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Japanese Coordinating Committee for MAB

Background of and My Relationship to MAB

Makoto Numata

My relationship to MAB began many years ago when the formal MAB activities started. A former stage of MAB was the IBP (the International Biological Programme) during the 1964-1972 period supported by biologists worldwide along the ecological guidelines of Dr. Worthington, his "whole organism biology". About 600 biologists, basic and applied, participated in the Japanese IBP project in 7 sections, the results of which were published as the JIBP synthesis, 20 volumes, by the University of Tokyo Press, 1975. IBP was organized by ICSU, and the IBP Committee of Japan was established in the Science Council of Japan. Much active research was conducted with funds for scientific research from the Ministry of Education, Science and Culture. In comparison with this, MAB Research has been conducted under a different organization. The MAB Branch of the UNESCO National Commission has a chairman and members (I was before the chairman of IHP and deputy chairman of MAB), but it has no budget for research activities. Another optional group of MAB is supported by a small budget from the Ministry of Education only for several meetings per year. MAB-related projects are proposed by MAB-minded scientists and supported by some central government ministries and agencies. There is no central organization for MAB such as the Science Council of Japan was for IBP. For example, the biosphere reserve is studied by university professors with funds from the Ministry of Education, Science and Culture, but the designation of the biosphere reserve is done by the Environment and Forestry Agencies. Recently, the Forestry Agency has proposed a Forest Ecosystem Reserve with a buffer zone along the guideline of MAB.

UNESCO was considering a post-IBP research project on environmental science stressing man (M). I participated in such a meeting for the first time in 1968, a regional seminar of UNESCO on "Ecology of Tropical Mountains" (Numata 1968). This developed afterward into MAB No. 6 "Human impact on mountain and tundra ecosystems".

Before this, there was the 11th Pacific Science Congress (Tokyo, 1966) in which I organized a symposium on "Island Ecosystems" and a special symposium on "Nature Conservation of Alpine and Subalpine Zones". In the latter, I had a trip to Kyoto through Tokyo, Kamikochi, Mt. Norikura and Takayama, and a symposium was held in Kamikochi in the Northern Japan Alps. At that time I traveled with 70 foreign scientists among whom was Dr. M. Batisse, then Director of Division of Ecology and Earth Science. He spoke to me

about the idea of the MAB in the post-IBP period on a train from Tokyo to Matsumoto. I was very impressed.

Besides this, I had close contact with Dr. F. di Castri who was the Director, Division of Ecological Sciences and the chairman of the Coordinating Council of UNESCO from the preparatory stage in 1971 to 1984. In particular, I remember well his request to the Japanese Government to establish Biosphere Reserves when I attended the early Coordinating Council with an official of the Ministry of Education, Science and Culture. After that, I strongly requested the Environment Agency to establish Biosphere Reserves, after which 4 Biosphere Reserves were designated. Before that, the Ecological Society of Japan requested the Government to preserve at least 10 typical forest areas for nature conservation.

In the Japanese system of nature conservation, the reserved areas are only core areas without buffer zones. The 4 Biosphere Reserves designated up to now are all national parks, however they are different in the concept. The National Park in Japan is zoned as a special protection area, 1st, 2nd and 3rd class special areas, and ordinary area, however in 1st, 2nd and 3rd class special areas cutting and man-made forests are permitted to some degree. These areas are actually not buffer zones in its original meaning. Therefore, we are not satisfied with the designation of the 4 Biosphere Reserves. Moreover, the Government and Parliament are not yet interested in ratifying the World Cultural and Natural Heritage Convention. If they establish an internal act for the World Heritage Convention, it can legally protect Bioshere Reserves and the like.

In my case, I attended the expert panel and the workshop on mountain ecosystem several times. After the beginning of MAB activities, the first workshop on mountain ecosystems was in Salzburg (1973) which was reported in Green Book No. 8. In the same year, we had one more workshop in Lillehammer, Norway where the title "mountain and tundra ecosyems" was adopted (Green Book No. 14). Following that was a regional meeting in the Himalayan area held in Kathmandu. At that time, an international centre for research and training was recommended to UNESCO to be established covering the Himalayan region. It was an epoch-making resolution to UNESCO (Green Book No. 34). After extensive contact between UNESCO and the Nepalese Government, ICIMOD (International Centre for Integrated Mountain Development) was established in Kathmandu in 1983. The sequence is described in detail in InfoMAB No. 10 (1988). The recent activities of ICIMOD are also described in detail in the ICIMOD Newsletter No. 9 (1988). These include mountain agriculture and forestry, animal husbandry, tourism, agriculture and forestry development, energy, environment and the role of women as the main subjects.

I remember well a workshop chaired by Dr. F. di Castri "Integrated ecological studies on human settlements" held at the UNESCO Headquarters by UNESCO and UNEP in 1975. It was a round-table discussion by ecologist, sociologist, psychologist, economist, and geographer, etc. The first day's discussion was on "What is ecology ?". We (Prof. Ellenberg and I) mainly considered biological ecology, however many of the others considered cultural and social ecology as well as natural ecology. It was based on the UN Conference on Human Environment, the UN Conference on Habitat and the Urban System Project of MAB.

Regarding the urban ecosystem study, I organized a project team on it with Governmental funds starting in 1971, particularly to study Tokyo and the Chiba area baycoast cities. During the long period of study, we

had contact with Prof. Steubing (Giessen), Prof. Sukopp (West Berlin), Prof. Duvigneaud (Brussels), Prof. Teradas (Barcelona), the late Prof. Giacomini (Rome), Prof. Boyden (Canberra), Dr. Soerjani (Jakarta), Prof. Pyakarnchana (Bangkok), Dr. Carmona (Mexico City), Prof. T. J. Pandian (Madurai), Prof. Öztürk (Izmir), and Prof. Mazing (Tartu) with the cooperation of Dr. Celecia (UNESCO).

The activities of these overseas groups on urban ecology have been very useful and helpful for us. The International Meeting of Experts on "Ecological Approaches to Urban Planning" was held in Suzdal, U. S. S. R. in Sept. 1984. It was a kind of comprehensive meeting, the first since the beginning of urban ecological studies. This is also described in InfoMAB No. 10 (1988), and recently the proceedings "Cities and Ecology" 2 Vols. were published in 1988. I wrote a book in Japanese on "Urban Ecology" (1987) based on our urban ecosystem studies since 1971.

There are some references, such as "Guidelines for field studies in environmental perception" (Technical Notes No. 5, 1977), "An integrative ecological approach to the study of human settlements" (MAB Technical Notes No. 5, 1979), and "Approaches to the study of the environmental implications of contemporary urbanization" (Technical Notes No. 14, 1983). In 1974, the First International Congress of Ecology was held in the Hague where it was decided to issue the journal "Urban Ecology" and "Agroecosystems" supported by the International Association of Ecology. It was also an epoch-making event in urban ecology. In the 5th International Congress of Ecology to be held in Yokohama in 1990, there is also a symposium on urban ecology based on the Working Group on Urban Ecology.

Again, some meetings on mountain ecology were the Tibet Plateau Symposium (Beijing, 1980), Division of Mountain Ecosystems in the International Symposium on Tropical Ecology (Kuala Lumpur, 1979), International Symposium on the Ecology of Development of Tropical and Subtropical Mountains (Chengdu, 1985), etc. which were promoted by Dr. Glaser of UNESCO.

In 1982, the 10th anniversary of MAB and UNEP was celebrated. The symposium "Ecology in Action" was held in Paris with 5 main themes: 1) comprehensive land use, 2) tropical forest, 3) marginal areas (desert, high mountain), 4) cities and urbanization, and 5) nature conservation. In the same year, UNEP published "The World Environment 1972-1982" for which I worked to make the draft in 1981, particularly on terrestrial organisms, agriculture, forestry, environment, human habitats, environmental education and public awareness, etc. In 1982, UNEP also published "Global Environmental Issues".

Regarding environmental education referred to in "The World Environment", Division of Science, Technology and Vocational Education of UNESCO promoting the International Environmental Education Programme with UNEP and also issuing a Newsletter "Connect" and Environmental Education Series. Besides these, there has been a Commission on Education in IUCN since 1984. When Dr. L. K. Shaposhnikov was the chairman, the First International Congress on Environmental Education was held by UNEP, UNESCO and IUCN in Tbilissi, USSR in 1974. International Conferences on Environmental Education are described in the MAB Calender (InfoMAB No. 10) which is closely related to Biosphere Reserves and the World Heritage Convention (cf. InfoMAB No. 10, p. 12-13).

Regarding nature conservation as well as environmental conservation, the Commission on Ecology of IUCN, IBP/CT, WWF, public Ecology Movements, the Friends of the Earth,

the Rain Forest Action Network, the UN Conference on Human Environment and the MAB Project of UNESCO have been the promoting force. In 1980, the World Conservation Strategy was published by IUCN, WWF and UNEP and widely distributed. In some countries, National Conservation Strategy has been promoted, such as in Nepal. In 1987, the World Commission on Environment and Development, funded by the Japanese Government, made a report on Man's Common Future with the central concept of sustainable development. The concept of sustainability is common to MAB's idea.

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(Chiba University)

Urban Landscape in Arid and Semi-arid Regions

——From Urumqui to Islamabad——

Sadatoshi Tabata

In August through September, 1988, we conducted an academic exploration from Urumqi and Kashgar in China to Hunza, Gilgit, Peshawar and Islamabad in Pakistan through Khunjerab Pass. The objective of the exploration was to investigate current states of environmental issues emerged in the process of urbanization in and around the cities located in arid and semi-arid regions.

A number of new capital cities have been developed throughout the 1950's and 60's. Some of those such as Canberra, New Delhi, Brasilia and Islamabad are located in the semi-arid region of relatively moderate climatic conditions. Other non-capital cities as those in Arizona of U.S.A., Xinjiang Uygur and Inner Mongolia Autonomous District in China have been developed around oases in the arid climatic zone. Our particular interests were in how the development of Islamabad, a new capital city of Pakistan, Karakoram Highway and the rural communities influenced the regional environment. The area investigated extends widely from Urumqi to Islamabad including four distinctive vegetation zones; ① oasis area with water fed by moutain glacier, ② area from Gilgit to Indus Plane, ③ humid area in the southern slope of Himalayas, and ④ area in Indus Plane. In terms of climatic condition and vegetation pattern, considerable similarities as well as differences were identified across the four zones.

Urumqi has been developed as a regional capital of Xinjiang Uygur Autonomous District with current population of approximately one million. Agricultural land extending into the desert with artificial irrigation utilizing water fed by glaciers in Tian Shan Mountains generates a characteristic landscape of the oasis community. The government of China has

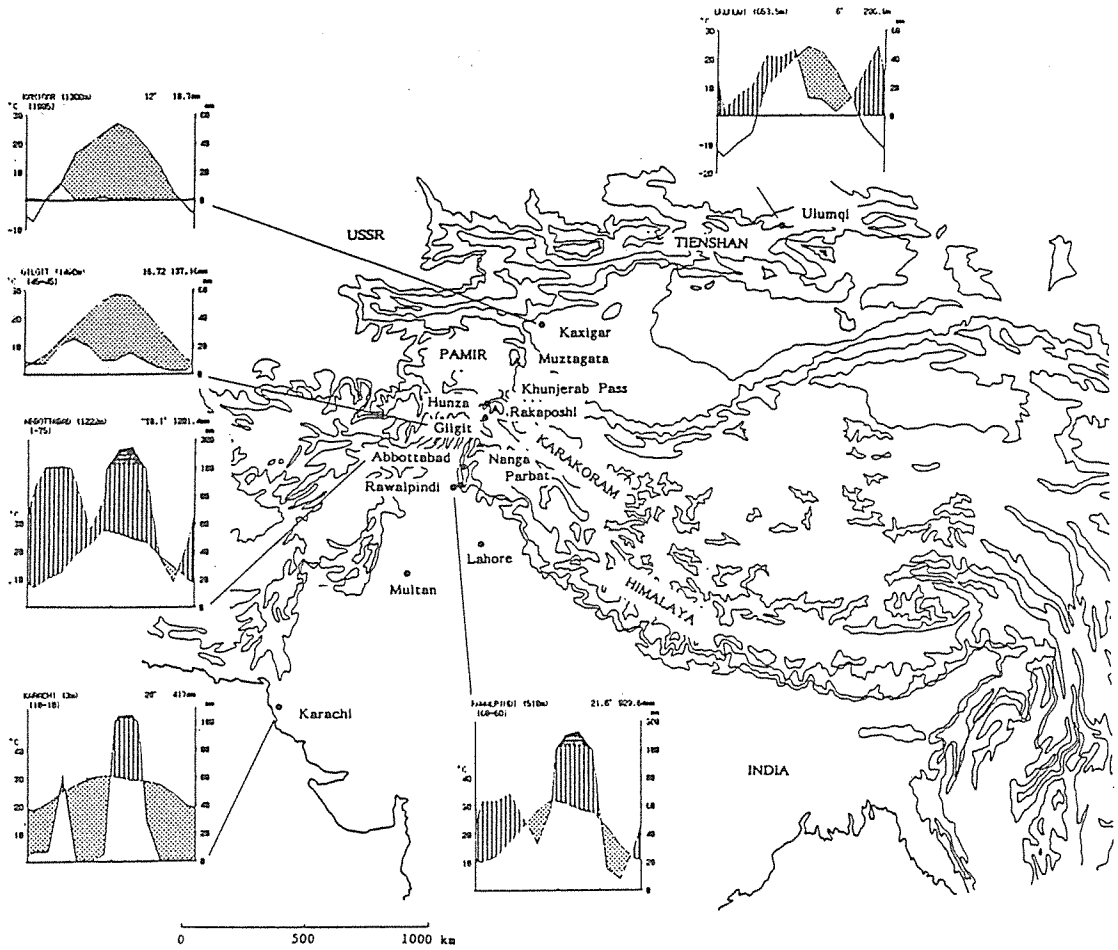

Fig. 1. Topography and Walter's climate diagram of the studied area. Our route is from Urumqi = Kashgar – Khunjerab Pass – Hunza – Gilgit – Chilas – Besham – Abbottabad – (Peshawar) – Islamabad – Rawalpindi = Karachi (=, by plane). Contour line intervals are 0-1000-2000-4000-6000 m (based on World Travel Map, Bartholomew (1976).

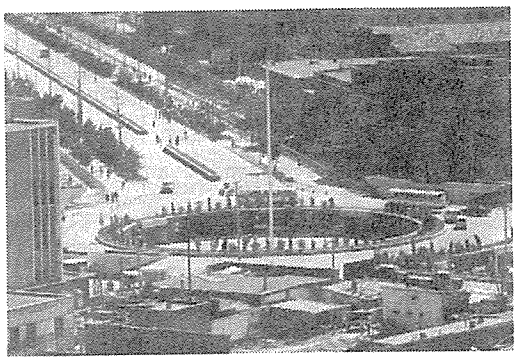

Fig. 2. Urumqi, China.

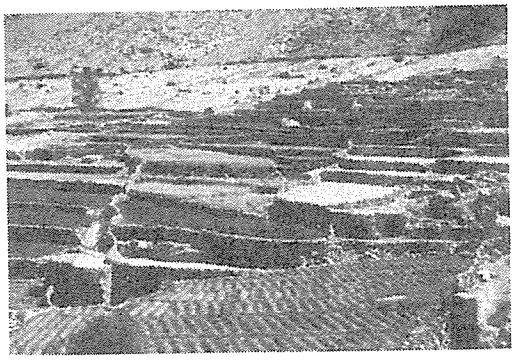

Fig. 3. Hunza, Pakistan.

established a national research institute of biology and soil science to encourage research activities for revegetation and regional development of the desert area.

The form of human habitations at Hunza and Gilgit which depend on glacial water supplied from Karakoram Mountains well demonstrates a critical condition sustained by water supply and greenery. However, on completion of Karakoram Highway in 1978 which connected the arid region on China side of Karakoram Mountains with the semi-arid region on Pakistan side, human migration, tourism and urbanization of the rural area have become outstanding phenomena.

In 1959, the government of Pakistan launched the new capital development project in Islamabad-Rawalpindi area and twenty years after its construction was initiated, population of the Capital District marks above one million. Enormous number of trees and shrubs were planted in and aroud the city in the process of the development. Those are now reaching their mature stage of growth creating a sea of green into which the entire city seems to be submerged. Revegetation of the surrounding mountains and hills with native species, strict regulations on animal grazing and timber harvesting and appropriate maintenance practices for street trees, public parks and open spaces have altogether led to the creation of an 'Ekumenopolis' that would be called 'A City in The Forest'.

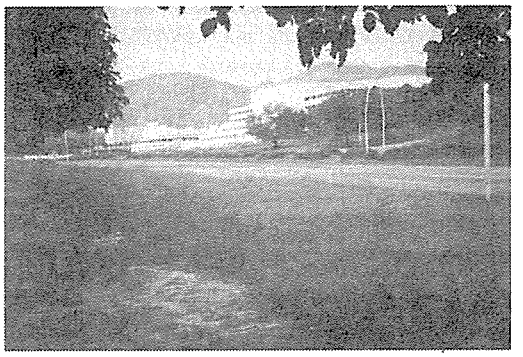

Fig. 4. Islamabad, Pakistan.

(Chiba University)

Surveys of the Biotic Communities and Sediments at Tidal Flats of the South and West Coasts of Korea

Eisuke Kikuchi

Surveys on the biotic communities and sediments in tidal flats at the west coast and the Nagdong river estuary, Korea, were jointly carried out by a group of Japanese and Korean scientists led by Prof. Yasushi Kurihara, Tohoku University, Japan, and Prof. Joon Ho Kim, Seoul University, Republic of Korea, financially supported by a Grant-in-Aid for Overseas Research from the Japanese Ministry of Education, Science and Culture.

On the west coast of the Republic of Korea, one of the largest tidal flats in the world has developed due to extremely great tidal range (about 8 m at spring tide). The total area of tidal flats amounts to almost 3 % of the land of Korea. On the other hand, in the Nagdong river estuary, the south-eastern Korea, the tidal range is relatively small (about 1.2 m at spring tide). The Nagdong river supplies a large amount of suspended and dissolved materials to the estuarine area, forming large tidal flats, salt marshes and sand bars.

Tidal flats generally have high activities of primary and secondary production, and organic decomposition. They are very important coastal systems as nursery grounds for fish, shellfish and crustaceans, and feeding and resting places for birds. In fact the Nagdong river estuary

is one of the main passage and wintering grounds for waders, plovers, and waterfowls in Korea[1, 2].

The field surveys were carried out in the Sinoeri tidal flat located at the central-western part of Korea on 23-25 September and in the tidal flat at the Ogryudeung sand bar of the Nagdong river estuary on 3-11 October, 1987.

The Sinoeri tidal flat (Fig. 1)

The Sinoeri tidal flat is a vast expanse in which many creeks run in all directions. The zone of salt marsh around tidal flat is narrow, and only a few halophytes, mainly *Suaeda japonica*, grow over the salt marsh. The differences between low and high water amount to about 8 m at spring tide and about 4 m at neap tide. The tide flows along the creeks twice a day. For biological and sediment analyses, 15 sampling sites were selected along a transect line across two creeks including the area of no vegetation. Although the tidal level at a low water was much lower than the ground level of transect line, water flow in the creeks was held by the exudation from the tidal flat around the creeks. The maximum difference in height between the creek and the mound top in this study area was about 3.5 m. The mound tops in the tidal flat were submerged only at a high water.

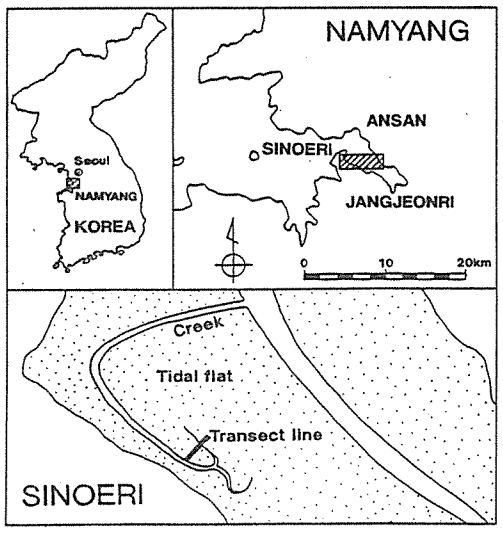

Fig. 1. Map of the Sinoeri, Namyang, Korea, showing the transect line used for sampling.

Water content, TC, TN, silt-clay content, electric conductivity (EC), pH and redox potential (Eh) of sediment soils were measured along the transect line. Eh increased generally with increasing relative altitude. On the other hand, the nearer the creeks, the higher was the water content, this being lowest at the top of the mound in the tidal flat, the reverse of Eh values. In addition, TC and TN content showed almost the same changes as the water content. The silt-clay content was generally high throughout the transect line. Salinity, pH and EC showed no consistent tendency and their ranges were 14-20‰, 7.6-8.4 and 2.5-3.6 mS/cm, respectively.

From the 15 sampling sites, 14 macrobenthic species, genera or families were recorded: 5 crabs, 1 amphipod, 2 molluscs, 4 polychaetes, 1 tubificid and 1 nemertean.

The distribution of crabs showed a clear zonation. *Macrophthalmus japonicus* was present near the creeks, *Hilice sheni* was found in the middle zone of the mound and *Ilyoplax pusilla* in small numbers around the top of the mound. This pattern of zonation was also observed with polychaetes. *Glycera* sp. and *Nephtys* sp. were present near the creeks, Capitellidae were in the middle zone of the mound and *Perinereis* sp. was at the top of mound. Among the molluscs, *Sinonovacula constricta* (bivalve) and the Gastropoda were found only at the creeks. In contrast nemerteans were present mainly around the top of mound.

Ogryudeung tidal flat in the Nagdong river estuary (Fig. 2)

In the Nagdong river estuary, the tidal flats and barrier sand bars are subjected to a con-

tinuous and intensive transformation. The tidal differences amount to about 1.2 m at spring tide and about 0.6 m at neap tide, and the intertidal zones are very shallow in comparison to the Sinoeri tidal flat. The main halophytes around these tidal flats are *Phragmites australis* and *Scirpus maritimus*. Reed marsh is developed in the supratidal zone and consequently is flooded only at the high water of the spring tide. On the other hand, *Scirpus* marsh is developed in the high mound of the intertidal zone. Samples of macrofauna and sediment were collected at 17 sites selected along 2 transect lines including the vegetation area at the Ogryudeung sand bar.

At the Ogryudeung tidal flat in the Nagdong river estuary, tidal amplitude was narrow and sediments were mainly sandy. Twenty-four macrobenthic species, genera or families were recorded. The macrobenthic species composition of the Nagdong river estuary was rich in comparison with that of the Sinoeri tidal flat. The noticeable zonation of macrobenthos was reflected by the emergent plants such as *Phragmites australis* and *Scirpus maritimus*. According to the distribution patterns of macrobenthos, the Ogryudeung tidal flat can be divided roughly into two parts; bare tidal flat with *Paranthura* sp., *Angustassiminea costanea*, and *Laternula limicola*; the reed and *Scirpus* marshes with *Ilyoplax pusilla*, *Corophium* sp., *Assiminea lutea japonica*.

It has frequently been demonstrated that one of the most important parameters which contribute to biological zonation in a tidal flat is a sediment type. The results of this survey showed that two bivalves, *Macoma contabulata* and *Corbicula japonica*, tended to colonize the sandy sediment (less silt-clay) and a crab *Macrophthalmus japonicus* the muddy sediment (much silt-clay). *Ilyoplax pusilla* and *Laternula limicola* tended to colonize the sandy-mud (intermediate silt-clay). Thus, the particle size

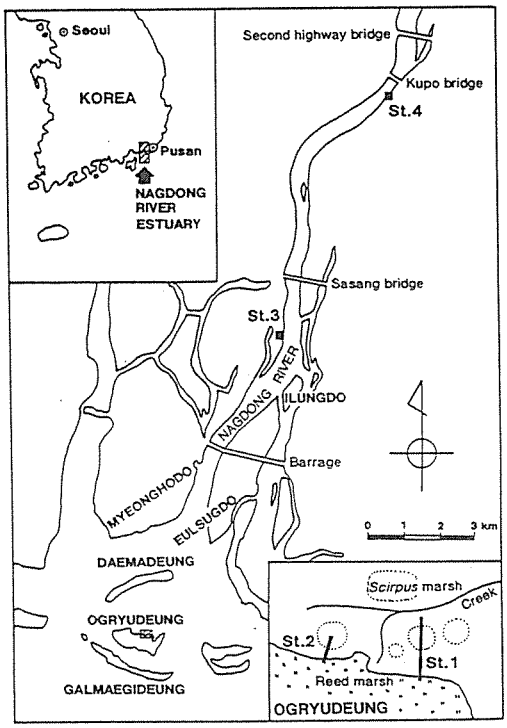

Fig. 2. Map of the Nagdong river estuary, Korea, showing the sampling stations.

distribution of sediment soils is also considered to contribute to the distribution of benthic animals in the tidal flat of the Nagdong river estuary.

With respect to the zonation of crabs, Nakasone introduced the zonation pattern to the vertical distribution of crabs in the Yuhi river estuary, Okinawa Island, Japan[3]. He classified the intertidal zone into four parts from low water to high water of the spring tide, the mixed zone constituted by some small common and uncommon species, the Macrophthalmine zone, the Ocypodine zone and the Sesarmine zone. In the Sinoeri tidal flat, *Macrophthalmus japonicus* inhabited mainly the lower tidal flat and *Helice sheni* inhabited the middle tidal flat, so they were considered to form zones equivalent to the Macrophthalmine and the Sesarmine zones, respectively. On the tidal flat of the Ogryudeung sand bar *M. japonicus* and *Ilyoplax pusilla* inhabited the lower tidal flat and the higher *Scirpus* marsh, respectively,

forming the Macrophthalmine and the Ocypodine zones. In Japan, a large number of *Helice tridens* usually inhabit the reed marsh[4]. However, *Macrophthalmus japonicus* was observed in the reed marsh of the Nagdong river estuary instead of *H. tridens*.

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(Tohoku University)

Improvement of Biological Productivity in Tropical Waste Lands

Kyoji Yoda

Various man-made waste lands have been expanding their area in remarkable speed with increasing human population and economic development in tropical countries. To prevent the deforestation and desertification by over-cutting, over-grazing, slush and burn farming, forest and ground fire, and mining is the urgent ploblem to maintain earth's environment in good condition and to sustain the biological productivity in tropical countries, especially that of food and forest products.

The Thai-Japanese cooperative project had been planned as one of scientific works in the frame of the Japanese MAB Program under the sponsorship of the Japanese Ministry of Education, Science and Culture, intending to clarify the ecological bases of the expansion of tropical waste lands, to apply the findings for the effective vegetational and soil management, and to establish practical ways for sustaining upland farming and silviculture in tropical countries.

The project has been carried out in Thailand from 1984 by a mixed team of scientists from Kasetsart University, Royal Forest Department, Department of Land Development, Forest Industry Organization, Kyoto University and Osaka City University.

The formation of waste lands in wet tropics, where the original vegetation was forests, is mainly caused by mismanagement of the plant-soil system after the deforestation. The following factors may be main causes for preventing the secondary succession on wet tropical waste lands. (1) The deterioration of soils, such as changes in soil property by mining, formation of laterite hardpan by over-cutting, run-off of surface soil by erosion, increasing soil compactness and decreasing water and fertilizer holding capacity by loss of soil organic matter. (2) The changes in microclimatic conditions near the soil surface by the bare land formation. (3) The severe competition between weeds and seedlings of migrating trees. (4) The lack of seed source for normal regeneration due to big scaled deforestation. (5) The grazing by cattle and water buffalos. (6) The ground fire in dry season.

Four different types of waste lands were selected for intensive researches and experiments, a silica sand waste land after an upland pump tin mining at Takua Pa in South Thailand, a laterite hardpan waste land after overcutting of original forest with grazing and ground fire at Ratchaburi in Central Thailand, a sandy loam waste land after a lowland slush and burn farming at Somdet in Northeast Thailand, and a grassland after the highland slush and burn farming at Huey Tung Jaw in North Thailand (Fig. 1).

Initial conditions of vegetation and soils at four experimental sites were measured in 1984, and experiments started from the beginning of 1985. Fast and slow growing commercial timber trees, fertilizing trees and coverplants, medical plants, and various crops were planted in treated soil plots by soil dressing, mulching, chemical and organic fertilizer application, weeding and plowing. The experimental sites were strictly protected from the grazing and ground fire.

We selected *Eucalyptus camaldulensis* for a main silviculture tree at three lowland sites by its fast growing nature under the low soil fertility and low and high soil moisture conditions, and *Pinus Kesya* for the highland site. Three regume trees, *Pterocarpus macrocarpus* and *Acacia mangium* for lowland and *Calliandra callothynis* for highland, were selected as the fertilizing trees. The growths of *Cryptomeria japonica*, *Chamaecyparis obtusa*, *Cunninghamia lanceolata*, *Paulonia tomentosa*, *Coffea arabica* (hybrid), and *Camellia sinensis* were tested at the highland site.

For the agricultural crops at waste land sites, we selected pineapple and cassava at Takua Pa, pineapple, cassava and maize at Ratchaburi, cassava, peanut, sorghum and maize at Somdet in which sorghum and maize were replaced by kenaf and rozel from 1988.

The growth of planted trees, biomass of cover plants and crops, changes in soil texture and fertility were measured at each end of the growing season from 1985 to 1988.

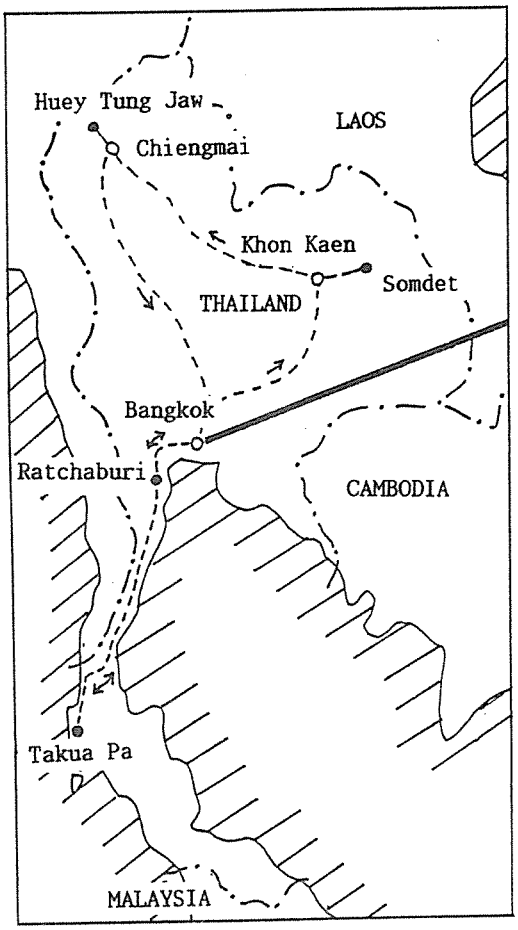

Fig. 1. Location of experimental areas of the Thai-Japanese research project on the improvement of biological productivity in tropical waste lands.

The results of our experiments suggested that different treatments and managements were necessary according to conditions at each sites to improve soil condition and for sustained silviculture and upland farming.

Takua Pa silica sand area after tin mining

Any distinct growth of *Eucalyptus* saplings was not observed at the control (no treatment) and plowing plots. The most remarkable growth was observed at the slime soil dressing plot with chemical and organic fertilizer appli-

cation, and the next was at the mulching plot by green leaves of *Imperata* grass. On the other hand, the growth of trees at the chemical and/or organic fertilizer applied plots was not so good by the low water and fertilizer holding capacity of the sand deposit.

Our tentative conclusion is: (1) The natural regeneration from the bare land to the original tropical rain forest will take geological years on such washed silica sand deposit area. (2) The agriculture and silviculture are also very difficult without much investment. If we consider some profit from the waste land, it will come from only by the utilization for residential, industrial and resort areas. (3) If we do not consider any profit from the area and can invest much money, the sustained agriculture and silviculture will be possible by the slime soil dressing and mulching with the application of much chemical and organic fertilizers. (4) If we can find some fruit crops of very high commercial value, some profit will be expectable by an intensive horticultural management using greenhouse or lattice house with various soil treatments.

Ratchaburi laterite hardpan area by overcutting

The original vegetation at Ratchaburi experimental area was a dry dipterocarp forest. Before the experiment, the area was a complex of bare lands on convexed area with shallow hardpan, thorn scrubs on concaved area with shallow hardpan, and bamboo thickets on deep hardpan and gully side area

Natural regeneration of original forest trees was observed at each type of area. The application of chemical and organic fertilizers did not show the expected effects on tree and crop growth. The hardpan shallower than 25 cm from the soil surface was crushed by a bulldozer but deeper hardpan was remained. It was softened by rain water, and tree roots could pass through it during the rainy season. The growth of *Eucalyptus* was good by higher water and fertilizer holding capacity of the soil and the symbiosis with mycorrhiza.

Our tentative conclusion is: (1) The natural regeneration to the original dry dipterocarp forest will be easy if we can protect the area from the cutting, grazing and ground fire. (2) Most trees from the dry dipterocarp forest and mixed deciduous forest, and dry tolerant fast growing trees can be planted if we can crush the shallow hardpan by a big bulldozer and can protect the area from grazing and ground fire. (3) The symbiotic effects of mycorrhiza on growth of *Eucalyptus* trees seem to be great. If we can produce all *Eucalyptus* saplings for new plantation using the Ratchaburi soil with the mycorrhiza, higher timber production will be expectable. (4) The cultivation cycle of *Eucalyptus* may be shortened at least by two years after the second generation by the coppice management. (5) Many crops can be cultivated during the rainy season by hardpan crushing, application of organic matter on the soil surface, and high farrow making for preventing rain water stagnation after heavy rains.

Somdet waste land after a lowland slush and burn farming

The original vegetation at the Somdet plantation area was a tall mixed deciduous forest. After slushed and burnt, this area was used for cassava plantation for more than ten years without any nutrition.

Our tentative conclusion is: (1) The natural regeneration of secondary forest will be easy if we can protect the area from ground fire in dry season and grazing, although it will take long time to reach the original tall mixed deciduous forest. (2) The critical limiting factor for tree growth at silvicultural plots was the drying up of upper soils in dry season. If we use big saplings germinated from seeds for

plantation, their tap roots may attain to more than 1 m in depth during the first growing season. (3) The application of chemical and organic fertilizers did not show any distinct effects on tree growth except at the initial stage. (4) For agriculture, the selection of dry tolerable crops, weed and fire control, and application of organic matter on the soil surface will be necessary.

Huey Tung Jaw grassland after a highland slush and burn farming

The original vegetation at Huey Tung Jaw experimental site, about 1,400 m in altitude, was a hill evergreen forest of *Castanopsis* spp. and *Quercus* spp. After slushed and burnt, the area had been used for upland rice, maize and poppy cultivation by a hill tribe. After the abandonment, the area changed into grassland of *Imperata* and *Eupatorium*.

Our tentative conclusion is: (1) The natural regeneration of secondary forest will be easy if we control the ground fire in dry season, although it will take long time for the regeneration to original forest because the natural dispersion of *Castanopsis* spp. and *Quercus* spp. will be very slow. (2) The line weed cutting and planting method will be the best for protecting planted saplings from strong wind and ultraviolet radiation in dry season. (3) The cutting along the contour line is necessary for preventing soil erosion. (4) The fire control in dry season and weed control at the planted line are necessary. (5) For the agricultural use, a terraced field making is effective for preventing erosion. (6) The use of shade tree or lattice house is necessary to protect fruit trees, coffee, tea, and flowers from strong wind and radiation.

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