modern science and how it relates to their everyday lives.

The National Science Museum is ideally located in Seoul in the center of the Korean academic community, where it enjoys the support of most of the scientists. It is the best institution within which the Smithsonian Institution can concentrate its support on the biological survey and related aspects during the initial 10-15 years in which ecosystem concept is being incorporated into the framework of scientific thinking. The museum currently has a research staff of four, three biologists and one geologist. These are young men who could be immediately utilized in their special area of interest. If progressive, they could become the nucleus of a cadre of productive researchers located at the museum. If not progressive, other young scientists should be invited to join with the Smithsonian Institution team, even if they are not members of the museum staff. All should work on short-term contracts until an individual has proved himself productive. By this process, selection of the best scientists could be accomplished within a few years.

Museum-to-museum cooperation between U.S. and Korean institutions would be most attractive to administrators in both countries and both museums would profit by this relationship. Even though the National Science Museum enjoys the support of most of the academic community, its development is hampered by a lack of experience in Korea. The museum is in dire need of more assistance from outside sources. This program could be responsible for helping orient the research staff. Smithsonian Institution support should not be limited to research and training; other divisions of the Smithsonian Institution should provide necessary support at all levels and in all branches of museum development. With this outside support, the National Science Museum can develop into a model institution in east Asia within which the Center for Environmental Studies may eventually evolve.

In summary, the following are the specific items to which particular attention should be paid in future program development:

1. The Director of the program should be the final and absolute authority on the program and its operations in Korea.
2. Commitment should be made to individual scientists only after the submission of a specific work plan.
3. All commitment to scientists should be of short duration until the quality of the individual's work is known.
4. Students should be supported for thesis and dissertation work only, and the term of support should be limited when the commitment is first made.
5. The Smithsonian Institution program should be in the National Science Museum, as an inter-museum program of cooperation would be most attractive to administrators in both the U.S. and Korea.
6. Support to the young well-trained scientists should be encouraged and those with promise should have priority over the older and more conservative professors.
7. The director of the program should continuously monitor the progress of research as a means of offering advice.
8. Any program should begin small and grow as competent people are located or trained.
9. Initially, the biological survey section of the 5-year plan would be ideal for beginning a small program of short-term research.

10. Support to Korea should include all classes of museum personnel.

PART TWO

The Smithsonian Ecology Program in Korea

Review and Recommendations

by

Ke Chung Kim, Department of Entomology
Assistant Professor and Curator of Insects
Consultant to the Smithsonian Office of Ecology
The Pennsylvania State University
University Park, Pennsylvania

An ambitious foreign research program in the developing country, particularly in collaboration with native scientists of the host country, faces two deterrent factors, self-defeating conservatism and academic inferiority. With these factors a scientific program like the Smithsonian Ecology Program in Korea always goes through a difficult and frustrating process before reaching a relatively satisfactory goal. Development of science and improvement of scientific quality in many developing countries is plagued by lack of qualified scientists, insufficient funds for instruction and research, insecurity of scientists, an old peremptory educational system, and above all a self-defeating conservatism in the politicosocial system. The challenge of improving scientific quality in the developing country may be met by a farsighted scientific program from a more advanced country, such as of the United States. Due to the simple fact that it is funded and administered by an external source, a program of this sort from outside of the country can easily and effectively break through the barrier of a conservative and peremptory system of the host country which plagues the development of science.

A preliminary phase of the Smithsonian Ecology Program in Korea was started under rather ambitious but ambiguous premises without a proper assessment of the feasibility and impact of the program to scientific community and individual scientists in Korea. In the period of two years the Smithsonian program has gone through a difficult and rather frustrating path in Korea. Most of the difficulty and frustration stems from incorrect judgement on the academic environment and inferior scientific quality of individual scientists in Korea. The Korean scientific community was not quite ready to takemaximum advantage of the program, although many scientists in and out of the country repeatedly pointed out the fact that Korean science should come out of the dark ages and move ahead. Many Korean scientists have been poorly trained in ecology and the fundamentals of biology, and have rather naive ideas about scientific research. Many of the participants in the program also had rather ill-conceived ideas about the American-funding and administrative processes. Individual scientists have nevertheless been bound by peremptory social and political system and conservatism in education. At the same time, many scientists or participants of the program were more interested in financial benefit and prestige rather than academic or scientific improvement from the program.

Korea has come a long way from political corruption and social chaos in the beginning of this decade. The Republic of Korea is on the verge of an "economic breakthrough" of significance to the economic well-being of the country. The country has been politically stable, and the Korea has become a young, vigorous, ambitious, and nearly self-sufficient country. On the other hand, the areas of science and education have not been in the main stream of the Korean development until 1966. Commercialism in educational institutions and an emphasis on quantity rather than quality and formality rather than the principles of education which are still prevalent have plagued important reforms in the curriculum and education system. The majority of Korean scientists are associated with educational institutions. Development of science has been limited by inactivity of Korean scientists who are stricken with insufficient salary, social, and political insecurity, poor facilities and libraries, and lack of research funds, and by peremptory educational system. However, in recent years a general mood of Korean scientific community has been ready to take off for a greater stride toward improving her scientific quality up to the international standard. The Korean scientific community needed a strong stimulus and catalytic mechanism to head for the improvement. The increasing prosperity in national economy and the stability in politicosocial system resulted in establishment of the Ministry of Science and Technology and the Korea Institute of Science and Technology. Establishment of these two institutions serves as an internal mechanism for a revolution of Korean science. The Smithsonian ecology program has served in certain ways as an external catalytic mechanism for a progressive movement of science in Korea.

In the period of 2 years the preliminary phase of the long-range Smithsonian Ecology Program in Korea was initiated: (1) to provide the general description of the vegetation, animal life, soils, physiography, and climate of the study area, (2) to prepare appropriate vegetation and physiographic maps to accompany the descriptions, (3) to carry out several research projects on preliminary survey of the physical characteristics, flora, and fauna of the study area by

Korean scientists, and (4) to prepare a sound 5-year plan of the long-range Smithsonian Ecology Program in Korea for submission to appropriate contracting and granting agencies.

A modest effort has been implemented to provide the general description of the vegetation, animal life, soils, physiography, and climate of the study area in the program period of 2 years. This effort was carried out by 13 Korean scientists and their assistants in various research projects. Most of these scientists spent about 35 days in the field during the program period. Field activities of these scientists have not been satisfactory, and results of their work have been meagre. The quality of their research has not been up to the level of average academic excellence, but was not unexpected in the beginning of the program. An unsatisfactory outcome of the field studies by Korean scientists may stem from several major factors: (1) Korean scientists have had no experience and knowledge to prepare a realistic research proposal which may be accomplished in a given time, (2) the field activities by Korean scientists have not been satisfactory because of poor and unrealistic planning and schedule and also of military difficulty in the study area, (3) Korean scientists have been overrated in their competence and left with individual research without proper scientific guidance, (4) Korean scientists have not kept up in modern techniques and current knowledge of the individual interested areas, (5) the initial administrative procedure was not satisfactory, and (6) Korean scientists have misunderstood the objectives of the program. However, this effort by Korean scientists has provided a general description of the vegetation, animal life, soils, and climate of the study area, although it is not satisfactory.

An attempt has been made to prepare vegetation and physiographic maps in the beginning of the program. However, it was soon realized that this task was too large to carry out and impossible to accomplish within 2 years with a little more than one month of field activities because of very complicated vegetation types, terrains, and military difficulty.

A modest proposal for ecological research and education entitled "Korean Center for Environmental Studies" has been prepared. This proposal should be completely revised in view of several recommendations made by people associated with the program. The sections of administrative organization, procedures, governmental and institutional associations, training of young scientists and retraining of established scientists, and budget will need special attention in the revision of the present proposal.

On the basis of my personal observations and analysis, the Smithsonian ecology program has played an important role in promoting a drastic change of Korean scientific environment. The real impact of the program to the scientific community in Korea will be very significant and should not be underestimated. The Smithsonian program has definitely served in several ways as an external catalytic mechanism for a revolution of Korean science. The Smithsonian program has provided an opportunity for Korean scientists to evaluate their scientific competence, and made Korean scientists to be competitive among themselves for scientific excellence by objective selection of individual proposals and other activities of the program. The program has given a new lease to the scientific life of young scientists and graduate students by giving them an equal opportunity of submitting a research proposals and of other research activities. Young scientists and graduate students do see a gradual breakdown of the peremptory educational system and political conservatism in science through a farsighted foreign program. The Smithsonian program served as a means of gaining a better perspective of Korean science and scientific research in society, and of giving a confidence of Korean government in Korean scientists and scientific community. The program provided an opportunity for Korean scientists to work together for a common objective and to minimize individual arguments for a greater and common goal. The Smithsonian program provided an indispensable opportunity for Korean scientific community to review the status of Korean science in the world, to expose scientific inferiority and to visualize the need of urgent efforts for improving their scientific quality. In summary, the Smithsonian ecology program has certainly revived the vitality of scientific community in Korea, and brought a new dimension in Korean biological science.

Recommendations:

1. The scope and objectives of the Smithsonian Ecology Program in Korea should be spelled out in clearer terms with regard to: (1) interests of the Smithsonian Institution, (2) upgrading of Korean scientific quality, (3) learning more about ecological principles and facts, (4) establishment of an autonomous "Korean Center for Environmental Studies," and (5) to work toward the development of the basic scientific information and theory required for the integration of Korean societies and their natural resources with objectives of helping Korean to become self-sufficient.

2. A point should be made that the Smithsonian Institution will let Korean government or a private body formed by a mutual agreement between the Smithsonian Institution and Korean government administer and assume a full responsibility of the program after an initial period, for instance 5 years. Until such time the Smithsonian Institution will take a full responsibility for the program and for the development of the Korean Center for Environmental Studies. The future participation of the Smithsonian Institution in the program will be considered toward the end of the initial 5-year period.

3. Major efforts of the Smithsonian Program in the first 5 years should be devoted to the educational aspect of the program through individual research, seminars, summer workshops, formal training toward advanced degree in the United States, and lectures by distinguished American ecologists.

4. The Smithsonian Program should not be built around an individual or a group of Korean scientists. All agreement and business of the

program should be made through the Ministry of Science and Technology, if not with the Ministry. In other words, the Smithsonian Program should be set up as a cooperative effort of the Korean government and the Smithsonian Institution to establish a Korean Center for Environmental Studies. In this way the management of the Korean fund will be simplified.

5. It should be clearly stated that the Smithsonian Program will be administered by the Program Director appointed by the Smithsonian Institution for the Smithsonian Institution. A Deputy Program Director who is also appointed by the Smithsonian Institution should assist the Program Director for the smooth operation of the program in Korea. The Program Director should be an American of excellent academic training and scientific career.

6. The Smithsonian Program should be operated under the unique and concise unified plan. Under this plan the Smithsonian Institution selects and supervises individual research in the program. Operation and performance of individual research project should be supervised by the Program Director. Smithsonian Institution should appoint the principal investigator or project leader for each research project until such a time that the Program Director considers the Korean scientists working in the program are competent to carry out their own research. A close supervision is to guarantee the success of individual research projects and upgrading of individual scientific quality of Korean scientists.

7. A physical association may be made with the Korea Institute of Science and Technology; office space and facilities may be rented

with endorsement of the Ministry of Science and Technology.

8. The Smithsonian Program should continue its association with the Korean Science-Culture Center (National Science Museum). An official agreement should be made with the Ministry of Education and the Science -Culture Center that the Center will provide space and facilities for the collections of animal and plants provided by the Smithsonian Program, and furnish proper curatorial care for these collections. These collections will be deposited permanently in the Center. Smithsonian Institution should propose an immediate program to train young Korean scientists for scientific and research staff of the Center in collaboration with Bernice P. Bishop Museum or the East-West Center. Training of the research staff of the Center is the most urgent matter in the development of the Center. This staff will support the exhibits and public education of the Center. This program does not have to be a big one, and may be partly financed by Korean government or USOM.

9. The Biological Survey envisioned by the Smithsonian Program should be an integral part of the program in the period of the first 5 years. After such an initial period the Biological Survey may become an integral part of the Korea Institute of Science and Technology or Science-Culture Center according to a circumstance of that time.

10. A proposal with respect to Korean share of the Program budget may be made to Korean government. Korean government may contribute on the basis of predetermined schedule by increasing the percentage of the Korean share; for example: first year - 5%, second year - 10%, third

year - 15%, fourth year - 20%, fifth year - 30%. After the first 5 years the Smithsonian Institution will share a gradually decreasing budget and scientific participation, and the administrative body and Korean government will take a full share of the budget and administrative responsibility of the program.

11. The Smithsonian Office of Ecology, which has conducted the Smithsonian Ecology Program in Korea, should make an effort to report to relevant ministries and agencies who were consulted in regard to the program in 1967. Comments should be requested from these offic s on the present version of the Proposal. Relevant ministries and agencies are the following:

Korea Institute of Science and Technology (President Dr. Choi)

Ministry of Science and Technology (Minister Dr. Kim)

Ministry of Education (Minister)

Ministry of Agriculture and Forestry (Minister)

Office of Rural Development (Director-General Kim)

Office of Forestry (Director-General)

United States Operations Mission in Korea (Director)

Yung Sun Kang (Seoul National University; National Committee of IBP)

PART THREE

Individual Project Reports

ON THE FISHES OF THE NORTHERN PART OF THE REPUBLIC OF KOREA

by

Choi, Ki Chul, Ph. D.,
Professor, Department of Biology
College of Education
Seoul National University

assisted by

Sang Lin Chun

Shin Sok Choi

INTRODUCTION

The salmonid fish, Brachymystax lenok, is an edible species with a distribution pattern limited to the cold mountain streams of the western part of the Taiback Mountain Chain. Most of the streams, however, cannot maintain their natural populations because of the reckless fishing. The only places which maintain their natural population are the small parts of the Sooib River, Yanggu Koon, and the Suwha River, Rinje Koon, near the DMZ. The present writer has considered the possibility of culturing them by comparing the streams which conserve their natural fish population to the streams which are deprived of their natural population by reckless fishing. To accomplish the purpose, the author has studied the distribution of the fishes which live in streams located near the DMZ. There have been no reports so far on the distribution of fresh water fish found in the DMZ area since its establishment. There were a few papers, however, before 1945.

Lee (1930) pointed out that Coilia ectenes, Plecoglossus altivelis, Hemibarbus labeo, Mugil cephlus, and Siniperca scherzeri are in Changtan; Himibarbus labeo and Siniperca scherzeri are in both Ryunchun and Chorwon; Siniperca scherzeri and Brachymystax lenok are in Koemwha; Brachymystax lenok, Hemibarbus labeo and Siniperca scherzeri in Rinje, Yangkoo, and Hongchun; and Plecoglessus altivelis, Salangichthus microdon, Oncorhynchus masou, O. keta, and Tribolodon hakonensis are in Kansung. Protosalanx chinensis and Sphoeroides ocellatus were added to the fishes known in Changtan.

Mori (1935) reported that Gobiobotia brevibarba are found at Rhunchun, and Chung (1954) pointed out that Liobagrus andersonii, Moroco lagowskii, M. owycephalus, Anguilla japonica and Aplocheilus latipes are in Koemwha, Kangwun Do.

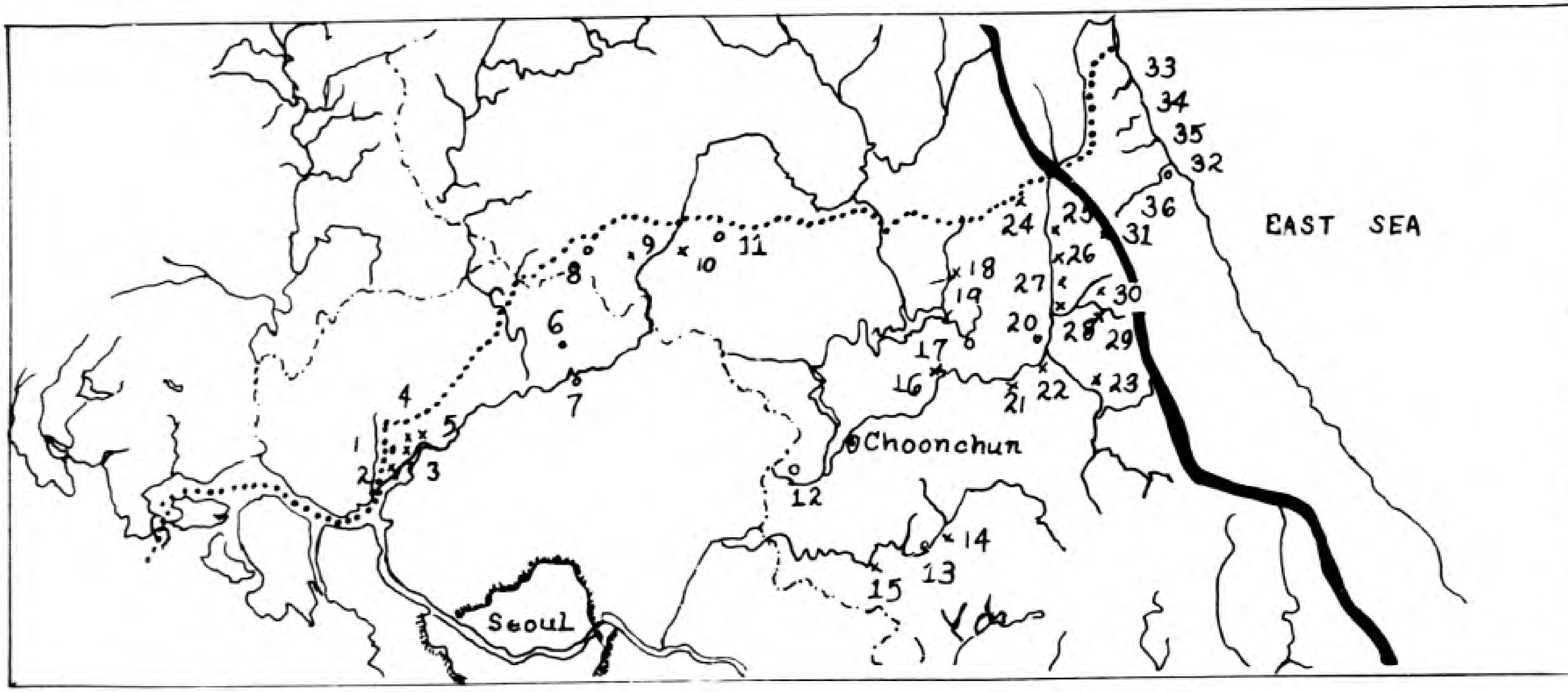
Only seventeen species of fishes are reported in the studied area up to now. The writer has collected 4615 individuals of 54 species of fresh water fishes at 28 stations from May, 1966, to April, 1968. Of these species, 45 were previously unrecorded in the area. Of 28 stations, several stations are quite a distance from the DMZ. The writer will report the microdistribution of fishes in the Han River in the near future.

STUDIED STATIONS AND METHODS

A. Studied stations (dates and stations are in the following Chart 1 and FIGURE 1).

Date	Studied stations
May 17-20, 1966	Moraedong, Mawoodong, Hakorangpo Chantankun, Kyunki Do.
Nov. 16-19, 1966	Punch Bowl, Linje Koon.
March 18-20, 1967	Wulhakri, Chunto Ri, Suwha Ri, Linje Koon.
June 23-26, 1967	Sooib River, Yangkoo Koon; Suwha River, Linje Koon; Kangchon, Choonsung Koon.
Aug. 16-20, 1967	Suwha River, Linje Koon; Chinbu Ridge, Linje Koon; Songhyon Ri, Hyonnae Myon, Kosung Koon; Koembong Temple Stream, Koejin Myon, Kosung Koon; Book River, Kansung Myon-Kosung Koon.
Sept. 22-24, 1967	Junkok-Rhunchun Koon; Myojangdong, Chulwun Koon; Tosung Ri, Koewha, Chulwun Koon.
Dec. 7-10, 1967	Sooib River, Yangkoo Koon; Kirin River, Rinje Koon; Suwha River, Rinje Koon.
March 14-17, 1968	Sooib River, Yangkoo Koon; Soyang River, Choonsung Koon; Kwandae Ri, Rinje Koon; Suwha River, Rinje Koon; Hanke River, Rinje Koon; Paro Lake, Yangkoo Koon; Dukchiri River, Tong Myon, Hongchun Koon.
April 18-21, 1968	Soyang River, Choonsung Koon; Sooib River, Yangkoo koon; Kwandaeri, Suwha River (Chuntori, Wulhakri), Rinje Koon; H anke River, Rinje Koon; Koolchiri, Bookbang Myon,

FIGURE 1. Showing studied areas and studied stations.



Studied stations:

1. Changtan
2. Moraedong
3. Maoedong area
4. Omokdong area
5. Bansung Ri, Hakorangpo
6. Rhyunchun
7. Junkok
8. Chulwun
9. Yong River
10. Tosung Ri, Koemwha
11. Koemwha
12. Kangchon
13. Hongchun
14. Dukchiri
15. Whayang River
16. Booksang Myon
17. Yangkoo
18. Sooib River
19. Yangkoo (Paro Lake)
20. Rinje
21. Kwantae Ri
22. Kyungro Jung
23. Kirin River
24. Punch Bowl
25. Suwha River (4)
26. Suwha River (3)
27. Suwha River (2)
28. Suwha River (1)
29. Hanke River
30. Backtam River
31. Chinboo Ridge
32. Kansung
33. Songhyon Ri
34. Myungpa Ri
35. Koebong Temple Stream
36. Book River

B. Methods

Tools and means for fishing are as follows:

1. Fishing by several kinds of hooks
2. Dragged net (meshes 2 cm x 2 cm)
3. Cast net (meshes 1 cm x 1 cm)
4. Insect net for fishing juvenile fishes
5. Electric shock by a battery of 200-300 volts

RESULTS AND DISCUSSION

The total number of fresh water fish collected at studied stations is 4615, belonging to 54 species. As stated in the introduction, the fishes recorded in the studied area are of 17 species, and the author could not confirm that Colia ectenes, Salangichthys microdon, Protosalanx chinensis, Tribolodon hakonensis, Mugil cephalus, and Spheroides ocellatus are inhabiting there.

The author has not studied the estuary area of each stream thoroughly enough to collect these species. The author, however, collected Coilia ectenes at Kongam Ri, Yeumchang Ri, Rangin Ri, Mapo, and Noryangjin; Salangishthys microdon at the Namtae River, Yangyang Koon, and Kyungpotae Kannoeng; Protosalanx chinensis at Kongam Ri, Yeumchang Ri, Tangin Ri, Mapo, and Noryangjin; *Tribolodon hakonensis* at the Namtae River (Yangyang Koon) and the Oshib River (Samchok Koon); and *Spheroides ocellatus* at the lower post of Kwangjang Ri in the Han River and the Sang River, Sokcho City.

As Choi (1968) reported, *Oncorhynchus masou*, *O. Keta*, *O. macrostomus* and *Chaenogobius annutaris urotaenia* live only in the eastern side on Taiback Mountain Chain.

Three species - *Lampetra reissuneri*, *Gnathopogon coreana*, and *Eloetris pisomis oxycephla* - were not recorded in the Han River. *Lampetra reissneri* is known in the rivers located in the northeastern coast near Wunsan. However, the author collected this species at Tosung Ri, Kal Myon, Chulwun Koon; the Suwha River, Rinje Koon; and confirmed that the species live in Choonsung Koon, Whachun Koon, Pyunchang Koon, Jungsun Koon, Yungwul Koon, and Jechun Koon. Especially Tosung Ri, Chulwun Koon areas abound with the fish belonging to this species, and the author collected 179 individuals of the species from the sand of a small puddle on September 23, 1967. There are facts evident here that tell us that this species must be distributed widely in upper and middle streams of the Han River.

Gnathopogon coreanus is known only in the Taetong, Nakton, and Sumjin rivers. The author, however, found the species at Maoedong and Hakorangpo of Changtan Koon and Hongchun Koon. The author also confirmed that this species live in the Han River flowing through Seoul, Wunju, Yangju Koon etc. It is expected that this species will be collected at many stations of the Han River.

Eleotris pisomis oxycephala was known only in Jeju Island and the Suton River, Soowun. The author, however, has collected this species at Bansun Ri, Hakorangpo, Changtan Koon; the Yong River in Chulwun Koon; Dukchi Ri, Tong Myon, Hongchun Koon; Kwantae Ri, Rinje Koon and the Suwha River, Rinje Koon etc. It is supposed that this species must be distributed widely in the Han River.

Jung (1954) reported that Moroco lagowsku is found at Koemwha, Kanwan Do, and Mori (1935) also reported that this species is collected at Hoeyang located in Norther part of DMZ. The author, however, could not confirm these facts and could not find this species on the west side of Taiback Mountain Chain.

The Sooib River, the Suwha River, and the Hanke River are studied relatively in detail and the author collected 357 individuals of 13 species, 924 individuals of 25 species and 121 individuals of 19 species respectively. Brachymystax lenok is found in these three steams.

Dominant species of fish at each station studied varied from season to season and region to region. In the case of the Suwha River, as shown in TABLE 5, Zacco temmincki was dominant species in March, 1967; Coresleuciscus splendidus in June, 1967; Zacco platypus in August, 1967; and Liobagrus andersonii in April, 1968. In the case of Kwantee Ri, Rinje Koon, Zacco platypus and Microphysogoio koreensis were dominant species in March, 1968; but Pungtungia herzi and Coreoperca herzi were predominant in April, 1968. In the case of Booksang Myon, Choonsung Koon, Zacco platypus was almost monopolistic in March, 1968. However, pungtungia herzi and Coreoperca herzi were predominant in April, 1968.

In the case of Kukchi Ri, Tong Myon, Hongchun Koon, where rapids are continuous, of 453 individuals of fishes collected 320 individuals were Zacco platypus. On the other hand, in the case of the swamp area in Maoedong, Changtan Koon, the total number of fish collected was 177 individuals, and 136 individuals of them were Carassius carassius. As shown in TABLE 3, in six stations studied Zacco temmincki was dominant species; in five stations, Z. platypus was dominant, and Carassius carassius was also dominant at the other five stations.

In most cases, Z. temmincki was distributed further up in the stream than Z. platypus. And the latter was distributed mainly in shallow clear rapids. On the other hand, Carassius carassius was found mainly in slow moving muddy water provided with many shelters.

As Choi (1968) pointed out, on the east side of the Taiback Mountain Chain, most cases show Moroco lagowskii, Plecoglossus altivelis, Oncorhynchus macrostomus and Chaenogobius annutaris urotaenia, etc. as dominant or subdominant species. In the upper stream of the Han River, however, Moroco oxycephalus, Moroco uchida, Zacco temmincki and Brachymystax lenok, etc. were dominant and subdominant species.

Anguilla japonica, Hemibarbus longistris, Pelteobagrus fluvidraco, Pungtungia herzi, and Cottus peocilopterus were each dominant species at one stations. The author, however, thought that most of them were exceptional. It's unusual to find carnivorous fish such as Pelteobagrus fluvidrace dominant, except in rare cases like that of the hibernating juvenile fish population. Cottus poecilopterus and Hemibarbus longistris often appear as dominant species in many regions.

The case of the Sooib River is a striking example of the microdistribution of fishes. All the species of fish shown in TABLE 5 were collected below Doota Pool, but only four species--*Brachymystax lenok*, *Carassius carrasius*, *Barbatula toni*, and *Cottus poecilopterus*--were found above Doota Pool. Of those species, *Carassius carassius* might have ascended as the stream was flooded and the others may not have been able to ascend a small fall at the Doota Pool.

Gonoprokopterus mylodon, a species distributed only in the Han River, was known as an inhabitant of Chung Pyoung, Kyonki Do, and Koemsung, Kangwun Do. However, the author collected the species at Junkok, Koemwha, Booksang Myon (Choonsung Koon), Rinje, Kwantae Ri, the Kirin River, the Suwha River, the Hanke River and the Whayang River. Moreover, Pochun Koon, Yangkoo Koon, Pyonchang Koon, Jungsun Koon, Yungwul Koon, Choongjo City, Tanyang Koon and Koesan Koon are known as the places inhabited by the species. These facts tell us that this species must be distributed widely in the upper and middle streams of the Han River.

Gobiobotia brevibarba is also a species found only in the Han River, and Hoeyang, (Kangwun Do), the Koemkang River, and Rhyunchun (Kyongki Do came to light as the places where the species inhabit. We colle cted this species at Junkok, Choonsung Koon, the Whayang River, Kwantae Ri, the Kiring River, the Suwha River and the Hanke River. Unfortunately, the author could not find this species in South Han River system, but it should be distributed widely in North Han River system.

CONCLUSIONS AND SUMMARY

A. Survey of fresh water fishes at 28 stations were undertaken from May, 1966, to April, 1968.

B. The writer collected 4615 individuals of 54 species of fresh water fishes at those stations.

C. The writer confirmed that Oncorhychus masou, O. keta, O. macrostomus, Chainogobius annutaris urotaenia are distributed on the east side of the Taiback Mountain Chain and Lampetra reissneri, Gnathopogon coreanus, Eleotris pisomis oxycephala were previously unrecorded species in the Han River.

D. Of 17 species reported by several students, Collia ectenes, Oncorhynchus masou, O. keta, Salangichthys microdon, Protosalanx chinensis, Tribolodon hakonensis, Mugil cephalus, Spheroides ocellatus were not collected by the writer at those studied stations. However, the author has collected all of them at the several other streams on the east side of the Taiback Mountain Chain and other stations on the Han River.

E. The Sooib River in Yangkoo Koon, the Suwha River in Rinje Koon, and the Hanke River in Rinje Koon were studied relatively in detail and 357 individuals of 13 species, 924 individuals of 25 species, 121 individuals of 19 species were collected respectively. The salmonid fish, Brachymystax lenok is found is those three streams.

F. Dominant species of fish at each studied station differ according to localities and seasons. In many cases *Moroco lagowskii*, *Plecoglossus altivelis*, and *Chaenogobius annutaris aroteania* are dominant species on the east side of Taiback Mountain Chain and *Carrassius carassius*, *Zacco platypus* and *Z. temmincki* are dominant in the Han River.

SUMMARY

A. We collected 40 species of fresh water fish at 10 streams located on the east side area of Taiback Mountain Chain from Soghyon Ri, Hyonnae Myon, Kosung Koon, Kangwon Do to Chodang Cave, Koenduck Myon, Sunchok Koon, Kangwon Do from May 25, 1966, to August 30, 1967.

B. Of 40 species, 14 are not distributed in the Han River, another 17 are not found in northern part of Wunsan and 11 are not distributed in the southern part of Woolchin located on the east side of Korea.

C. Thirty-three species of northern fresh water fishes, sixteen of southern species, and 60 of the Han River species are not distributed in the studied area.

D. The writer considered that the studied area should include the intermediate district of Amur and China subregion. The writer also believes that the difference of the fresh water fish fauna of the studied area northern part, southern part, and Han River has been produced by ecological and geohistorical factors.

E. The facts that Gnathopogon strigatus, Cobitis rotundicaudata, Coreoperca Kawamebari and Leucopaarion petersi are distributed in the studied area is a remarkable thing. On the other hand, the writer feels strange that Gobio govio, Pseudorasbora parva, Zacco platypus and Z. temmincki are not found in the areas studied.

TABLE 1. Fishes collected in both the Injin and Han River systems.

Family and Species	No. Stations at which collected
Family Petromyzontidae	
Lampetra reissneri Dybowski	4
Family Salmonidae	
Brachymystax lenox Pallas	8
Family Plecoglossidae	
Pleoglossus altivelis T. & S.	4
Family Siluridae	
Parasilurus asotus L.	9
P. microdorsalis Mori	8
Family Bagridae	
Pelteobagrus fluvidrace Richardson	2
Pseudobagrus emarginatus Sowerby	11
Liobagrus andersonii Regan	16
Family Cyprinidae	
Carpinus carpio L.	5
Carassius carassius L.	15
Hemibarbus labeo Pallas	14
H. longirostris Regan	16
Gonoprokopterus mylodon Berg	8
Pseudogobio esocinus T. & S.	16
Gnathopogon coreanus Berg	4
Sarcocheilichthys czerskii Berg	2
S. wakiyae Mori	2
Pungtungia herzi Herzenstein	15
Moroco lagowskii Dybowski	5
M. oxycephalus Bleeker	14
Coreoleuciscus splendidus Mori	17
Ospariichthys bidens Gunther	5
Zacco platypus Tem. & Sch.	20
A. temmincki Tem. & Sch.	18
Acheilognathus signifera Berg	10
Gobiobotia brevibarta Mori	11
Microphysogobio koreensis Kori	15
Microphysogobio longidorsalis Mori	12

TABLE 1. Cont.

Family Cyprinidae (cont.)	
Cobitis taenia L.	19
C. rotundicaudata Wakiya & Mori	12
Misgurnus anguillicordatus Cantor	13
Lefua costata Kessler	6
Barbatula toni Dybowski	12
Family Ophicephalidae	
Ophicephalus argus Cantor	3
Family Epinephelidae	
Coreoperca herzi Herzenstein	14
Siniperca scherzeri Steindachner	12
Family Eleotridae	
Eleotris pisonis Tem. & Sch.	10
Family Gobiidae	
Gobius similis Gill	10
Family Cottidae	
Cottus poecilopterus Heckle	4

TABLE 2. Fishes collected only in the Injin River system.

Family and species	No. stations at which collected
Family Coilidae	
Coilia ectenes Jordan & Seale	1
Family Salangidae	
Protosalanus chinensis Basilewsky	1
Family Gioboninae	
Gnathopogon strigatus Regan	4
Pseudorasbora parva Tem. & Sch.	2
Family Leuciscinae	
Aphyocypris chinensis Gunther	1
Family Acheilognathinae	
Rhodeus ocellatus Kner	1
Family Anguillidae	
Anguilla japonica Tem. & Sch.	6
Family Mugilidae	
Mugil cephalus L.	1
Family Eleotridae	
Mogurnda obscura Tem. & Sch.	1
Family Cottidae	
Trachydermus fasciatus Heckle	1
Family Tetraodontidae	
Speroides ocellatus Osbeck	1
Family Cyprinodontidae	
Aplocheilus latipes Tem. & Sch.	2

TABLE 3. Fishes collected only in the Han River system.

Family and Species	No. stations at which collected
Family Salmonidae	
Oneorchynchus masou Brevoort	2
O. keta Walbaum	2
O. macrostomus Gunther	2
Family Salangidae	
Salangichthys microdon Bleeker	1
Family Gioboni.iae	
Ladislavia taczanowskii Dybowski	1
Family Leuciscinae	
Moroco sp. Uchida	6
Tribolodon hakonensis Gunther	1
Family Gobiidae	
Chaenogobius annutarius Hilg.	3

TABLE 4. Fishes collected in streams of the east coast of Korea.

Family and species	No. stations where collected
Family Salmonidae	
*Oneorhynchus masou Brevoort	1
*O. keta Walbaum	1
*O. macrostocius Gunther	2
Family Plecoglossidae	
Mecoglossus altivelis T. & S.	3
Family Salangidae	
*Salangichthys microdon Bleeker	1
Family Cyprinidae	
Moroco lagowski Dybowski	4
Moroco sp.	1
Tribolodon hakonensis Gunther	1
Zacco temmincki Tem. & Sch.	1
Family Cobitidae	
Cobitis taenia L.	4
Misqurnus anguillicaudatus Canton	2
Lefua costata Kessler	3
Barbatula toni Dybowski	2
Family Gobiidae	
Gobius similis Gill	3
*Chaenogobius annutaris Hilg.	3

*Found only on the east coast.

TABLE 5. Seasonal differences in the number of fish caught in the Suwha River.

Species	Date-- Mar. 18 '67	Mar. 16 '68	Apr. 20 '68	June 25 '67	Aug. 16 '67	Dec. 9 '67
Family Petromyzontidae						
Lampetra reissneri Dybowsky	1	2	3	.	.	.
Family Coregonidae						
Brachymystax lenok Pallas	7	.	.	.	.	.
Family Siluridae						
Parasilus asotus L.	1	.	4	.	.	.
Family Bagridae						
Pseudobagrus emaginatus Sowerby	2	.	2	9	.	.
Liobagrus andersonii Regan	15	3	32	.	.	.
Family Cyprininae						
Carassius carassius L.	1	62	1	.	.	.
Subfamily Gioboninae						
Hemibarbus longistris Regan	.	17	4	.	2	42
Gonoprokopterus mylodon Berg	.	1	15	1	.	5
Pseudogobio esocinus T. & S.	.	4	1	.	2	1
Pungtungia herzi Herzenstein	13	25	16	3	2	.
Subfamily Leuciscinae						
Moroco oxycephalus Blecker	7	11	5	.	.	.
Coreoleuciscus splendidus Mori	1	.	19	27	.	.
Opsariichthys bidens Gunther	.	.	.	.	2	1
Zacco platypus Tem. & Sch.	.	27	14	3	54	29
Z. temmincki Tem. & Sch.	57	11	1	7	1	2
Subfamily Acheilognathinae						
Acheilognathus signifer Berg	1	6	1	1	.	.
Subfamily Gobiobotinae						
Gobiobotia brevibarba Mori	1	.	14	1	.	.
Microphysogobio koreensis Mori	.	5	15	.	.	.
M. longidorsalis Mori	6	9	11	10	4	1
Subfamily Cobitinae						
Cobitis taenia L.	21	16	22	3	.	.
C. rotundicaudata Wakiya et Mori	5	5	4	.	.	.
Misgurnus anguillicaudatus Cantor	4	34	2	.	.	.
Barbatula toni Dybowski	4	3	25	.	.	.
Family Epinephelidae						
Coreoperca herzi Herzenstein	4	7	19	10	3	.
Family Eleotridae						
Eleotris pisonis oxycephala T & S	4	43	8	1	.	1

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A PRELIMINARY STUDY OF THE PHYTOPLANKTON OF THE HAN RIVER ESTUARY

by

Yung Ho Chung, Ph. D.,
Professor, Department of Botany,
College of Liberal Arts and Sciences,
Seoul National University

assisted by

Young Moo Kang
Jae Hyung Shim

INTRODUCTION

The Han River is the second largest river in South Korea that originates from Mt. Gumgang in North Korea and is joined with the South Han River from Mt. Daeduk. This river flows into the Yellow Sea which is on the west side of Korea. The Han River estuary is located at Kanghwa-Gun, Kyunggi-do, an area which is a part of the DMZ.

I attempted to clarify the phytoplankton of this area together with some important environmental factors. A few studies on the plankton of some rivers were reported, but none of the estuarine area have been carried out. This work, then, is the first attempt of that field in Korea.

METHOD OF WORK

I selected six areas for surveying and sampling in and near the DMZ (FIGURE 1.). Monthly checks of environmental factors and collections of materials were performed from April, 1967, through April, 1968. In particular the diurnal fluctuation of salinity was checked each hour from 6 a.m. through 6 p.m. on September 7, 1967, to compare the distribution of phytoplankton in estuarine waters and the effect of sea water.

A qualitative microplankton net (Muller gaze No. 15) was used for the collections. Material collected was fixed with Fleming's solution for twenty-four hours and, after rinsing in running water, was stored in 70% alcohol. Permanent preparations were made by embedding in pleurax; surface water temperature was measured at a depth of 30 cm. Hydrogen ion concentration was determined colorimetrically by the brom thymol blue indicator method for pH range, 6.0 - 7.6, and phenol red for pH range 6.8 - 8.4. Dissolved oxygen was determined by the modified Winkler method and salinity was determined by the Mohr method.

RESULTS AND DISCUSSION

The materials collected were stored in 154 bottles and 770 slides were prepared for identification. The results of this work will be considered in two phases.

A. Environmental features

The most important factor in an estuary is the mixing of river and sea water. FIGURES 2 and 3 show seasonal variations in temperature, pH, and dissolved oxygen. The pH values in all areas are lowest in winter. The pH is lowest at Chollyu-ri and hightest at Choji-ri, Oepo-ri, and Inhwari. The annual cycle of dissolved oxygen in estuarine waters is closely correlated with temperature. The dissolved oxygen in all areas is generally highest in winter and lowest in late summer. On the contrary, temperature is generally highest in summer and lowest in winter.

Salinity is the most important factor in estuarine waters. FIGURE 4 shows the diurnal changes of salinity in relation to the depth of water, based upon tidal changes. It is suggested that the daily rhythm of salinity in the estuary is mainly due to the tidal fluctuations. This fact is closely correlated with the distribution of phytoplankton in the estuary.

B. Biological features

The materials collected at all areas were classified by Engler's classification system (1956) resulting in 69 genera, 212 species, 1 subspecies, and 20 varieties belonging to 4 phyla, 4 classes, 3 subclasses, 12 orders, 4 suborders, 25 families and 2 tribes.

TABLE 1 lists the species. The total number of samples of phytoplankton identified was 238. Of these 238, 40 species and 8 varieties were previously unrecorded in Korea.

TABLE 1. A taxonomic list of phytoplankton flora in the Han River estuary.

Phylum Cyanophyta
 Class Cyanophyceae
  Order Chroococcales
   Family Chroococcaceae
    Anacystis incerta Lemmermann
  Order Hormogonales
   Suborder Nostocinales
    Family Oscillatoriaceae
     Oscillatoria tenuis C.A. Agardh
    Family Nostocaceae
     Nostoc linckia (Roth) Bornet

Phylum Pyrrophyta
 Class Dinophyceae
  Subclass Dinoflagellatae
   Order Peridiniales
    Family Ceratiaceae
     Ceratium hirundinella O. F. Muller

Phylum Chrysophyta
 Class Chrysophyceae
  Order Silicoflagellatae
   Suborder Siphonotestinales
    Family Dictyochaceae
     Dictyocha fibula Ehrenberg
     **Distephanum speculum* (Ehrenberg) Haeckel
     **D. Speculum* (Ehren.) Joergensen
      var. *octonarium* (Ehren.) Haeckel
 Class Bacillariophyceae
  Subclass Centricae
   Order Discales
    Family Coscinodiscaceae
     Melosira distans (Ehren.) Kutzing
     Melosira granulata (Ehren.) Ralfs

* Newly recorded in Korea

TABLE 1. (Cont.)

Melosira granulata (Ehrenberg) Ralfs
var. angustissima O. F. Muller
M. islandica O. F. Muller
M. islandica O.F. Muller
subsp. helvetica O.F. Muller
M. italica (Ehrenberg) Kutzing
*M. juergensii C.A. Agardh
M. nummuloides C.A. Agardh
*M. octogona A. Schmidt
M. sulcata (Ehren.) Kutzing
M. varians C.A. Agardh
*Stephanopyxis niponica Gran & Yendo
S. palmeriana (Greville) Grunow
S. turris (Greville)
*Thalassiosira condensata (Cleve)
T. hyalina (Grunow)
Sceletonema costatum (Greville) Cleve
Coscinodiscus anguste-lineatus A. Schmidt
*C. angstii Gran
C. asteromphlus Ehrenberg
C. centralis Ehrenberg
C. curvatulus Grunow
*C. debilis Grove
C. excentricus Ehrenberg
C. gigas Ehrenberg
C. granii Gough
C. janischii A. Schmidt
*C. kutzingii A. Schmidt
C. lineatus Ehren.
C. marginatus Ehren
C. megalomma A. Schmidt
C. niditus Gregory
C. nodulifer A. Schmidt
*C. oculus-iridis Ehren.
C. nodulifer + Schmidt
C. perforatus Ehren.
C. radiatus Ehren.
C. rothii (Ehren.) Grunow

TABLE 1. (Cont.)

Coscinodiscus stellaris Roper
*C. su--oulliens Jorgensen
C. subconcavum Grunow
C. eutilis Ehrenberg
C. wailesii Gran & Angst
Cyclotella Bodanica Eulenst
Cyclotella comta (Ehren.) Kutzing
Cyclotella kutzingiana Thwaites
Cyclotella operculata (Agardh) Kutzing
Cyclotella striata (Kutzing) Grunow
*Cyclotella striata (Kutzing) Grunow
var. ambigua Grunow
Coscinosira oestrupi Ostenfeld
Schroedella delicatula
Family Actinodiscaceae
Arachnoidischus ehrenbergii Bail
A. ornatus (Brebisson) Greville
Actinoptychus undulatus (Bail) Ralfs
Actinoptychus splendens (Shadb.) Ralfs
Asterolampra grevillei Wallich
Asteromphalus falbellatus (Brebisson) Greville
Family Eupodiscaceae
Actinocyclus ehrenbergii Ralfs
Actinocylus moniliformis Ralfs
Family Soleniaceae
*Rhizosolenia delicatula Cleve
Rhizosolenia setigera Brightwell
Order Biddulphiales
Family Chaetoceraceae
Chaetocera affinis Lauder
*Chaetoceras ?compressus Lauder
Chaetoceras curvisetus Cleve
Chaetoceras didymus Ehrenberg
Chaetoceras danicus Cleve
Chaetoceras holsaticus Schutt
Chaetoceras lorenzianus Grunow
Chaetoceras Meulleri Lemmermann
Bateriostrum delicatulum Cleve
Bateriastrum varians Lauder

TABLE 1. (Cont.)

Family Biddulphiaceae

Eucampia zoodiacus Ehrenberg
Ditylium brightwellii Grunow
Dytylium sol Grunow
Triceratium favus Ehrenberg
T. reticulum Ehren.
Biddulphia aurita (Lyngbye) Brebisson
B. longicrusis Greville
B. pulchella Gray
B. regia (Schultze) Ostenfeld
B. rhombus (Ehren.) W. Smith
B. sinensis Greville
*Isthmia nervosa Kutzing
Bellerochea malleus (Brightwell) Van Heurck

Subclass Pennatae

Order Araphidales

Family Fragilariaceae

Grammatophora marina (Lyngbye)
Rhabdonema arcuatum Kutzing
Rhabdonema adriaticum (Kutzing) Rabenhorst
Diatoma elongatum Agardh
*D. hyalinum Kutzing
D. vulgare Bory
*Plagiogramma vavheurekii Grunow
Meridion circulare Agardh
Fragilaria capucina Desm.
Fragilaria construens (Ehren.) Grunow
F. crotonensis Kitton
F. cylindrus Grunow
F. intermedia Grunow
*F. islandica Grunow
F. oceanica Cleve
F. virescens Ralfs
Raphoneis amphiceros Ehren.
Synedra acus Kutzing
Synedra acus Kutzing
var. angustissima Grunow

Synedra affinis (Kutzing)
Synedra affinis (Kutzing)
var. *fascioculata* (Kutzing) Grunow
Synedra cyclopum Brutschy
S. fulgens (Greville) W. Smith
S. gaillonii (Bory) Ehrenberg
S. pulchella Kutzing
S. tabulata (Agardh) Kutz.
S. ulna (Nitzsch) Ehren.
S. ulna (Nitzsch) Ehren.
var. *amphirhynchus* (Ehren.) Grunow
S. ulna (Nitzsch) Ehren.
var. *impressa* Hustedt
S. ulna (Nitz.) Ehren.
var. *oxyrhynchus* (Kutz.) Van Horck
S. ulna (Nitz.) Ehren.
var. *ramesii* (Herieand & Peragaud)
Thalassiothrix frauenfelldii Grunow
T. longissima Cleve & Grunow
T. nitzschioides Grunow
Asterionella formosa Hassal
A. gracillima (Hantzaeh) Heiberg
A. japonica Cleve
**Campylosira cymbelliformis* (A. Schmidt) Grunow

Order Raphidicidales

Family Eunotiaceae

Eunotia lunaris (Ehren.) Grunow
Ceratoneis arcus Kutz.

Order Monoraphidales

Family Achnanthaceae

Cocconeis pediculus Ehrenberg
C. placentula Ehren.
C. scutellum Ehren.
**Achnanthes brevipes* Agardh
Campyloneis grevillei (Smith) Grunow

Order Biraphidales

Family Naviculaceae

*Mastogloia minuta Greville
*Diploneis fusca (Gregory) Cleve
*D. splendida (Greville) Cleve
Frustulia rhomboides (Ehren.) De Toni
F. vulgaris (Thwaites) De Toni
Pleurosigma affine Grunow
P. angulatum (Queck.) W. Smith
*P. compactum Greville
P. elongatum W. Smith
P. fasciola Ehrenberg
*P. intermedia W. Smith
P. naviculaccum Brebisson
P. normanii Ralfs
P. pelagicum
P. rectum Donkin
P. rigidum Smith
var. incurvata Grunow
*P. salinarum Grunow
Gyrosigma acuminatum (Kutzing) Rabenhorst
G. attenuatum (Kutz.) Rabenhorst
G. balticum (Ehren.) Rabenhorst
*G. strigile (W. Smith)
*Caloneis bacillaris (Gregory) Cleve
Neidium dubium (Ehren.) Cleve
Stauroneis anceps Ehren.
Pinnularia borealis Ehre.
P. gibba Ehren.
P. viridis (Kutz.) Cleve
Navicula americana Ehren.
N. anglica W. Smith
N. bacillum Ehren.
N. cancenlata (Lyngbye) Brebisson
N. cryptocephala Kutzing
*N. distans (W. Smith) Grunow
*N. elegans W. Smith
N. exigua (Gregory) Muller
N. falaiensis Grunow
N. gracilis Ehren.
N. mutica Kutz.
N. oppugnata Hustedt

Navicula placentula (Ehren.) Grunow
N. pupula Kutz.
var. *rectangularis* (Gregory) Grunow
N. radiosa Kutz.
N. rhynchocephala Kutz.
N. salinarum Grunow
**Donkinia recta*
var. *intermedia* (Donk.)

Family Cymbellaceae

Cymbella affinis Kutz.
C. aspera (Ehren.) Cleve
C. graciles (Rabenhorst) Cleve
C. lanceolata (Ehren.) Brebisson
C. parva (W. Smith) Cleve
C. tumida (Brebisson) Van Heurck
C. turgida Gregory
C. ventricosa Kutz.
Amphora lineolata Ehren.
Gomphonema acuminatum Ehren.
G. acuminatum var. *Brebissonii* (Ehren.) W. Smith
G. acuminatum Ehren.
var. *coronata* (Ehren.) W. Smith
**Gomphonema exignum* Kutz.
G. gracilis Ehren.
G. intricatum Kutz.
G. olivaceum (Lyngbye) Kutz.
**Didymosphenia geminata* (Lyngbye) M. Schmidt

Family Amphiproraceae

**Amphiprora hyperborea* Kutzing

Family Epithemiaceae

**Rhopalodia giberula* (Ehren.) O.F. Muller

Family Nitzschiaceae

Hantzschia amphioxys (Ehren.) Grunow
var. *xerophila* Gruner
Nitzschia acicularis W. Smith

*N. acuminata (Kutz.) W. Smith
N. amphibia (Kutz.) Grunow
N. closterium W. Smith
N. constrieta (Gregory) Grunow
var. parva Van Heurck
*N. delicatissima Cleve
N. filiformis (W. Smith) Hustedt
N. frustulum (Kutz. Grunow
N. gracilis Hants.
*N. hungarica Grunow
N. Kutzingiana Hilse
*N. lanceolata W. Smith
N. longissima (Brebisson) Gran
N. longissima (Brebisson) Gran
var. reversa W. Smith
*N. obtusa W. Smith
var. scapeliformis Grunow
N. palea (Kutz.) W. Smith
N. paradoxa Gmelin
N. scalaris W. Smith
N. seriata Cleve
N. sigma (Kutz.) W. Smith
N. sigma (Kuetz.) W. Smith
var. intermedia W. Smith
N. spectabilis (Ehrenberg) Ralfs
N. vermicularis Grunow
N. vitrea Norman

Family Surirellaceae

*Surirella biseriata Brebisson
var. bifrons (Ehrenberg) Hustedt
S. elegans Ehren.
S. eximia Greville
*S. gemma Ehren.
S. robusta Ehren.
S. robusta Ehren.
var. splendida (Ehren.) Van Heurck
S. tenera Gregory

Phylum Chlorophyta

Order Chlorococcales

Family Eremosphaeraceae

Halosphaera viridis Schmitz

Family Hydrodictyaceae

Pediastrum boryanum (Tuppin) Meneghini
Pediastrum duplex Meyen

Family Coelastraceae

*Scenedesmus quadrispina Chodat

Order Conjugatae

Suborder Euconjugatae

Family Zignemataceae

Spirogyro setiformis (Roth) Kutzing

Suborder Desmidiinales

Family Desmidaceae

Tribe Closterieae

*Closterium lineatum (Kutzing) Rebenhorst

Tribe Dosmarieae

Desmidium aptogonum Brebisson

TABLE 2. Quantitative distribution of species of phytoplankton by habitats in the Han River estuary.

Habitat / AREA	Marine	Brackish	Fresh	Fresh & Brackish	Brackish & Marine	Fresh, Brackish, & Marine	Total
Jollyu-ri	74	7	73	11	5	1	171
Wolgon-ni	70	6	28	4	5		113
Chosan-ni	56	7	16	1	3		83
Inhwa-ri	65	5	19	3	5		97
Oepo-ri	70	10	16	2	5		103
Choji-ri	69	6	17	1	5		98
Total	114	16	87	9	11	1	238

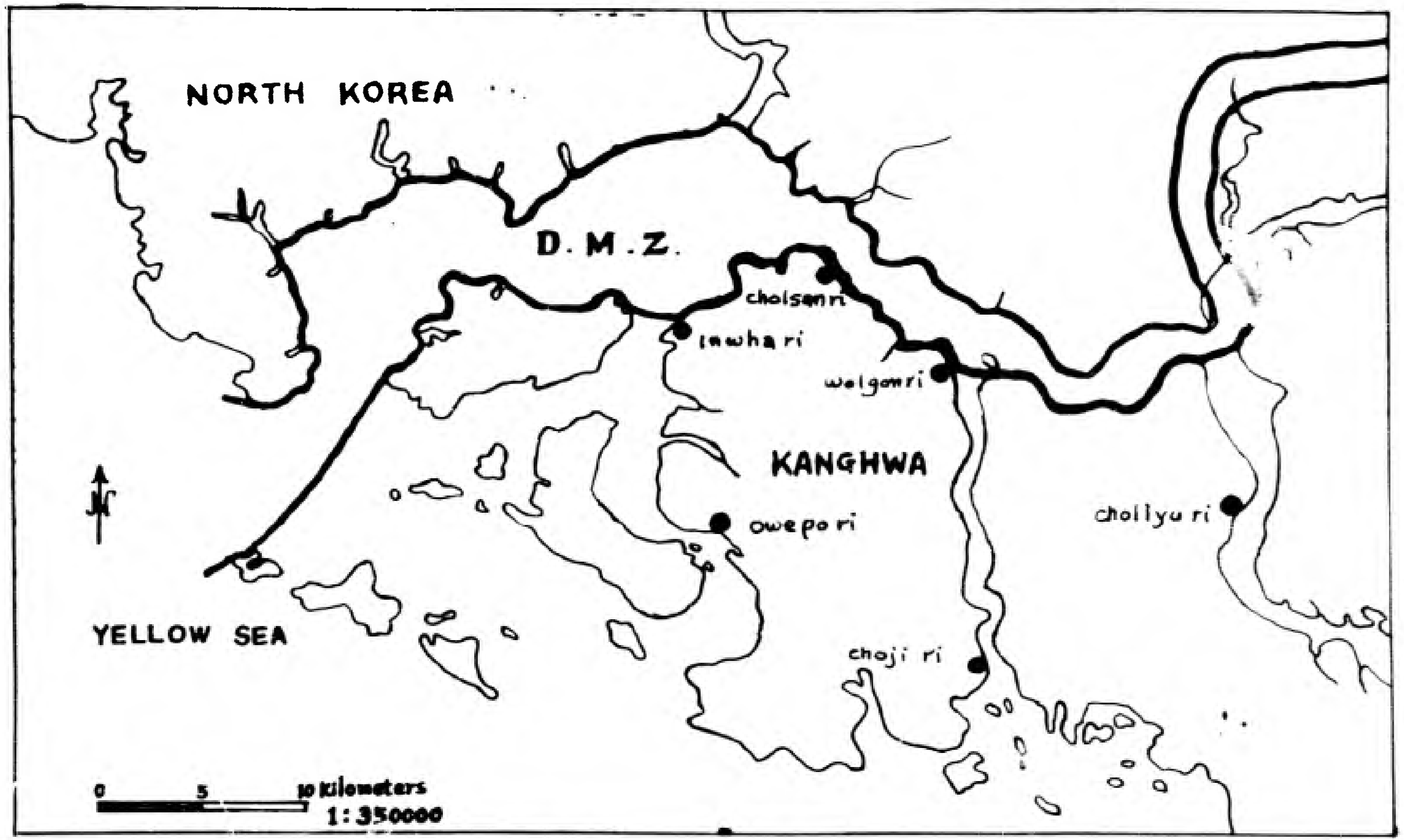

Fig.1 A map showing six researched areas in the Han River Estuary

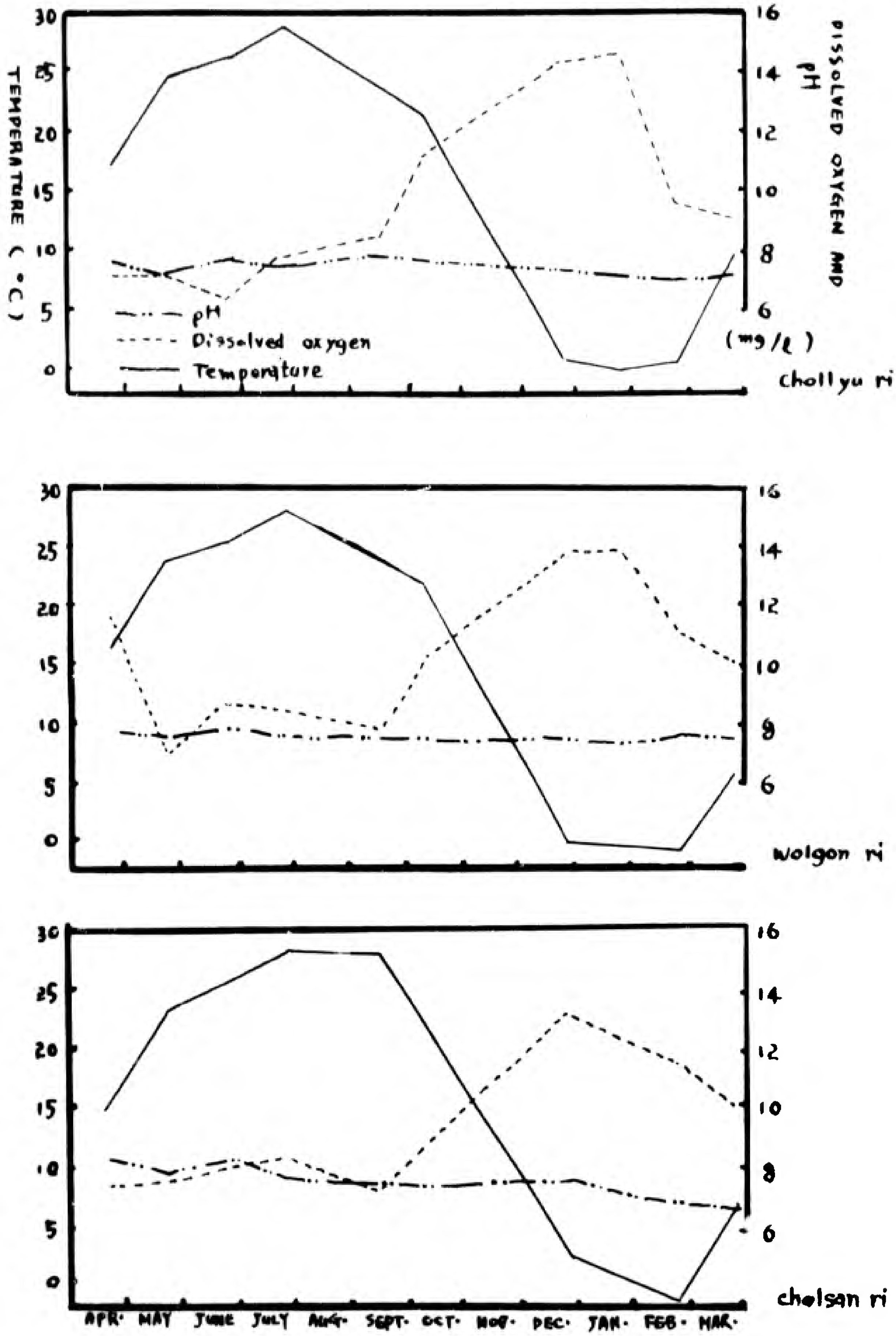

Fig. 2 Seasonal variation in pH, Temperature and Dissolved Oxygen

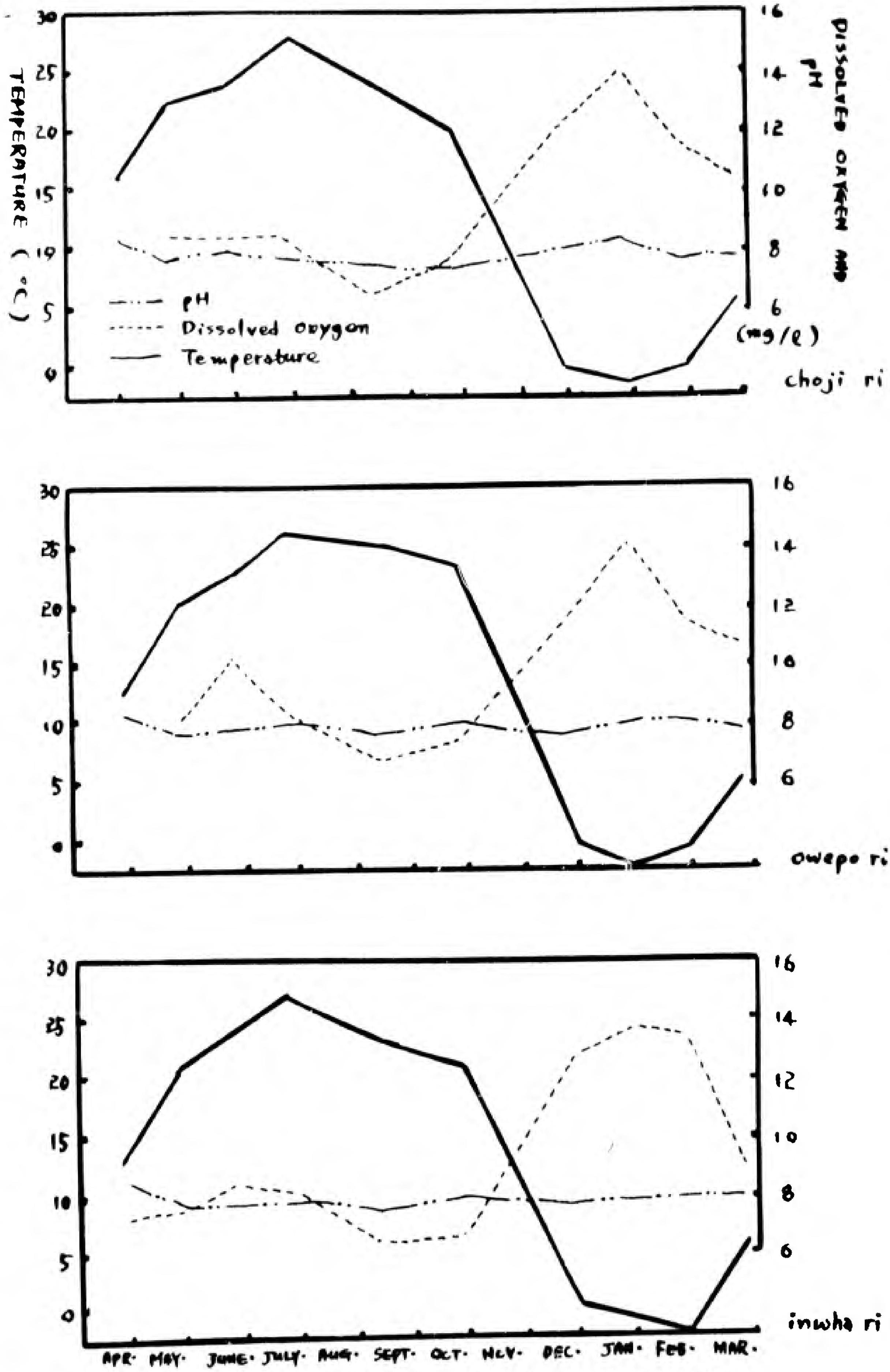

Fig.3 Seasonal variation in pH, Temperature and Dissolved oxygen.

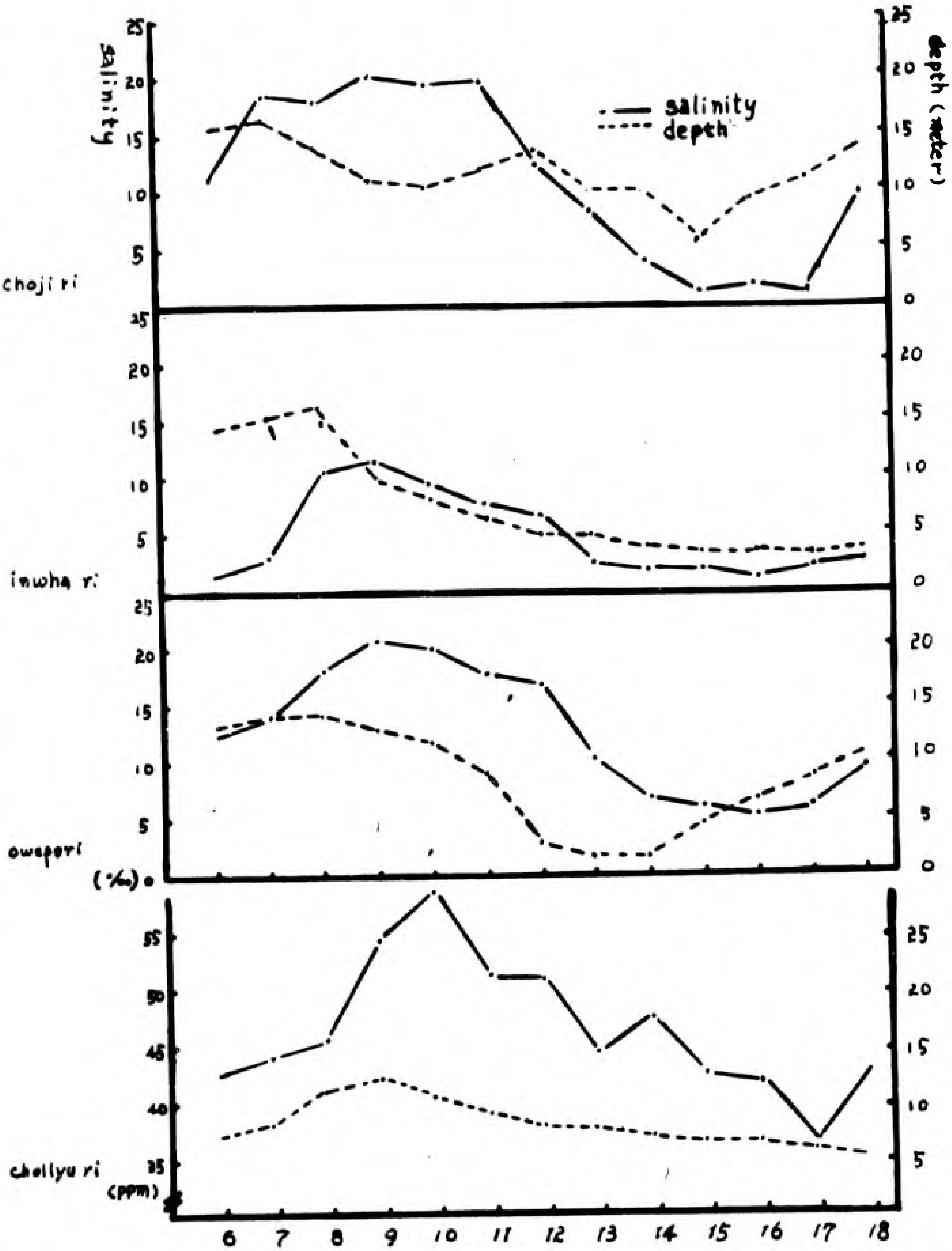

Fig. 4 Diurnal change in Salinity and water depth of the Han River Estuary

In considering the distribution of phytoplankton, it appears that marine forms are predominant, except in Jollyuri, where marine and fresh water forms are abundant. Possibly this is because Jollyuri is an upper region of this estuary. In general there are more kinds of plankton at the upper region of an estuary than at the mouth of an estuary. A proportional distribution of phytoplankton according to its habitat (TABLE 2) is much smaller in marine forms in Jollyuri than in other areas. It is agreed with the fact of distribution of salinity.

CONCLUSION AND SUMMARY

This study was carried out as part of Smithsonian-Korean research in the DMZ area of Korea from April, 1967, through April, 1968. The conclusive results are as follows:

A. Surface water temperature, hydrogen ion concentration, dissolved oxygen, and salinity were determined to be the environmental factors in the Han River estuary.

B. From the materials collected to clarify the phytoplankton flora in this estuary, 238 kinds of phytoplankton were identified and classified according to Engler's classification system--69 genera, 212 species, 1 subspecies, and 20 varieties belonging to 4 phyla, 4 classes, 3 subclasses, 12 orders, 4 suborders, 25 families, and 2 tribes.

C. Forty species and 8 varieties are recorded in this report for the first time in reference to Korea.

D. The distribution of marine forms is closely correlated with that of salinity in the estuarine water.

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A LIST OF PLANTS COLLECTED IN KOREA

by

Chung, Yung Ho, D. Sc.,
Professor, Department of Botany
College of Liberal Arts and Sciences
Seoul National University

Lee, Il Koo, D. Sc.,
Professor, Department of Biology
Kong Kuk University

Lee, Yung No, D. Sc.,
Professor, Department of Biology
Ewha Womans University

Pak, Man Kyu, Honorary Doctorate,
Professor, Department of Biology
Catholic Medical College

assisted by

Young Moo Kang
Ho Joon Lee
Yoo Sung Lee
In Soo Chung

In an overall effort to enumerate the microflora of the study area, two summers were spent collecting plants in the northern part of the Republic of Korea. During this period approximately 5000 specimens were collected of which over 3000 have been identified as 763 kinds and belonging to 99 families. These plants represent the major plant species comprising the vegetation across the peninsula of Korea. In general, plants were most abundant in the abandoned lands of the DMZ, but no quantitative studies were made.

Most of these plant specimens are stored in the herbaria of the home university of the professor who collected the specimen and in the Smithsonian Institution. The largest collection, including members of 90 families, is stored at the Department of Botany, College of Liberal Arts and Sciences, Seoul National University. The major portion of Gramineae and Cyperaceae is stored in the herbarium at Ewha Womans University.

The list of plants here are arranged in the order of Engler (1924), as this was the only arrangement available at the herbarium of Seoul National University. It is hoped that this list will be useful to those persons studying plants of Korea. Most of these plants will be made available to specialists through the Office of Ecology, Smithsonian Institution.

PLANTS COLLECTED DURING THE ECOLOGICAL STUDY IN KOREA

1. Family Polypodiaceae

Aetropteron polyblepharon (Roemer) Nakai
Asplenium incisum Thumberg
Asplenium sarellii Hooker
Athyrium Brevifrons Nakai
A. nipponicum (Mettenius) Hanc e
A. vidalii (Franch. et Savatier) Nakai
A. yokoscense (Franch. et Savatier) Christ.
Camptosorus sibiricus Ruprecht
Colysis elliptica Ching
Coptidipteris wilfordii (Moore) Nakai & Momose
Crypsinus hastatus (Thunberg) Copeland
Davilla mariesii Moore
Diplazium thunbergii Nakai
Dryopteris bissetina (Baker) Christ. var. sacrosancta (Koidz.)Ito
D. crassihrizoma Nakai
Gymnocarpium dryopteris (L.) Newman
Lastrea palustris (Salis.) J. Smith var. koreana Nakai
Lepisorus thunbergianus (Kaulf.) Ching
L. ussuriensis (Regel) Ching
Onoclea orientalis Hook.
O. sensibilis L. var. interrupta Max.
Physematum manchuriense (Hooker) Nakai
Polystrichum craspedosorum Diels.
P. trypteron Presl.
Pteridium aquilinim (L) Kuhn var. japonicum Nakai
Ptiliopteris (Kumtze) Hayata
Woodsia polystichoides Eaton var. veitchii Hooker

2. Family Osmundaceae

Osmunda cinnamonea L. var. fokiensis Copeland
O. claytoniana L.
O. japonica Thunberg

3. Family Salviniaceceae

Salvinia natans Allioni

4. Family Equisetaceae

Equisetum arvense L.
E. hyenale L.

5. Family Lycopodiaceae

Lycopodium chinense H. Christ.
L. obscurum L.
L. serratum Thunberg

6. Family Taxaceae

Taxus cuspida Sieb. & Zucc.

7. Family Pinaceae

Abies holophylla Max.
A. nephrolepis Max.
Juniperus utilis Koidzum
Picea jazoensis Max.
Pinus densiflora Seib. & Zucc.
P. koreiensis Sieb. & Zucc.
Thuja koreiensis Nakai

8. Family Typhaceae

Typha orientalis Presl.

9. Family Sparganiaceae

Sparganium ramosum Hudson
S. stenophyllum Max.

10. Family Potamogetonaceae

Potamogeton franchetii Bennett & Baagae

11. Family Graminae

Agropyrum ciliare Franchet
A. koryoense Honda
A. semicostata (Steudel) Kitakawa
A. yezoens Honda
Agrostis clavata Trin.
A. hiemalis Britton
A. matsumurae Hackel & Matsumura
A. perennanans (Walter) Tuckerman
Alopeculus amurensis Momarov
Andropogon brevifolius Swartz var. *genuina* Hackel

Aneilema japonicum (Thumb.) Kunth
Arthraxon hisoidus (Thunberg) Mikino var. breviseta Regel & Hara
A. hispidus (Thun.) Mikino var. centraasiaticus Honda
A. hispidus (Thun.) Mikino var. tipica Honda
Arundinella hirta Tanaka var. ciliar Koidzumi
Beckmannia syzigachene (Steudel) Fernald
Bromus japonicus Hout.
Calamagrostris arundinacea (L) Roth.
C. epigeios (L) Roth
C. langsdorffii Trin.
Cinna latifolia (Trevir)Griseb.
Cymbopogon goeringii (Steudel) Honda
Diarrhena japonica Franchet & Savatier
D. mandshurica Max.
Digitaria violascens Link.
Eccoilochloa cotulifera A. Camus
Echinochloa crus-galli Beauv. var. edulis Honda
E. hispidula (Retz.) Nakai
E. macrocorvi Nakai
Eleusine indica Gaert.
Eragrostis cilianensis (Allion) Link & Vignolo-Lutati
E. ferruginea (Thun.) P. De Beau.
E. japonica Trin.
E. niwahokori Honda
Eriochloa villosa (Thun.) Kunth.
Festuca ovina L. var. vulgaris Koch
F. subulata Trin.
Glyceria leptolepis Ohwi
Hemathera japonica (Hackel) Rosh.
Hemathria compressa L. var. japonica (Hack.) Y.Lee
Hierochloa odorata Beau.
Imperata cylindrica (L) Beau. var. koenigii (Retz.)
Durand & Schinz
Isachaemum anthephoroidea Miquel
Isachne globosa (Thunberg) Kuntze
Melica nutans Lium.
Melica onoei Franz. & Savatier
Microstegium nudum (Trin.) A. Cam.
M. viniveum (Trin.) E. Camus var. polystachyum
Miscanthus sacchariflorus Bentk. & Hooker
M. sinensis Anderson
M. sinensis Anderson var. purpurescens (Anderson) Rendle
Molinia japonica Hack.
Muhlenbergia hugelii Trin.
Oplismenus undulatifolius (Arduina) Beau.
Panicum bisulcatum Thumberg
Paspalum thumbergii Kunth. & Stendel
Pennisetum alopecuroides (L) Spreng.

Pennisetum alopecuroides (L) Spreng.
P. japonicum Trin.
Phacelurus angustifolia Nakai
Phalaris arundinaceae L. var. genuina Hackel
Phragmites japonica Steud.
P. longivalvis Steudel
P. prospratus Makino
Poa acroleuca Steud.
P. stricta Steudel
P. viridula Palibin
Sacciolepis angusta (Trin.) Staff
S. indica (L) Chase
S. spicata (L) Honda
Sasamorpha purpurascens (hackel) Nakai var. borealis (Hackel) Nakai
Schizachyrum brevifolium (Swartz) Nees & Buse
Setaria lutescens (Weigel) Hubbard
S. pyconocoma (Steudel) Nene. & Nakai
S. viridis (L) Beau.
S. viridis (L) Beau. var. pachystachys (Franc. & Savatier) Makino
Spodiopogon sibirica Trin.
Sporolus piliferus (Trin.) Kunth.
Stipa coreana Hack. var. japonica Y. Lee
Themeda japonica Tanaka
Trisetum sibiricum Rupr.
Zizania caudiflora (Turcz.) Nakai
Zoysia japonica Steudel
Z. sinica Hance var. tenuis Nakai & Yamamoto

12. Family Cyperaceae

Bulbostylis capillaris (L) C. B. Clarke
B. tinuissima (D. Don) Nakai
Carex aphanolepis Franc. & Savatier
C. atrata L.
C. biwensis Franc.
C. bostrychostigma Max.
C. dickinsii Franc. & Savatier
C. dispalata Boott.
C. drymophila Turcz.
C. jaluensis Komarov
C. lancelota Boott.
C. leiorhyncha C. A. Meyer
C. leucochloa Bunge
C. meyeriana Kunth.
C. morrowii Boott. var. temnolepis Ohwi
C. nanella Ohwi
C. neurocarpa Max.

Carex orthouachys Franc. & Savatier
C. planiculmis Komarov
C. rhynchophysa C. A. Meyer
C. shimidzensis Franch.
C. siderosticta Hance
C. stenostachys Franch. & Savatier
Cyperus amuricus Max. var. laxus Nakai
C. difformis L.
C. hakonensis Franc. & Savatier
C. iria L.
C. orthostachys Franc. & Savatier var. robustus (Nakai) Hara
C. rotundus L.
C. serotinus Rottb.
Eleocharis afflata Steud.
E. pellucida Presl.
Fimbristylis annua (Allion) Roemer & Schul.
F. dichotoma (L) Vahl.
F. subbispicata Nees
F. tristachya Rbr.
Kyllingia brevifolia Rott. var. leiocarpa (Franc. & Savatier) Hara
Leiocarpha microcephala R. Brown
Pycreus globosus Reich.
P. odoratus Urban
P. rubromarginatus (Mein.) E. Camus
P. sanguinolentus (Vahl.) Nees
Scirpus fluviatilis (Torr.) A. Gray
S. fuirenoides Max. subsp. jaluanus T. Koyama
S. juncoides Roxb.
S. karuziawensis Makino
S. mitsukurianus Makino
S. nipponicus Makino
S. pseudofluitans Makino
S. sylvaticus L. subsp. lancifolia Nakai
S. triqueter Linner
S. wuchurai subsp. asiatica (Beetle) T. Koyama
S. wuchurai var. nipponicus Nakai

13. Family Araceae

Arisaema amurense Max. var. serratum Nakai
A. amurense Max. var. typicum Nakai
A. peninsulae Nakai var. atropurpurem Nakai
A. robustum (Engler) Nakai
Symplocarpus renifolius Schott & Miq.

14. Family Eriocaulaceae

Eleocharis wicharai Bockeler
Eriocaulon robustus Makino
E. sikokianum Max.

15. Family Commelinaceae

Aneliena japonicum (Thunberg) Kunth.
Commelina communis L.
Lathyrus maririmus Bigelow

16. Family Pontederiaceae

Monochoria korsakowii Regel & Maack.

17. Family Juncaceae

Juncus alatus Franc. & Savatier
J. decipiens Nakai
J. krameri Franch. & Savatier
Luzula capitata Nakai

18. Family Liliaceae

Allium japonicum Regel
A. sacculiferum Max.
A. senescens L.
Clinaronia udensis Traut. & Meyer
Convallaria keidkei Miquel
Disporum ovale Ohwi
D. sessile D. Don
D. smilacinum A. Gray var. album Max.
D. viridescens (Max.) Nakai
Erythronium japonicum Decaisne
Gagea lutea KerGawley
Hanabusya asiatica Nakai
Hosta clausa Nakai
H. japonica Thunberg var. lancifolia Nakai
H. longipes Nakai
Hemerocallis aurantica Baker
Heloniopis orientalis (Thunberg) Koidzumi var. prupurea Nakai
Lilium amabile Palibin
L. buschianum Loddiges
L. davaricum Gawler
L. distichum Nakai & Kam.
L. miquelianum Makino

Lilium pseudotiginum Carriere
Liriope koeana Nakai
Maianthemum dilatatum (Wood) Nelsonet & MacBride
Polygonatum humile Fisher & Max.
P. inflatum Komarov
P. involucratum Max.
P. japonicum Morren & Decaisne
P. lasianthum Max. var. coreanum Nakai
Scilla sinensis (Loure.) Merrill
Smilacina japonica A. Gray
Smilax china L.
S. niponnica Miquel
S. sieboldii Miquel
Tofieldia nuda Max.
Tricyrtis dilatata Nakai
Veratrum grandiflorum Loesner
V. japonicum Loesner

19. Family Dioscoreaceae

Dioscorea japonica Thumberg
D. quinqueloba Thunberg

20. Family Iridaceae

Belamcanda chinensis LeMann.
Iris ensata Thunberg var. spontanea (Makino) Nakai
I. koreana Nakai
I. nana Nakai
I. nertschiskia Irdiges
I. rossii Baker
I. savatieri Nakai
Lythrum anceps Makino

21. Family Orchidaceae

Cephalanthera longibracteata Blume
Limnorchis hologlottis Max. & Neveski
Liparis japonica Max.
Platanthera mandarinorum Rich.
P. metabifloria F. Maekawa

22. Family Piperaceae

Tricercandra japonica (Siebold) Nakai

23. Family Salicaceae

Populus davidiana Dode
P. maximowiczii Henry
P. nigra L. var. italica Du Roi
Salix gracilystyla Miq.
S. hultenni Flod.
S. koryianagi Kimura & Gouz.

24. Family Juglandiceae

Juglans sinensis Dode

25. Family Betulaceae

Alnus japonicum Steud.
A. sibirica Fisher Var. hirsuta Koidzumi
Betula ermanii Chamisso
Carpinus erosa Blume

26. Family Fagaceae

Castanea crenata Siebold & Zucc.
Quercus acutissima Carr.
Q. aliena Blume
Q. dentata Thunberg
Q. mongolica Fisher & Turcz.
Q. variabilis Blume

27. Family Ulmaceae

Celtis bungeana Blume
Hemiptelea davidii (Hance) Planch.
Ulmus laciniata Meyer
U. macrocarpa Nance
Zelkova serrata (Thumberg) Makino

28. Family Moraceae

Fatoua villosa (Thumberg) Nakai
Morus alba L.
M. bombycis Koidzumi

29. Family Urticaceae

Boehmeria paraspicata Nakai
B. spicata (Thunberg) Nakai
B. tricuspis (Hance) Nakai
Duretia platanifolia Francz. & Savatier
Lilea peploides Hooker & Arnott
Urtica angustifolia Fischer
U. laetevirens Max.

30. Family Loranthaceae

Viscum coloratum (Komarov) Nakai Form. *lutescens* (Makino) Kitagawa

31. Family Aristolochiaceae

Asarum heterotropoides var. *seoulense* (Nakai) F. Maekawa

32. Family Polygonaceae

Bilderdykia incana Nakai
Bistorta vulgaris Hill
Lagunae cochinchinensis Loure. var. *pilosum* (Rox.) Nakai
Persicaria aestiva Ohki
P. blumei Gross & Nakai
P. conspicua Nakai
P. hydropiper (L) Spach. var. *vulgaris* Nakai
P. lapathifolia S. F. Gray
P. sagittata (L) Gross var. *americana* (Meis.) Nakai
P. senticosa Nakai
P. sieboldi Ohki
P. thunbergii (S. & Z.) Gross var. *coreana* Gross
P. triangularis Nakai
Polygonum aviculare L.
P. aviculare L. var. *buxifolium* Ledebour
Rumex acetosa L.
R. acetosella L.
R. coreanus Nakai
Tovara filiformis (Thunberg) Nakai
T. latiformis Nakai

33. Family Chenopodiaceae

Chenopodium alba L. var. centrobrum Makino
C. bryniaefolium Bunge
C. puberulum Iljin
C. stenophyllum Koidzumi
Suaeda japonica Makino

34. Family Amantharaceae

Achyranthes japonica (Miquel) Nakai
Amaranthus mangostanus L.

35. Family Aizoaceae

Mollugo stricta L.

36. Family Portulacaceae

Portulaca oleracea L.

37. Family Caryophyllaceae

Cerastium caespitosum Gilbert var. glandulosum Wirtgen
Dianthus sinensis L.
D. superbus L.
Lychnis cognata Max.
L. liusiana Makino
L. sieboldii von Houtte
Melandrium firmum (Siebold & Zucc.) Rohr.
Moehringia lateriflora Fenzil & Ledebour
Pseudostellaria davidii (Franch.) Max.
P. heterophylla (Miq.) Pax.
Sagina crassicaulis S. Watson
Stellaria aquitica Scopali
S. bungeana Fenzl.
S. media (L.) Cyrillus
S. uliginosa Murray

38. Family Ranunculaceae

Aconitum ciliare D. C.
A. neotortuosum Nakai
A. pulcherrimum Nakai
A. uchiyama Nakai
Actaea erythrocarpa Fisch. var. nigra Willd.
Adonis amurensis Regel & Radde var. parviflora Nakai

Adonis amurensis var. ramosa Makino
Akebia quinata (Thunberg) Decaisne
Anemone amurensis Komarov
A. raddeana Regel
Aquilegia oxysepala Traut. & Meyer
Caltha minor Nakai
Cimicifuga foetida L.
Clematis apifolia D. C.
C. brachyura Max.
C. ianthina Koehne var. mandschurica (Regel) Nakai
C. ianthina Koehne var. violacea (Max.) Nakai
C. koreana Komarov
C. mandschurica Max.
C. mandschurica Max. var. lancifolia Nakai
C. maximowicziana Franch. & Savatier var. paniculata (Thunberg) Nakai
C. ochotensis Poik.
C. patens Morren & Decne
C. trichotoma Nakai
C. tubulosa Turcz.
C. urticifolia Nakai
Hepatica asiatica Nakai
Lycootonum pseudolaere Nakai var. erectum Nakai
Pursatilla cernua var. Koreana Y. Lee
P. koreana (Yabe) Nakai & Mori
Ranunculus chinensis Bunge
R. japonicum Thunberg
R. tachiroei Franch. & Savatier
Thalictrum actaefolium Siebold & Zucc. var. brevistylum Nakai
T. aquilegifolium L. var. japonica Nakai
T. filamentosum Max.
T. rhaphanorhizon Nakai
T. thunbergii D. C. var. hypoleucum Nakai
T. tuberiferum Max.
T. uchyamai Nakai

39. Family Berberidaceae

Berberis amurensis Ruprecht
B. koreana Palibin
B. koreanum Nakai

40. Family Menispermaceae

Cocculus trilobus (Thunberg) D. C.
Menispermem dahuricum D. C.

41. Family Magnoliaceae

Magnolia sieboldii Kock

42. Family Lauraceae

Benzoin obtusilobum (Blume) O. Kuntze

43. Family Papaveraceae

Chelidonium sinense D. C.
Corydalis ambigua Cham. & Schlech.
C. maximowiczii Nakai
C. ochotensis Turcz.
C. platycarpa Makino
C. ternata Nakai
C. turtschaninovii Besser var. pectinata (Max.) Nakai
Dicentra spectabilis G. Don
Drelytra spectabilis Don
Hylomecon vernale Max.

44. Family Crucifera

Arabis halleri L.
A. nipponica De Boiss.
Capsella brusa- storis (L) Medicus
var. triangularis Gruner
Cardamine flexuosa Wither.
C. komarvi Nakai
C. leucantha (Tausch.) O. E. Schultz
C. lyrata Bunge
Descurainia sophia (L) Webb & Plantl.
Dontostemon dentatus (Bunge) Ledebour
Lepidium apetalum Willd.
Rorippa palustris (Leyser) Besser
Thalapsis arvense L.
Turritis glabra L.

45. Family Droseraceae

Drosera rotundifolia L.

46. Family Crassulaceae

Crostachys japonicus (Max.) Reger
Sedum aizoon L.
S. kamtschuticum Fisher
S. polystichoides Hemsley
S. sarmentosum Bunge
S. takesimense Nakai

47. Family Saxifragaceae

Astilbe chinensis Max., Franc., & Savatier var. typica Nakai
A. koreana (Komarov) Nakai
Chrysosplenium barbatum Nakai
C. flagelliferum F. Schmidt
C. grayanum Max.
Deutzia corena LeVeille & Vaniot
D. globrata Komarov
Hydrangea serrata Seringe
Mukdenia rosii (Oliver) Koidzumi var. typica Nakai
Philadelphus schrenckii Ruprecht
P. tenuifolius Ruprecht
Rodgersia podophylla A. Gray var. viridis Nakai
Saxifraga fortuanii Hooker var. glabrescens Nakai
S. mandshuriensis Komarov
S. octopetala Nakai

48. Family Rosaceae

Agrimonia coreana Nakai
A. pilosa Ledebour var. japonica Nakai
Crataegus pinnatifida Bunge var. typica C. k. Schneider
Duchesnea wallichiana (Seringe) Nakai
Filipendula glaberrima Nakai
F. koreana Nakai
Geum aleppicum Jacquin
G. japonicum Thunberg
Malus baccata (L) Bork. var. mandshurica (Max.)
C. K. Schneider
P. centigrana Max. var. mandshurica Max.
Potentilla chinensis Seringe
P. chinensis Seringe var. concolor Franc. & Savatier
P. centigrana Max. var. mandshurica Max.
P. cryptotaeniae Max.
P dickinsii Franch. & Savatier var. breviseta Nakai
P. fragaroides L. var. typica Max.
P. freyniana Borom.
P. kleiniana Wight
P. leiniata Wight & Arnatt var. robusta Franch.
P. paradoxa Nuttal
Prunus ishodoyana Nakai
P. leveilleana Koehne
P. mandshurica Koehne
P. nakaii Leveille var. typica Nakai
P. padus L.

P. persica (L) Botsch
P. viveilleana Koehne var. typica Nakai

Rosa polyantha Siebold & Zucc. var. genuina (Franc. & Sav.) Nakai & Kaw.
Rosa rugosa Thunberg var. typica Regel
Rubus coreanus Miq.
R. crataegifolius Bunge
R. oldhami Miq.
R. parvifolius L. var. triphyllus (Thunberg) Nakai
Sanguisorba carnea Fisher
S. glabularis Nakai
S. hakusanensis Makino
S. officinalis L.
S. tenuifolia Fisher & Link var. rubra Fisher
Sorbaria stellipila (Max.) C. K. Schneider var. rufa Nakai
Spiraea frischiana C. K. Schneider var. obtusifolia Nakai
S. koreana Nakai
S. microgyna Nakai
S. pubescens Turc. var. leiocarpa Nakai
S. prunifolia Siebold & Zucc. simpliciflora Nakai
S. salicifolia L. var. lanceolata Torrey & Gray
S. stellipilla Schneider

49. Family Leguminosae

Aeschynomena indica L.
Amphicarpaea japonica (Komarov) Nakai
Cassia noname Seibold & Nakai
Crotalaria sessiliflora L.
Desmodium racemosum (Thunberg) D. C.
Kummerowia stipulaceae (Max.) Makino
K. striata (Thunberg) Schindler
Indigofera kirilowo Max. & Palibin
Lespedeza bicolor Turcz. var. japonica Nakai
L. bicolor Turcz. var. sericea Nakai
L. cryptobotrya Miq.
L. cuenata G. Don
L. intermedia Nakai var. retusa Nakai
L. maximowiczii C. K. Schneider
L. maximowiczii C. K. Schneider var. tomentella Nakai
L. noname Siebold & Nakai
Lotus corniculatus L. var. japonicus Regel form. typica Nakai
Medico ruthenica (L) Ledebour
Melilotus suaveolens Ledebour
Pueraria thunbergiana (Seibold & Zucc.) Betham
Sophora angustifolia Seibold & Zucc.
Spodiopogen sibericus Trin.
Trifolium repens L.

Vicia amoena Fisher var. typica Regel
V. amurensis Oett. var. silvatica (Komarov) Hara
V. japonica A. Gray
V. nipponica Marsumura var. typica Nakai
V. pallida Turc.
V. pseudo-orobus Fisher & Meyer
V. subcuspicata Nakai
V. unijuga Braun var. tipica (Traut.) Nakai
V. venosa Max. var. baicalensis Max.

50. Family Geranicaeae

Geranium japonicum Franch. & Savatier
G. koreanum Komarov
G. sibiricum L.
G. thunbergii Seibold and Zucc. var. roseum Nakai

51. Family Oxalidaceae

Oxalis corniculata (L) Small
O. strieta (L) Small
Xanthoxalis corniculata (L) Small

52. Family Rutaceae

Fagara manchurica (Bennett & Daniel) Honda

53. Family Simarubaceae

Ailanthus altissima Swingl.
Picrasoma ailanthoides (Bunge) Planchon

54. Family Polygalaceae

Polygala japonica Hout.

55. Family Euphorbiaceae

Galarhaeus sieboldiana (Morren & Decaisne) Hara
Securinega subfruficosa (Pallas) Rehder

56. Family Anacardiaceae

Rhus javanica L.

57. Family Celastraceae

Celastrus orbiculatus Thumberg
Euonymus alatus (Thunberg) Siebold
E. sieboldianus Blume
Trypterygium regelii Sprarge & Taketa
Turibana oxyphylla Nakai

58. Family Staphyleaceae

Staphylea bumalda (Thunberg) D. C. var. typica Nakai

59. Family Aceraceae

Acer formosum Carr. var. coreanum Nakai
A. ginnala Max.
A. ginnala Max. var. divaricatum Nakai
A. mandshuricum Max.
A. mono Max.
A. negundo L.
A. pseudo-sieboldianum (Paxton) Kamarov
A. pseudo-sieboldianum (Paxton) Komarov var. koreanum Nakai
A. pseudo-sieboldianum (Paxton) Komarov var. languinosum Nakai

60. Family Balsaminiaceae

Impatiens noli-tangere L.
I. textori Miquel

61. Family Rhamnaceae

Havenia dulcis Thunberg var. koreana Nakai & Kimura
Rhamnus davurica Pallas
R. koraiensis C. K. Schneider

62. Family Vitaceae

Ampelopsis humulifolia Bunge var. incisa Nakai
Parthenocissus thumbergii (Siebold & Zucc.) Nakai
Vitis amurensis Ruprecht
V. coignetiae Pulliat
V. ficifolia Bunge var. thunbergii (Siebold & Zucc.) Nakai

63. Family Tiliaceae

Tilia amurensis Reprecht var. barbigera Nakai & Kowamoto
T. taquetii C. K. Schneider

64. Family Malvaceae

Hibiscus trionum L.

65. Family Dilleniaceae

Actinidia arguta Planch.
A. kolomikto Max.
A. polyana Max.

66. Family Guttiferae

Hypericum ascyron L. var. genuinum Max.
H. confertissimum Nakai
H. erectum Thunberg form. montanum Nakai
H. gebleri C. A. Meyer
H. japonicum Thunberg
H. laxum (Blume) Koidzumi

67. Family Violaceae

Viola acuminata Ledebour var. typica Nakai
V. albida Palibin
V. albida Palabin var. takabasii Nakai
V. boissie Makino
V. choerophylloidea (Regel) W. Becker
V. collina Besser
V. grypoceras A. Gray
V. hirtipes Moore
V. ishido Nakai
V. kamibayashii Nakai
V. keiskei Miq. var. okuboi Makino
V. mandschurica Becker
V. pachyrhiza Franch.
V. phalacrocarpa Max.
V. primulifolia L. var. glabra Nakai
V. seoulensis Nakai
V. variegata Fishcher & D. C.
V. xanthopetala Nakai

68. Family Thymelaeaceae

Daphne kamtschatica Max. var. jezoensis (Max.) Ohwi

69. Family Elaeagnaceae

Elaeagnus crispa Thunberg var. typica Nakai

70. Lythraceae

Lythrum anceps (Koehne) Makino
Rotala uliginosa Miquel

71. Family Oenotheraceae

Epilobium cepalostigma Hausk.
E. palustris L.
E. pyrricholophum Kanchet & Sav. var. typica Nakai
Ludwigia prostrata Rox.
Oenothera odorata Jaquin

72. Family Araliaceae

Acanthopanax sessiliflorum Seeman
Aralia elata Seem
Eleutherococcus senticosus Max.
Kalopanax pictum (Thunberg) Nakai var. typica Nakai

73. Family Umbelliferae

Angelia davurica (Fisher) Benth. & Hooker
A. decursiva Franch. & Savatier
A. distans Nakai
A. ezernevia Kitagawa
Angelia gigas Nakai
Anthriscus sylvestris Hoffm.
Bupleurum longe-radiatum Turcz.
B. scorzoneraefolium Willd. var. stenophyllum Nakai
Cnidium japonicum Miquel
C. monnieri Cusson
C. officinalis Makino
Ostericum sieboldii (Miquel) Nakai
Peucedanum deltasideum Makino
P. terebinthaceum Fisher & Reich
Pleurospermum katschaticum Hoffm.
Porphyroscias decursiva Miquel
P. megaphylla Diels
Sanicula chinensis Bunge
Sium cicutaefolium Gmel. var. latifolium Komarov
S. ninsi L.
Spuriopimpinella brachycarpa (Komarov) Kitagawg
Torilis japonica (Hout.) D.C.

74. Family Cornaceae

Cornus brachypoda C.A. Meyer

C. controversa Hemsley
Macrocarpium officinale Nakai

75. Family Eriscaceae

Rhododendrum micranthum Turc.
R. macronulatum Turc.
R. schlippenbachii Max.

76. Family Primulaceae

Androsace saxifragafolia Loure.
A. umbellata (Loure.) Merrill
Lysimachia borystachys Bunge
L. clethroides Duby
L. davurica Ledebour
L. leucantha Miq.
L. maritiana Lamarck
Primula jesoana Miquel
P. sieboldii Morr. form. spontanea Takeda

77. Family Plumbaginaceae

Limonium tetragonum (Thunberg) Bullock

78. Family Symplocaceae

Palura chinensis (Ker.) Nakai var. pilosa Nakai

79. Family Styraceae

Styrax japonica Seibold & Zucc.
S. obassia Seibold & Zucc.

80. Family Oleaceae

Forsythia densiflora Nakai
Fraxinus rhynchophylla Hance
F. sieboldiana Blume var. serrata Nakai
Ligustrum ibota Seibold var. angustifolium Blume
Syringa formossissima Nakai
S. oblata Lindl. var. dilata Rehd.
S. palibibiana Nakai var. kamibayashii Nakai
S. reticulata Hara
S. robusta Nakai form. glabra Nakai

81. Family Loganiaceae

Mitrasacme nudicaulis Reinw. & Blume

82. Family Gentianaceae

Gentiana axillaryflora Leveille & Vanoit var. coreana Nakai
G. eollingri Fawcett
G. jamesii Hemsley
G. scabra Bunge var. buergeri Max.
G. squarrosa Ledebour
Menyanthes trifolata L.
Swertia chinensis Hemsl. & Forb.

83. Family Asclepiadacеae

Cyanchum [illegible] yifolium Matsumura
Pcynostelma paniculata (Bunge) K. Schumann

84. Family Convolvulaceae

Calystegia japonica (Thunberg) Choisy
C. soldanella Koem. & Schult
Cuscuta australis R. Brook

85. Family Boraginaceae

Brachbotrys paridiformis Max. & Oliver
B. secundum Max.
Lithospermum arvense L.
Trigonotis peduncularis Bentham
T. radicans Max.

86. Family Verbenaceae

Callicarpa japonica Thunberg var typica Nakai
Clerodendrum trichotomum Thunberg
Vitex rotundifolia L.

87. Family Labiatae

Agastache rugosa O. Kunthe
Amethystanthus inflexus (Vahl) Nakai
Elscholtzia patrini Garck.
E. saxatalis Nakai & Kit
Galechoma hederaceae L. var longituba Nakai
Lamium album Lium.
L. barbatum Seibold & Zucc.
Leonurus sibiricus L.
Lycopus coreanus leveille
Meehnia urticifolia Makino
Orthodon praecox (Lemoine) Bailey

Orthodon grosseserratum Max. P
Perilla sikokiana Nakai
Phlomis umbrosa Turcz.
Prunella asiatica Nakai
Salvia chauroenica Nakai form. glomerifolia Chung
S. plebeia R. Brown
Saturela coreana (Leville) Nakai
Scutellaria indica L.
S. strigilloa Hemsley
S. transitra Makino
Stachys japonica Miquel
S. reideri Chamisso var. hispidula Hara

88. Family Solanaceae

Lycium chinense Miller
Scopolia parviflora (Dunn) Nakai

89. Family Scrophulariaceae

Majus japonicus Kuntz.
Melampyrum roseum Max. var. typicum Franc.
Pedicularis respuinata L.
P. respuinata L. var oppositifolia Miquel
P. respuinata L. var. umbrosa Komarov
Phteirospermum japonicum (Thunberg) Kuntz
Scrophularia grayana Max.
S. kadudensis Franc.
S. koreana Nakai
Veronica diamantiana Nakai
V. linariaefolia Pallas
V. P seudolongifolia Prinz.
V. siberica L.

90. Family Lentibulariaceae

Utricularia intermedia Heyne
U. japnoica Makino

91. Family Phrymaceae

Phryma leptostachya (Mich.) L.

92. Family Plantaginaceae

Plantago asiatica Decaisne
P. depressa Willd. form. minor Komarov
P. japonica Franc. & Savatier

93. Family Rubiaceae

Asperulla platygalium Max. var. aplina Max.
Galium davaricum Turcz. var. leiocarpum Nakai
G. kamtschuticum Stell var. acutifolium Hara
G. minuta Nakai & Hara
G. paradoxicum Max.
G. trifidum L. var. brevipendunuculatum Regel
G. verum L. var. asiaticum Nakai
Rubia akane Nakai
R. iesoensis Miyaba & Miyake
R. pratensis (Max) Nakai
Vicia japonica A. Gray

94. Family Caprifoliaceae

Diervilla florida D.C.
Lonicera japonica Thunberg var. brachypoda Nakai
L. praeflorens Batal.
Sambucus seiboldiana Blume form. lasiocarpa (Nakai) Lee
S. williamsii Hence var. coreana Nakai & Kawamota
Viburnum erosum Thunberg var. furcipilum Franch & Savatier
V. sargentii Koehne
Weigela florida (Bunge) D.C. var. glabra Nakai
W. subsessilis (Nakai) Bailey

95. Family Adoxaceae

Adoxa moschatettina L.

96. Family Valerianaceae

Patrinta repestris Jussieu'
P. saniculaefolia Hemsley
P. scabiosaefolia Fisher & Link
P. villosa (Thunberg) Jessieu
Valeriana dagoletiana Nakai & F. Maekawa
V. fouriei Briquet var typica Hara

97. Family Dipsacaceae

Scabiosa mansenonsis Nakai

98. Family Campanulaceae

Adenophora radiatafolia Nakai var. angustifolia Nakai
A. remotiflora Seibold & Zacc
A. Stricta Miquel
A. tetraphylla Makino
A. tetraphylla Makino var.tetraphylla Makino

Asyneuma japonicum (Miq.) Briquet
Campanula cephalotes Fisher & Kerr
C. punctata Lamarck
Hanabusaya asiatica Nakai
Lobelia sessilifolia Lamb
Platycodon glaucum (Thunberg) Nakai

99. Family Compositae

Achillea siberica Ledeb.
Adenocaulon adhaerescens Max.
Ainslaea acerifolia Schultz-Bipon & Zoll.
Ambrosia artemisufolia var. elatior Descoutilis
Antennaria leontopodioides (Willd.) Hakai
Artemisia asiatica Nakai
A. capillaris Thunberg
A. feddei Leveille & Vanoit
A. gigantea Kitamura
A. japonica Thunberg
A. keiskeana Miquel
A. mongolica Fisher & Besser var. tenuifolia Turcz
A. princeps Pampon var. oxientalis Hara
A. stolonifera (Max.) Komarov
Aster ageratoides Turcz. var. genuinus Max.
A. hayatae Leveille & Vanoit
A. hispidus Thunberg
A. holophyllus Hemsley
A. incisus Fisher
A. kantoensis Kitamura
A. lautureanus Franc.
A. scaber Thunberg
A. tataricus L.
Bidens biternata (Loure.) Merrill, Sherf & Sherf.
B. maximowicziana Oett.
B. parviflora Willd.
B. tripartita L.
Caclia krameri Matsumura
Carpesium abro tanoides L. var. thunbergianum Makino
Centipeda minima (L.) A. Braun & Anderson
Cephalonopols segetus (Bunge) Kitamura
Crysanthemum boreale Makino
C. sibericum Fisher
C. zawadskii Herb. var. latifolium Kitamura
Cirsium Maackii Max. var. koraiense Nakai
C. pendulum Fisher & D.C.
C. semtidens Nakai
Erigeron annuus L.

E. canadensis L.
E. fortuneii Turcz. var. simplicifolium (Makino) Nakai
E. lindleyanum D. C.
E. linifolius Willd.
Eupatorium japonicum Thunberg
Hemistepta lyrate Bunge
Hieracium umbellatum L.
Inula japonica Thunberg
Ixeris chinensis (Thunberg) Nakai
I. dentata (Thunberg) Robinson
I. nippoinica Nakai
Lactuca bungeana Nakai
L. chelidoniifolia Makino
L. denticulata Max. var. typica Max.
Lactuca indica L.
Leibnitzia anandria (L.) Nakai
Ligularia fischeri (Ledeb.) Turcz.
L. stenocephala Mats. & Koidzumi
Matricaria inodora L.
Paraixeris chelidoniifolia Nakai
P. denticulata Nakai
Picris japonica Thunberg
Prenanthus chinensis Thunberg
Prenanthus tanakae Franch. & Savatier
Saussurea diamantica Nakai
S. eriophylla Nakai
S. grandifolia Max. var ginuina Herder
S. pseudogracilis Kitamura
S. seoulesis Nakai
S. ussuriensis Max.
Senecio argunnensis Turcz.
Senecio campestris D. C.
S. pierotii Miq.
Siegesbeckia glabrescens Makino
S. pubescens Makino
Solidago virgaurea L. var. leiocarpa A. Gray
Sonchus arvensis L. var. uliginosus Traut.
Syneilesis palmata (Thunberg) Max.
Synurus excelsus (Makino) Kitamura
S. palmatopinnatifidus var. indivisus Kitamura
Xanthium chinensis Miller

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SOME EFFECTS OF FIRE ON VEGETATION

by

Soon Woo Hong, D. Sc.,
Professor, Department of Botany
College of Liberal Arts and Sciences
Seoul National University

assisted by

Yong Keel Choi

INTRODUCTION

For the last eighteen years the area in and near the demilitarized zone (DMZ) has been abandoned by its civilian population. Many areas have been reoccupied by military forces who often burn the fields and forests in order to improve visibility. Civilians burn adjacent areas, to remove bush and litter for agricultural purposes, as has been the common practice for many hundreds of years. Forest fires may be seen in the area near the DMZ at any time of year, especially in the spring, from March to June, and sometimes during July and August, the rainy season.

Because of the frequency of fires in these area and the destruction caused by some of them, it is believed desirable to have a better understanding of its affect on vegetation growth and development, reproduction and production. This paper attempts to elucidate some of the changes due to fire, and points out some mechanisms whereby plants are able to withstand these frequent fires.

STUDY METHODS

For the sake of convenience, the research is divided into two parts, field and laboratory works. Field work includes plotting for experimental sites, plant collections, soil sampling, measurements of temperature at the burning sites, and determination of vegetation changes after burning. Laboratory works consisted of soil analysis, germination tests of seeds collected in the field, phenological study of indicator plants, flora of rehabitants after burning, and detection of soil microflora population changes a ccording to the ages of burnt soil.

A. Field work

1. Experimental sites

a. Chulwon, grassland

b. Punch Bowl, grassland combined with pine trees

c. Mt. Hyang-no, shrub forest

d. Bang-Chuck-gol, grass and pine forest

e. Korang-Po, grass field

f. Myo-zang-dong, grass field

g. Wha-Chun; bush, vine salix, pine community

h. Mt. Sam-Hack, bush dominant

i. Yun-Chun, grassland

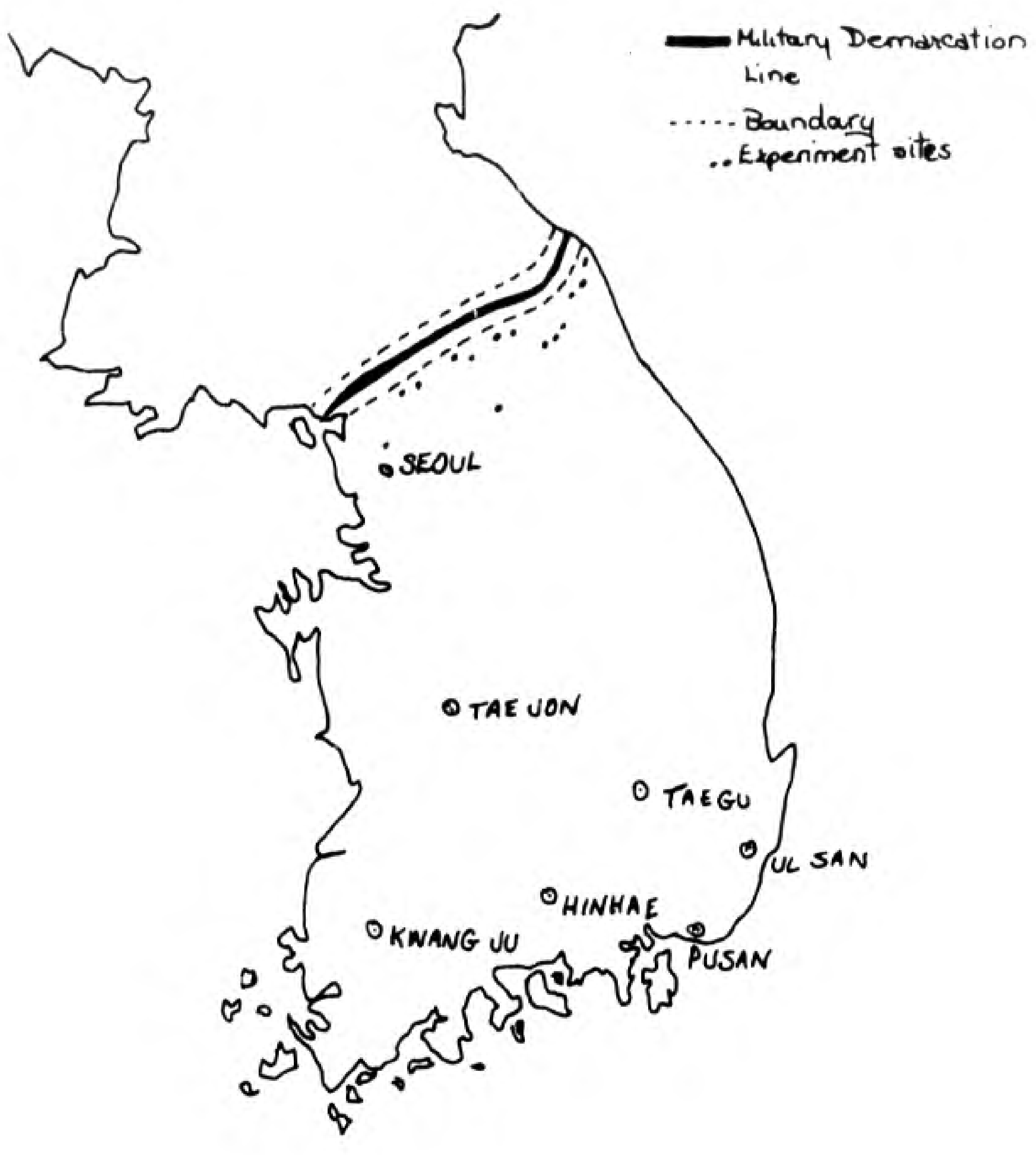
j. Mt. Dai-Am, bush combined with pine

k. Wha-Jin-Po, pine forest

i. Mt. Do-Bong, tall timber forest

All the above sites are shown in Figure 1.

FIGURE 1. Map of Korea.



2. Soil sampling

   a. Soil samples used for analysis were taken from all the sites (burnt and adjacent unburnt control areas) about 2 kg in accordance with the soil profile, respectively. Soil samples were collected from the upper 5 cm and to a depth of 10 cm.

3. Collections

   a. The plants appearing in burnt areas were collected to determine the vegetation changes after burning, the morphological study of the indicator plants, and for the classification of the tolerant and intolerant plants to fire. The collections of plants are kept in the department of botany, College of Arts and Sciences.

4. Measurement of temperature at the burning site

   A. Temperatures reached by burning plants were measured by high-scaled thermometers at the burning sites. The measurements were carried out at three sites, two of which were grasslands and the other was a young pine forest.

B. Laboratory works

1. Morphological study of indicator plants

a. Collected plants were classified by their root types.

2. Chemical soil analysis

a. Soil analysis of the samples is now being proceeded by the following methods:

(1). Soil pH---the pH of soil was measured twice, once by soil pH meter at the sites and the other by the method of 0.01 m $CaCl_2$ in the laboratory.

(2). Calcium---Turbidimetric and calcium oxalate method

(3). Nitrogen--semi-micro Kjeldhal and Ninhydrin method

(4). Potassium--Sodium cobalt nitrite method

(5). Phosphorous--Ammonium molybdate blue method

(6). Organic matter--Walkley method

(7). Magnesium--Mehlich's method

(8). Total soluble salt content of soil--conductivity method

3. Population changes of soil microflora

   a. This study was carried out by the dilution plate method. Population changes were detected on three kinds of microflora cultured in incubator at 31 1°C. Bacteria were counted on the third day after inoculation, and both actinomycetes and other fungi media for the above microflora are as follows:

      (1). Bacteria; Nutrient Agar medium

      (2). Fungi: Czapek's Agar medium

      (3). Actinomycetes; Jensen's Agar medium

   b. Both "1" and "3" were followed by pouring method and "2" by surface method.

4. Germination test

   a. In order to know the indirect effects of fire on germination of seeds, a test is now being prepared. The test will include treatment of the various concentrations of KOH solution to seeds as well as heat treatment, for KOH is believed to be released in large amounts from ashes after burning (Ahlgren, 1960).

5. Flora after burning

a. It is now being proceeded monthly through the quadrate method at the Sam-Hack site. When the work is finished successfully the above method will be applied to all the experimental sites.

RESULTS AND DISCUSSION

A. Type of fires (TABLE 1.) and temperature at the burning site

1. Type of fires

Referring to TABLE 1., the fires occurred at the above sites (among 25 sites) were identified as 19 cases of surface fire, 3 cases of gound fire, and 3 cases of crown fire. Therefore, it is confirmed that the fires in Korea mainly consist of surface fires. Particulary in Korea, there are few cases in which fires are caused by lightening, and none of the fires were observed except artificial or accidental fires.

The scales of burning in Korea are nearly like Figure 2. In general, all the sites adjacent to the DMZ area have been treated with continuous fires, for military purposes, after felling or mowing, like FIGURE 3.

TABLE 1. A list of sites where fires were observed showing date type of fire.

Site	Date of Fire	Type of Fire
Susang-Ni (1)	March 1-2, 1968	Surface
Susang-Ni (4)	March 15-16, 1967	Surface
Ice Cream Mountain	Late March, 1967	Surface
Myozangdong (2)	April 1, 1968	Surface
Susang-Ni (2)	April 2-3, 1968	Surface
*Myozangdong (3)	April, 5, 1968	Surface
Susang-Ni (3)	April 5, 1968	Surface
Myozangdong (1)	April 5-7, 1968	Surface
Nylon Bridge	April 5-10, 1968	Ground
Sam-ee-Chun	April 10-15, 1968	Surface
Kunboonsa (2)	April 15, 1968	Surface
Kunbongsa (1)	Middle April, 1967	Surface
Wangjinkun	April 16, 1968	Ground
Whajinpo (1)	April 21, 1968	Crown
Mt. Bookhan	April 21,1968	Crown
Limdang-Ni	April 22-25, 1968	Surface
Chang-ga Hill	April 24-25, 1968	Surface
Pallang-Ni	April 25-26, 1968	Surface
*Wolwoon-Ni	April 27, 1968	Surface
Kaa-ri	May 19, 1967	Surface
Bangchuckgol	June 1, 1967	Surface
Chinboodown Hill	June 19, 1967	Surface
Koragnpo	August 10-12, 1967	Surface
Mt. Sam-Hack	Late December	Surface
Whajinpo (2)	December 25-30, 1967	Crown

*Location where temperatures were taken.
(1,etc.).To indicate that soils were collected more than one time on site. Numbers correspond to numbers in TABLE 4.

GRAPHIC NOT REPRODUCIBLE

FIGURE 2.

FIGURE 3.

2. Temperature at the burning site

   a. Surface fire in the area of Myozangdong; characteristics of the plant community:

      10-15 year old pine trees--dominant;

      5-10 year old Rhodendron;

      10 year old Alnus;

      Lespedeza var. Pedunculata nakai;

      Quercus acutissima CARP.

      Temperatures measures--the temperatures at the burning site during burning and 5 cm from the flame showed temperatures ranging from 165-200°C.

FIGURE 4.

b. Ground fire in the area of Wanjinkun; characteristics of plant community: Mischanthus sinensis anders--dominant, Quercus acutissima CARP. Mischanthus sinensis was almost dried out and the Quercus was already felled to prevent from invasion of the agents of North Communists. Temperatures measured 5 cm from the flame showed 120-140°C.

FIGURE 5.

c. Surface fire in the area of Wol-woonni; characteristics of plant community: Mischanthus senensis Anders--dominant, Pine tress 2-3 years old.

Mischanthus sinensis Anders was almost dried out at thattime and pine's litter layer covered soil surface.

Temperature when measured 5 cm from the flame during burning showed 120-145°C.

GRAPHIC NOT REPRODUCIBLE

FIGURE 6.

B. Classification of rehabitant plants (TABLE 2.).

The list of plants appeared commonly in the 20 sites after burning.

TABLE 2. A list of fire resistant plants that sprout within the first year following fire.

Plant	Root type
Adenophora coronoplfolia Fisch	S**
*Artemisia brachyphylla Kitamura	O**
Aster ageratoides Turcz	O
Atractylodes lyrata Sieb et Zucc var. chinensis Kitamura	S
*Carex alterifolia Franch	O

TABLE 2 (cont.).

*Carex lanceolata Bott var. nana Leveil et Van	O
Erythronium japonicum Decais	B**
Hosta clausa Nakai	O
Lespedeza cyrtobotrya Miq. var. pedunculata Nakai	O
Lilium amabile Palib	B
Lilium distichum Nakai	B
Lysimachia chlethroides Duby	O
*Mischanthus coreensis Hack	O
Polygonatum japonicum Morr et Decais	O
*Potentilla cryptotaeniae Max	O
Pteridium aquilinum Kuhn var. latiusoulum Undrew	O
Pulsatilla Koreana Nakai	S
Rubus parvifolius L. var. concolor Nakai	O
Sanguisorna argutipense Nakai	O
Saussurea diamantica Nakai	O
Scilla sinensis Meer	B
Senecio pieroti Miq.	O
Syneilesis palmata Max	O
Thalictrum aquilegifolium L. var. japonicum Nakai	O
Veratrum grandifolium Loesen	O
Zizania latifolia Turcz	O

**Note: "O" is old root type, "S" is storage root type and "B" is bulb root type.
*Note: characteristic plants of burned area.

The above mentioned plants were identified as fire tolerant plants which can survive burning. Of the 26 kinds shown in TABLE 2, 18 species generally have the old root type as shown in FIGURE 7, 5 species have bulb type as shown in FIGURE 8, and three species have storage root type as shown in FIGURE 9.

GRAPHIC NOT REPRODUCIBLE

FIGURE 7.

FIGURE 8.

FIGURE 9.

FIGURE 10.

Through the preliminary survey, from its start to the present, Mischanthus coreensis Hack and Carex alterifolia Franch were confirmed as fire indicator plants in the area near DMZ. The plants appearing most frequently in the burnt site were known as potentila cryptotaeniae Max, Mischanthus coreensis Hack, Carex alterifolia Franch, Carex var. nans Leveil and Van, and Artemisia brachyphylla Kitamura, which were asterisked in TABLE 2. Especially, Lespedeza var. pedunculata Nakai, which is reported as the intolerant plant to fire was proven as one of the fire tolerant plants in Korea. In FIGURE 10 it can be easily seen to be true. Refer to FIGURE 10.

Pinus densiflora, which represents one of the dominant species in Korea, proved to be the plant with the lowest tolerance to fire. These plants are apt to die from light surface fires as well as from crown fires. However, they didn't die from the ground fires. Refer to figures 11 and 12.

GRAPHIC NOT REPRODUCIBLE

FIGURE 11.

FIGURE 12.

C. Soil analysis

1. Mean values of two readings of pH of soil by

0.01 m $CaCl_2$ method (TABLE 3).

TABLE 3. Mean value of two pH readings of soils on burned and unburned areas.

Site		Burned		Unburned	
	Depth-------	0-5 cm	6-10 cm	0-5 cm	6-10 cm
Chang-ga		6.4	4.8	5.7	5.35
Ice Cream Mountain		5.45	5.3		
Kunbongsa		6.15	4.7	5.9	5.5
Kwanwoori		5.1	4.9		
Limdang-Ni		6.7	5.9	5.2	5.45
Myozangdong (1)		5.37	4.8		
Myozangdong (2)		5.5	4.9		
* Myozangdong (3)		5.1	4.95		
Pallang-Ni		6.6	5.7		
Sam-Hack Mountain		5.1	4.5		
Susang-Ni (1)		5.7	5.6		
Susang-Ni (2)		6.05	5.8		
Susang-Ni (3)		6.05	5.45		
Susang-Ni (4)		5.75	5.15		
Whajinpo		6.3	4.55		
*Wolwoon-Ni		5.8	5.3		

* collected sample immediately following fire.

In regard to TABLE 3, a reasonable assumption can be made that the considerable amounts of ash left on the ground after burning decreases acidity, since ash is rich in alkaline material, and, according to numerous papers, potassium carbonate (7%) and other similar salts, dissolve well in water (Ahlgren, 1960). This change in acidity may vary with the depth and type of soil. Ahlgren (1960) found that an increased pH of surface soil following burning lasted 10[illegible] years. On the other hand, the others found that the lowered acidity of surface soil returned to normal a few months after burning. The above table is similar to these reports.

2. Detection of nitrogen by semi-micro Kjeldahl method

TABLE 4. Results of nitrogen test on soils.

Site		Total N/gr. dry basis
Mt. Dai-Am (1,100 m)	1	0.817 mg
"	2	0.829 mg
"	3	0.805 mg
"	4	0.751 mg
"	5	0.406 mg
"	6	0.014 mg
Mt. Daisung (1,000 m)	1	0.035 mg
"	2	0.043 mg
"	3	0.014 mg

3. Other minerals in burnt soil

Potassium, magnesium, phosphorous, calcium, organic matter, and total soluble salts content in burnt soil are now being analyzed for studies of the mineral changes which are closely related to the reproduction and productivity of plants. A certain procedures are already finished, but the results are under calculation on the basis on dried soil/gr.

D. Germination test

1. Nineteen kinds of seeds were collected to study the effects of fire in laboratory work. See TABLE 5.

TABLE 5. Species collected for germination tests.

Pennisetum japonicum Trinius	Setaria viridis Beauv
Plantago asiatica L.	Robinia pseudo-acacia
Agrimonia coreana Nakai	Pinus densiflora Siebet Z.
Carlesia officinale Makino	Echinochloa crusgalli B.
Angelica acutiloba Kitagawa	Ezonomaskasa-suzuki
Oenothera biennis L.	Hieracium coreanum Nakai
Iris nertchinskia Lodd	Mischanthus chinensis
Prunella vulgaris L.	Rubus crataegifolius Bunge
Picris hieraciodes L.	Justica procumbers L.
Sophora flavescens AIT	

E. Population of soil microflora

TABLE 6. Soil bacterial and fungal count on unburned area.

Site	No. of Bact. x 10^3/dried soil gr
Mt. Dai-Am (1,100 m) 1	1,197
" 2	1,630
" 3	3,160
" 4	897
" 5	740
" 6	895
Mt. Daisung (1,000m) 1	230
" 2	530
" 3	360
	No. of Fungi x 10^3/dried soil gr
Mt. Dai-Am (1,100 m) 6	200
Mt. Daisung (1,ooo m) 1	100
" 2	200
" 3	200

TABLE 7. Soil bacterial and fungal counts on burned area. April 19-25, 1968.

Site	Depth (cm)	Bacteria	fungi	Actinomycetes
			(x 10^3 / gr dried soil)	
*Wangjin Kun (250m)	0-5	14	3	151
	10	18	5	86
Nylon Bridge(50m) 1	0-5	88	3	112
	10	33	13	39
" 2	0-5	40	6	235
	10	40	8	53

TABLE 8. Bacterial and fungal count after burns. May 5-10, 1968.

Site	Depth	Bacteria	Fungi	Actinomycetes
*Wolwoonni (100m)	0-5	60	9	97
	10	36	4	117
Wolwoonni (100m)	0-5	30	4	137
	10	6	3	71
Limdangni (350m)	0-5	14	8	25
	10	47	6	63
Limdangni (350m)	0-5	26	4	69
	10	34	3	53
Changga Hill (200m)	0-5	115	2	171
	10	20	2	84
Changga Hill (200m)	0-5	27	3	34
	10	11	2	81
Pallangni (300m)	0-5	51	4	129
	10	39	5	66
Kunbong (500m)	0-5	8	9	66
	10	20	2	76
Kunbong (500m)	0-5	6	5	51
	10	8	3	51
Whajinpo (100m)	0-5	33	4	47
	10	46	4	56

*Burning at the time we visited.

At present, there are few reports related to the changes in soil microflora population after burning except those of soil bacteria. The soil bacteria population after burning is expected to grow small, since burning frequently raises the soil pH, a factor critical to bacterial growth. But the result described in TABLES 6, 7, and 8 might not be explained easily.

It seems that the population changes of soil microflora may vary with the type of soil, the scale of burning, pH of soil and ages of soil after burning. At a glance at the tables, they seemed to have a certain tendency; the population of soil microflora was increased a little by burning.

On the other hand, burning may not be a significant factor in increasing the number of soil microflora. This study will be continued in more details on the relationship between soil pH and temperature at the burning site.

F. Flora of rehabitant after burning

1. Site: Sam Hack

2. Characteristics of plant community prior to burning

a. Quercus scutisma CARR

b. Q. Mc.-cormickii CARR

c. Lespedeza

d. Mischanthus sinensis

e. Q. angusie-lepidota Nakai

f. Q. Variabilis Blume

g. Pinus densiflora Sibet Z.

h. Azalia (dead)

3. Kind of fire: Surface fire

4. Time of burning: End of December, 1967

5. Size of grass quadrate: 1 m^2

6. Appeared plant in the burnt site (TABLE 9)

TABLE 9. First plants to appear following burning.

March 1, 1968	April	May
None	Potentilla cryptotaeniae Max Carex alterifolia Franch Mischanthus sinensis Festuca var. Vulgaris Koch Senecio pierotii Miq. Laibnitzis anandria Nakai Lespedeza var. pedenculata Nakai Quercus scutisma CARR	

CONCLUSION AND SUMMARY

In general there are few cases which were caused by lightening and no fire was observed to have been caused but by artificial or accidental fires. Even then, the most scales of burning in Korea are like FIGURE 2. Temperature 5 cm from flame at the burning site were known to range from 165-200°C in surface fires in Myozangdong, a pine-oak dominant community; from 125-245°C in surface fires of Wol-wooni, Mischanthus dominant area; and from 120-140°C in ground fires of Wangjinkun, Mischanthus dominant, respectively.

Through the preliminary survey, fire indicator plants in Korea were confirmed as Mischanthus coreensis Hack and Carex alterifolia Franch. The plants of highest frequency appeared in burnt sites were Potentillia cryptotaeniae Mac, Mischanthus coreensis Hack, Carex alterifolia Franch and Artemisia brachyphylla Kitamura. Lespedeza were proved as one of the fire tolerant plants (TABLES 2 and 9) and Pinus densiflora was found out as the lowest intolerant plant to fire.

The acidity of burnt soil was decreased according to the considerable amount of ash left on the ground. The acidity of surface soil was more decreased than that the below 10 cm of soil.

The changes of soil microflora seemed to have a certain tendency. The population of soil microflora was increased a little by the effects of fire.

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MICROBIAL POPULATIONS IN THE HAN RIVER ESTUARY

by

Soon Woo Hong, D. Sc.,
Professor, Department of Botany
College of Liberal Arts and Sciences
Seoul National University

assisted by

Yung Chil Hah

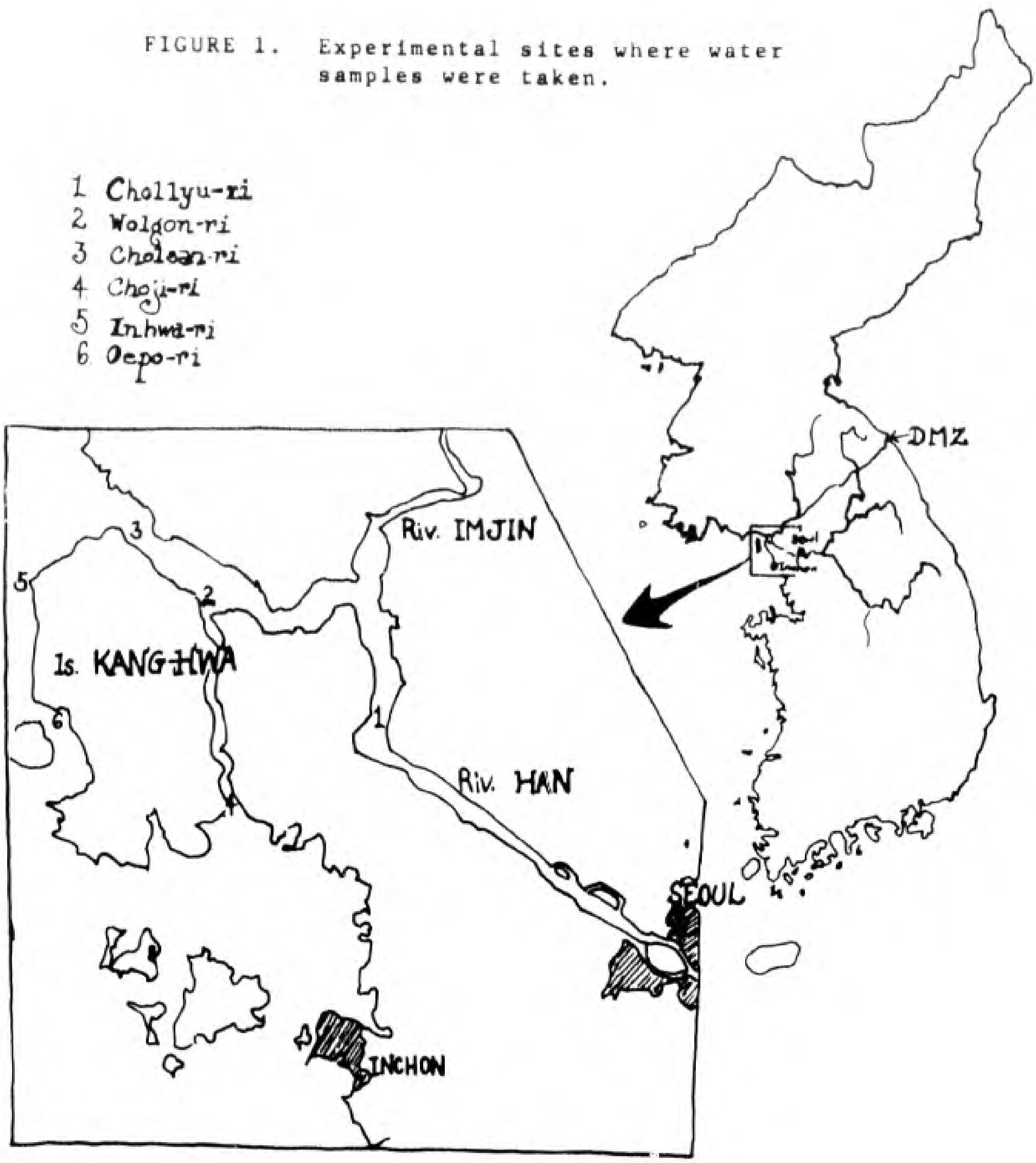
INTRODUCTION

The Han River, which is one of the largest in Korea, is proud of her beautiful scenery. She originates in the Taiback Range near the DMZ area, Kangwon-do. The river flows toward the Yellow Sea through Chungchongbuk-do, Kyunggi-do, and Seoul. The river water is being utilized in many ways, such as in supplying drinking water to Seoul with a population of over four million inhabitants, for industrial uses in Kyung-In Manufacturing District, and for agricultural uses.

The river has been polluted every day by the increasing population of Seoul and the sewage water of many industrial plants. The above facts came to close up as public damage to the sea as well as to the residents in Kyung-In District.

Since 1965 we have been examining the pollution of the river water near Seoul and the distribution of microorganisms in accordance with it. Recently we attempted to study the distribution of E. Coli, an organism which is an indicator of pollution, along with fungi and general bacteria at the sites in the Han River estuary where fresh water is being mixed with sea water near Kanghwa Island. The results, even though they are not completed, are presented as a survey report.

FIGURE 1. Experimental sites where water samples were taken.



MATERIALS AND METHODS

For examining the changes of microbial populations on the estuary water of the polluted Han River in relation to the changes of salinity, which occur continuously in the area of the river estuary, we have determined the numbers of coliform and general bacteria, and fungi, and we have measured and analyzed several environmental factors such as air temperature, water temperature, hydrogen ion concentration, dissolved oxygen, and salinity.

At each of ten collecting points in each of six major collecting sites (FIGURE 1), we collected 300 ml water. These collections were carried out monthly from May to September, 1967. The dates and numbers of the collections as well as the depth of each sampling point at the time of sampling are shown in the TABLE 1.

All the samples from a major collecting site were mixed to minimize errors in sampling. From this sample (usually 3,000 ml), six test tubes of approximately 50 ml of water each were saved, sealed, and placed on ice; then transported to the laboratory.

TABLE 1. Dates and numbers of individual samples taken from each point, depending on water depth.

Site	Date	Number	Amt. of Sample & Depth Surf.	3m	6m
			ml	ml	ml
Chollyu-ri	May 31	3	100	100	100
	June 30	3	100	100	100
	July 30	3	100	100	100
	Sept. 7	3	100	100	100
	Sept. 27	3	100	100	100
Wolgon-ri	May 31	2	150	150	
	June 30	2	150	150	
	July 30	3	100	100	100
	Sept. 7	2	150	150	
	Sept. 27	3	100	100	100
Cholsan-ri	May 31	1	300		
	June 30	2	150	150	
	July 30	2	150	150	
	Sept. 7	3	100	100	100
	Sept. 27	3	100	100	100
Chogi-ri	June 1	2	150	150	
	July 1	3	100	100	100
	July 31	2	150	150	
	Sept. 8	3	100	100	100
	Sept. 28	3	100	100	100
Inhwa-ri	June 1	3	100	100	100
	July 1	3	100	100	100
	July 31	3	100	100	100
	Sept. 8	3	100	100	100
	Sept. 28	3	100	100	100
Oepo-ri	June 1	2	150	150	
	July 1	3	100	100	100
	July 31	3	100	100	100
	Sept. 8	2	150	150	
	Sept. 28	2	150	150	

All samples from a major collecting site were mixed to minimize errors in sampling. From this (usually 3,000 ml) sample, six test tubes were were sealed, saved, and delivered to the laboratory.

On arriving at the laboratory, the six 50 ml samples were thoroughly remixed and five 1 ml samples were taken. Each of these was placed in 9 ml of sterile water. Dilutions were continued thus to 1×10^2 -- 1×10^5 and 0.1 ml. Samples of each were inoculated on the surface of a total of fifteen agar plates, three from each of the five samples, under aseptic conditions within' two minutes after the final dilutions were made.

Three kinds of culture media were used for inoculation. For general bacteria, Difco standard nutrient agar was used; for the coliform group of bacteria, Eosin methylene blue agar was used; and Czapek's agar was used for fungi.

Inoculated plates were inverted and placed in an incubator at 37 ± 1°C. Coliform bacteria plates were removed in eighteen hours, general bacteria in forty-eight hours, and fungal plates remained from seven to nine days.

Colonies were counted using the Quebec colony counter. Salinity was determined by Mohr's method. First we obtained the chlorinity by using the silver nitrate titration method with potassium chromate as an indicator. Thus, the salinity was calculated by the following equation (Strickland, 1965):

$$\text{Salinity} = 0.03 + 1.805 \ (\text{Chlorinity})$$

Dissolved oxygen was determined by using Winkler's thiosulphate titration method with starch solution as an indicator (Strickland, 1965). The hydrogen ion concentrations were measured with a Beckmann pH meter, Model G.

RESULTS AND DISCUSSION

Maximum, minimum- and average values of the physical and chemical factors, such as **air** temperature, water temperature, hydrogen ion concentration, dissolved oxygen and salinity, measured and analyzed at the site and in the laboratory during this examination period are shown in TABLE 2.

TABLE 2. Physical and chemical factors of the estuary taken at the time of visits from May to September, 1967.

	Maximum	Minimum	Average
Air temperature (°C)	31.0	16.0	25.35
Water temperature (°C)	29.3	12.0	22.71
pH	8.1	7.32	7.634
Dissolved oxygen (mg/1)	8.9	7.6	8.2
Salinity (o/oo)	25.69	0.06	8.073

The regional characteristics of each experimental site in the Han River estuary are shown respectively in TABLE 3.

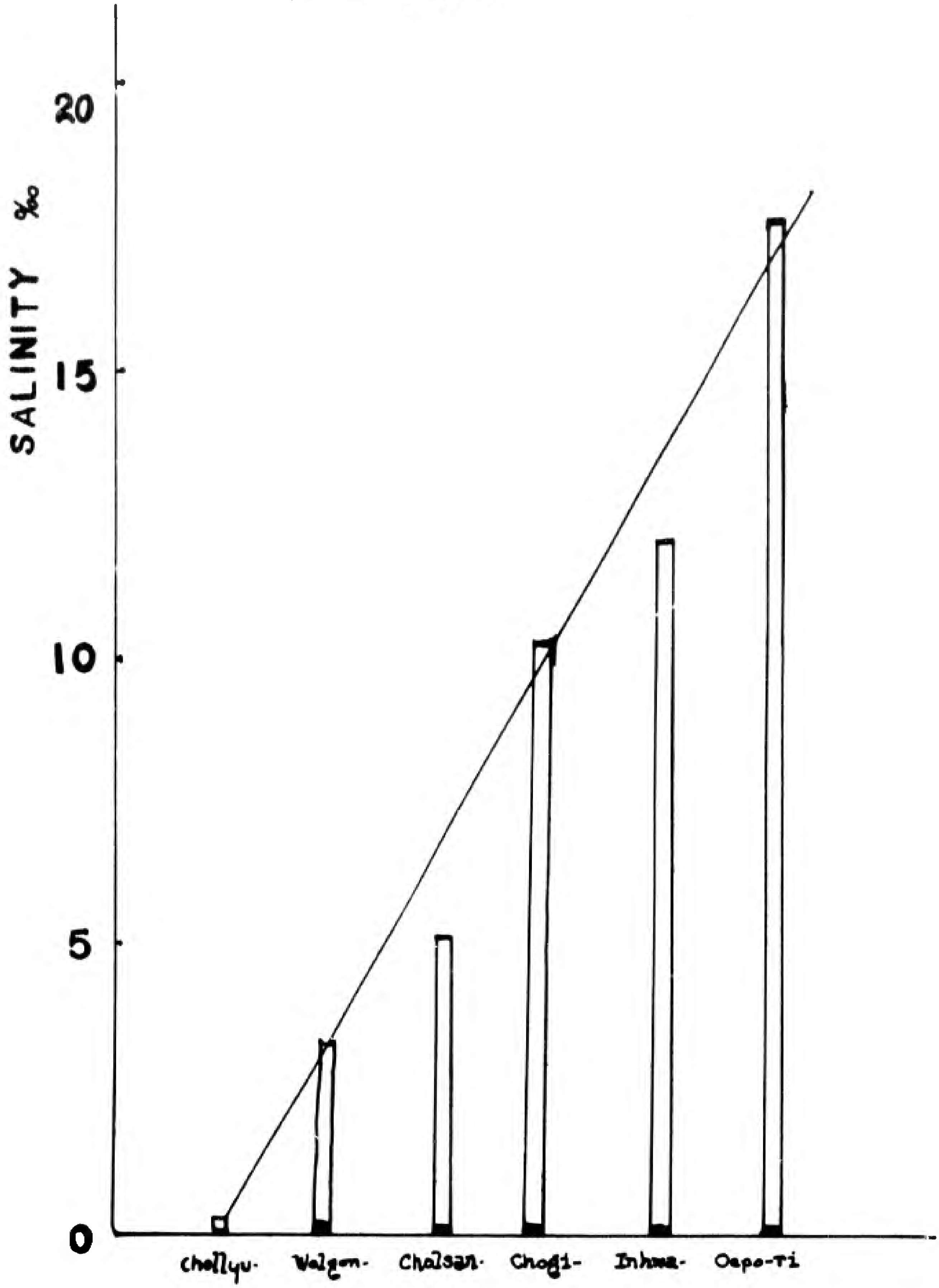
TABLE 3. The distances and average values of several environmental factors at each experimental site obtained from May to September, 1967. The distances were measured from the base point of the old Han River Bridge following the stream.

Site	Distance (km)	pH	D.O. (ml/L)	Salinity (oo/o)
Cholly-ri	34.3	7.62	8.2	0.116
Wolgon-ri	57.5	7.52	8.9	3.224
Cholsan-ri	64.8	7.56	8.3	5.224
Choji-ri	74.0	7.68	8.0	10.183
Inhwa-ri	77.3	7.66	7.6	12.126
Oepo-ri	87.8	7.69	8.1	17.566

As the distance from Seoul increased, the salinity increased (FIGURE 2). The hydrogen ion concentration of each site was similar to those of Wood (1959) in the estuary of Lake MacQuarie. Figure 3 shows that the average numbers of the general bacteria, coliform group and fungi collected at each site.

In the case of coliform bacteria, the numbers of them showed decreasing intention from 165,300 ml at Chollyu-ri to 27,100 ml at Oepo-ri in the order of distance. However, it insists on the

FIGURE 2. Graph showing the salinity in each experimental site.



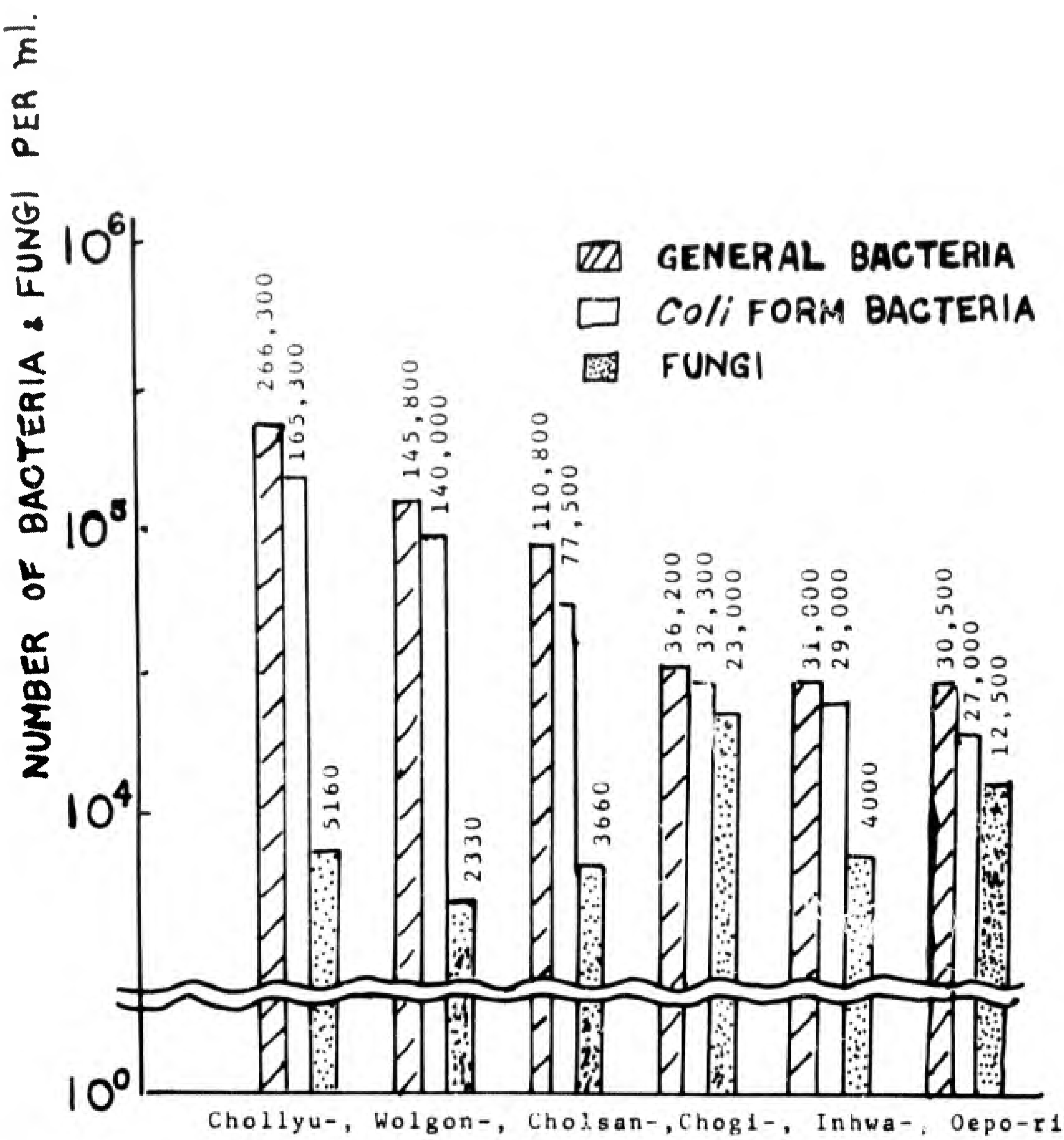


FIGURE 3. Number of general bacteria, coliform bacteria and fungi of each experimental site.

high pollution of Han River estuary, comparing with 20,000 ml in Tokyo Bay (Nieta, 1961), and with the small number in the Lake MacQuarie estuary (Wood, 1959).

In the case of bacteria, the population study which was carried out with the surface water and close to the bottom in the Gulf of Manaar, India, its number was 100-850 ml at the water surface, generally 200 to 300 ml near the bottom (Velankar, 1955).

In Lake MacQuarie, Wood (1955) described the number as 5 - 13,000 and it resulted from the inflow of nutrients into the lake by the inflow of fresh water from the land after heavy rains. He asserted that this was one of the main factors of microbial population in water.

Otherwise, Oppenheimer (1960) set forth that the aerobic bacteria from the surface water of Texas Bay ranged from 5×10^5 to 5×10^7 for the water at the surface and the tidal edge, and from 5×10^7 to 3×10^9 for sediments. There were little significant differences between the pollution of the exposed sediments at low tide and those covered by three feet of water (Wood, 1953).

The total numbers of bacteria determined in this experiment were medium, comparing with those reported by the above investigators.

However, the large number of coliform bacteria of the Han River estuary resulted, we presume, from the influence of the inflow of foul water drained from Seoul and many farmlands in the vicinity of the river, on which farmers usually manured a lot of excrements from men and animals. Most of the coliform bacteria contaminated from river water diminishes in the sea water after about four weeks (Nieta, 1961).

But continuous flowing of the coliform bacteria from the Han River seems not to give rise to the natural decomposition of the coliform bacteria.

The relation of locality as to the distance of the Han River waterway to the salinity of each site was shown in FIGURE 2 and the relationship between the number of bacteria and salinity is illustrated in FIGURE 4.

It may be said that the decrease in number of bacteria close to the sea is due to the dilution effect of the sea water. However, the result of our investigation in which we had inoculated the water sample from Chollyu-ri on the media having sodium chloride in different concentrations, TABLE 4 and FIGURE 5.

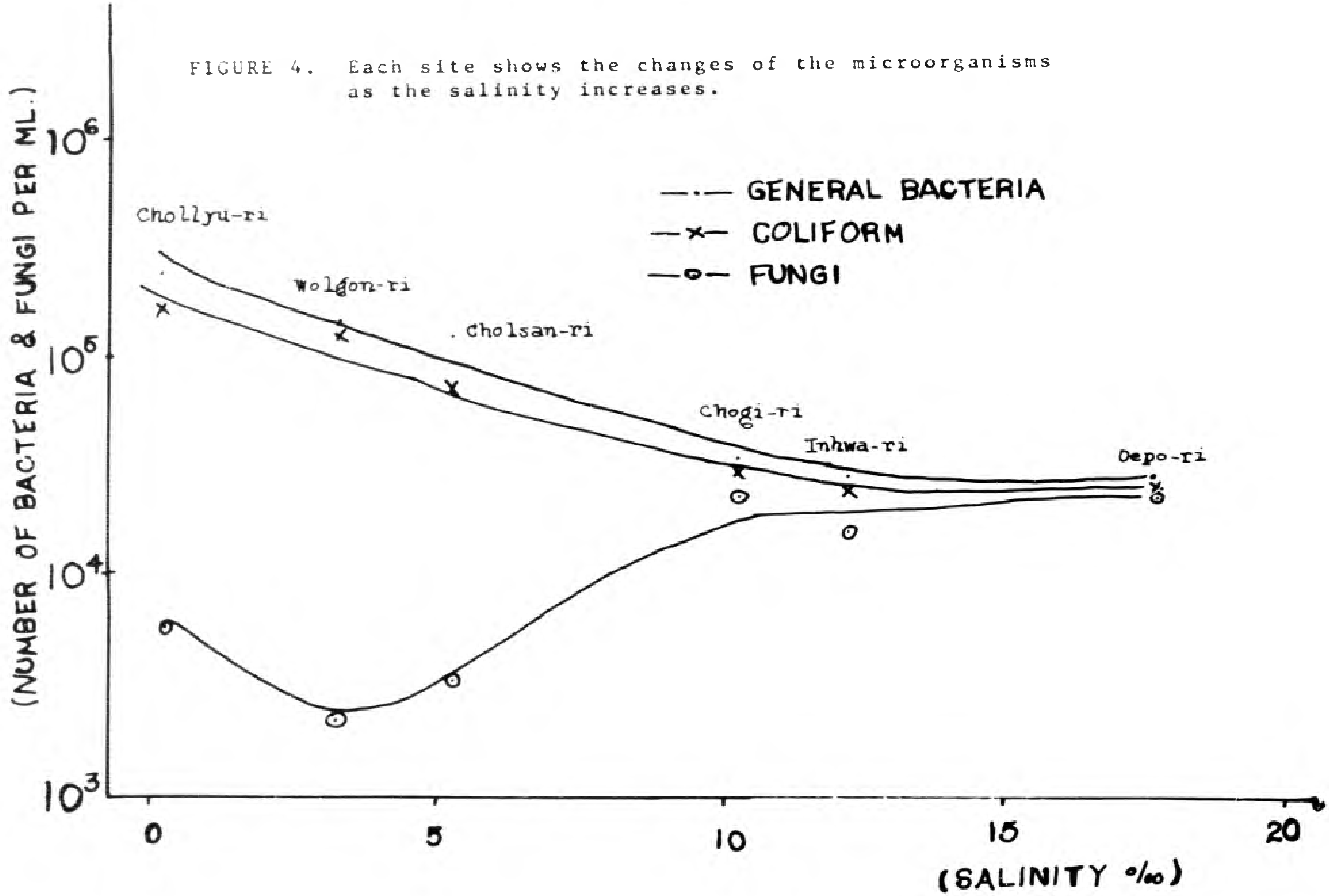


FIGURE 4. Each site shows the changes of the microorganisms as the salinity increases.

FIGURE 5. Growth index of general bacteria on nutrient agar media which are added by different concentrations of sodium chloride.

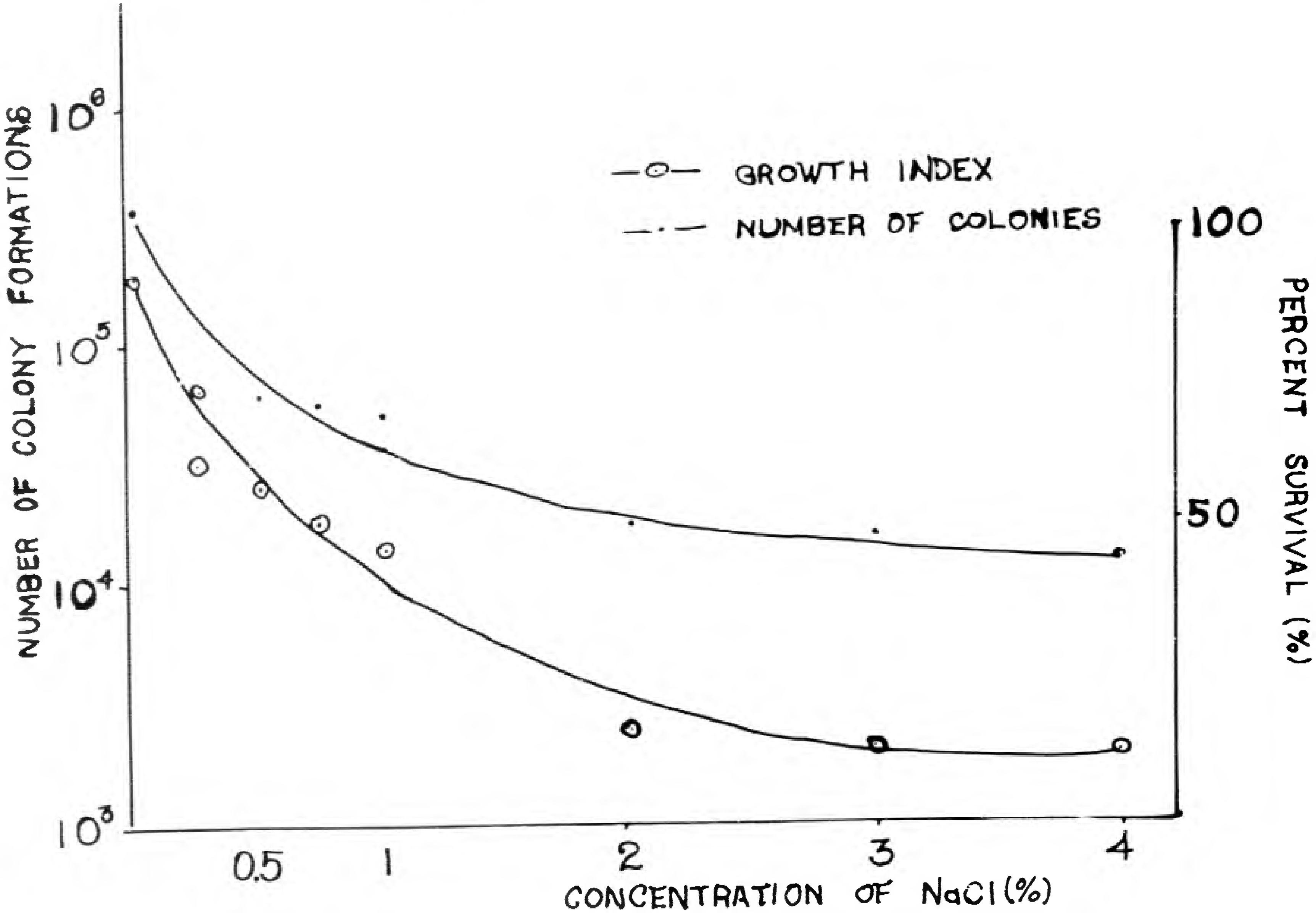


TABLE 4. Growth index of general bacteria on nutrient broth agar with different concentrations of SODIUM CHLORIDE.

Concentration of NaCl (%)	Number of colonies (per ml)	Survival (%)
0	116,500	100.0
0.25	71,000	60. 9
0.50	67,000	57.5
0.75	60,000	51.5
1.0	55,000	47.2
2.0	18,500	15.7
3.0	16,000	13.7
4.0	13,000	11.2

The formation of colonies of general bacteria diminished as the concentration of sodium chloride increased.

The growth index of bacteria from river water reported by Salle (1961) showed similar intention with that of our experiment indicated in the TABLE 4 and in FIGURE 5. And by the specific salinity requirement the fresh water bacteria as compared with the marine ones (Korinek, 1927).

Summing the above results there were definite relationships between the decreasing numbers of bacteria and increasing salinity as shown in the study of the Han River estuary. It can be said the decrease in number of bacteria will occur with the increase in salinity of water in which they lived. Further study on the adaptation of the fresh water bacteria to marine bacteria are interesting and needed.

Among the microorganisms identified from the estuary water in this period of study the proteolytic bacteria such as Eschrichia coli, Basillus subtilis, and B. megaterium, and the bacteria belonging to Pseudomonadales such as Aerobacter spp., Salmonella spp., and Shigella spp. were predominant. Also we found such fungi as Mycoplana spp., Saccharomyces spp., Actinomyces spp., Penicillium spp., Aspergillus spp., and Rhizopus spp. to be common.

The microbial flora of the water in Lake MacQuarie examined by Wood (1959) found that proteolytic bacteria formed a great percentage of the whole flora in the sediment. Actinomycetes ' and other fungi were very numerous in late summer. Coliform bacteria were not found in uncontaiminated estuarine water. Their presence indicated recent contamination (Wood, 1959).

Comparing with the above, the results of our examinations suggest the need of construction of some sewage plants in the area of the Han River.

CONCLUSION

In the Han River estuary the general bacterial counts ranged from 30,500 to 266,300; coliform groups were 27,000 to 165,300; and fungi ranged from 2,330 to 23,000 per milliliter of the water in the period from May to September, 1967. These numbers were higher than that of international security limit in public health, 300 per milliliter. Furthermore, coliform bacteria, which are indicators for the rate of water pollution, formed 81.6% of general bacteria. By these facts it can be said taht the water of the estuary was highly polluted. And it was also confirmed that the proteolytic bacteria such as Bacillus subtillis and B. megaterium took the place of predominance in the microflora of the estuary. The high pollution of the estuary, it was assumed, resulted from the drained water of Seoul and its thickly populated districts, and from the waste water thrown by many industrial plants in the area of the down stream of the river. Since the dirty water was discharged into the sea without any purification processes before its inflow into the river, many of the water closets in the residences of inhabitants were not constructed ideally, and also the excrements of men and animals were usually used to fertilize the farm lands, it seemed possible for the water of the Han River estuary to show such high pollution.

As the water of the Han River progresses toward the sea, its salinity increases and the fresh water becomes diluted. Accordingly, as the salinity and dilution increase, the number of polluting microorganisms decreases.

It seems that these decreases of bacterial counts are mainly due to the weak tolerance of fresh water bacteria to marine water and the influence of dilution effect by the sea water.

The study of water pollution needs to examine the whole flora of heterotrophic, fresh water, and marine bacteria to disclose the correlations between the flora and their environmental factors, especially the pollution rate, and to investigate the self-purification of estuaries through a long period.
In this country continuous pursuit of this problem is firmly demanded in the future.

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DROSOPHILID FAUNA OF SIX REGIONS NEAR THE DEMILITARIZED ZONE IN KOREA

by

Kang, Yung Sun, D. Sc.,
Professor and Head, Department of Zoology,
College of Liberal Arts and Sciences,
Seoul National University

INTRODUCTION

Since the truce of Korean War was made, the demilitarized zone (DMZ) has been uninhabited and undisturbed for 14 years (1953-1967). This area (width: 4 km, length: 249 km) begins at the northern part (37° 46' ; 126° 15') of Kyodong Island located in the west coast of Korea, and ends at the small fishery village, Song-Hyunlii, ($38^{\circ}37'$; $128^{\circ}17''$) located in the east coast.

All civilians having been prohibited (or restricted) to enter this area including its adjacents from the time of truce, these are considered to be very interesting places for living things including Drosophila population.

Until 1940, the knowledge concerning the drosophilid fauna in Korea, was consisted of only the records of several species of Drosophilia reported by Kikkawa and Peng (1938), and Nakayama and Okamoto (1940). Since 1955, however, Drosophila survey in Korea has attracted the attentions of taxonomists and geneticists, and repeated surveys have been carried out by Chung (1955, 1958, 1960), Chung et al. (1956), Chung & Rho (1959), Paik and Kim (1957), Lee (1959, 1962, 1964, 1966), Kang et al. (1958, 1959, 1960, 1965a, 1965b, 1966), Kang & Lee (1961) and Kim (1963, 1964). By reviewing the above records, approximately 100 species of Drosophilidae are known in Korea. But the demilitarized zone including its adjacents has not been investigated biologically until 1966. Since the truce was made, the demilitarized zone has been well conserved. So this area can be expected to develop a rich breeding site for Drosophila, and the outcome of the experiment can be contributed to determine the degree of environmental diversities of ecological niches in the area. Besides it may also provide the basic knowledge to study the speciation problem of Drosophila population in Korea. As the first step for the study of the above problem, preliminary survey was made during a period ranging from October 1966 to June 1968.

METHOD

Collecting sites were selected on the basis of ecological factors, such as humidity, temperature, altitude, and vegetation of plant. Regions and dates of collections are as shown in Table 1. The major part of the collections was made not only by using large trap cans (height: 30 cm, diameter: 15 cm) baited with fermenting apples, banana, peaches and pears, but by net sweeping in various sorts of vegetation. The binocular dissection microscopes were generally adequate both for dissection of genital organ and for observation of specimens.

RESULT AND DISCUSSION

A total of 5022 flies were represented by 7 genera, 34 species, as given in Table 2. Most flies of the genus Drosophila were attracted to the fermenting fruits. But flies of the genus Amiota were captured by net sweeping from human eyes. Also, net sweeping from various kinds of grasses and fungi gave the occurrence of the genus Stegana, Leucophenga, Liodrosophila, Scaptomyza, and Mycodrosophila.

Among the species lured to the baits, Drosophila auraria (1089 specimens, 21.68% in frequency) and D. angularis (556 specimens, 11.07%) were predominant in number. These species were distributed abundantly in Mt. Hyangnobong (eastern part), Kaari and Myojangdong (central part) and Munsan (western part). Scaptomyza pallida (523 specimens) and S. graminum (366 specimens) occurred at comparatively high frequency in this survey. Also, common species obtained were D. brachynephros (425 specimens), D. unispina (311 specimens), D. histrio (212 specimens), D. coracina (209 specimens), D. sordidular (188 specimens), D. kuntzei (185 specimens) and D. nigromaculata (166 specimens).

a. Eastern part: A total of 1552 specimens (30.90% in total) belonging to 27 species and 7 genera were sampled. According to Takada (1954) and Ishihara (1955), D. suzukii was collected only in the low regions (below 240 m). Kang et al (1959), however, captured it on the highlands of about 800 m sea level. The collection of D. suzukii was also performed in a certain place at an altitude of 1100 m of Mt. Hyangnobong by the use of traps. A few flies of the genus Stegana and Liodrosophila were secured only in this region. The survey in Punch-bowl was made only one time, so the number of flies (365 specimens) presented in Table 2 can not be considered to represent the exact members living in this area. It is interesting to see, however, that D. sexvittata was collected only in this region.

b. Central part: A total of 2658 flies (52.93% in total) representing 29 species and 6 genera were obtained. Most species among them were D. auraria (740 specimens, 28.21% in frequency) and D. angularis (272 specimens, 10.23%). It is noticeable that, among 6 collecting sites, the largest number of specimens was captured in Kaari located in the central part of Korea. Common species noted were D. coracina (197 specimens), D. brachynephros (166 specimens) and D. sordidula (124 specimens). And D. clarofinis (8 specimens), D. testacea (8 specimens) and Mycodrosophila japonica (3 specimens) were collected only in this area. It is remarkable that the number of flies (352 specimens, 13.24%) obtained in Myojangdong is much smaller than that of Kaari's (2306 specimens, 86.76%). The fact is also interesting that one of the most common species, D. angularis, was not found in Myojangdong. The main reason of this marked faunistic difference between Kaari and Myojangdong may be that all grass fields and mountains of Myojangdong were set on fire for the military purpose recently, while those of Kaari were not.

c. Western part: The collection record provided 812 individuals (16.17% in total) which represented 16 species covering 3 genera. D. auraria was dominant species, showing 145 flies (17.85%), while D. angularis ranked next, exhibiting 110 individuals (13.54%). The survey in this area having been made only one time as in Punch-bowl, it is difficult to draw a conclusion on the drosophilid fauna of this area.

SUMMARY

Collections of the drosophilid flies were made at six regions near the demilitarized zone in Korea from October 1966 to June 1968, with particular attention to their habitats and distribution. A total of 5022 flies representing 34 species belonging to 7 genera were obtained mostly by the traps baited with fermenting apples and banana, partially by the aid of net.

The data accumulated over a period of 21 months are summarized in this paper. *Drosophila auraria* and *D. angularis* were found to be most common showing the most extensive distribution. In eastern part, a total of 1552 individuals (30.90%) representing 27 species, 7 genera were sampled. In central part, a total of 2658 flies (52.93%) yielded 29 species, 6 genera. In western part, a total of 812 specimens (16.17%) which belong to 16 species representing 3 genera were collected.

Table 1. Regions and dates of collection

Region	Location	Altitude	Date
1) Mt. Hyangnobong	Eastern part (38°15';128°17')	1200 m	(1) Jun. 16-20'67 (2) Oct. 1 - 5'67 (3) May 23-28 '68
2) Punch-bowl	Eastern part (38°15';128°5')	1100 m	(1) Oct. 18-23'67
3) Myojangdong	Central part (38°15';127°10')	400 m	(1) Apr. 13-19'67 (2) Aug. 15-19'67 (3) May 8-12'68
4) Kaari	Central part (38°16';127°45')	780 m	(1) May 18-22'67 (2) Jun. 15-19'68
5) Munsan	Western part (37°50';126°40')	150 m	(1) Sep. 25-29'67
6) Kangwha Is.	Western part (37°45';126°25')	200 m	(1) Apr. 1- 5'68

Table 2. Species and number of flies collected in 6 regions near DMZ.

Area / Species	Eastern part		Central part		Western part		Total
	1	2	3	4	5	6	
Stegana sp. from Mt. Sulak	6	-	-	-	-	-	6
Amiota alboguttata	4	-	6	-	3	-	13
A. alboguttata, forma Koreana	2	1	1	-	-	-	4
A. variegata	36	9	8	28	8	-	89
Leucophenga magnipalpis	19	-	2	-	-	-	21
L. concilia	8	-	-	-	-	-	8
L. maculata	3	-	4	-	-	-	7
Mycodrosophila japonica	-	-	3	-	-	-	3
M. Koreana	4	2	-	-	-	-	6
Liodrosophila castanea	2	-	3	-	-	-	5
Scaptomyza graminum	127	-	134	31	72	2	366
S. pallida	182	-	223	24	94	-	523
Drosophila alboralis	13	-	-	-	-	-	13
D. histrioides	12	8	9	-	-	-	29
D. sexvittata	-	35	-	-	-	-	35
D. trilienata	4	-	3	-	-	-	7
D. coracina	12	-	197	-	-	-	209
D. bifasciata	46	-	11	-	-	-	57
D. suzukii	14	-	6	17	19	-	56
D. melanogaster	-	-	46	-	37	1	84
D. clarofinis	-	-	8	-	-	-	8
D. auraria	204	-	642	98	141	4	1089
D. angularis	105	69	272	-	110	-	556
D. brachynephros	113	75	166	2	69	-	425
D. unispina	70	42	108	-	91	-	311
D. nigromaculata	55	7	79	-	25	-	166
D. kuntzei	37	53	82	-	13	-	185
D. testacea	-	-	8	-	-	-	8
D. bizonata	-	-	11	6	38	-	55
D. histrio	49	64	57	-	42	-	212
D. tenuicauda	5	-	6	-	-	-	11
D. virilis	55	-	14	72	-	-	141
D. lacertosa	-	-	73	26	27	-	126
D. sordidula	-	-	124	48	16	-	188
Total	1187	365	2306	352	805	7	5022

1. Mt. Hyangnobong 2. Punch-bowl 3. Kaari
4. Myojangdong 5. Munsan 6. Kangwha Is.

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SOME GEOLOGICAL INVESTIGATIONS IN THE NORTHERN PART OF THE REPUBLIC OF KOREA

by

Kim, Bong Kyun, D. Sc.,
Professor, Department of Geology,
College of Liberal Arts and Sciences,
Seoul National University

assisted by

Yong Ahn Park

INTRODUCTION

The present report is concerned with the representation and discussion of the data and results of preliminary geological investigations along the southern boundary of the DMZ. The areas investigated cover Whajinpo, Whiyangnobong, Cheolwon, Myujangdong, Punch Bowl, and Kangwha Island. The preliminary survey has been done for one year (June, 1967, to June, 1968) in order to obtain data leading to a more comprehensive study.

Our long term proposal comprises, principally, geologic mapping, weathering of rocks, water transport, and sedimentology in the Imjin River Valley and on the east coast of Korea.

The purpose of the study is to elucidate geology of the regions with special attention to irrigation and discovery of mineral deposits, and to provide geological information and data relevant to the distribution and density of plants and animals. Furthermore, geology necessary for understanding the ecological requirements of the associated biota will be clarified.

METHOD OF THE WORK IN THE FIELD AND LABORATORY

A. Method of the work in the field

1. Tracing of rock formations; that is, the key formations
2. Taking rock samples
3. Finding numbers of important geologic structures
4. Observing the characteristic lithology of exposed rocks
5. Determining the interrelationship of key beds
6. Observing and determining the type character of stream sediment
7. Measuring the strike and dip of the beds using M-2 compass or clinometer
8. Special investigation for metallic or nonmetallic mineral deposits

B. Laboratory work

1. Preparing a complete geologic map (principally integrating all the data obtained in the field and plotting the data on topographic map)
2. Making the geologic cross section
3. Microscopic study of the rock and mineral thin sections
4. Petrogenetic analysis and interpretation of the main rock types

5. Analysis and interpretation of mineral deposits

6. Establishment of geologic columnar section

RESULTS AND DISCUSSION

A. Results

Generally speaking, new knowledge and better understanding of the geologic structure and history, ore deposits, stratigraphy, topographic characters and weathering patterns of the areas studied; that is, Punch Bowl, Kangwha Island, Myojangdong, and Mt. Kumback, were obtained. These results are briefly described below:

1. Punch Bowl Basin

The geology and origin of the Punch Bowl Basin, as summarized from Kim and Park (1967):

a. The Punch Bowl Basin is made up of granite only

b. The rims of the basin are composed of metasedimentary rock

c. The metasedimentary rock sequence was intruded by the Punch Bowl granite

d. Thus, the differential weathering effects on the two different rock exposures, which are granite body and metasedimentary rock sequence, respectively, resulted in a circular shaped basin, the so-called Punch Bowl Basin

2. Kanghwa Island

The geology of the Kanghwa Island (Kim and Park, 1968) is composed of crystalline schists which belong to the Yeoncheon System, the Kanghwa granitic gneiss correlated with the Kokuryo granitic gneiss, the Kimpo Formation which is chiefly composed of conglomerate and sandstone, and the Manisan granite. The formation of Kanghwa Island is considered due to faulting and rise of sea level at the end of Pleistocene. The reasons for the explanation will be shown in the discussion.

3. Myojangdong

The area is underlain by metasedimentary rock, granite, tuffaceous rock, and basalt. Here the metasediments are mainly mica schist, quartzite, and gneiss. (The metasediment sequence is the lowermost one in the area) These metamorphic rock units are called the Yeoncheon System, which was named after the type locality of Yeoncheon. This Yeoncheon System extends to the southwest and northeast direction the strike of N 30°-27° E. The Yeoncheon System is supposed to be of pre-Cambrian Age (Archaeozoic).

The granite, which is distributed in the eastern and southern parts of the area, intruded into the above mentioned metasedimentary rocks. The age of the granite is considered to be Cretaceous. The granite body is overlain by the tuffaceous deposit. Based on microscopic examination, the granite is biotite granite.

The newly discovered tuffaceous deposit is mainly found in the central part of the area. Thus the geology of the area differs from earlier reports. The formation overlies the Yeoncheon System and granite body. The formation is intruded by the quartz porphyry. However, the new formation is not completely traced in the study area. Hence, the geologic boundary between the tuffaceous formation and other rocks units is not continuous in the southern and northern parts. We expect this new formation to be late Cretaceous.

The basalt flow which is mainly found in the northern part of the area is restricted to the lowland or drainage areas of tributaries of the Imjin River. According to the remanent magnetism for the basalt in the area, the geologic age of the basalt is late Pleistocene.

4. Mt. Kumhak area

This area is adjacent to the Myojangdong area so the geology is similar. Most parts of the area, however, are underlain by basalt. The other chief rock type is granite. This granite is overlain by the basalt flow; therefore, the basalt flow is younger than the granite. The interesting facts are that the basalt overlies mainly the erosional surfaces of the granite and the distribution of the basalt is restricted to drainage areas or lowlands. Based on the flow direction criteria, the basaltic lava was supplied from the northeast of the studied area.

B. Discussions

1. Punch Bowl geology

The fact that the metasediments are intruded by the Punch Bowl granite is certainly clarified by the xenolith of the metasediment found in the adjacent granite body. Accordingly, the metasediments are older than the granite. Considering the meneral composition of the granite body and metasediments, it is reasonable to believe that the differential weathering affects on the two rock units caused the Punch Bowl Basin.

Although we may consider other causes for the formation of the basin, no evidences were found for an alternative explanation.

3. Kanghwa Island

Considering the lithology of the typical crystalline schist system found in Yeoncheon, Kyunggi Province, the mica schists, marble crystalline dolomite and quartzite, are grouped into one sequence that can be positively correlated with the Yeoncheon System. So the crystalline schist system in the island is the lowest sequence.

The distribution pattern of the Kimpo Formation on the east side of the island and on the west coast of the mainland and the syenite intrusion pattern on the east coast of the island indicate the possibility of faulting along the present narrow sea channel between the island and the mainland. Furthermore, to the northern extension of the channel, the granite exposure which has a straight line outline also is suggesting the faulting. For the cause of the channel there might be another alternative explanation, but the writers prefer the faulting based on mentioned data.

3. The Myojangdong and Mt. Kumhak area

Here we have to discuss the basalt flow problem and the tuffaceous deposits. According to the previous geologic reports of the basalt flow in the area concerned, the basaltic lava erupted from fissures. But based on our previous investigation, the lava erupted from volcanic vents which are located a few miles north of the study area. However, the vent area cannot be studied because it is north of the DMZ. Most basaltic flows are restricted to lowland or drainage systems in the area studied with one prominent flow direction. The flow direction structure is considered to suggest the vent rather than the fissure eruption. Also the distribution pattern of the basalt strongly suggests that the lava flowed from a volcanic vent.

The tuffaceous deposit is considered to be younger than the metasediments because the tuffaceous deposits overlie the metasediments believed to be pre-Cambrian in age. There is not an overturned structure. Geclogic maps of the Myojangdong were not completed in time for this report.

CONCLUSIONS

A. The metasedimentary rock sequence was intruded by the so-called Punch Bowl granite.

B. The weather attacks on these rock masses resulted in differential weathering, and the Punch Bowl basin was thus formed.

C. The beginning of the differential weathering in the area very possibly was late Cretaceous in age.

D. The geology of Kanghwa Island is principally composed of crystalline schists which can be correlated with the Yeoncheon System. The kangwha granitic gneiss is correlated with the Kokury granitic gneiss and the Manisan granite and dike rocks.

E. The Manisan granite is biotite-hornblende granite, and it intruded into the crystalline schists and Kanghwa gneiss.

F. The stratigraphic contact between the crystalline schists and Kanghwa gneiss could not be determined positively and further detailed investigations are required.

G. The Kimpo Formation of the island overlies the Kanghwa granitic gneiss.

H. The tuffaceous rocks, which were newly found by the writers, overlie the Yeoncheon System.

I. It is considered that the basalt flow erupted from vents, not from fissures, and that the age of the basalt flow was late Pleistocene.

J. It is supposed that the Kanghwa Island was formed due to a fault and a rise of sea level at the end of the Pleistocene era.

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INSECT HOST-PARASITE RELATIONSHIPS WITH EMPHASIS ON THE PINE MOTH.

by

Kim, Chang-Whan,
Professor and Dean,
School of Engineering and Science
Korea University

assisted by

Jin Il Kim

Jin Kook Oh

INTRODUCTION

A comparison of the diversity of insects found in the various vegetation types on abandoned areas in the study area and in adjacent forests and cultured areas was attempted with emphasis on learning the relationship between injurious insects and their parasites. The parasites and predators were attempted in relation to the vegetation.

This preliminary survey is being made to learn the insect fauna in both areas.

METHOD OF THE WORK IN THE FIELD AND ANALYSIS IN THE LABORATORY

Collection of insects was made by using insect nets. Hunting was done mostly along road sides in the DMZ and on mountains and within forests of the adjacent areas, particularly in Yanggu Koon. Insects collectd were pinned and labeled using standard methods and they are located in the collections of Korea University, Seoul, Korea.

TABLE 1. Collecting sites indicating the most common plants and insects.

Collecting site	Common plants	Common insects
1. Western lowlands	Quercus mongolica Lespedeza intermedia Lespedeza bicolor	Coleoptera Acrothinium gaschkevitchii Hemiptera Graphosoma rubrolineatum
2. Mt. Gamak & Mt. Samichon	Rhododendrum yezoense R. schlippenbachii	Coleoptera Oxycetonia jucanda Lepidoptera Minois dryas bipunctatus
3. Chorwon	Quercus mongolica Salix gracillistyla S. koriyanagi Robinia pseudoarcacia	Coleoptera Oxycetonia jucunda
4. Mt. Kodai		Orthroptera Oedaleus infernalis Coleoptera Oxycetonia jucunda
5. Hwachon	Pinus densiflora	Coleoptera Oxycetonia jucanda Trichius communis
6. Yanggu(Sokkokri & Kwangchiryong)	Pinus densiflora (low) Quercus mongolica	Coleoptera Oedionychus vibex Liroetis coeruleipennis
7. Punch Bowl	Pinus densiflora	
8. Mt. Daiam	Pinus densiflora (low) Quercus mongolica (high)	
9. Mt. Keunbong	Quercus mongolica Pinus densiflora	
10. Mt. Hangnobong	Quercus mongolica Pinus koriensis	Orthroptera Podisma morii

TABLE 2. Numbers of species collected in each collecting area.*

Collecting sites	1.	2.	3.	4.	5.	6.	7.	8.	9.		10.	
									I .	II.	I.	II.
Orthoptera												
Locustidae	5	5	4	5	2	3	3	1	3	3	-	2
Tettigidae	-	-	-	-	1	1	-	-	-	-	-	-
Tettigonidae	3	3	3	3	-	-	1	-	-	2	-	2
Gryllotalpidae	-	1	-	-	-	-	-	-	-	-	-	-
Gryllidae	1	1	1	2	-	-	1	-	-	1	-	-
Blattidae	-	-	-	-	1	1	-	-	-	-	-	-
Mantidae	2	1	3	-	-	-	1	-	-	-	-	-
Dermatoptera												
Labiduridae	-	-	-	-	-	-	-	-	1	1	-	-
Plecoptera												
Perlidae	-	-	-	-	-	2	-	-	-	-	-	-
Isoptera												
Termitidae	-	-	-	-	-	-	-	-	1	-	-	-
Odonata												
Calopterygidae	-	-	2	-	-	-	1	1	-	-	-	-
Agrionidae	1	-	-	-	-	-	4	-	-	-	-	-
Libellulidae	-	4	5	1	-	1	-	-	-	-	-	-
Hemiptera												
Cydnidae	-	2	-	-	-	-	-	-	-	-	-	-
Plataspidae	-	-	-	-	-	1	-	-	-	-	-	-
Pentatomidae	1	3	3	-	3	3	3	1	3	-	2	1
Urostylidae	-	-	-	-	1	1	-	-	-	-	-	-
Coreidae	3	1	1	3	4	6	2	-	1	1	-	2
Lygaeidae	-	-	1	-	-	-	-	-	-	-	-	1
Notonectidae	-	-	-	-	-	-	-	1	-	-	-	-
Gerridae	-	-	-	-	-	1	-	1	-	-	-	-
Reduviidae	-	-	-	-	3	2	-	-	-	-	-	-
Nabidae	-	-	-	-	1	1	-	-	-	-	-	-
Pyrrhocoridae	-	-	-	-	1	-	-	-	-	-	-	-
Miridae	1	-	1	1	1	2	2	-	1	1	1	1

*Refers to collecting site numbers used in TABLE 1.

Collecting Sites	1.	2.	3.	4.	5.	6.	7.	8.	9. I	9. II	10. I	10. II
Hemiptera (cont.)												
Nepidae	-	-	-	-	-	-	-	1	-	-	-	-
Cercopidae	-	-	1	-	-	-	-	-	-	-	-	1
Aradidae	-	-	-	-	2	-	-	-	-	-	-	-
Cicadidae	-	-	1	-	-	-	-	-	-	-	-	-
Ciccadelidae	-	-	-	-	-	1	1	-	-	-	-	-
Ledridae	-	1	-	-	-	1	1	-	-	-	-	-
Membracidae	-	-	1	-	-	-	-	-	-	-	-	-
Dictyopharidae	-	-	-	1	-	-	-	-	-	-	1	-
Derbidae	-	-	1	-	-	-	-	-	-	-	-	-
Belostomatidae	-	-	-	-	-	-	1	-	-	-	-	-
Tettigellidae	-	1	1	1	-	-	-	-	-	1	-	-
Neuroptera												
Myrmeleonidae	-	-	-	-	-	1	-	-	-	-	-	-
Mecoptera												
Panorpidae	1	1	1	-	-	-	-	-	-	1	-	2
Lepidoptera												
Libytheidae	-	-	-	-	-	-	-	-	-	-	-	1
Geometrydae	-	-	-	-	1	4	-	-	-	-	-	-
Lymantriidae	-	1	-	1	-	2	-	-	1	-	-	-
Noctuidae	-	-	-	1	-	3	-	-	-	-	-	-
Aigeriidae	-	1	-	-	1	-	-	-	-	-	-	-
Drepanidae	-	-	-	-	1	-	-	-	-	-	-	-
Hesperiidae	-	-	-	-	1	2	-	-	-	-	-	-
Papilionidae	3	5	3	4	3	5	-	-	-	-	-	-
Pieridae	1	2	3	3	-	2	1	-	1	-	-	-
Lycaenidae	1	-	2	1	1	3	-	-	-	-	-	-
Nymphalidae	1	3	6	4	5	13	1	-	-	-	-	2
Satyridae	2	2	3	1	5	4	-	-	-	-	-	-

TABLE 2. (Cont.)

Collecting sites	1.	2.	3.	4.	5.	6.	7.	8.	9. I	9. II	10. I	10. II
Coleoptera												
Cocindelidae	-	-	-	2	-	2	-	-	-	-	-	1
Carabidae	-	-	1	-	1	-	-	-	-	1	-	-
Staphylinidae	-	-	-	-	-	-	-	1	-	-	-	-
Histeridae	-	1	-	1	1	-	-	-	-	-	-	-
Hydrophilidae	-	-	-	-	-	-	-	2	-	-	-	-
Cantharidae	-	-	-	-	-	-	-	-	-	2	2	-
Coccinellidae	-	1	2	-	-	3	-	-	1	-	1	-
Buprestidae	-	-	-	-	1	1	-	-	-	-	-	-
Elateridae	-	-	-	-	2	4	-	-	-	-	-	-
Tenebrionidae	-	-	-	-	1	-	-	-	-	-	-	-
Othniidae	-	-	-	-	-	-	-	-	-	-	1	-
Oedemeridae	-	-	-	-	1	3	-	-	-	-	1	-
Meloidae	-	-	-	-	1	-	-	-	-	-	-	-
Mordellidae	-	-	-	-	-	2	-	-	-	-	-	-
Epicaupidae	-	-	-	-	-	1	-	-	-	-	-	-
Chrysomelidae	5	2	6	-	3	14	-	2	2	-	-	1
Cerambycidae	1	3	2	1	8	6	-	-	-	-	10	-
Curculionidae	2	3	1	2	7	10	1	-	1	1	1	1
Scarabaeidae	1	3	3	1	7	6	-	-	1	2	2	-
Hymenoptera												
Tenthredinidae	-	2	3	1	1	5	-	-	-	-	4	-
Argidae	1	-	4	-	1	2	-	-	-	-	-	-
Ichneumonidae	-	4	3	1	6	18	-	1	-	3	1	5
Braconidae	-	-	-	-	-	-	1	-	-	-	-	-
Elasmidae	1	-	-	-	-	-	-	-	-	-	-	-
Formicidae	-	-	1	-	-	-	-	-	-	-	-	-
Scolidae	-	1	-	1	1	1	-	-	-	-	-	-
Chrysididae	-	1	1	-	-	-	-	-	-	-	-	-
Vespidae	3	6	7	6	7	3	1	-	-	1	-	1
Pompilidae	-	2	-	-	3	1	-	-	-	-	-	-
Sphecidae	2	5	3	1	2	2	1	-	-	-	3	2
Andrenidae	-	3	-	3	2	-	-	-	-	-	2	2

Collecting sites	1.	2.	3.	4.	5.	6.	7.	8.	9. I	II	10. I	II
Hymenoptera (cont.)												
Halictidae	-	-	4	2	-	-	-	-	1	-	-	-
Mellitidae	-	-	2	-	-	-	-	-	-	-	-	-
Megachilidae	1	1	5	-	1	-	1	2	-	1	-	-
Apidae	-	2	1	-	4	8	2	1	-	2	2	4
Diptera												
Bibionidae	-	-	-	-	-	1	-	-	-	-	-	-
Stratiomyiidae	-	-	1	-	1	1	-	-	-	-	3	-
Coenomyiidae	-	-	-	2	-	-	-	-	-	-	-	-
Solvidae	-	-	-	-	-	1	-	-	-	-	1	-
Tabanidae	-	-	2	-	-	1	-	-	-	-	-	-
Bombyliidae	1	3	-	1	-	-	-	-	-	-	-	-
Asilidae	-	2	-	-	3	7	-	2	-	-	3	-
Dolicopodidae	-	-	-	-	-	1	-	-	-	-	-	-
Syrphidae	2	5	6	1	5	8	1	1	-	3	6	2
Conopidae	-	2	-	-	1	1	-	-	-	-	-	-
Scatophagidae	-	-	1	-	-	-	-	-	-	-	3	-
Phasiidae	-	-	-	-	2	1	-	-	-	-	-	-
Trypetidae	-	-	1	1	-	3	-	-	-	-	2	1
Agromyzidae	-	-	-	-	-	-	-	-	-	-	-	1
Cordyluridae	-	1	-	-	-	-	-	-	-	-	-	-
Chlorpidae	-	-	-	-	-	-	-	-	-	-	-	1
Anthomyiidae	-	-	1	-	-	4	-	-	-	-	1	-
Muscidae	-	-	1	1	1	1	-	1	-	-	-	-
Calliphoridae	-	1	-	-	-	-	-	-	-	-	-	-
Sarcophagidae	-	1	-	-	-	-	2	-	-	-	1	-
Tachinidae	-	-	-	-	-	-	-	-	-	-	1	-

The data is insufficient for analyzing the relationships between vegetation and insect fauna. The vegetation in whole areas is rather similar; that is, Quercus mongolica is becoming dominant under that Lespedeza and Rhododeneum sp. etc. are growing, whereas Pinus densiflora is disappearing gradually. It is, however, worth-while to note that a locust, Podisma morii Bey-Bienko, which was reported from Mt. Baekdu (the highest mountain in Korea), was collected at Mt. Hyangro-Bong (18 specimens, 17 Sept., 1967) and Mt. Daiam (6 specimens, 1 Oct., 1967) and also a butterfly, Neptis raddei Bremer, which occurred in middle to north Korea, was hunted at Kwangchryung, Yanggi area (1 specimen, 3 June, 1967).

On the other hand, the forests composed of pine trees have been displaced with broad-leaved trees as the result of Korean War fires, so that the distribution of pine tree forests are rarely found near the DMZ except the middle and east districts of the DMZ and the pine moth did not occur in these areas. If the northern boundary of occurrence of insect pests could be lined with accuracy, the key factors, particularly the biological factors, inhibiting the outbreak of the pest would be revealed by comparative study of the conditions in both sides of it.

CONCLUSION AND SUMMARY

This is just a preliminary survey on the insect fauna in the DMZ areas. The survey was carried out in a short period, from June to October, 1967, and the results obtained are insufficient for preparing a manuscript or coming to any conclusions.

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PLANT SUCCESSION IN ABANDONED FIELDS

by

Kim, Choon Min, D. Sc.,
Professor, Department of Biology
College of Education
Seoul National University

assisted by

Young Deuk Rim
Nam Kee Chang

INTRODUCTION

There are no studies on upland field succession in the DMZ since the fields were abandoned after the Korean War. These fields had been regularly harrowed and seeded to vaious crops in the spring and autumn for cultivation. After the Korean War ceased in 1953, the fields were abandoned and protected from furrowing; thus they became awailable for a study of plant succession

This report is confined to record the number and distribution of upland vegetation in the DMZ of Korea.

STUDY AREA

Three areas selected are Umi-dong, Sukdo-dong, and Punch Bowl. These belong to the middle section of the DMZ. Although there are many well protected upland fields, it is uncommon to find available fields for survey because the mines underlaid restrict field activities in the survey.

Of the three areas studied Umi-dong and Sukdo-dong are located near Chulwon district and the upland fields selected in the two places lie at elevation of 100 feet to 150 feet. The Punch Bowl is a small basin surrounded by ridges over 4000 feet high.

The soil is sandy loam derived from granite with gravels except Sukda-dong, where silty loam is derived from basalt. Rainfall averaged 1000 mm per year for the years 1950-1967.

METHODS

A. Field survey

A 50 x 50 m grid system was established in the field and the locations of grasses and woody plants were mapped in the three places from June to October, 1967. There were 30 units, 25 x 25 m, in the grid system, but because of the various size of the upland fields, ten of the grid units were smaller than 50 m^2 and varied from 10 m^2 to 20 m^2. To know what species might colonize the abandoned field, the presence of ground species was recorded in twelve quadrates, 25 cm^2, in each stand. The quadrates were located at three-pace intervals over the stands. For each species within the quadrates, the frequency and dry weight were measured.

B. Laboratory work

The soil samples were collected at layers A (0-5 cm) and B (5-10 cm). The soils were dried at 80°C for 72 hours and sieved through a stainless steel 2 mm mesh.

The soil pH was determined on one set of samples using a glass electrode and a 2.5:1, soil: distilled water mixture. Loss on ignition was determined in duplicate by ignition of oven-dry soils in a muffle furnace at 550°-580°C for not less than four hours. Nitrogen was determined in duplicate, occasionally triplicate, on oven-dry soils by the micro-Kjeldabl method and expressed as a percentage of the oven-dry weight of soil. Exchangeable calcium was determined by versenate, potassium by flame photometer, and phosphorus colorimetrically using ammonium molybdate and stannous chloride. Exchangeable base and hydrogen were determined by Brown methods.

The primary intent was to use this data to detect future changes in composition and to compare the floristic composition in relation to soil conditions.

RESULTS AND DISCUSSION

A total of 17 species was recorded in the three upland fields in the DMZ. They comprise the annuals, perennials, and woody plants as shown in TABLE 1.

TABLE 1. The average frequency and dry weight of plants found in fifteen year old abandoned fields.

Stand---------	Umi-Dong		Punch Bowl		Sukda-dong	
Elevation----	150 ft.		400 ft.		100 ft.	
Soil----------	Granitic		Granitic		Basaltic	
	F%	DW%	F%	DW%	F%	DW%
SPECIES:						
Arundinella hirta	100.0	291.8	100.0	121.3	63.0	55.4
Miscanthus sinensis	-	-	8.0	1.9	97.0	89.0
Artemesia japonica	65.0	22.4	1.5	0.2	45.0	12.5
Phaseolus trilobatus	23.0	4.8	-	-	2.0	0.8
Artemesia feddei	5.-	2.0	-	-	-	-
Rosa davurica	5.0	2.7	-	-	-	-
Aeschynomene indica	0.3	+	11.0	7.5	12.0	2.3
Rubus cretaegibolius	+	+	-	-	-	-
Kummerobia striata	-	-	15.0	3.0	-	-
Patrinica scabiosoefolia	-	-	10.0	4.1	-	-
Artemisia asiatica	-	-	5.0	4.6	3.0	0.6
Salix koreansis	-	-	3.0	5.6	-	-
Patrinica villosa	-	-	3.0	5.6	27.0	4.1
Achillia mongolica	-	-	2.5	1.1	-	-
Potentilla fragarioides	-	-	-	-	11.0	1.4
Pulsatilla koreana	-	-	-	-	1.0	0.1
Viola mandshurica	-	-	-	-	+	+

However, in the DMZ in 1967, sixteen years after abandonment, 65% of the common species were perennials and 18% were woody species.

The most abundant and widespread perennial was Arundinella birta in Umi-dong and the Puch Bowl. In sukda-dong, Miscanthus sinensis was the dominant species. Artemisia japonica also had a high quadrate frequency average in these atands. The density of annuals in these stands was much lower than in the neighboring places, since often only one individual of a species occurred in a quadrate.

The woody plants recorded in the upland fields only represent three species; Rosa davurica, Rubus erataegibolus, and Salix koreansis. A few individuals of each species were present on the entire field. The number of woody species is small in comparison to the data obtained in the field of 12 years abandonment in Tennessee (Quarterman, 1957). Judging from this data it seems that the upland field succession has been proceeding slowly.

This study was undertaken to examine the relationship of successional stages and soil conditions in the upland fields. From the TABLE 2. it can be said that the mineral soils of Sukda-dong, where the Miscanthus sinensis is dominated, contain less humus and total nitrogen than the soils of the other two places.

However, Arundinelle hirta colonized on soil that had more wetness and had a higher amount of humus and total nitrogen. Due to the fact that the lesser chance to field survey restricts the data obtainable; there is not enough data to consider the relationship between successional stages and soil conditions.

TABLE 2. Soil properties of some fifteen year old abandoned upland fields.

Soil property	Layer	Stand		
		Umi-dong	Punch Bowl	Sukda-dong
pH	A	4.82	4.25	4.71
	B	4.50	4.31	4.45
Weight loss on ignition (%)	A	9.40	8.90	7.18
	B	8.19	9.00	5.24
Weight water loss (%)	A	40.80	31.41	29.96
	B	38.20	40.01	21.94
Nitrogen (%)	A	0.32	0.27	0.22
	B	0.31	0.28	0.18
Potassuim (%)	A	0.14	0.26	0.15
	B	0.13	0.22	0.20
Copper (%)	A	0.43	0.33	0.41
	B	0.19	0.37	0.16
Magnesium (%)	A	0.034	0.031	0.037
	B	0.030	0.049	0.031
Phosphate (ppm)	A	3.15	3.40	3.30
	B	1.59	3.57	3.49

SUMMARY

In the upland fields of DMZ, the widespread and most abundant grasses are Arundinella hirta and Miscanthus sinensis. Thus, in 1967, 16 years after field abandonment still perennials were dominant. Considering the rate at which woody species colonize abandoned fields in Tennessee, U.S.A., colonization of upland fields in the DMZ by trees and shrubs has been slow.

THE RELATIONSHIP BETWEEN FOREST TYPES AND SOIL NUTRIENTS

by

Kim, Choon Min, D. Sc.,
Professor, Department of Biology
College of Education
Seoul National University

assisted by

Young Deuk Rim

Nam Kee Chang

INTRODUCTION

In this study the relationship between forest types and soil nutrients was investigated.

The vegetation types are oak, pine, and oak-pine stands.

TABLE 1 and 2 show the structure of forest types. TABLE 3 shows the properties of forest soils.

TABLE 1. Forest types in Kaari, Kconryangri, Choonkokri, and Whachun.

Species	Mean distance (cm)	Mean area occupied by species (cm^2)	Relative density (%)	Relative dominance (%)	Relative frequency (%)	Frequency (%)	D.B.H.
Kaari Oak Forest							
Quercus mongolia			45.5	42.0	70	0.70	8.95
Q. variabilis	267	45367	27.5	17.0	35	0.35	5.95
Pinus densiflora			25.0	40.0	45	0.45	17.26
Koonryangri Pine Forest							
Pinus densiflora			61.5	75.2	69	0.69	28.04
Quereus mongolica	226	32689	26.9	15.9	38	0.38	6.31
Q. mongolica			5.8	6.0	8	0.07	19.03
Q. variabiles			5.8	2.9	11	0.11	5.52
Chookakii Oak Forest							
Quercus variabilis			62.0	54.6	72.7	0.727	17.55
Q. mongolica	216	29860	26.0	24.6	44.4	0.44	15.60
Pinus densiflora			12.0	20.8	27.2	0.27	20.71
Whachun Oak Forest							
Quercus vaiabilis			82.0	74.0	92	0.92	9.01
Pinus densiflora			6.0	11.8	15	0.15	25.99
Pinus Koraiensis	140	12544	4.0	7.9	8	0.08	22.77
Quercus mongolica			4.0	2.3	8	0.08	3.50
Q. dentata			4.0	3.7	8	0.08	8.28

TABLE 2. Undergrowth in Kaari, Koonryangri, Choon KoKri, and Whachun.

Kaari Oak Forest	Doonryangri Pine Forest	Choonkokri Oak Forest	Whachun Oak Forest
Lespendeza bicolor	Cocylus heterophylla	Euoilopus cotulifer	Zespedeza bicolor
Atractylodes tyrata	Frexinus rhynchophylla	Aster scaber	Benjoin obtusilobum
Atemisia japonica	Benzoin obtusilobum	Hepatica asiatica	Rhus javanica
	Quekcus dentata	Smilex akina	Quercus dentata
	Lespedza bicolor	Codomopois lancedata	Acter scaber
	Acer formosum	Thalictrum aquilegifdium	Atractylodos tytata
	Rhus verniciflua	Atractylodos typata	Pueraria thunbergii
	Miscanthus sp.	Nepeta cataiia	Eceoilopus cotulifer
	Euoilopus cotulifer	Platycodon glaucum	Arundinella hirta
	Atractylodes tyrata	Artemisia japonica	
	Artemisia japonica	Lespedeza bicolor	
	Pueraia thumbergii	Morus bombycis	
	Aster scaber	Ampelosio brexipedunculata	
	Amethrystomthus exisus	Rhus javanica	
		Benzoin obtusilo bum	

TABLE 3. Soil texture.

	Depth (cm)	Kaari oak forest	Koonryani pine forest	Choonkokri oak forest	Whachoon oak forest
Clay (%)	0	30.08	5.75	21.23	17.31
	10	25.51	3.77	26.99	17.20
	20	23.14	10.05	31.59	20.74
	30	22.90	10.05	31.59	24.17
Silt (%)	0	13.93	1.20	21.78	19.44
	10	16.71	0.73	20.45	14.48
	20	17.74	4.10	19.00	15.50
	30	13.74	15.05	23.01	12.85
Fine sand (%)	0	28.22	23.00	29.89	32.29
	10	28.87	16.65	34.76	35.79
	20	29.73	16.70	30.21	39.23
	30	30.85	45.45	25.32	34.28
Coarse sand (%)	0	28.22	71.05	17.05	30.95
	10	27.52	78.75	15.76	34.66
	20	27.51	73.50	15.25	34.54
	30	32.51	29.45	20.16	28.69

TABLE 4. Chemical nutrient elements.

Soil pH	0	5.85	5.30	6.69	6.34
	10	5.60	5.40	5.89	6.02
	20	5.10	5.40	5.68	5.89
	30	5.00	5.20	6.05	6.15
Loss on ignition (%)	0	26.27	19.80	24.23	23.96
	10	8.41	7.10	7.08	6.88
	20	7.21	7.30	5.32	4.97
	30	5.21	7.50	4.24	4.21

TABLE 4. (cont.)

Total N (%)	0	0.93	0.85	1.08	1.05
	10	0.32	0.21	0.41	0.34
	20	0.18	0.17	2.27	0.27
	30	0.14	0.13	0.23	0.17
Available P (ppm)	0	16.27	11.63	21.46	21.49
	10	9.34	8.51	17.22	16.21
	20	7.27	6.62	11.48	10.14
	30	11.48	4.94	9.84	7.83
Exchangeable Ca (%)	0	0.23	0.32	0.19	0.25
	10	0.19	0.23	0.16	0.18
	20	0.17	0.19	0.25	0.17
	30	0.21	0.21	0.21	0.22
Exchangeable My (%)	0	0.110	0.099	0.065	0.054
	10	0.070	0.097	0.050	0.051
	20	0.057	0.103	0.056	0.063
	30	0.055	0.042	0.039	0.048
Base exchange capacity (me) (%)	0	41.0	32.6	31.4	32.5
	10	34.5	29.5	38.5	37.4
	20	31.5	32.4	34.4	39.1
	30.	32.6	31.1	29.1	29.3
Exchangeable hyclrogen (m.e.%)	0	19.5	12.0*	11.0*	22.1
	10	23.2	11.7	13.2	18.7
	20	21.4	13.7	14.9	22.4
	30	22.2	12.8	15.4	13.7
Base stauration (%)	0	52.4*	63.2	67.7	35.1*
	10	32,8	60.0	65.9	49.4
	20	32.1	57.7	56.7	42.7
	30	32.0	58.8	47.0	53.52
Moisture content (%)	0	52.3	50.4	92.3	40.3
	10	24.1	32.8	33.5	31.2
	20	20.1	19.2	19.9	20.0
	30	13.4	15.1	30.9	18.3

* 5%
** 1%

THE DISPERSION RATIO AND SOIL NUTRIENTS OF THE ERODED SOILS

by

Kim, Choon Min, D. Sc.,
Professor, Department of Biology,
College of Education
Seoul National University

assisted by

Young Deuk Rim
Nam Kee Chang

INTRODUCTION

For many years attention has been called to the enormous losses resulting from soil erosion. In this study the dispersion ratio of silt and clay of eroded soils was measured as a criterion for discovering more about soil ersion . The status of soil nutrients was also traced in relation to the density of vegetation.

RESULTS AND DISCUSSION

Dispersion ratio: TABLE 1 shows the soil texture and dispersion ratio of the eroded forested soils, in and out of the DMZ.

The dispersion ratio was found to decreas as the vegetation became spars (FIGURE 1).

Soil nutrients: TABLE 2 shows the status of soil nutrients of the variou soil. Among the soil nutrients the available phosphorus and humus are closely related with the dispersion ratio (FIGURE 2).

TABLE 1. Soil texture and dispersion ratio of the eroded soils.

Area		Kwangnung	Yanggu I.	Yanggu II.	Suyuri	Ejongbu
Slope		15°	25°	10°	10°	10°
Aspect		S	S	SW	SE	S
Stand		pine	pine	sparse	sparse	sparse
Plot		2	3	4	3	4
	DEPTH (cm)					
Clay	0	24.28	5.817	3.52	3.52	1.15
	10	24.63	7.292	3.12	4.36	4.50
	20	2959	5.10	3.67	5.20	4.16
	30	29.42	6.26	1.08	7.56	2.70
Silt	0	21.05	3.61	2.82	1.66	0.27
	10	21.16	2.26	2.21	2.53	2.05
	20	23.06	3.61	2.07	1.68	1.39
	30	19.37	6.55	1.36	3.40	1.41
Fine sand	0	31.68	20.06	30.87	11.86	1.41
	10	29.66	17.57	10.86	12.66	20.46
	20	29.00	16.50	13.37	10.95	17.13
	30	29.63	22.00	12.02	18.90	14.63
coase sand	0	23.57	70.83	57.16	82.35	17.54
	10	23.87	72.80	70.57	79.72	71.66
	20	20.57	74.48	87.34	82.50	76.74
	30	21.35	65.26	83.18	70.12	77.26
Dispersion ratio	0	44.96	9.43	6.48	5.99	1.30
	10	45.73	9.58	5.78	6.73	6.20
	20	50.26	9.01	4.81	6.88	5.55

FIGURE 1. The dispersion rate of forest soils.

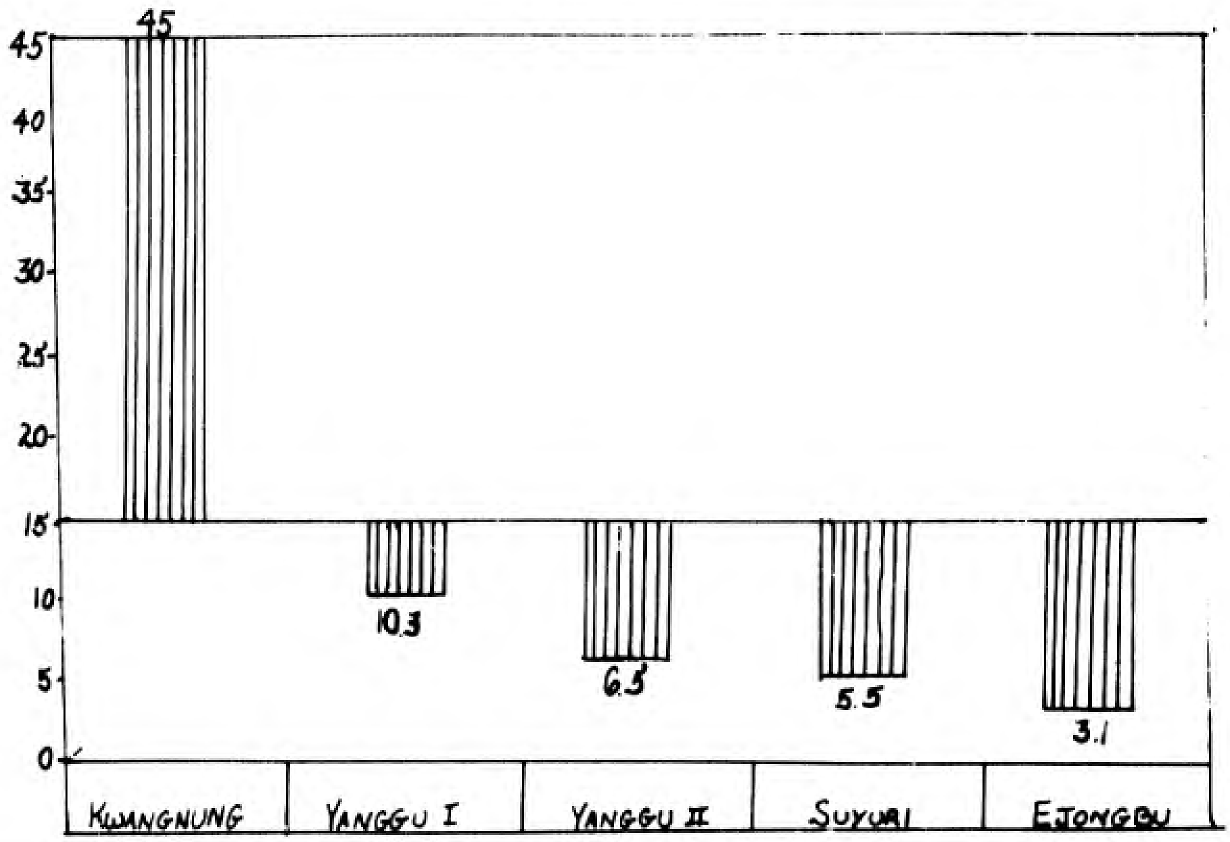

FIGURE 2. The status of soil nutrients of the eroded soils.

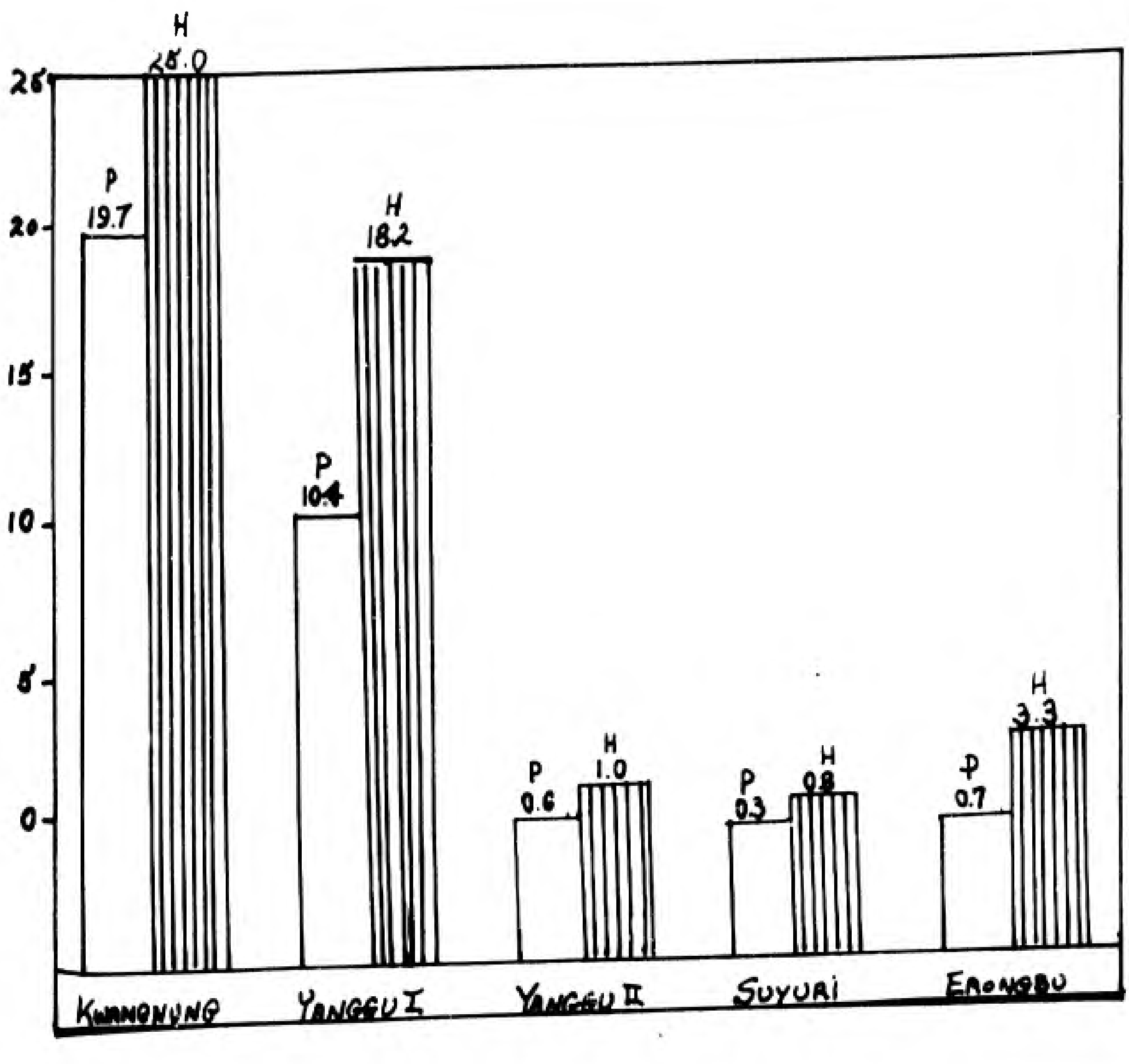

TABLE 2. The status of soil nutrients obtained from the eroded soils.

Properties	depth (cm)	Kwangnung	Yanggu I	Yanggu II	Suyuri	Ejongbu
PH	0	5.47	5.36	5.30	5.90	5.96
	10	5.58	5.60	5.05	4.60	5.05
	20	5.51	5.30	4.77	4.70	5.15
	30	5.28	5.30	4.78	5.05	4.89
Loss on ignition (%)	0	26.10	18.27	0.99	0.85	3.14
	10	7.90	6.70	3.43	2.07	5.18
	20	6.80	6.67	4.63	2.41	2.38
	30	5.30	6.47	3.03	2.43	2.34
Total nitrogen (%)	0	0.92	0.82	0.24	0.05	0.44
	10	0.20	0.22	0.22	0.29	0.26
	20	0.15	0.18	0.18	0.17	0.14
	30	0.12	0.16	0.12	0.08	0.08
Available phosphorus (ppm)	0	16.38	10.36	0.26	0.09	0.95
	10	9.00	5.98	0.29	0.15	2.26
	20	6.90	5.14	0.18	0.12	1.02
	30	8.50	4.43	0.11	0.10	0.59
Exchangeable Ca (%)	0	5.50	0.32	0.07	0.07	0.12
	10	0.11	0.13	0.11	0.09	0.14
	20	0.10	0.13	0.06	0.08	0.15
	30	0.81	0.12	0.47	0.05	0.06
Exchangeable K (%)	0	0.18	0.26	0.12	0.07	0.11
	10	0.16	0.21	0.18	0.10	0.22
	20	0.17	0.17	0.12	0.06	0.10
	30	0.20	0.20	0.11	0.04	0.09

TABLE 2. (Cont.)

Properties	depth (cm)	Kwangnung	Yanggu I	Yanggu II	Suyuri	Ejongbu
Exchangeable Mg (%)	0	0.10	0.09	0.52	0.05	0.15
	10	0.69	0.08	0.86	0.08	0.21
	20	0.56	0.06	0.52	0.26	0.21
	30	0.55	0.05	0.06	0.03	0.18
Base exchange capacity (m.e. %)	0	42.10	33.13	27.10	13.80	23.10
	10	36.40	29.73	25.70	23.20	23.78
	20	32.00	31.46	27.65	24.40	23.95
	30	33.20	29.53	26.18	25.20	19.63
Exchange bases (m.e. %)	0	15.90	16.23	18.52	7.89	12.80
	10	7.50	13.70	15.48	12.20	11.05
	20	9.60	13.63	17.35	13.00	10.98
	30	9.50	13.63	15.92	11.30	8.70
Exchangeable hydrogen (M.E. %)	0	26.20	16.73	8.67	5.70	12.80
	10	26.80	16.23	10.22	11.10	12.75
	20	23.90	17.17	10.30	11.70	12.10
	30	28.80	16.00	10.25	11.90	10.93
Base stauration (%)	0	38.20	50.13	68.03	50.70	53.28
	10	28.80	45.26	60.58	52.20	47.08
	20	28.70	42.80	63.48	52.80	44.75
	30	28.50	45.26	60.63	51.70	44.80
Moisture content (%)	0	55.20	50.93	15.00	7.20	7.15
	10	23.50	34.50	14.85	13.20	18.75
	20	20.30	18.90	10.43	12.20	14.80
	30	12.40	15.40	8.30	9.96	12.98

ON THE ECOLOGY OF *PINUS DENSIFLORA*

by

Il Koo Lee
Professor, D. Sc.
Kon Kuk University

assisted by

Ho Joon Lee

INTRODUCTION

All the taxonomists, ecologists, and dendrologists will not deny the fact that Pinus densiflora occupies more than 70% of the forests in Korea. Although P. densiflora has been attacked by the insect pets Dendrolinus spectadilis and Thecodiplosis daponicus in recent years, it is undoubtedly a dominant species growing wild in a vast area of many different environments.

Morphological and taxonomical studies were made by Uyeki H. (1928) and the results of the study on the geographical distribution of P. densiflora were reported by Yoshioka K. (1958).

In performing the investigation of the DMZ area in South Korea under the financial assistance of the Smithsonian Institution, the author became aware of the fact that red pine, P. densiflora, was disappearing from the DMZ area. The present study started, therefore, in order to investigate the reason why red pine, growing wild throughout the country, has been replaced by other broad-leaved trees in the DMZ.

The field investigation was made not only on the whole DMZ area, which extends 180 miles from Kanghwa Island in the west to the east coast through the central region, but also throughout Korea, i.e., east coast, Kyunggi-do, Honam and Kyongnam regions, and the islands of Koje, Wando, Hongdo, and Jeju.

GEOGRAPHICAL DISTRIBUTION OF PINUS DENSIFLORA

As a result of the field investigation throughout the Korean peninsula and Japan, excepting the Hokkai prefecture, it bacame known as a matter of fact that red pine grow wild throughout Korea.

According to Yoshioka K. (1958), *P. densiflora* is distributed around Lake Hungkii of the Sino-Russian border in the north, Laotung Peninsula and Raesan of the Shantung Peninsula in China, Simokita Peninsula in the east, and Yaku Island in the south.

The pine trees growing wild all over the China mainland are *P. massoniana* and *P. sinensis*. As shown in the **Figure 1** of the geographical distribution, the major country for growing red pine is Korea, Japan, and a part of the China mainland. The geographical distribution of red pine as described above has been investigated since 1964 in South Korea.

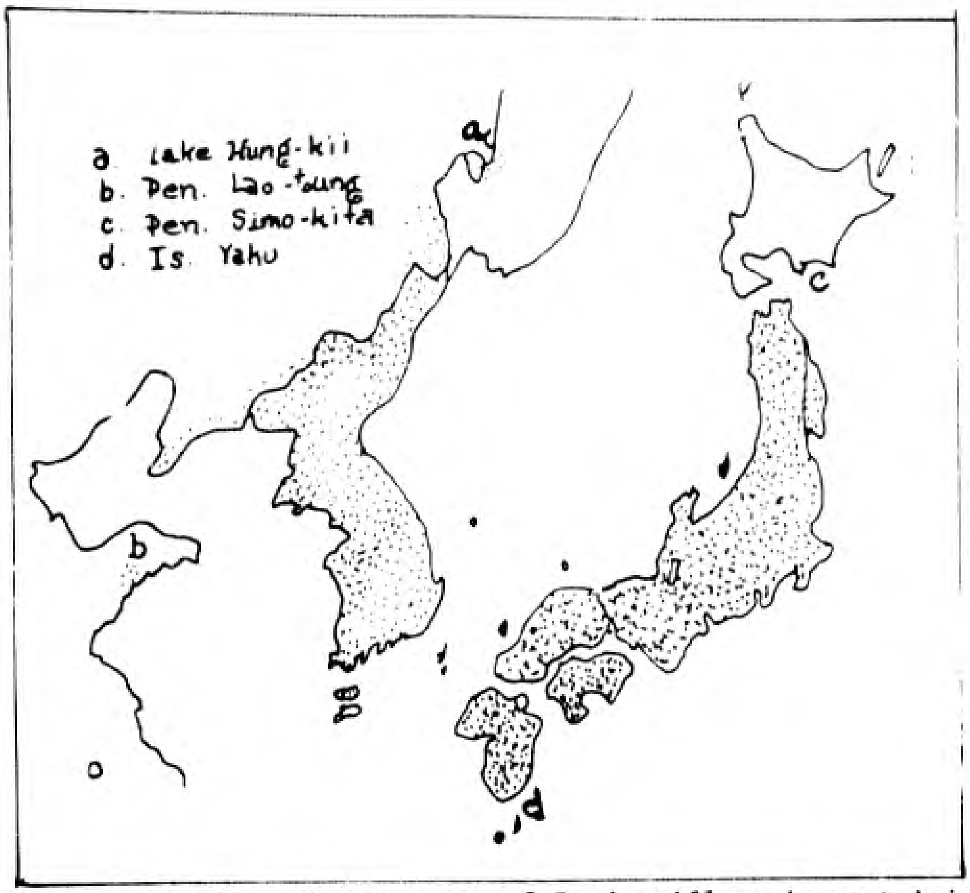

Fig. 1. The distribution area of P. densiflora in east Asia.

On Jeju Island, situated off the southern extremity of the Korean Peninsula, we only found one old red pine forest located 700 m above the sea level and west of Mt. Han-na. Pinus thumbegii was grown alone all over the island. Red pine also grows wild on the islets of Koje, Namhae, and Bokil, although P. thumbergii is found predominantly more here. However, on the inland area P. thumbergii grows wild in some areas on the east coast of Korea, i.e., south of Pohang and the south coast of Byunsan peninsula , while red pine shows an overwhelmingly dominant distribution in all other areas. The forest of P. thumbergii in the vicinity of Kangnung of the east coast is artificially planted.

CAUSE OF THE DOMINATION OF <u>PINUS</u> <u>DENSIFLORA</u> IN KOREA

H. Walter (1927) reported that *Pinus sylvestris*, which is similar to red pine in both ecological and morphological aspects, is dominant in the European continent because of the following factors:

A. Reforestation of a needle-leaf tree in waste land,

B. Good use of the needle-leaf for construction material,

C. Strong dissemination of the seeds,

D. Ready artificial improvement, and

E. Growth capability even in barren land where fallen leaves are collected.

K. Yoshioka (1958) indicated as follows: Red pine have bacome a dominant species because of its ecological characteristics and artificial effects.

A. Ecological characteristics

1. Strong dissemination of the seeds.
2. As it is a light-loving plant and grows repidly in the early stages, it is not overgrown by other trees.
3. Ready growth even in barren land.

B. Artificial effects

1. Ready infiltration into deforested areas

2. Ready infiltration into areas following forest fires

3. Ready forestation

The writer considers the primary factors of the dominant distribution of red pine in Korea as follows:

A. Ecological characteristics

1. It requires less temperature, water, and nutritious matter to survive.

In view of the fact that red pine is distributed from latitude 31° to 45°, it may be easily presumed that the living limitation of red pine to temperature is wide. It grows well anywhere except in an extremely damp area. As it is not adversely affected by extreme dryness, it may be commonly seen growing along the rocky mountain slopes.

Fig. 2. Pine trees growing along the mountainous slopes at Changwi-dong.

2. Mycorrhizae is a parasite on the root.

H. L. Mitchell (1937) reported that as a result of the experiment on Pinus strobus, the growth of the mycorrhizae-infected sapling is better than that of the nonmycorrhizae-infected sapling. S. Miyasaki (1943) also reported that mycorrhizae seems to have the nature of absorbing a very small anount of water and nutritious matter and supplying both to the red pine. This is possible as the parasite produces mycellium all the more according to the dryness in barren and dry mineral soil.

3. Strong dissemination of the seeds.

The species that has a great cover degree next to the red pine in Korea is probably the oak, Quercus. The Quercus seed is 50-100 times larger than that of the pine and has a little dissemination because it rolls down in sloping areas, whereas the pine seed will be dispersed scores of meters away in the breeze because of its light wings.

B. Geographical conditions

1. The underground wall rocks of the whole forest in Korea are generally formed of 65% granite. The soil on the wall rocks of granite is extremely barren and dry. It is natural, therefore, that the red pine grows thickly on such ground of less water and nutritious matter as mentioned previously above.

2. Little precipitation.

The annual rainfall in Korea is relatively little in comparison with that of Japan and Formosa. What is more important is little rainfall in the months of March and April which greatly restricts the growth of other trees. The pine, however, which has the least demand for water, grows well regardless of the rainfall.

C. Consequences of artificial effects.

1. The Korean people have a strong thought of respecting the red pine from ancient times. As the pine forest is dry and has few weeds growing in its midst, no animals and vipers live there. Therefore, our Korean ancestors planted the red pine in the vicinity of villages and tombs from olden times. This traditional custom of the Korean people might have

greatly expanded the area of the pine forests throughout the country.

2. The pine trees as unique timber.

The pine timber ;een exclusively used as a unique material for the construction of buildings, bridges, furniture, and fixtures, etc. This fully suggests the fact that the most comprehensive efforts had been made to some extent to foster the red pine.

3. Expansion of pine forests by the fields burnt away for cultivation and accidentally by forest fires.

As reported by S. Honda in 1910, the red pine expanded its cover degree all the more by the fields burnt away for cultivation. In other words, the population growth eventually makes it ne:essary to reclaim new arable land. Such reclamation, however, can be only possible in the forests of broad-leaved trees. As already reported by Lee and Monsi (1963), no one reclaims the pine forest due to the fact that the crops cannot be grown in deforested soil of the pine forest.

The fields burnt away for purposes of cultivation are tilled without fertilization for two or three years; then, leaving these fields full of organic matter caused by the first fallen leaves when they dry up, new forests and fields are reclaimed. The old reclaimed land, left as it is, is the most suitable for the seed of the red pine, which has a strong enough disseminating power to infiltrate into these areas.

GEOGRAPHICAL DISTRIBUTION OF PINUS DENSIFLORA (See Figure 3.)

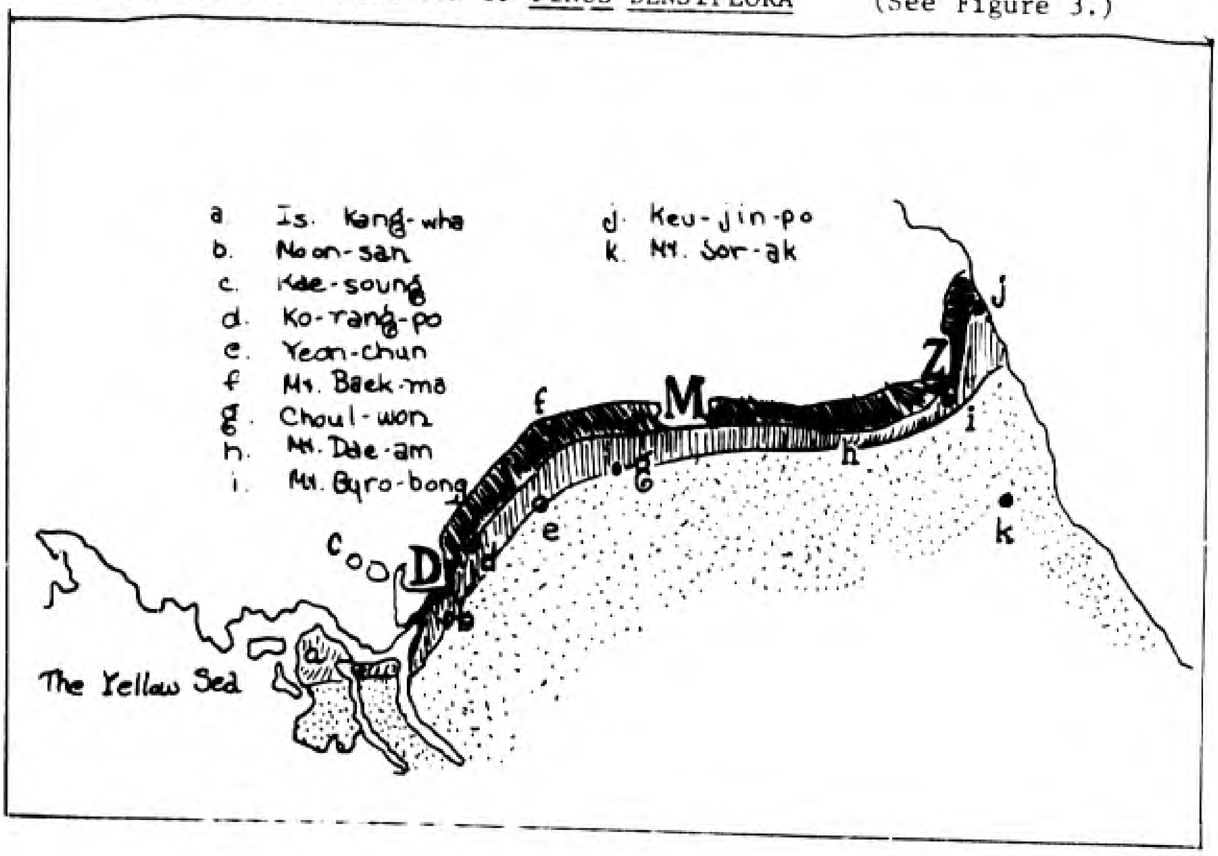

Fig. 3. Horizontal line represents the DMZ; vertical line indicates the area in the south of the DMZ; and dotted line indicates area where pine trees presently grow wild.

A. The DMZ area, starting from Kangwa Island in the west, and continuing to Koujinpo on the east coast, which covers an area of 180 miles, is divided into five zones for the sake of convenience. They are (1) Kanghwa Island, (2) Moonsan, (3) Yonchon-Dholwon, (4) Yangku-Hyangnobong, and (5) the eastern seashore.

1. Kanghwa Island

In Choulsan-Ri, on the northern end of Kanghwa Island, the Han River flows about 2 km distance from where North Korean farm villages can be seen. Therefore, the island is one of the most strategic points needed to defend the free South Korea from the aggression of the North Korean Communist regime. One can see a few pine trees but no pine forests in the mountains of the northern part of the island. However, there are many pine forests in the flat area of the central and southern island regions, while all of the mountains 200-300 m above sea level are completely bare (Plate 1. a,b).

2. Moonsan

The writer visited the DMZ in the Moonsan area in 1960 and was surprised to see that pine trees were completely banished from the entire area. The species newly infiltrated into the area where once there were rice-paddy fields and roads was Robinia pseudoacacia and Quercus. A great deal of Salix infiltrated into the humid soil of the rice-paddy fields. (Plate 1., c,d,e,f, and Plate 2. a)

3. Yonchon-Cholwon

Pine forests could only be seen in the vicinity of Koryangpo along the DMZ line. Pine trees were banished away from most of this area. If there are any pine trees in this area they grow along the mountains" rocky slopes, precipitous cliffs, or south of Mt. Koryo in the vicinity of Myozang-dong (Plate 2., b,c,d,e,f).

4. Daesongsan-Hyangnobong

This area is the steepest region which forms the main Taibaek Range where the front line passage and position of the ROK army is in the mountains and Punch Bowl, respectively. During the Korean War, the mountain ridge was used as a road for traffic became the hot place for fighting. The valleys have been abandoned since the war. Consequently, no pine trees could be seen in the vicinity of the pass and mountain ridge of the front line. There are some pine trees growing in the valleys and other mountains distant from the military roads (Plate 3., a,b,c).

5. Tp. Koembong-Koujinpo

This area covers the lean and long flat region facing the east sea and the entire foot of the Taibaek Range. There are pine forests of more than 5-100 year old trees in three places: along the roadside of the flat region; the forest of <u>Pinus thumbergii</u>, planted along the seashore; and a vast pine forest throughout Whajinpo. However, all of the pine trees around the mountain foot were deforested to the extent that one could no longer see any trace of a red pine forest. There is only the forest of an aged pine tree in the vicinity of Koembong Temple, which was burnt down during the Korean War (Plate 3., d,e). Plate 3,f, shows the typical pine tree at a control in Jinburi, 25 km away from the south of the DMZ.

REASON FOR THE BANISHMENT OF RED PINE FROM THE DMZ

It is noticeable fact that all of the trees in the DMZ area have been steadily deforested in order to strengthen the defensive works against the infiltration of communist guerrillas, which has been occurring frequently in recent years. In addition, fire is also used concurrently in order to remove herbs. In spite of the deforestation and fire, broad-leaved trees like Quercus, Lespedeza, and Robinia, etc., are not killed, but regrow every year. Pine trees are killed. This may fully explain why pine trees banished from the DMZ area.

The Korean War destroyed the forest land north of the Imjin River in the Moonsan area, thereby red pine was banished. In the banished place of red pine in the Moonsan area, forests of Quercus and Robinia have been formed. In the neighboring hills of Maju Op charcoal can be seen here and there within the broad-leaved forest, which bespeaks the forest fire caused by the war. Also, one cannot even see a single piece of lumber used for houses in Changdan, once a small town. Now only stone fences and foundation stones can be seen. At present, Robinia and Salix infiltrate into this area. In the 200 m hills at the intermediate point toward Changdan across the Freedom Bridge, there is Pinus rigida, half of which is burnt down and the other half continues to grow. This proves that P. rigida has the capacity to regrow.

Baekma Hill, in the vicinity of Cholwon, is famous for being a fierce battle ground during the Korean War. At present, however, red pine grows wild abundantly in this hilly area because the seeds of the pine trees in other neighboring plateaus, which didn't suffer from the war disasters, flew into this hilly area.

Since the armistice in 1953, it has been steadily propagated and preserved, as well as in the demilitarized zone.

EXPERIMENTS ON THE SPROUTING

The pine tree has no sprouting power, in general, as is mentioned above. The following experiments were performed in order to obtain substantial data concerning the sprouting power of the pine tree.

A. Experiment 1.

Red pines of 5-6 years old were cut at 15 cm height above the ground. None of the stems sprouted as is shown.

TABLE 1. Sprouting experiments on *P. densiflora*.

Date	Locality	No. of material	Age	Sprouting
Apr. 3, 1964	Changwi-dong	10	5-6	None
	Mt. Kowhang	5	"	"
May 1, 1964	Changwi-dong	10	"	"
	Mt. Kowhang	5	"	"

After this experiment, the writer picked up the stumps at Uminae in the vicinity of Seoul in 1967 and observed that many of them had sprouted. It was therefore considered that the pine tree might be a new species. From olden times this place has been referred to as "Uminae", which means "the sprouting of pine trees" in literal translation.

B. Experiment 2.

The green shoots on the main stem of 7-8 year old red pines was cut 3 cm from the end. The result of this experiment showed that more than ten shoots were sprouted per tree on August 1. This was the sprouting between two leaves on the short shoot.

TABLE 2. Branch sprouting experiments on P. densiflora.

Locality	No. of Material	No. of sproutings per tree	Minimum sprouting shoots per tree	Maximum sprouting shoots per tree
Changwi-dong	5	5	3	11
Mt. Kowhang	5	5	4	10

C. Experiment 3.

All the leaves of the 5-6 year old red pines were removed in order to observe its resprouting. This experiment was performed with three sample trees at Changwi-dong on July 28, 1964. The results of the experiment are as follow:

TABLE 3. Resprouting by needle removal on P. densiflora.

Locality	Removal of leaves (%)	Resprouted	Withered
Changwi-dong	100	None	Withered
Mt. Kowhang	100	None	Withered

DISCUSSION AND CONCLUSION

This paper is prompted by the disappearance of red pine from the entire DMZ in the Moonsan area. It is felt quite strangely that the pine tree which covers more than 70% of the forests and fields throughout the country can no longer be seen in the vast area in the north of Imjin River, south of the DMZ. When charcoal, produced by forest fires, was found in the forest land of Moraenae and Maji Op, the writer considered this sufficient evidence to justify the presumption that the war disasters banished all the pine trees. The pine trees were withered by forest fires regardless of their size. Therefore, it cannot be denied that the pine tree is very weak in its life as compared to <u>Quercus</u>, <u>Lespedeza</u>, and <u>Robinia</u>. In order to prove that the whole forest and fields in this area were completely burnt down by the war disasters during the Korean War, the writer inquired directly to General H. Chang and General K. Choung, who were the commanders in this front line area as well as many other officers. All these war veterans confirmed what the writer believed to be true.

As a result of the field investigation throughout 180 miles of the DMZ area conducted thereafter, it was made known that the pine tree was also banished away from the whole area 3-4 km south of the DMZ line, except part of the central mountainous area.

This banishment of the pine tree resulted from an exhaustive deforestation and incendiary fires, defensive precaution against further infiltration of the North Communist guerrillas into the south. If the pine tree had the same sprouting power as Quercus, Lespedeza, and Robinia, it might be saved from such exhaustive deforestation.

As proven by the three latter experiments described above, most of the pine trees have no sprouting power; therefore, they are eventually withered by lumbering and/or forest fires. This contrasts markedly with the reason why the pine tree became the dominant species.

SUMMARY

It may be fully known that Korea is the chief producing country of pine trees from the pan-Asian viewpoint of the geographical distribution of the pine trees.

Throughout the study concerning the reason why the pine tree became a tree of maximum cover in Korea and the observation of natural preservation status of all sorts of trees in the DMZ area for nearly 20 years after the Korean Armistice, it has become known that almost all of the pine trees have been banished.

This phenomenon has resulted from the ecological characteristics of the pine tree itself which has no sprouting power at all, war disasters, deforestation, and incendiary fire that have been steadily carried out up to date since the armistice.

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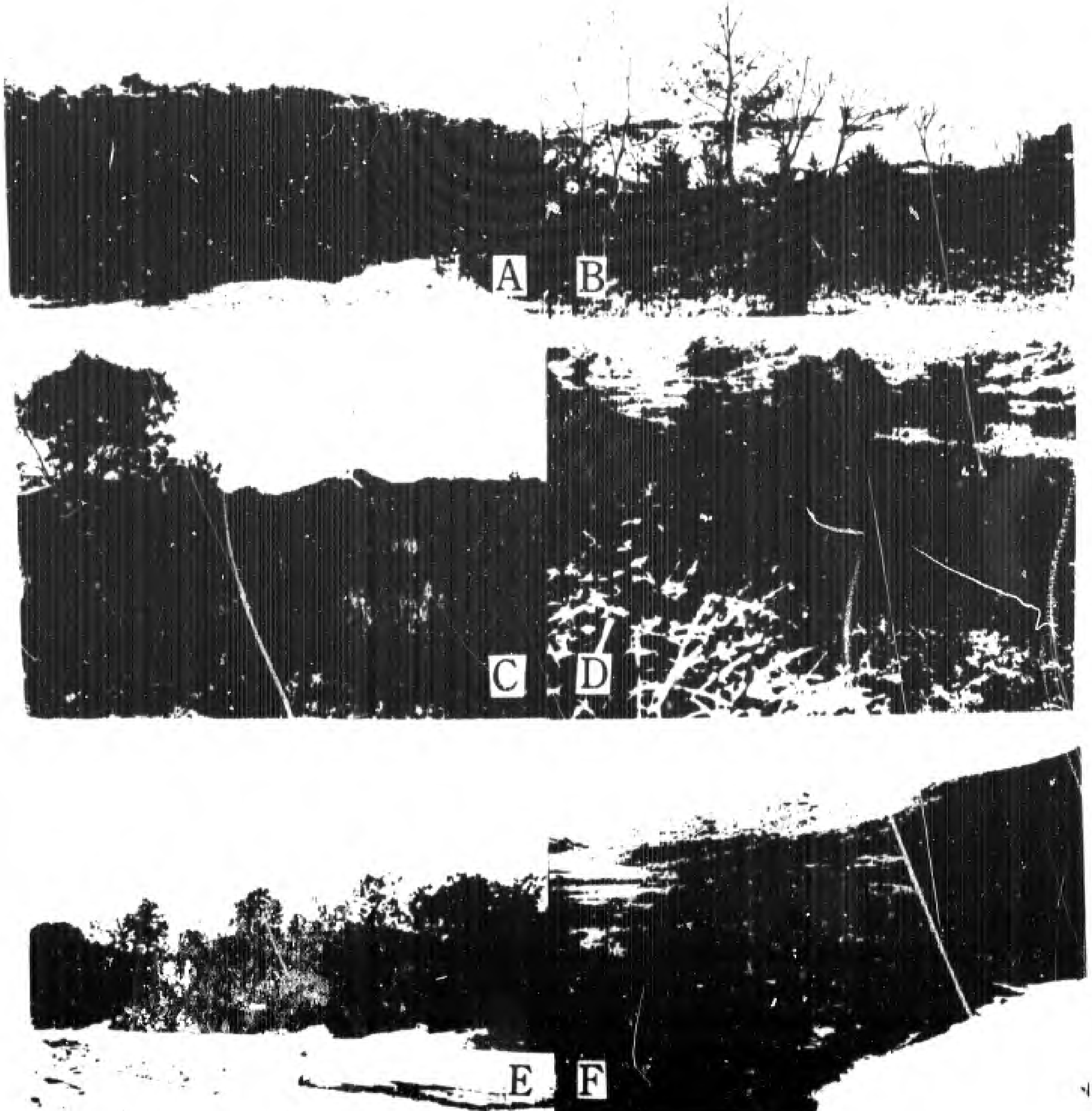

PLATE 1. a. A red pine forest in a plateau south of the central region of Kanghwa Island.

b. North Korea is overlooked across the Han River from the Northern end of Kanghwa Island. Broad-leaved trees and some red pine grow in the front.

c. Salix infiltrates into the post-area of rice-paddy field in the DMZ north of Moonsan area.

d. Broad-leaved trees infiltrate post-area of field along the riverside in the DMZ north of Moonsan area.

e. Broad-leaved trees infiltrates (same area as "d").

f. Red pine isn't seen at all along Sammi riverside in the vicinity of Koryangpo.

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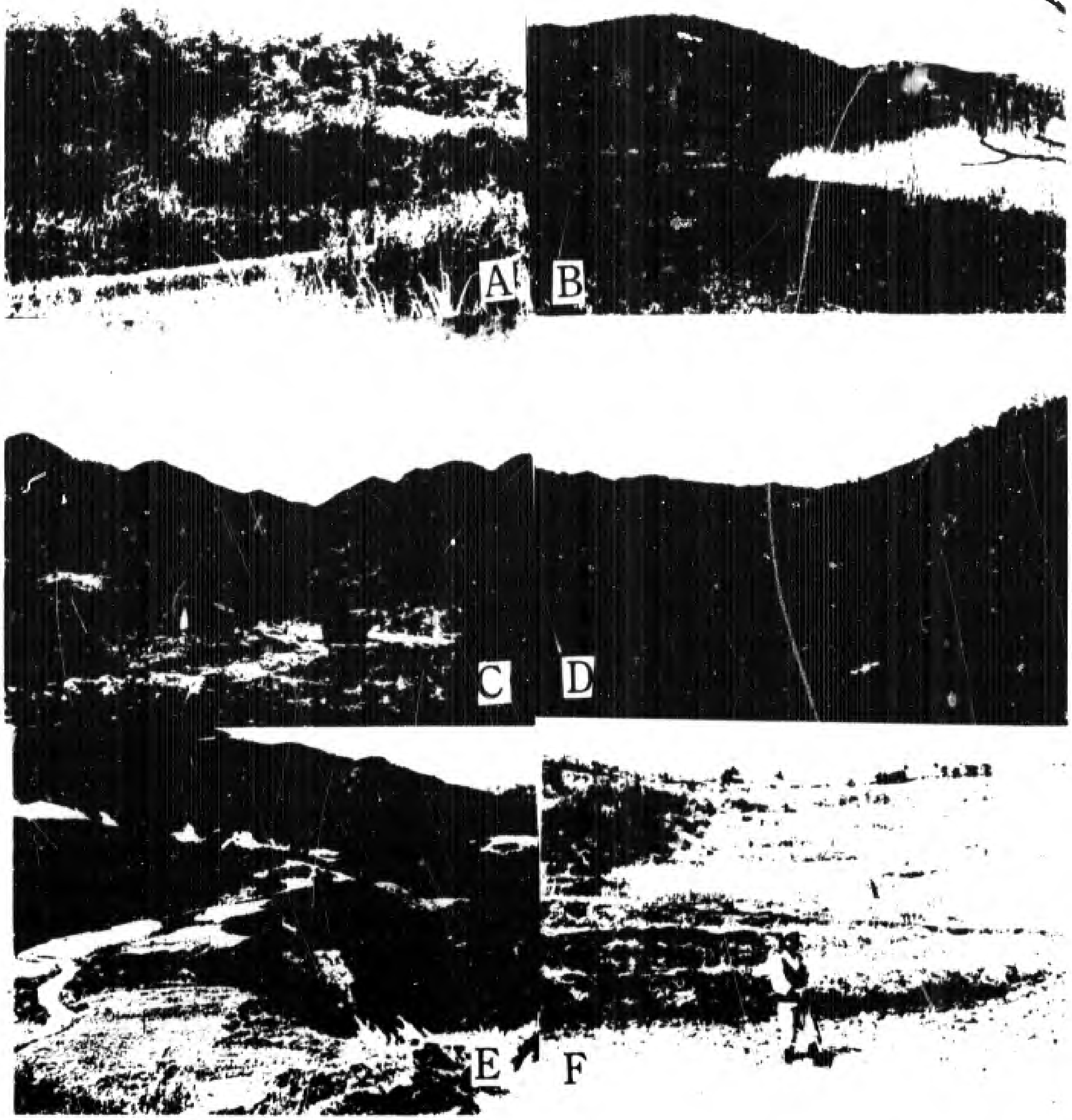

PLATE 2.

a. Robinia infiltrates post-area of field in vicinity of Koryangpo.

b. Broad-leaved forest in post-area of rice field and hill in DMZ, north of Teal Bridge.

c. Some pine trees can be seen on left mountainside, 2 km north of Yonchon.

d. No trace of pine trees in vicinity of DMZ, north of Yonchon.

e. Red pine is not observed from 1 km north of Yonchon.

f. Almost no red pine can be seen at the intermediate point toward Uncheon from Jeonkok south of Yonchon.

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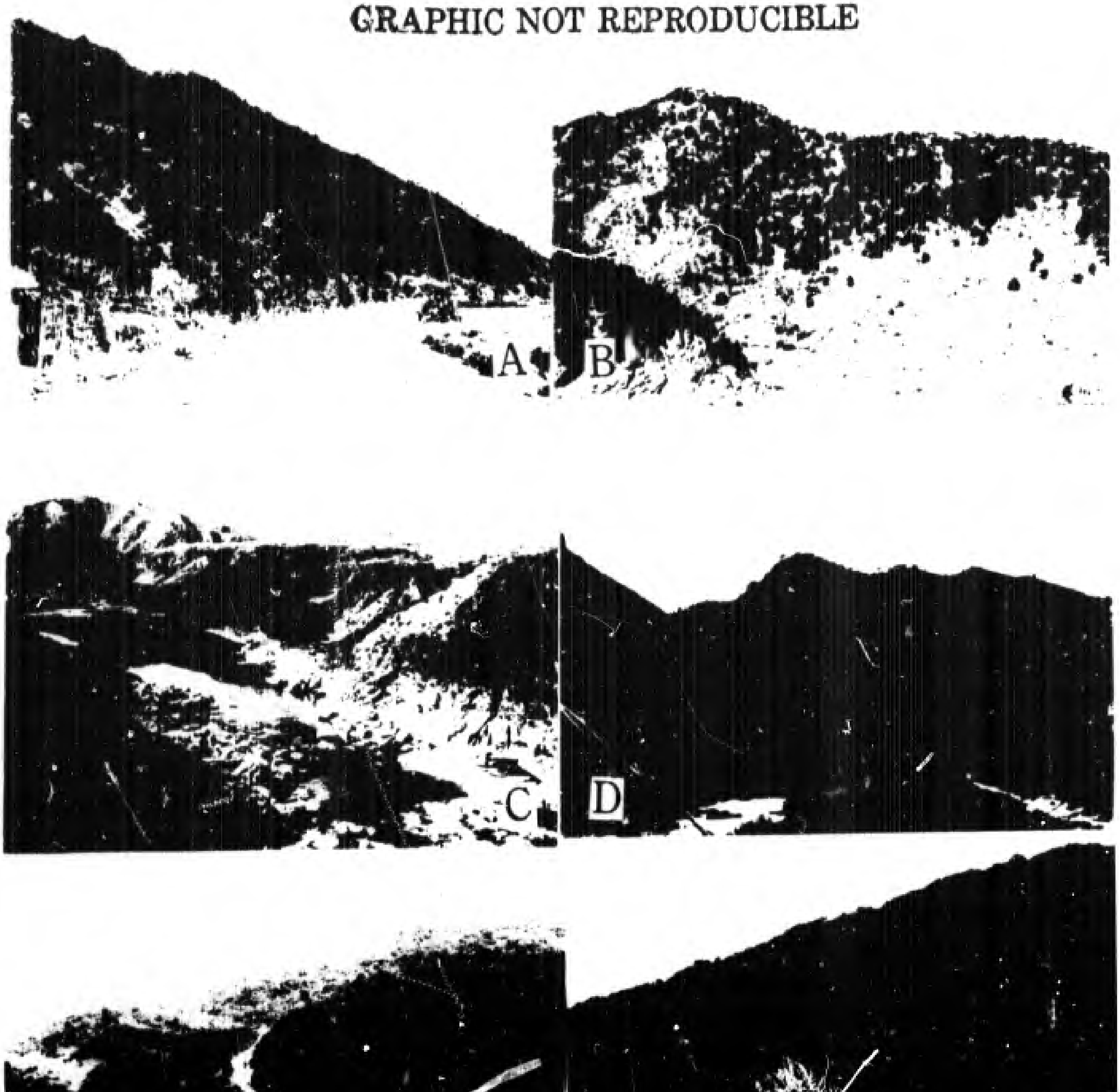


PLATE 3.

a. No sign of red pine 1 km south of Myochangdong in the DMZ,north of Yonchon.
b. Red pine is observed along the roadside 4 km south of Cholwon.
c. Red pine is not grown in the mountain of the downstream of Sungil Bridge in vicinity of Cholwon.
d. Pine tree banished away from vicinity of Mt. Daesong , east of Cholwon.
e. Puch Bowl is overlooked from Mt. Daeam. No pines can be see.
f. <u>Quercus</u> grows thick along military roadside of 1400 m hill of Hyangno-bong.

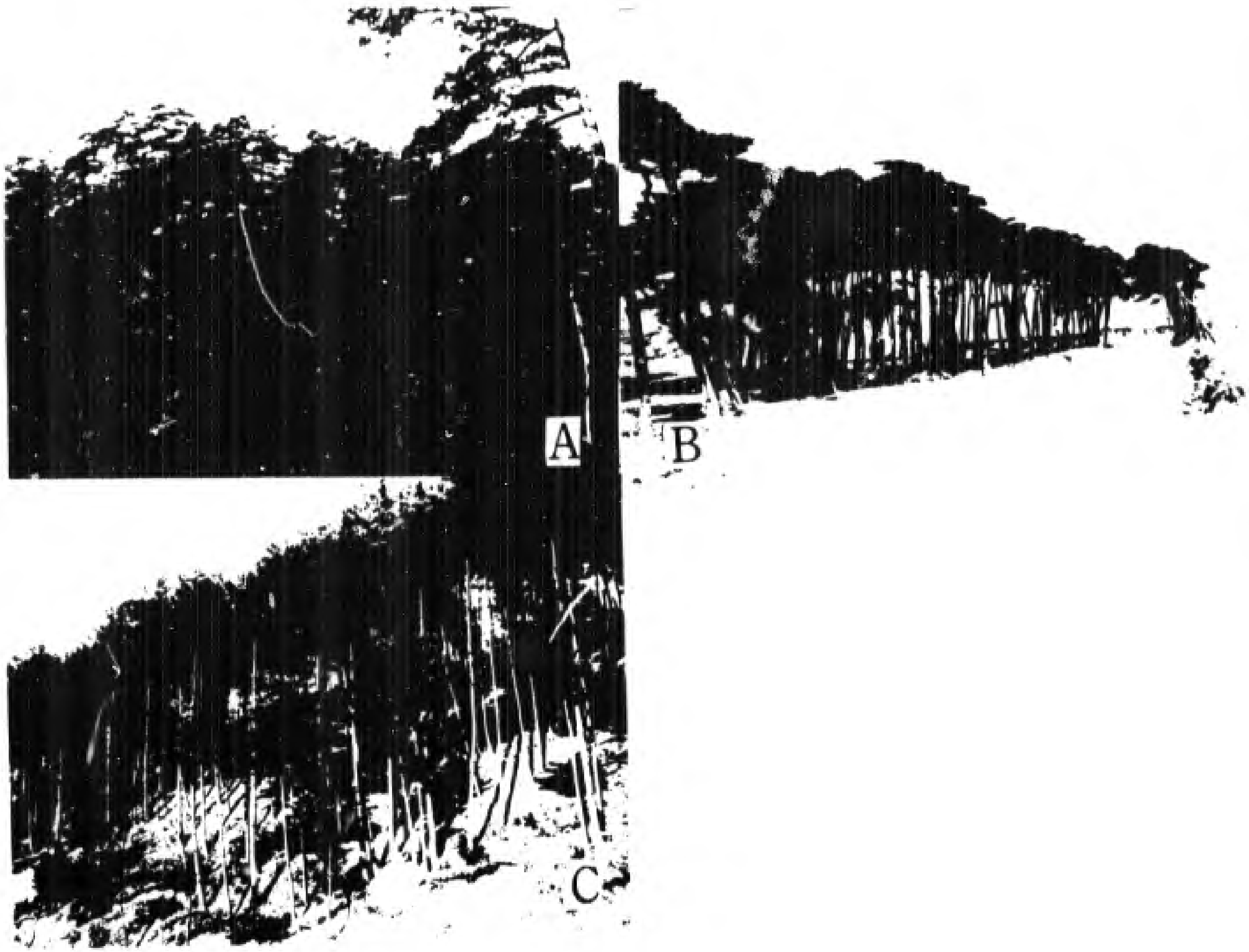


PLATE 4.
a. Red pine forest in vicinity of Keumbong Temple.
b. An aged pine forest along the roadside 4 km south of Kojinpo in the east coast.
c. The pine forest for control at Hajinbu, 25 km south of the DMZ.

THE COMPOSITION AND DISTRIBUTION OF MAMMAL POPULATIONS

by

Won, Pyong Hooi, D. Sc.,
Professor, Department of Biology,
Dong Guk University

assisted by

Hai Poong Lee

[illegible] San Kim

INTRODUCTION

Since 1950, the DMZ area has been more of an untouched area, preserved in a state of wilderness, than any other area in Korea. Because of this, the area is expected to have some ecological differences.

We did surveys to study the distribution and composition of mammals populations in the adjacent areas to the DMZ from June, 1965, to May, 1968, totaling 62 days and 9 trips. During this study, small mammals were col ected by live and small traps and larger mammals were observed and confirmed by talking with both hunters and local inhabitants.

Because most of the studied areas were located in Army operation zones, we were forced to limit our survey periods, and, in doing this, we could not do justice to this report. However, we feel that if this work is continued with improved methods and more time allowance, more satisfactory results can be expected.

AREAS STUDIED

A. Punch Bowl

A few farmhouses were located in this area which is in the mountains, about 500 m above sea level. Here we collected for two days all mammals by live and snap traps baited with peanut butter. Eleven individuals representing two species were collected, with four other species confirmed as present by farmers' information. We feel the reasons we didn't collect as many mammals as we expected in this area were due to the fact that these mountains are not rocky and are not heavily forested.

B. Myozangdong

This area, located in the center of our country, is characterized by open fields covered with tall reeds. As an Army operation objective, all these fields are set afire every spring.

In this study we collected 6 species and 58 individuals of small mammals by snap traps baited with peanut butter and peanuts. We also confirmed the existence of five other species of large mammals which we collected by shotgun.

We have to remember that in this area there is a more abundant distribution of Korean water deer than in any other area of Korea. We believe this abundance is due to the fact that the many open fields covered with tall reeds provide ideal conditions for water deer habitation.

C. Mt. Hyangro

This area is 1240 m above sea level and is covered with heavy broad-leaved trees. Our survey work was carried out on a mountain ridge (sea level--1200 m) with the use of snap traps baited with peanut butter and peanuts. In this survey, we collected 5 species and 25 individuals with 5 other species confirmed as present including the Manchurian black bear, the Korean wild boar, and the Korean tiger.

D. Gorangpo

This area is also adjacent to the DMZ area. Here a few farmhouses are seen in the open fields. In this area, we collected 1 specie and 2 individuals by using snap traps baited with peanut butter for one night. We collected only limited species and numbers, but we expect that there are other small mammals as this area is open field covered with low vegetation.

E. Mt. Kunbong

This area has comparably high mountains and is covered with old needle-leaf trees. In this area we collected 1 species of rodent and 2 indiciduals in one night. Snap traps for small mammals were baited with peanut butter. We confirmed that Korean wild boar and small flying squirrels inhabited this area.

F. Sulak Osaikri and Kansung Gazinri

Osaikri is a small village which is located in the valley of Mt. Sulak and is surrounded by very high, rocky mountains. In this area, we collected small mammals by snap traps baited with peanut butter and cuttlefish. We caught 4 species and 47 individuals with 9 other species confirmed including the Korean wild boar, the Manchurian black bear, and the Manchurian goral. As shown above, many mammals inhabit this area.

2. Kansung Gazinri is a small fishing village located on the eastern seashore of Korea. In this village we collected 3 species and 33 individuals in four nights by using snap traps baited with vegetable oil and fried fish. We collected 33 roof rats, Rattus rattus, and we know and have known that the roof rat is distributed in almost all harbors and harbor villages in our country.

TABLE 1. Studied area and date.

Studied area	Date	
Punch Bowl	Nov. 17, 1966 -	Nov. 20, 1966
Myojangdong	Apr. 9, 1967 -	Apr. 15, 1967
Mt. Hyangro	June 23, 1967 -	June 29, 1967
Yanggu-gari	May 18, 1967 -	May 22, 1967
Gorangpo	Aug. 21, 1967 -	Aug, 28, 1967
Mt. Kunbong	Oct. 4, 1967 -	Oct. 9, 1967
Myojangdong	Dec. 26, 1967 -	Dec. 31, 1967
Mt. Hyangro	April 23,1968 -	Apr. 29, 1968
Mt. Sulak and Kansung-Gajinri	May 23, 1968 -	May 29, 1968

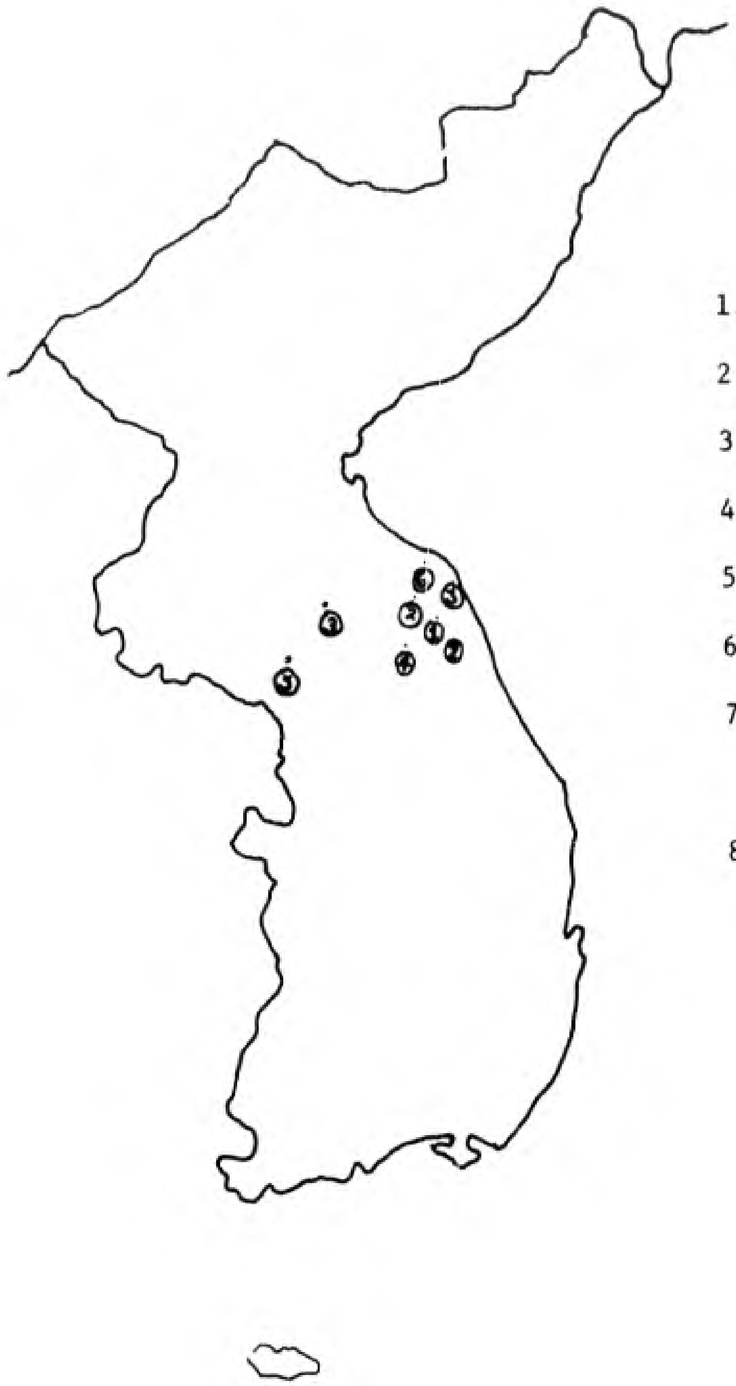
Total = 9 trips; 62 days.

TABLE 2. Collected species and numbers.

Species	AREAS**1.	2.	3.	4.	5.	6.	7.	8.
Apodemus agrarius	10	43	13	4	2	2	34	
Apodemus speciosus	1		5				3	
Charronia flavigula		*			*		*	
Clethrionomys rufocanus		4	5	1			9	
Eptesicus nilssonii							*	
Erinaceus europaeus		*						
Hydropotes inermis	*	6						
Lepus sinensis	*	*	1	*	*	*	*	
Meles meles		*	*		*	*	*	
Mustela siberica	*	1	*		*	*	*	
Mus mollossinus								3
Naemorhedus goral							*	
Nyctereutes procyonoides		*	*		*	*	*	
Panthera tigris			*					
Pipistrellus abramus								*
Rattus norvegicus		2						4
Rattus rattus								26
Sorex caecutiens							1	
Sus scrofa			*			*	*	
Talpa micrura	*	2		*				
Tamias sibiricus			1			*	*	

* Confirmed but not collected.
** Corresponding area names:
1. Punch Bowl
2. Myojangdong
3. Mt. Hyangro
4. Yanggugarf
5. Gorangpo
6. Mt. Kunbong
7. Mt. Sulak
8. Kansung Gajinri

SURVEY AREA



1. Mt. Hyangro
2. Punch Bowl
3. Myozangdong
4. Yang Gu-Gari
5. Gorangpo
6. Mt. Kunbong
7. Mt. Sulak (Osaikri)
8. Kansung-Ganzinri

SOME BIRD OBSERVATIONS NEAR THE DEMILITARIZED ZONE

by

Won, Pyong Oh, D. Sc.,
Professor, Department of Biology,
Kyung Hee University

assisted by

Han Chung Woo
Mi Za Chun

INTRODUCTION

The authors surveyed the seasonal distribution of birds that could be seen in the DMZ area from February 10, 1966, to January, 1968. They conducted bird banding and collecting at the same time. The survey period, banding, collections, and birds observed are shown in TABLES 1, 2, and 3.

MAIN SURVEY AREAS

1. Temporary resting area of waterfowl and hawks

In the delta area at a junction point of the Imjin and Han Rivers, there lies a reed bed. During the ebb tide, various waterfowl and large hawks gather around the exposed reclaimed land and feed. Especially from the end of October until the middle of November fall migrating flocks concentrate temporarily and feed. They fly further southward if they find it impossible to feed due to freezing.

At the time of northward migration during spring the waterfowl and large hawks rest temporarily. The author visited the area during the middle of December but was unable to witness them since they all flew away toward the south.

2. Wintering ground of waterfowl and large hawks on the east coast

Waterfowl and large hawks winter in the seashore ranging from Kosung down to Kangnung and the nearby lakes. It is especially interesting to see the *Cygnus olor* migrating at Kyungpodae Lake. There is a case of four *Otis tarda dybowskii* migrated to the area.

3. Panmunjom and Munsan area

A threatened bird such as *Grus japonensis*, *Nipponia nipponia*, and rare large birds such as *Grus vipio*, *Ardea purpurea*, and also *Butastur indicus* are found breeding here. It is interesting that we observed several pairs of *Circus melanoleucos* in the nearby reed bed during their courtship. They might be breeding here.

4. Wintering ground of *Emberiza yessoensis continentalis* in Munsan

Hundreds of *Emberiza yessoensis continentalis* have been seen on 19 December, 1967, in *Alnus* and *Robinia* forests (thick grass) close to the junction point of the Imjin and Han Rivers. They were feeding on grass seed.

NOTEWORTHY SPECIES ACCOUNT

1. Grus japonensis. Two were observed in the area between Joint Security Area (37°55',126°40'E) and Panmunjom on February, 1966.

2. Grus vipio. Fifteen were observed on February 10, 1966, in the area between Panmunjom and north of the DMZ, while another two were at the recreation ground for the UN forces in south of DMZ.

3. Nipponia nipponia. This is a threatened species about which no surveyed report has ever been made since it vanished after the war. However, on February 10, 1966, three were observed by Won and Col. Barnes at Panmunjom.

4. Ardea purpurea manilensis. One was observed on May 18, 1966, at 37°55'N,126°40'E. It probably was flying northward toward breeding ground.

5. Columba livia rupestris. On May 18, 1966, twenty were observed at Imjin-myon and Sanjang-myon (37°55'N, 126°46'E). On December 18, 1967, in the vicinity of Imjin Bridge. They are found breeding in Imjin Bridge.

6. Circus melanoleucos. On May 19, 1966, two of summer plumage were observed at a reed bed in the Imjin River, 37°55'N,126°50'E. We can suppose that they probably must be in the nearby reed bed; however, we cannot observe their nesting site.

7. Aquila chrysaetos japonica. One observed on May 19, 1966, at 37°55'N,126°50'E.

8. Aegypius monachus. One was observed at Songji Lake in Kosung-kun, Kangwon-do. On February 11, 1968, we obtained one male adult caught by a soldier in Panmunjom through Mr. M.E.J. Gore.

9. Sturnus sturninus. Three were observed at Maji-ri, Baechak, on August 11, 1967.

10. Gallinago gallinago, One was observed at Mahji-ri, Baechak on August 11, 1967. The hitherto known Collection record reveals that the species was collected during March, April, May, September, October, and November. There is no record of collection during August.

11. Butastur indicus. We have confirmed on August 22, 1967, one nestling being fed by soldiers, and this was one of the three nestlings found in the DMZ, Paju-kun.

12. Chaetura caudata. On September 11, 1967, we observed three during their flight at Yanggu, in Kangwon-do.

13. Nycticorax nycticorax. On December 18, 1967, we observed one adult during its flight on a road in Koyang-kun, Kyunggi-do leading to Munsan.

14. Circus aeruginosus. On December 18, 1967, and December 19, 1967, we observed several birds during their flight throughout Munsan and Imjin River bank, and one in Kosung on January 6, 1968.

15. Cygnus columbianus jankowski . On January 4, 1968, we observed five at Songji Lake in Kosung-kun, Kangwon-do, and on January 6, 1968, we also observed one flight of 11 birds, during their northbound flight near Sokcho.

16. Motacilla alba lugens. On January 4, 1968, we observed one on the seashore between Kosung and Sokcho.

17. Melanitta fusca. The species is commonly seen on the seashore between Kosung and Kangnung. Among ducks, it is a representative dominant species commonly seen here.

18. Bucephala clangula. The species is also a dominant species commonly seen here on the east coast during the winter. Many were seen during January 5-7, 1968.

19. Phalacrocorax capillatus. Among Phalacrocorax that could be seen in the east coast during winter, and it is seen almost everywhere.

20. Haliaetus albicilla. On January 5, 1968, we observed one at Sonji Lake in Kosung, Kangwon-do, and on January 6, 1968, we also observed another two in the same place.

21. Cygnus cygnus. On January 6, 1968, we observed one feeding on the seashore, south of Sokcho Bay.

22. Cygnus olor. Twenty birds were seen by us at Kyungpodae Lake in the outskirts of Kangnung on January 6, 1968.

23. *Crocethia alba*. Thirty were found resting on the top of rocks on the seashore between Sokcho and Kangnung.

24. *Prunella colaris*. Seven were observed on the top of Whaak Mountain in Kapyong, Kyunggi-do, on October 12, 1967.

25. *Larus schistisagus*. We observed several birds mixed with flocks of *Larus canus* on the seashore in Kosung and Sokcho on January 5-7, 1968. The species was seen mixed with *Larus canus* and *Larus crassirostris*. However, they were also frequently seen forming in their own flocks.

SUMMARY

This bird survey was performed from February 10, 1966, to January 8, 1968, totaling 31 days and nine trips. We banded 102 birds of 23 species, among which we collected 28 birds of 13 species and 113 species were observed. Especially, we have reported here about 25 noteworthy species.

TABLE 1. A list of the birds banded during the period from May 17, 1966, to October 12, 1967.

Species	Number banded
Emberiza rutila	38
Pica pica	10
Emberiza ciodes	9
Sturnus cineraeus	6
Saxicola torquatos	5
Emberiza fucata	3
Emberiza spodocephalus	3
Parus major	3
Alcedo atthis	2
Anthus hodgsoni	2
Cinclus pallasi	2
Dendronanthus indicus	2
Lanius bucephalus	2
Lanius cristatus	2
Motacilla cinerea	2
Parus palustris	2
Phoenicurus auroreus	2
Cettia diphone	1
Dendrocopos kizuki	1
Emberiz a aureola	1
Emberiza tristrami	1
Hirundo daurica	1
Sitta europaea	1
Total	101

TABLE 2. A list of birds collected and preserved as museum specimens.

Species	Number collected
Carduelis sinica	10
Falco tinnunculus	3
Coturnix coturnix	2
Croethia alba	2
Paradonornis webbiana	2
Tetrastes bonasia coreensis	2
Accipiter nisus nisosimilisis	1
Bucephala clangula	1
Buteo buteo burmanicus	1
Circus aeroginosus	1
Egretta alba	1
Melanitta fusca stejnegeri	1
Pyrrhula pyrrhula	1
	TOTAL--- 28

TABLE 3. Birds observed between February 10, 1966, and January 8, 1968.

Species	Number observed
Aythya fuligula	Abundant
Bucephala clangula	"
Carduelis sinica	"
Cyanopica cyanus	"
Emberiza rustica	"
Emberiza Rutila	"

TABLE 3. (Cont.)

Species	Number observed
Larus canus kamtschatschensis	Abundant
Larus crassirostris	"
Melanitta fusca stejneger	"
Paradoxornis webbiana	"
Parus major	"
Passer montanus	"
Phalacrocorax capillatus	"
Pica pica japonica	"
Emberiza yessoensis	100+
Corvus corone orientalis	62
Hirundo rustica	58
Corvus monedula dauricus	50
Bombycilla garrulus centralasiae	40+
Croethia alba	32
Motacilla alba leucopsis	29
Phasianus colchicus karpowi	27
Emberiza cioides	26
Emberiza fucata	22
Columba livia rupestris	20+
Cygnus olor	20
Motacilla cinerea	19
Garrulus glandarinus	18
Grus vipio	17
Cygnus columbarius jankowskii	16
Streptopelia orientalis	15
Saxicola torquatus stejnegeri	12
Lanius bucephalus bucephalus	11
Carduelis spinus	10
Hirunda daurica	10
Oriolus chinensis	10
Buteo buteo burmanicus	8
Egretta alba	8
Eophona migratoria migratoria	8
Eurystomus orientalis	8
Cettia diphone	7
Prunella colaris	7
Egretta intermedia	6
Parus palustris	6
Phoenicurus auroreus auroreus	6
Ardea cinerea jouyi	5
Halcon pileata	5

TABLE 3. (Cont.)

Species	Number observed
Lanius cristatus lucionensis	5
Larus schistisagus	5
Microscelis amauritos	5
Monticola solitaria	5
Musicapa narcissina zanthopygia	5
Pyrrhula pyrrhula	5
Alcedo atthis	4
Dendronanthus indicus	4
Emberiza spodecephala	4
Falco tinnunculus	4
Chaetura caudacuta	3
Circus aeruginosus spilonotus	3
Circus melanoleucus	3
Hiliaeetus abicilla	3
Nipponia nipponia	3
Parus varius	3
Sturnus cineraceus	3
Sturnus sturninus	3
Terastes bonasia coreansis	3
Accipiter soloensis	2
Anthus hodgsoni	2
Cinclus pallasii	2
Circus cyaneus cyaneus	2
Coccothraustes coccothraustes	2
Coturnix coturnix	2
Dendrocopus kizuki nippon	2
Dendrocopus major	2
Grus japonensis	2
Lanius tigrinus	2
Mergus serrator	2
Muscicapa cyanomelana	2
Otus osio	2
Porzana paykyllii	2
Sitta europaea	2
Turdus naumanni naumanni	2
Uragus sibiricus	2
Accipiter nisus nisosimilis	1
Aegypius monachus	1
Alauda arvensis quelpartae	1
Aquilla chrysaetus japonica	1

TABLE 3. (Cont.)

Species	Number observed
Ardea purpurea manilensis	1
Buteo lagopus menzbier	1
Buteo rufinus	1
Butastur indicus	1
Charadius dubius curonicus	1
Cuculus canorus	1
Canulus micropterus	1
Canulus staturatus horsfieldi	1
Cygnus cygnus	1
Dendrocopus leucotos	1
Emberiza aureola	1
Emberiza elegans	1
Emberiza tristrami	1
Falco columbarius	1
Gallinago gallinago	1
Milvus migrans lineatus	1
Motacilla alba lugens	1
Nyctiorax nyctiorax	1
Pericrocotus roseus	1
Phylloscopus occipitalis	1
Podicepe caspicus	1
Podiceps ruficollis poggei	1
Regulus regulus japonensis	1
Sterna hirundo	1
Turdus naumanni eunomus	1
Urosphena squameiceps	1

AN INVESTIGATION OF SOME BOTTOM FAUNA OF SOME RIVERS

by

Yoon, Il Byung, B. S.,
Instructor, Department of Biology,
Woo Suk University

assisted by

Kun Kim

INTRODUCTION

Water pollution plays an important role in the ecology of animals that dwell on river bottoms. Tsuda et al. (1952) and Kawai (1964) studied the effects of pulp mill waste, Miseku (1960) observed the influence of the mine waste, and Akiyama et al. (1964) and Kimura (1957) reported on the water pollution from cities, which were located on rivers.

Water level fluctuation in the lakes and rivers also is an important factor in disturbing the equillibrium of bottom fauna. Grimas (1962) and Vadanabe (1965) observed the effects of the fluctuations of lake levels on the bottom fauna and Kawai (1951) reported the effects of rapidly increasing water levels and current velocity caused by rains on the alteration of the bottom fauna in rivers.

In this study we are attempting to elucidate the stream fauna before more detailed ecological studies are attempted.

METHOD OF WORK IN THE FIELD

We made an effort to set up plots for investigation, taking into consideration the vegetation types along the rivers and the type of river bottoms. We made many trips to places near the DMZ to investigate the bottom fauna and their distribution in relation to the differences in locality, vegetation type, altitude, depth of water, current velocity, and river bottom type. The methods used in collecting animals, mainly aquatic insects, from the river bottom were:

A. Hand net

This net was made of fine mesh and used both for collecting insects and other animals that live among the loose stones in rapid streams. The net was set edgewise against the bottom, facing upstream. The animals, dislodged by stirring the bottom, were swept into the net by the current.

B. Surber square-foot stream bottom sampler

The Surber sampler was made of steel and folded up compactly (50 cm X 50 cm) for carrying in the field. It consisted of two frames hinged together. One frame carried the net that stretched downstream by the flow of water, thus trapping bottom-dwelling forms, while the other marked the boundary of the square foot from which the collection was to be made. In use, the net was placed in the stream with the opening upstream. The frame marking the bottom area that was to be sampled was worked carefully into the substrate. It held its position in the current by foot pressure while the operator used his hands to pick out the larger stones from which clinging organisms were washed into the net. After the larger stones had been picked up, washed, and discarded, the remainder of the area inside the frame was gently churned up with fingers to secure burrowing and other forms in the substrate. The contents of the net were then washed out by reversing the net in a white enameled vegetable dish, half full of water. Larger individuals were either picked out with a pair of forceps or transferred to a sieve. These specimens were then placed into sample bottles of 70% alcohol. Often the hand-picking of each individual organism from the trash was a time consuming, but essential, job. Usually a few small stones with some sand and fine gravel would be taken with the organisms.

C. Iron dredge to collect soil animals

Bottom soil samplers were shoveled into the dredge and whirled with the hand, and then, while the water was turning rapidly, the dredge was raised to leave the debris on the bottom. The organisms, being lighter than the debris, would float and could be picked up

D. A butterfly net was used to collect adult insects.

E. In winter, when the streams were frozen, collections were made by breaking the ice while using rubber boots and gloves. It was very difficult to pick up a sample because they were immediately frozen.

RESULT AND DISCUSSION

A. We made three surveys at a small stream called Du-ta-yun, or Chung-mu-chong, very near the DMZ. During each survey we checked the air temperature, water temperature, width of stream, depth at point of sampling, and type of bottom. In the future we will have a plan for analyzing water for oxygen, carbon dioxide, alkalinities, and other factors.

The dates of field collections are shown in TABLE 1. After the collection, we studied and classified the collected samples, mainly aquatic insects, as shown in TABLE 3. Many of them are under examination in the laboratory. Classifying the collected samples in species is a very time consuming job for a great number of individuals are collected in each survey. The process of identification of collected organisms will continue into the summer vacation period.

TABLE 1. Dates of field collections and areas surveyed.

Date of Survey	Area visited
May 18-21, 1967	Kaa-ri
June 23-29, 1967	Hyangno-bong Konbongsa
Aug. 16-21, 1967	Hyangno-bong
Sept. 11-15, 1967	Imjin-myun
Sept. 22-25, 1967	Myojang-dong
Oct. 4-6, 1967	Kon bong sa
Dec. 7-10, 1967	Yang-gu
Mar. 14-16, 1968	Yang-gu
Apr. 18-21, 1968	Yang-gu

DESCRIPTION OF COLLECTING STREAMS

A. Below are the areas from which we collected specimens.

1. Kaa-ri (east end of the DMZ)

There is a small rapid stream over the ridge named Kwangchi-ryung in Kaa-ri. The stream base rock is white granite and the substrate of the riffle is composed of rough rocks and large-sized white rubble. The average dimensions of the stream are eight feet wide and one foot deep. Air temperature on May 19, 1968, was a maximum of 28.3°C and a minimum of 8°C. The water temperature was 15°C at 3:00 P.M.

2. Du-ta-yun (Yang-gu, east of DMZ line)

The stream bottom is rocky and the substrate of riffles is composed of sand or medium-sized pebbles. The stream flows through woody banks and there is a small waterfall and round pool about 30 feet in diameter. The average width of the stream is 30 feet with a depth of two feet. On December 7, 1967, the air temperature ranged from -3°C to -15°C. Water temperature was 0°C. On April 18, the air temperature was 17.5°C and water temperature was 9.8°C. at 2:00 P.M.

3. Hyangno-bong (east area of DMZ line)

Hyangno-bong is 1283 meters in elevation. There is a very small rivulet near the mountain top in a thickly-wooded area. This rivulet flows very rapidly and the water is cool even in the summer. The average width of the rivulet is two feet and substrate is white smooth sand or small-sized pebbles covered with dead leaves in the shallow places.

TABLE 2. Temperatures on Hyangno-bong Mountain

Air temperature	Water temperature	Time	Date
20°c	9.5°C	11:00 AM	June 24, 1967
28°C	10.2°C	1:00 PM	Aug. 17, 1967

4. Kon Bong Sa

Kon Bong Sa is an old abandoned Korean temple near the DMZ in an area of some military activity. There is a rapid stream near the temple which flows between brushy banks where there is a well-lighted area in which we collected.

The stream bottom is composed of sands or gravels. The average width is 2-3 meters with a depth of 20 centimeters. Air temperature was 17°C and water temperature was 12°C at 12 o'clock on October 6, 1967.

5. Myojang-dong (middle area of DMZ line)

The stream named Yong-gang River starts from the DMZ and flows slowly through a wooded field. The average width of the stream is approximately 40 feet and a depth of 2 feet. The river bottom is composed of black-colored volcanic rocks and large or medium-sized rubble. On september 23, 1967, the water temperature was 17.5°C and the air temperature was 18.3°C at 2:00 P.M.

6. Imjin-myun (west area of DMZ line)

Imjin-gang riverside is the DMZ line and its lower portion is influenced by tides of yellow sea. We collected insects in a small tributary of this river. The stream flows very slowly. The bottom is composed of smooth sand and it is well lighted, the banks being without sufficient trees to shade the stream.

Table 3. A partial listing of bottom insects

Number of area studied*	1	2	4	6**
Order Ephemeroptera				
Family Ephemerellidae				
Ephemerella nigra	*			
Ephemerella sp.	*			
Ephemerella sp.	*		*	
Ephemerella basalis	*	*	*	
Ephemerella sp.		*	*	
Ephemerella rufa				*
Ephemerella sp.	*	*	*	*
Family Siphlonurideae				
Ameletus montanus	*			
Siphlonurus binotatus	*			
Isonychia japonica				*
Family Ephemeridae				
Ephemera sp.			*	*
Family Baetidae				
Baetiella japonica		*	*	
Baetis thermicus				*
Family Leptophlebiidae				
Choroterpes trifurcata	*		*	

* Refer to pages 6,7, and 8.
** Area numbers 3 and 5 are not included as they are as yet unclassified.

Number of area studied --------	1	2	4	6
Order Ephemeroptera				
Family Ecdyonuridae				
Cinygma sp.	*			
Cinygma hirasana	*			
Cinygma sp.		*		
Ecdyonurus kibuensis			*	*
Ecdyonurus yoshidae			*	*
Rhithrogena japonica			*	
Epeorus aesculus			*	
Epeorus uenoi			*	
Epeorus hiemalis			*	*
Epeorus ikanonis			*	
Epeorus latifolium			*	*
Epeorus curvatus				*

Order Plecoptera	1	2	3	4	5	6
Family Perlidae						
Oyamia gibba	*	*				
Paragnetina tinctipennis	*	*	*	*	*	*
Gibosia jezoensis	*	*				*
Oyamia sp.		*	*	*		
Family Perlodidae						
Pseudomegarcys sp.			*			

Number of area studied --------	1	2	3	4	5	6
Order Plecoptera (cont.)						
Family Scopuridae						
Scopura longa			*			
Family Nemouridae						
Amphinamura sp.			*	*		
Family Chloroperlidae			*			
Family Peltoperlidae				*		
Order Trichoptera						
Family Stenopsychidae						
Stenopsyche griseipennis	*	*	*			
Stenopsyche sp.		*			*	
Family Polycentropidae						
Polycentropus sp.	*					
Family Rhyacophilidae						
Rhyacophila sp.		*				
Rhyacophila sp.			*			
Rhyacophla sp.			*			
Rhyacophila sp.					*	
Family Hydropsychidae						
Hydropsyche ulmeri		*	*	*		*
Hydropsyche gifuna						*
Hydropsyche echigoensis						*

Number of area studied --------	1	2	3	4	5	6
Order Trichoptera (cont.)						
Family Psychomyiidae						
Psychomyia sp.			*			
Family Philopotamidae						
Dolophilodes				*		*
Family Hydroptilidae					*	
Family Nymphulidae						
Nymphula interruptalis	*					
Order Odonata						
Family Gomphidae						
Davidius fujiama			*			
Gomphus postocularis					*	
Sinogomphus flavolinbatus					*	
Order Coleoptera						
Family Psephenidae						
Eubrinax sp.				*	*	
Order Diptera						
Family Simuliidae						
Simulium japonicum				*		

Number of area studied	1	2	3	4	5	6
Order Diptera (cont.)						
Family Bibocephaladae						
Bibiocephala montanabispina				*		
Order Megaloptera						
Family Corydalidae						
Protohermes grandis					*	*

CONCLUSION AND SUMMARY

A. We set up the plots with consideration of the types of riverbed and the adjacent environments.

B. We are now attempting to investigate the bottom fauna and dominant species according to the environmental factors, seasonal and annual changes of the bottom animals.

GRAPH. The six areas studied for species.

Photo 1. The tributary of the Imjin-gang River.

GRAPHIC NOT REPRODUCIBLE

Photo 2. The Kaa-ri stream.

Photo 3. Pool with the waterfall at Du-ta-yun.

Photo 4. Yonggang River located at Myojang-dong.

Photo 5. The stream of M. Roadside at Du-ta-yun.

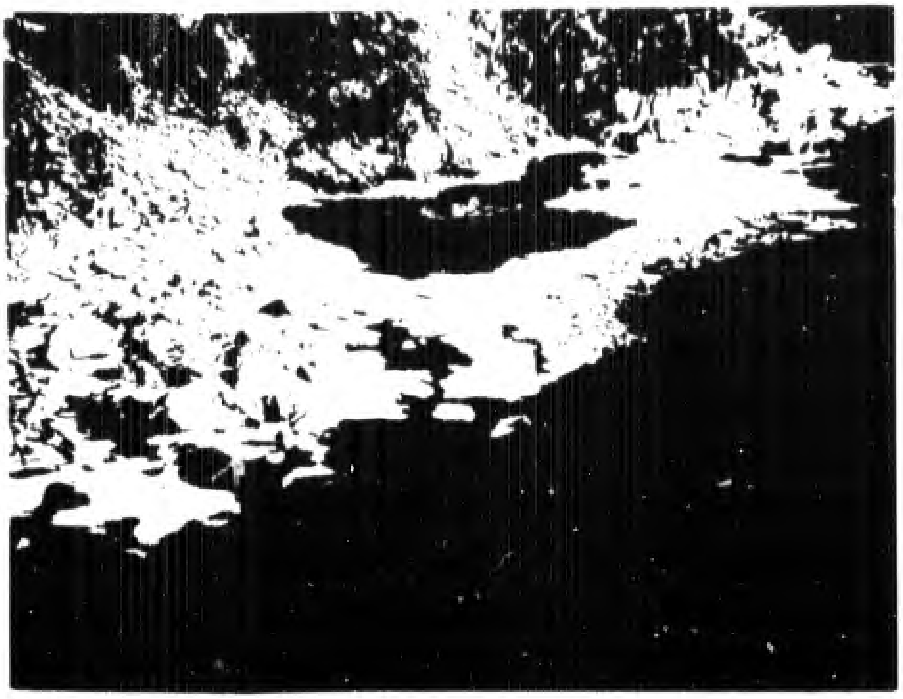


Photo 6. The stream of Du-ta-yun in winter.

Photo 7. The stream
near Konbong-sa Temple.

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13. ABSTRACT

A 2-year planning study was conducted in Korea to develop a long-range, ecologically oriented program of research and education, with emphasis on a Study Area bordering the Demilitarized Zone. The primary objectives were: (1) to help Korean scientists initiate a series of research projects on the physical characteristics, vegetation, and animal life in the Study Area and (2) to prepare a 5-year plan for ecological research and education in the form of a proposal that could be submitted to granting agencies. A Korean Center for Environmental Studies has been proposed to implement the 5-year plan at a cost of nearly $3 million. The current military situation and financial austerity have militated against an immediate follow-up of the proposal. Meanwhile the plan is being revised on the basis of suggestions by private foundations, university faculty, and government agencies in the U. S. and Korea with a view toward making it ready when financial support and conditions in Korea are propitious. (Part II, AFOSR-68-2149)

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