NATURAL SCIENCES IN CHINA

Report from a visit to the People's Republic of China
by a delegation from
the Royal Danish Academy of Sciences and Letters

The Royal Danish Academy of Sciences and Letters
and the Danish Research Administration

Copenhagen, June 1976

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(Authors of sections are indicated by initials)

INTRODUCTION

In October 1974 a Chinese scientific delegation from Academia Sinica visited Denmark at the invitation of the Royal Danish Academy of Sciences and Letters.

In December 1974 professor *Kuo Mo-jo*, President of Academia Sinica, invited a Danish science delegation to pay a return visit to China. This invitation was accepted and a delegation was nominated after consultations between the Royal Danish Academy of Sciences and Letters and the Danish Research Councils. The delegation consisted of the following seven professors representing different fields within the natural sciences:

S. Dalgaard-Mikkelsen (toxicology),
T. Fenchel (ecology),
N.O. Kjeldgaard (molecular biology),
P. Olesen Larsen (organic chemistry),
N.I. Meyer (solid state physics, chairman of the delegation),
B. Mottelson (nuclear physics),
A. Strid (botany).

The visit to China took place from October 19 to November 3, 1975. This report contains rather detailed information about the different Chinese institutions that were visited. The various sections of the report were written by the members of the delegation closest to the subject in question. The views and findings expressed are those of the individual members of the team. A special tour to Lanchow was arranged for Mottelson from October 28 to November 2. Unfortunately it has not been possible to include Mottelsons contributions. They will be published later as a supplement to this report.

Thanks are due to the Danish Research Councils and to the Danish Academy of Technical Sciences for financial support.

Our programme in China was well organized and we received much kindness and hospitality. Altogether we visited about 3o scientific establishments and universities in Peking, Shanghai, and Canton as well as the Shanghai Industrial Exhibition, the Canton Fair, a people's commune near Canton and places of historical and scenic interest. We were everywhere accompanied by guides and interpreters and cars were always at our disposal.

Scientific visits generally followed the same pattern. Being received in the tea room of the institute we were first given a brief political introduction, usually by the vice-chairman of the revolutionary committee, describing the miseries of old China and the achievements after liberation. Then one of the senior scientists presented the development, organization and main research programmes of the institute. One of us acted as chairman of the visiting delegation and gave a brief account of current work in the corresponding field of study in Denmark. Visits to the various laboratories followed; several specialists, some of whom spoke good English, presented their work and there was usually some discussion. Finally we returned to the reception room for more tea and a general discussion of the research programme of the institute.

All of us gave one or more lectures. With interpretation and the following discussion a lecture often took a whole morning or afternoon. There was usually a keen interest and a lively discussion.

Our programme was a pleasant blend of scientific visits and excursions to places of cultural and scenic interest. We saw some of the main attractions in Peking like The Forbidden City with the Palace Museum, the Summer Palace, the Great Wall, and the Ming Tombs. Our trip to China was concluded in a most memorable way with a day-long tour on a river boat at Kweilin where beautiful weather allowed us to enjoy fully the unique landscape with steep limestone mountains and thatched farmhouses in luxuriant subtropical settings along the river.

We wish to express our sincere thanks to all organizations and individuals who contributed in making our visit to China pleasant and successful. These include the officials of Academia Sinica, our guides and interpreters, the staff of the various institutes visited, the Danish Ambassador Mr. *J. Paludan*, and the staff of the Danish Embassy in Peking.

ITINERARY FOR THE DELEGATION

Wednesday,	Oct. 15th.	Departure from Copenhagen.
Thursday,	Oct. 16th.	Arrival in Bangkok.
Saturday,	Oct. 18th.	From Bangkok to Hong Kong by plane.
Sunday,	Oct. 19th.	From Hong Kong to Canton by train. Lunch at the border station. Preliminary receival in Canton. From Canton to Peking by plane. Preliminary receival in Peking airport.
Monday,	Oct. 2oth.	Morning: Meeting in Academia Sinica. Afternoon: Excursion to the summer palace.
Tuesday,	Oct. 21st.	Morning: SDM, TF, NOK, POL, AS visit to Institute of Microbiology, Academia Sinica. NIM visit to Institute of Semiconductors. BM lecture at Tsinhua University. Afternoon: SDM, TF, NOK, POL, AS visit to Institute of Zoology, Academia Sinica. NIM lecture at Hotel Peking. BM discussion of lecture at Hotel Peking. Evening: Welcome banquet given by Academia Sinica.
Wednesday,	Oct. 22nd.	Morning: SDM lecture at Institute of Zoology. TF, NOK, POL, AS visit to Institute of Botany, Academia Sinica. NIM lecture at Institute of Physics. Morning and afternoon: BM visit to Institute of Atomic Energy. Afternoon: SDM, TF, NOK, NIM visit to Institute of Biophysics, Academia Sinica. POL continued visit to Institute of Botany. AS lecture at Institute of Botany.
Thursday,	Oct. 23rd.	Morning: SDM visit to Peking Veterinary Station. TF, NOK, AS visit to Institute of Genetics, Academia Sinica. POL, NIM, BM visit to Tsinhua University. Afternoon: SDM, TF, NIM, AS friendship store. NOK lecture at Institute of Biophysics.

		POL visit to Institute of Chemistry, Academia Sinica. BM continued discussion of lecture. Evening: Return banquet at the Royal Danish Embassy.
Friday,	Oct. 24th.	Morning: Visit to Peking University by the whole delegation. Afternoon: Visit to The Forbidden City by the whole delegation.
Saturday,	Oct. 25th.	Morning and afternoon: Excursion to the Great Wall and the Ming Tombs. Evening: Reception by Vice-Premier *Hua Kuo-feng*.
Sunday,	Oct. 26th.	From Peking to Shanghai by plane. Afternoon: Excursion in Shanghai. Evening: Banquet given by the Standing Revolutionary Committee of the Municipal Authorities..
Monday,	Oct. 27th.	Morning: SDM, TF, NOK, POL, AS visit to Institute of Biochemistry, Academia Sinica. BM, NIM visit to Fudan University. Afternoon: SDM, TF, NOK, POL, AS visit to Institute of Organic Chemistry, Academia Sinica. BM visit to Institute of Nuclear Physics. NIM ill in bed.
Tuesday,	Oct. 28th.	Morning: Visit to Shanghai Industrial Exhibition by the whole delegation except NIM. Afternoon: SDM, TF, NOK visit to Institute of Pharmacology. POL, AS visit to Institute of Botany, Academia Sinica. BM visit to Institute of Metallurgy. Evening: SDM, TF, NOK, POL, NIM, AS from Shanghai to Kwangchow (Canton) by plane.
Wednesday,	Oct. 29th.	Morning: SDM, TF, NOK, POL, AS visit to Sun Yat-sen University. BM from Shanghai to Lanchow by plane.

Afternoon:
SDM, TF, NOK, POL, AS visit to Botanical Garden, Kwangchow.

Evening:
Cultural entertainment.

Thursday, Oct. 3oth.

Morning:
SDM, TF, NOK visit to Institute of Entomology, Kwantung Province and visit to South China Sea Institute of Oceanology, Academia Sinica.
POL, AS visit to Kwantung Provincial Institute of Botany.
NIM recreation after illness.

Afternoon:
Visit to the Canton Fair (whole delegation).

Friday, Oct. 31st.

Morning:
Visit to Ping Chow People's Commune (whole delegation).

Afternoon:
SDM lecture in Kwangchow.
NIM lecture in Kwangchow Science Center.
POL lecture in Kwangchow.

Evening:
Performance of Chinese acrobats.

Saturday, Nov. 1st.

Morning:
Visit to Municipal Museum of Kwangchow.
From Kwangchow to Kweilin by plane.

Afternoon:
Visits to places of interest in Kweilin.

Evening:
Chinese acrobats.

Sunday, Nov. 2nd.

Boat excursion on the river.

Evening:
Banquet given by the revolutionary committee of Kweilin.

Monday, Nov. 3rd.

Morning:
Visit to the caves in Kweilin.
From Kweilin to Kwangchow by plane.

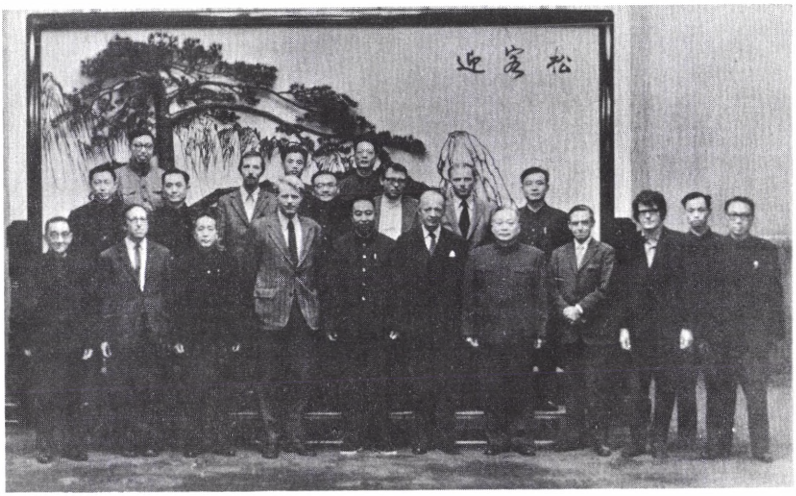
Afternoon:
SDM, TF, NOK, POL, AS visit to Zoological Garden in Kwangchow.
NIM visit to Physics Department of Sun Yat-sen University.

Evening:
Farewell banquet in Kwangchow.

Tuesday, Nov. 4th.

From Kwangchow to Hong Kong by train.
POL departure for Japan.

Thursday, Nov. 6th. SDM, TF, NOK, NIM, AS from Hong Kong to Copenhagen via Bangkok.



Official photo taken at the reception of the Danish scientific delegation by vice-premier Hua Kuo-feng.

In the first row from the left:

Pei Shih-Chang, B. Mottelson, Wu Heng, N.I. Meyer, Hua Kuo-feng, J. Paludan, Chien San-Chiang, Dalgaard-Mikkelsen, T. Fenchel.

Second row from the left:

interpreter, Cheng Chung-chih, A. Strid, Hu Han, N.O. Kjeldgaard, Olesen Larsen.

ACADEMIA SINICA

The morning after our arrival in Peking the whole delegation participated in a research seminar at Academia Sinica. The seminar took place in the Academy's building in the northwestern part of Peking. Chinese participants were the following:

Wu Heng; Vice-president of Academia Sinica,

Chien San-chiang; Deputy Secretary-general of A.S.,

Hu Han; Professor, Institute of Genetics, Chairman of the Chinese delegation to Denmark in 1974,

Cheng Chung-chih; Professor, Institute of Semiconductors,

Wu Tsao-wen; Deputy director of the Bureau of Foreign Affairs, A.S.,

Kuan Keh; same as previous,

Liu Chih-ying; Responsible person in the Bureau of Planning, A.S.,

Yu Nai-nsin; Head of a department in the Bureau of Foreign Affairs, A.S.,

Feng Yin-fu; same as previous.

Introductory talk by Mr. Wu

Mr. *Wu* read an introduction which lasted about one hour. The main points in his talk were as follows:

Academia Sinica was founded in November 1949 at a time when there were very few scientific research workers in China. Since then a rapid development has taken place. Before the cultural revolution in 1966 there were 12o institutes under the auspicies of the Academy.

After the cultural revolution some of the Academy institutes were transferred to provincial governments and other regional bodies according to *chairman Mao's* instructions about the balance between central and local authorities.

There remain now 3o research institutes under the Academy which acts as a center for the natural sciences in China. The main aims are:

1) To solve important problems related to science and economy of China.
2) To study new branches of science.
3) To develop basic science.

The Chinese scientists are called upon to catch up with the advanced countries of the world. The development of science should be adapted to the national economy.

As *chairman Mao* has stated: "Theory depends on practice, comes from practice and serves practice". This is the principle of unity of theory and practice. Science and technology has been promoted in the service of the proletarian party and the people. Examples were mentioned of scientists working with the people in rural communes solving agricultural problems: Breeding of tobacco, new types of rice with high yields and resistance to diseases.

There is a free debate between different schools of science. Disputes should be solved through experiments and practice in competition between the different schools of thought. Mention was made of *chairman Mao's* advice: "Rely on own forces and take initiatives in own hands", but it was also stressed that science should give contributions to mankind in general.

The oil exploration was mentioned as a new field, as well as geological surveys in the Himalayas.

The Academy also popularizes scientific knowledge. According to *chairman Mao*, science should be a mass movement and the people should participate and contribute their experience. Mr. *Wu* concluded that there is still a gap between China (as a developing country) and the advanced industrial countries.

<u>Introductory talk by Niels I. Meyer</u>

As chairman of the visiting delegation NIM gave an introduction to Danish science policy problems which lasted about 45 minutes. The main points in this talk were the following:

1) The main reasons for doing research in the Danish society.
2) Problems related to fundamental research. The basic role of Danish universities in the field of fundamental research.
3) The autonomy of Danish universities. The internal steering principles of Danish universities.
4) Relationship between the science councils and the universities. Influence of science council support on the total research activities.
5) Contract research.

6) Research on important short-term problems of the Danish society. Relations between decision-makers and science advisers.

7) Applied research and development. Technological service institutions.

8) International cooperation.

General discussion

The Danish delegation raised a number of questions:

1) About the relation between the Academy institutes and the universities. The answer was that there used to be a tight connection, but it was now weaker and consisted, for instance, of joint seminars.

2) About the specified goal of catching up with the advanced nations. Academy officials answered that they were primarily thinking of the scientific and technological level. This does not necessary mean that they want to copy our material standard of living.

3) About the uneven distribution of scientific experience between the different provinces. It was answered that they are primarily interested in securing a coverage of the important scientific fields, e.g. by creating national centers where scientists from the provinces can be trained.

Concluding remarks

It was rather difficult to establish a concrete discussion about science policy problems with the Chinese. They did not appear to be interested in such a discussion.

RECEPTION OF THE DELEGATION BY VICE-PREMIER HUA KUO-FENG

On October 25 at the return from a daylong excursion to the Great Wall and the Ming Tombs, one of our interpreter/hosts informed us that the delegation would be received in the late afternoon by one of the leaders of the People's Republic. At 17.oo the delegation left for a governmental office near *Tian an Men* square accompanied by the Danish Ambassador, Mr. Paludan, and was greeted by vice-premier of the State Council *Hua Kuo-feng*, minister of interior security. The reception took place in the presence of several Chinese scientists: *Wu Heng*, *Pei Shih-Chang*, *Chien San-Chiang*, *Hu Han*, and a representative of the Ministry for Foreign Affairs. After the traditional remarks of welcome, *Hua Kuo-feng* gave a survey of Chinese agricultural policy and its relations to science policy. This appeared as a short summary of the discussions at the national agricultural conference in *Hsiyang* which was concluded on October 15 by a summing-up report by *Hua Kuo-feng*.

His survey expressed the following views to the delegation:

"Before liberation China was rather backward. In spite of being an agricultural country it had to import agricultural products because of natural disasters. The industrial basis was poor; only 15o.ooo tons of steel per year were produced when the country was liberated. We have made some progress in the past 25 years, although comparatively speaking the degree of industrialization is still low. In agriculture we have tackled the problem of clothing and feeding the people, but the level in agriculture is still low. With respect to industry we have laid some foundations, but there are still gaps to modern industrialized countries. Our policy in developing our national economy is to make agriculture the foundation and industry the leading factor. First feeding and clothing the people. If we cannot produce we must import, but the international market cannot sell that much. If we succeed in agriculture it can supply raw products and manpower to industry and we can produce. If we develop industry better we can supply agriculture with more machines. The agriculture rests on social-collective earnings which we have learned from *Tachai*, an example in agriculture first emphasized by *chairman Mao*. When he proposed to follow *Tachai* this movement developed rapidly and there are examples of learning from *Tachai* in all parts of the country. At present more than 3oo counties do a good job in learning from *Tachai*. We set as targets and we hope that by the end of 198o one third of the counties will be of *Tachai* type. By then the economic level will be greatly improved. By 198o we hope to have greatly increased agricultural mechanization. This does not only mean to add more tractors or combiners, but e.g. in South China we must have drainage and irrigation. Besides, we shall make full use of resevoirs. We have more rain in the South than in the North and we want to transport water from the South to the North. That means higher horsepower machinery. Mechanization also means production of fertilizer. In addition to the introduction of equipment from other countries, we also build small factories in our country; in Kwangchow you will find these small and medium size factories.

These are our plans. To realize these plans means a great effort. We try to realize *chairman Mao's* call, by the end of 198o to build an industrial foundation independently. After 198o we will use 2o years or more to make China into a country with modern agriculture, industry, defense, and technology.

This sets a very important and hardeous task for our scientists. To develop modern science means a great effort for our Chinese scientist, and we need modern science. This should not only rely on the scientific institutions but also on the masses of the people. This not only requires efforts from the Academy of Agriculture but effort from all institutions down to the level of the county. We also need the efforts of the county scientific organizations and the peoples communes organization and the brigades. We want to utilize the experience of the great masses. The same is true in industry; we must not only rely on the Academy but on efforts at the grass-root level.

We urge the Academy of Sciences to make an effort in basic research. We emphasize the policy to take initiatives in our own hands and rely on our own efforts.

After the foundation of the People's Republic of China, Denmark was among the first to recognize China, so we have a long history of friendship. After the foundation of the People's Republic, the U.S. tried to restrict and blockade us, but this was settled by the visit of president Nixon in 1972. In the Stalin period we had good relations with the U.S.S.R. and they gave us assistance. When Kruschow came to power that changed and they took up a policy of social-imperialism. Later on they tore up all contracts and withdrew all experts. This gave us lots of problems. Some factories were just with bare walls and the blueprints were taken away. This made us build our country independently and take matters in our own hands, and this enhanced our vision to build up the country with our own hands. Through these years practice has shown that in this way industry develops faster and not slower. We are willing to have friendly exchange with friendly countries. We believe that countries big and small should be on equal foot, the big should not bully the small, the strong not the weak. All countries have their strong points, we should respect each other. We should further develop the friendship between China and Denmark. Denmark has many good things to offer, Denmark has helped us greatly and supported us in the U.N. When the U.S. still proceeded with a provocation policy, Denmark was among the first to break this. Because of premier Hartling's visit last year the friendly relations have been enhanced. Your visit will also enhance the friendship between our two peoples. We have no conflicts of interest. Denmark also feels in some way threatened by the U.S.S.R.

I think that in the coming years the friendship not only between our two peoples but also between the scientists of our two countries will be developed.

As for trade the inside is the first, the outside the second. The trade between Denmark and China has been increasing over the last years and will further increase.

At this trip you will also see *Shanghai*, *Kwangchow* and *Kwei-lin*, and Mottelson will go to *Langchow*. We hope this is only the beginning and we hope you will come again if possibilities allow".

After this exposition, which took about an hour, there was a short exchange of views during which the Ambassador extended an invitation to the vice-premier to visit Denmark to study Danish agriculture, and the chairman of the delegation expressed our hopes for an increased cooperation between the scientists of our countries.

Meyer asked the vice-premier whether China was planning to introduce nuclear power reactors in the nearest future. The vice-premier answered that China has enough coal and oil for many decades to come. Therefore they were not planning at the moment to build nuclear power reactors. But they were following the development of the technology in order to be prepared if the need for extra power sources should arise.

INSTITUTE OF ZOOLOGY, ACADEMIA SINICA, PEKING

The zoological institute was visited in the afternoon of October 21 by Dalgaard-Mikkelsen, Fenchel, Kjeldgaard, Olesen Larsen, and Strid. At the usual tea reception the director of scientific studies, Professor *Chang Chi-yi* told us that the staff consisted of 5oo persons of which 38o were research workers and technicians. There were four main areas of research:

1) *Taxonomy and faunistic studies* (including departments for entomology, vertebrates, and invertebrates),

2) *Applied zoology* (i.e. pest control; useful animals),

3) *Endocrinology* (acupuncture anaesthesia, a project we were not shown; the function of insulin; endocrinology of reproduction),

4) *Cell biology* (biomembranes, tumor immunology, nucleus-cytoplasm interactions).

The institute also included a department for development and construction of scientific equipment.

In the *department of taxonomy* we were shown the insect collection (2 million specimens), the collection of fish (5o.ooo specimens) and the mammal collection. The collections seemed professionally curated and well kept; the department constituted a considerable faunistic expertise and knowledge. We were informed that the panda population in Szechwan was increasing in a protected area (on the following day we saw three individuals in the Peking Zoo, and later another three individuals in the Canton Zoo). As everywhere else the collection included only Chinese animals and its purpose was purely faunistic and taxonomic whereas evolutionary aspects were not studied.

In the *department of applied zoology* we were introduced to a number of projects. One was concerned with the treatment of 5th instar silkworms with juvenile hormones (applied by spraying). This, we were told, prolonged the stage with 1-1½ days and increased silk production by 1o-3o%. The hormone was synthesized at the Institute of Chemistry which is now trying to produce analogues of the hormone. One group was studying the application of sex pheromones for controlling *Grapholeta molesta* ("oriental fruit moth"). So far, the hormone was applied to obtain an early forecast of appearance of the insect, thus optimizing insecticide application.

The toxicology of chlorinated hydrocarbons was also studied. During the sixties the use of these compounds decreased (as in the West) due to their persistence in nature. The occurrence in fish and chickens was monitored (the concentrations were generally not found to be alarming) and the accumulation in the body of fish was studied by C-14 labelled DDT and autoradiography. This group also studied the degradation of organophosphorus pesticides.

The *department of cell biology* was concerned with tumour studies, in particular the production of antigenes by inplanting mice sarcoma in chickens. We were also shown some strange experiments in goldfish. The Chinese goldfish has a double tail-fin whereas its wild ancestor does not. By injecting m-RNA from the wild type into goldfish eggs these developed into fish with entire tails; this character was claimed to be inherited! We were shown entire- and double-tailed goldfish in tanks and told that these remarkable results were explained by replicases. The membrane project was concerned with the inner membrane of mitochondria and the effect of ATP-ase on the association and dissociation of this membrane.

The *endocrinology department* worked with insulin analogues in order to elucidate the function of the molecule. This work was closely related to projects at the Shanghai Institute of Biochemistry and the Institute of Biophysics in Peking. Another project, with which we were also later to see in other institutes, was concerned with the use of analogues of the "luteinizing release hormone". This lo-peptide hormone was first found and later synthesized in China. A 9-peptide analogue also stimulated ovulation in mammals and the spawning of fish. It is now used in veterinary practice for horses and mink and for inducing spawning of grass-carps in ponds. The latter may become of considerable economic importance.

Among the biological institutes we visited, the Institute of Zoology in Peking was one of the best equipped and most active.

INSTITUTE OF MICROBIOLOGY, ACADEMIA SINICA, PEKING

This institute was visited by Dalgaard-Mikkelsen, Fenchel, Kjeldgaard, Olesen Larsen, and Strid in the morning of October 21. After a welcome speach by the vice-chairman of the revolutionary committee, Mr. *Yang*, including the usual phrases, Mr. *Kuo*, a leading member of the research staff, gave a general outline of the institute. It had been established in 1958 and currently had a staff of 4oo of which 3oo were scientists or technicians. We were informed that there were three main lines of research:

1) *Taxonomy of microorganisms* studied in order to contribute to the knowledge of national resources, and for educational purposes;

2) *Projects motivated by economical interests*, e.g. study of useful or harmful microorganisms (excluding medical microbiology which was not studied at the institute);

3) *Projects within microbial genetics and biochemistry.*

We were then shown four laboratories. One group worked on the classification of bacteria, particularly Gram-negative, non-fermentating soil bateria; the group considered to extend its activity also to Gram-positive bacteria (*Corynebacteria*). Only classical bacteriological methods were used, but not, e.g. DNA base ratios although the group was aware of the existence of the method. The group had not published any results and had apparently been set up recently although the laboratory made a somewhat old-fashioned impression. There was a culture collection of about 8.ooo strains of bacteria and fungi maintained on slant cultures, as lyophilized cells, on wheat grain, or on sand cultures.

Another group worked on the taxonomy and distribution of mushrooms, particularly edible ones. We were shown beautiful water colours of *Russula* and *Lactarius* species. There was also a mycological herbarium including about 4o.ooo specimens, neatly preserved in metal cabinets. The collection had been transferred from the Institute of Botany. We were informed that mushrooms were grown commercially in Southern China. No studies on the cultivation of edible mushrooms were carried out at the institute, however.

We were shown a laboratory occupied with the *industrial use of bacterial fermentation*. One project concerned the production of glutamic acid from organic waste, using bacteria and yeast. The yield of the process was studied by isolating the product by means of electrophoresis, thin-layer chromatography and ion-exchange resins. In a related project the production of fumaric acid (used for the manufacture of some kind of plastic polymer) was based on the fermentation of oil wastes by *Candida*. A third group worked on the isolation of *Aspergillus* cellulase, which was used for producing glucose from cellulose waste. This group also had a pilot plant (which we were not shown) for studying industrial fermentation processes.

The last laboratory we saw was concerned with *plant viruses and phages*. One group studied the prevention of phage infection in industrial fermentation tanks. The work included EM-studies, screening for resistant strains, and attempts to make process modifications. This group had published some of their results. One project consisted in the isolation of strains of fungal viruses.

One group was concerned with the synthesis of the infectious RNA molecule of TMV *in vitro* in cell-free systems of wheat embryos. The group had also isolated and characterized the protein coat component of TMV and attempted to isolate replicases. This work implied the use of C-14 labelled amino acids (made in China) and liquid scintillation counter (imported; Nuclear Enterprise).

Finally one group studied plasmid DNA of *Staphylococcus* and of enterobacteria in order to understand tetracyclin resistance.

Taxonomical work at the institute did not appear to include evolutionary aspects. Considering the strict orientation towards applied research, it was also surprising that there was no work in fields such as soil microbiology, microbiology of sewage treatment, or pollution. Before leaving the institute we were presented with a reprint (*Acta Genetica Sinica* 2: lo7-113, 1975) of a paper by two staff members criticizing Monod for being "idealistic" and mutations by chance for being in conflict with dialectical materialism; it called for further criticism of Monod's book "Chance and Necessity". Questioning about the availability of the book in China, we were told that there were only two copies in the country.

The institute had one of the three Chinese-built *electron microscopes* we saw in Peking. It was built three years ago, had a lo Å resolution and a magnification power of 2.5 x 10^5; for ultrathin sectioning an LKB-microtome was used (as in other institutes). Light microscopes were East German (Zeiss); chemicals, thermostated baths, heat cabinets, table centrifuges, etc. were mostly produced in China.

INSTITUTE OF GENETICS, ACADEMIA SINICA, PEKING

The Institute of Genetics was visited by Fenchel, Kjeldgaard, and Strid in the morning of October 23. The director of scientific studies, Mr. *Hu Han*, told us that the institute was established in 1951 with a staff of 2o, predominantly working with improvement of cereal strains. In 1959 it was enlarge to its present size (a staff of about 2oo) and in 1964 moved to its present building in the northern outskirts of Peking.

The institute comprised four laboratories:

1) The *laboratory of molecular genetics* worked with the transfer of factors for sporulation and synthesis of amylase and proteolase in *Bacillus subtilis*. Although we did not quite comprehend the details of the study, it was clearly related to the maximization of amylase yield in industrial plants.

2) A *laboratory of developmental "genetics"* worked with the transplantation of fertilized eggs of sheep. In an attempt to increase the stock of karakul sheep in Inner Mongolia, fertilized ovae of this race were transplanted into females of the less valuable Mongolian sheep. The institute had developed the technique successfully in 1974 and the research group was now mainly concerned with introducing and teaching the method in a commune in Mongolia.

3) The project receiving most attention at the institute seemed to be the *breeding of new strains of wheat and rice*. The technique, which was also used without any modifications at the Peking University and at the Botanical Institute, was based on *growing haploid plants from pollen*. The maximum frequency of induction was lo% in rice, somewhat lower in wheat. Diploids were produced with colchicin treatment or spontaneously. The technique seemed to have been applied at the institute since 1968 (with rice) and 197o (with wheat). Some strains developed at the institute were apparently studied in experimental plots, but none of them seemed so far to have been grown on any large scale.

4) The last laboratory we were shown worked with *human gene-*

tics. One project consisted of the screening of mentally retarded inhabitants of a local commune for atypical karyotypes and their classification. In another project abnormal karyotypes in leucaemia cells were studied. None of these projects represented anything novel; they seemed to be based on very modest quantitative samples.

With the exception of the laboratory working with the improvement of cereal strains, the institute - as far as we saw it - was nearly devoid of instruments, and the level of activity did not seem to be particularly high. We were informed that a group in Shanghai worked with population genetics but had no opportunity to visit this group.

INSTITUTE OF BOTANY, ACADEMIA SINICA, PEKING

The Institute of Botany is housed in a former temple complex in the NW. part of Peking, next to the Zoological Garden, and not far from Academia Sinica.

Fenchel, Kjeldgaard, Olesen Larsen, and Strid visited the Institute in the morning of October 22. In the same afternoon Strid gave a lecture on "Continental Drift and the Early Evolution of Angiosperms" while Olesen Larsen had talks with some of the phytochemists of the institute.

In the morning we were kindly received by a delegation including the following:

Tsui Cheng; Director, plant physiology.
Li Shen; Responsible member of the revolutionary committee.
Yü Te-Tsun; Professor, taxonomy.
Hong de-yuan; Scientific worker, taxonomy.
Chin Yu-huang; Scientific worker, nitrogen fixation.

At the usual cup of tea director *Tsui* gave a general presentation of the institute.

The institute had a staff of over 3oo, representing seven departments:

1. *Dept. of taxonomy,*
2. *Dept. of plant ecology,*
3. *Dept. of paleobotany,*
4. *Dept. of plant physiology,*
5. *Dept. for the study of biological nitrogen fixation,*
6. *Dept. of phytochemistry,*
7. *Dept. of cytology and morphology.*

The *department of taxonomy* was engaged in the massive task of writing the *Flora Republicae Popularis Sinicae*, which will eventually run into c. 8o volumes and cover all the c. 3o.ooo species of flowering plants in China. Four volumes had already been published and six more were said to be in print. About 1oo scientific workers were engaged in writing the Flora, 3o of them in Peking and the rest at other departments throughout the country. Six skilled artists worked full-time with preparing the illustrations. The work appeared to be up to the highest international standards. It was planned to be completed in the remarkably short period of ten years.

The department had also recently produced the *Iconographia Cormophytorum Sinicorum*, a semipopular work containing short descriptions and line drawings of about 8.000 Chinese mosses, vascular cryptogams, and flowering plants, mostly common or economically important species. Four volumes (each of c. 1.000 pages) had been published, and the fifth (and last) was said to be in print.

The Academy publishes *Acta Phytotaxonomica Sinica* (4 fascicles, c. 520 pp. in 1974; 3 fascicles, c. 380 pp. so far in 1975) which has English titles and summaries. Many new species discovered in connection with the flora project were being published in this periodical. The descriptions were accompanied by full Latin diagnoses, type citations, and often line drawings of high quality.

We were presented with three volumes of the *Iconographia*, one volume of *Flora R. P. Sinicae* (part of Rosaceae, written by Prof. *Yü Te-Tsun*) and the 1974 and 1975 issues of *Acta Phytotaxonomica Sinica*.

The herbarium is the largest in China. The number of specimens was given as "over 1 million", about eighty per cent of which had been collected after liberation. It was neatly arranged (according to Engler's system) in wooden cabinets, but somewhat scattered and short of space. The mycological collection (about 40.000 specimens) had been moved to the Institute of Microbiology. The herbarium is quite prepared to receive and loan study material. Some exchange with foreign institutes (e.g. Kew and Edinburgh) was already in operation, and Prof. *Yü Te-Tsun* expressed interest in receiving duplicates of Thai plants from Denmark in exchange for specimens from southern China. The herbarium staff spent much time in routine identification of specimens (mainly medical plants) sent in from all over the country.

Taxonomic and floristic survey appeared to be given high priority in accordance with the party's line of mass movement in collecting and classifying medical and other potentially useful plants. This was evident from some of the ideologically oriented articles in recent issues of *Acta Phytotaxonomica Sinica*. Cytotaxonomy, biosystematics and other theoretical branches of taxonomy were almost non-existent. The Botanic Garden of Peking is outside the city. It was said to be rather small and have only one small greenhouse. The botanic gardens do not appear to have been accorded a precise role after the cultural revolution, and their status remains vague.

At the *department of plant ecology* research work was highly geared towards serving production. It was reported that work was now being pursued along four main lines.

1. *Ecology of crops with special reference to intercropping.* Different combinations of wheat, corn, millet, ground nuts, and soy beans were being tested. The work was carried out in cooperation with a people's commune where the experimental grounds were situated. In recent years the Chinese have remarkably increased land utilization by progress in multiple cropping and intercropping systems. Some details can be found in the report of the American Plant Studies Delegation (1975, pp. 114-117).

2. *Irrigation of rice crops with waste water* from factories to study the effects of water pollution. *Purifying effect of water plants* in relation to pollution. Few details were given.

3. *Grassland ecology* (utilization and improvement). The work was being carried out at a field station in Inner Mongolia.

4. *Vegetation mapping.* A series of general and more detailed multicolour vegetation maps were presented. Work was being concentrated in the Tibetan highlands and in the subtropical regions of SW. China.

On the way to the paleobotany laboratory we were briefly shown a Chinese-made transmission electron microscope which appeared identical to the one at the Institute of Zoology (resolution lo Å). The light microscopes used at the institute were partly Chinese-made but mostly imported from E. Germany (Zeiss, Jena).

We were introduced to the paleobotany laboratory by Prof. *Hsu Zen*, en elderly gentleman who had spent several years in India and Sweden and returned to China in the early nineteen fifties. He had recently published his remarkable discovery of a *Glossopteris* flora occurring in a band of deposits some 5o km N of the Himalayas, i.e. on land that presumably never belonged to Gondwanaland. Other paleobotanical observations indicated a very rapid uplifting of the Himalayas in the Pliocene and Pleistocene. More interesting results can no doubt be expected from analyses of material recently collected at high altitudes in Tibet.

At the *department of plant physiology* we were shown laboratories concerned with a) plant growth hormones, b) storage of fruits and vegetables, and c) herbicides. In the plant hormones laboratory studies were being made on the hormones present in water chestnut (*Eleocharis tuberosa*); the main concern was the application of plant hormones in agriculture. The fruit storage work consisted mainly of simple experiments designed to determine the optimum temperature, oxygen and carbon dioxide levels for storage of apples, pears, tomatos etc. Tomatos could be stored for c. 5o days at lo^{o}C with high CO_2 and low O_2 levels. The study of herbicides was also of an entirely applied nature. In seedling beds of rice good results on both dicot weeds and *Cyperus* were obtained with a combination of DCPA[x] and MCPA[x] (3 kg/ha). Nitrofen (NIP)[x] or PCP[x] was applied just after transplantation. Nitrofen was reported to be used on one million hectars in China. *Avena fatua* in wheat fields was killed by suffix (l kg/ha). Some work was also carried out on residue contents in vegetables and on the biological characterisation of weed seedlings.

The work on *biological nitrogen fixation* was introduced by Mr. *Chin Yu-huang*, a leading member of the department, who spoke good English. His work appeared to be among the technically most advanced at the institute; it was concerned with

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[x] formulas, see next page.

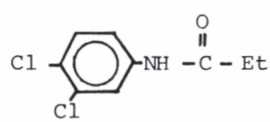
the isolation, purification and crystallisation of nitrogenase obtained from *Acetobacter winogradsky*. Frozen cells were disrupted by ultrasound, centrifuged, and heated to 6o$^{\circ}$C for 6 minutes; the crude extract was fed into a chromatographic column under anaerobic conditions. The nitrogenase consisted of two components, an iron-protein and a molybdenium-iron-protein. The latter had been purified and crystallised; it had a molecular weight of c. 26o.ooo and consisted of four subunits. The crystals were needle-shaped and disintegrated when exposed to air.

Four main topies were pursued at the *department of cytology and morphology*:

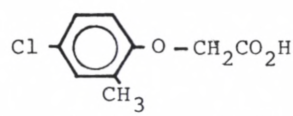
a) anther culture in connection with high protein breeding,
b) somatic cell fusion,
c) endosperm culture and embryology,
d) comparative morphology.

Formulas:

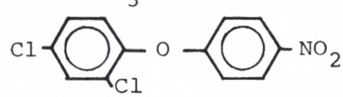
DCPA = propanil:



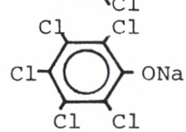
MCPA:



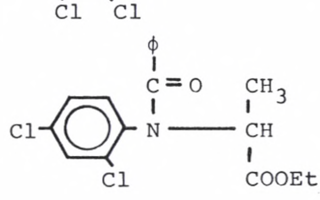
NIP = nitrofen:



PCP:



Suffix:



We were able to see the work on anther culture *in vitro*. This method is now used on a massive scale in China for production of homozygous lines from F_1 plants in rice and wheat. The technique involves growing of anthers on an artificial medium in test tubes under controlled light and temperature conditions. The medium was a standard Murashige and Skoog medium supplemented with additional amounts of sucrose, thiamine chloride, auxins, lactalbumen hydrolysate and 2,4-D. The developing calli were transferred to a new medium when 1-3 mm in diameter. In most cases the callus tissue would be haploid, obtained by division of pollen grains. Roots or shoots would appear after c. 2o days. In some varieties large frequencies of albino plantlets were produced. The green plantlets were eventually transplanted to pots and grown to maturity. The maximum frequency of induction was c. 1o% in rice (1oo anthers planted, 1o green plantlets obtained), somewhat lower in wheat. Up to 5o% of the plants obtained were homozygous diploids produced by spontaneous doubling. Formation of heterozygous diploids from somatic anther tissue could be prevented by adding auxins (kinetin) and other substances to the growth medium.

The method undoubtedly has some prospects, but also definite limitations as a plant breeding technique. As we were later to learn similar or identical work was carried out at several institutes throughout the country. Surprisingly enough there seemed to be little or no coordination; scientists in one province were largely unaware of work carried out in other provinces.

The work in natural products chemistry was described by Ms. *Dai Lun Kai*. It was mainly directed towards drug research, but some work was also performed on vegetable oils, polysaccharides, and gums. The structure of a cytotoxic substance was presently under investigation. Also some compounds of possible use in the treatment of bronchitis, including a flavonoid from *Gingko biloba*, were studied.

INSTITUTE OF PLANT PHYSIOLOGY, ACADEMIA SINICA, SHANGHAI

Olesen Larsen and Strid visited this institute in the afternoon of October 28. We were met by the following persons:

Mr. *Wan ne-nan*, responsible member of the revolutionary committee,

Mr. *Wan men-yong*, office of the revolutionary committee,

Mr. *Chen Tsu-Ching*, dept. of phytohormones,

Prof. *Chiao jun-sen*, dept. of microbiology,

Mr. *Tang Chang Cheng*, phytotron.

The institute was founded in 1953 and at that time had a staff of 43. The present number of employees was 42o, about 26o of them research workers (4o% women). The institute was divided into six departments, doing research work in the following fields:

1. *Dept. of cell physiology*: growth of cells and organ formation; haploid culture; somatic cell hybridization.

2. *Dept. of photosynthesis*: transfer of energy in photophosphorylation; exploring ways of increasing photosynthetic efficiency in crops; characterizing varieties of rice.

3. *Dept. of biological nitrogen fixation*: structure and function of nitrogenase; mechanism of symbiotic nitrogen fixation; transfer of genes for nitrogen fixation.

4. *Dept. of phytohormones*: weed control in farmland; control of organ abscission (cotton balls); physiology of flowering in sugar beets.

5. *Dept. of microbiology*: antibiotics for agricultural use (wheat); bacterial resistance to antibiotics; bacteriophages.

6. *Phytotron*: influence of temperature, humidity and day length on flowering and seed development in wheat and rice.

The institute also had a small farm in a suburb of Shanghai.

We were able to see work in the following laboratories:

Cell hybridization. The work was in an early stage. It involved cell wall degradation by means of an enzyme extracted from the fungus *Trichoderma* (strain EA 3 no. 867), and fusion of isolated protoplasts from different species, e.g. *Brassica* and barley. Dikaryots were obtained, but no callus formation had been observed so far.

Phytohormones. In this laboratory work was concentrated on the physiology of organ abscission with special reference to the shedding of cotton balls. Gibberellin in a concentration of 2o p.p.m. could significantly reduce shedding when applied directly on the unfertilized ovary (style removed). Gibberellin + CCC (2-chloro ethyltrimethylammonium chloride) sprayed on whole cotton plants in the field reduced shedding with up to 5o%. The transfer of photosynthetic products from leaves to flowers (balls) had been studied by means of C-14 labelling. Gibberellin treatment significantly increased the rate of transfer.

Symbiotic nitrogen fixation. Studies were carried out on the biochemistry of nitrogenase. This work did not seem to differ from what we had already seen at the Institute of Botany in Peking. Research was also conducted on the genetic basis for the production of nitrogenase and the biochemical interaction between host and bacterium in this respect. Root-nodules in some non-leguminous plants (*Elaeagnus, Casuarina, Cycas*) were under study, and there were preliminary attempts to inoculate non-leguminous crop plants with strains of nitrogen-fixing bacteria.

The phytotron was of an impressive size, and occupied a large separate building. It had been constructed in the late nineteen sixties. The total available area was 36o m^2, 255 with artificial light and 1o5 with natural light. The artificial light section was divided into 19 growth chambers each of c. 14 m^2. In each growth chamber four 6.ooo watt Xenon lamps provided a light intensity of 3o.ooo lux one meter from the light source. Temperature could be regulated between o and 5o ^{o}C and humidity between 3o and 9o%. Air was taken in through the perforated floor and sucked out through vents in the walls. In the natural light section water was constantly poured over the glass roof to provide insulation.

The phytotron was used to study photoperiodic sensitivity in varieties of rice and the influence of unfavourable temperatures on flowering and seed development in rice and wheat.

KWANTUNG PROVINCIAL INSTITUTE OF BOTANY, KWANGCHOW (CANTON)

In the morning of October 3o Olesen Larsen and Strid visited the Kwantung Institute of Botany in Kwangchow. This was established in 1929 as a department under Sun Yat-sen University. After liberation it came under Academia Sinica and after the cultural revolution under the Bureau of Science and Technology of Kwantung Province. It had a total staff of 41o including 23o scientific workers, and was divided into seven departments:

1. *Plant taxonomy*,
2. *Economic botany and plant chemistry*,
3. *Plant physiology and biochemistry*,
4. *Geobotany and plant ecology*,
5. *Plant genetics*,
6. *Introduction and acclimatization*,
7. *Landscape gardening*.

The two last-mentioned were in the Botanical Garden. One building housed the herbarium and library and another (a few minutes drive away) the experimental laboratories; both were just outside the Botanical Garden. Other buildings were under construction nearby.

We were received by the following persons:

Mr. *Wang Hung*, Chairman of the revolutionary committee of Kwantung Institute of Botany,

Mr. *Ling Yu-ren*, Head of the Department of Plant Taxonomy,

Mr. *Kuo Chun-yen*, Scientific worker in the Dept. of Plant Physiology,

Mr. *Chang Hung-shi*, Scientific worker in the Dept. of Economic Botany,

Prof. *Chen Feng-huai*, Professor and Vice-chairman of the revolutionary committee, Botanical Garden.

Mr. *Kuo* who had studied in the United States (Univ. of East Lansing and Chicago) acted as our interpreter.

The *department of plant taxonomy* took active part in the Flora of China project and was also producing two important regional floras of the provinces of Kwantung and Hainan. The latter will comprise 4 volumes, 3 of which had already been published. We were both presented with a copy of Vol. III of this flora (629 pp.). It contains keys, synonymy, descriptions, and numerous illustrations; latin descriptions of c.3o new species are found in an appendix. The first volume of the flora of Kwantung will be published in the end of this year; six volumes were planned in all. The department was also producing a flora with coloured illustrations and semipopular descriptions of medical plants to be used by bare-foot doctors. One volume with c. 2oo species had been published and two more were planned. Paintings and drawings were generally of high quality.

The herbarium had a collection of c. 6oo.ooo specimens (higher plants only), most of them collected in the last 25 years. There was a card index to all specimens. Mr. *Chow*, who was in charge of the herbarium, would welcome exchange with foreign institutes, and was particularly interested in material from other countries in South East Asia.

The library was unexpectedly large; it had a total of c. 3o.ooo volumes (including many pirate editions) and subscribed to 2oo periodicals. The annual budget for buying new books and journals was 3o.ooo yuan (c. 9o.ooo kr.). There was a fine collection of old books, and we were shown some neatly illustrated herbals from the Ming dynasty.

There was said to be a division for anatomy and palynology under the department of plant taxonomy, but we were not able to see any of the work there.

One laboratory under the department of economic botany and plant chemistry was *screening local plants that might be used to cure cancer*. Plants traditionally used by local people were fed to mice and rats inoculated with S 1o8 and Walker 256 tumours. As always, cooperation with the peasants and people's communes was stressed. So far the work was carried out on a purely empirical basis. Some promising results had been obtained with *Cephalotaxus fortouni* and certain species of bamboo.

Another laboratory under the same department was *screening* *woody plants to obtain oil* for food and industrial purposes. Promising results were reported with seeds of *Podocarpus nageia* and *Scleropyum wallichianum.* The work was in a preliminary stage, and the analytical equipment seemed somewhat primitive.

The *department of plant physiology and biochemistry* had several projects of which we were briefly introduced to three. The first involved study of the respiratory activity of seedlings of inbred lines of maize as part of a programme on biochemical and physiological aspects of heterosis in cereals. The second was a study of hormones inducing flowering in *Agave.* The third project was a study of a virus causing damage to *Citrus* plantations; this virus had been spreading rapidly in the last few years. Apical meristems which are more or less virus-free were cultivated on an artificial medium and plantlets were raised. This method has been used with some success for potatos in Denmark, but prospects are probably less good for long-lived perennial plants.

The *department of plant genetics* had only recently been established. The only research project shown to us was raising of haploids of rice by means of pollen culture; the work seemed identical to that carried out in Peking and Shanghai.

We were not able to see any of the research at the department of geobotany and plant ecology. It was said to deal with pollution and reforestation problems.

KWANTUNG BOTANICAL GARDEN, KWANGCHOW (CANTON)

Dahlgaard-Mikkelsen, Fenchel, Kjeldgaard, Olesen Larsen, and Strid visited the Kwantung Botanical Garden, Kwangchow, in the afternoon of October 29. We were received by Prof. *Chen Feng-huai* (vice-president of the revolutionary committee of Kwantung Provincial Institute of Botany) and Mr. *Li Teh-chong* (responsible person of the Dept. of Introduction and Acclimatization) in a small pavillion overlooking a pond and a fine planting of *Taxodium*, *Cryptomeria*, *Metasequoia*, and *Araucaria*. The garden covered the huge area of 1ooo hectars on former waste land in the outskirts of Kwangchow; only part of this was at present laid out as a botanical garden.

Prof. *Chen*, an elderly gentleman who had studied in Edinburgh, gave a brief introduction. The construction of the garden was started as late as 1958. There were now about 3.ooo species of indigenous and foreign subtropical and tropical plants. The labour force comprised over a hundred workers. A seed catalogue for 1975/76 had recently been published; it listed 538 species of both indigenous and exotic plants.

The main task was said to be the introduction of useful plants (trees for reforestation, medical and other economic plants), but there were also large ornamental collections of ferns and orchids as well as bamboos (about 5o species). We were shown a large plantation (at least a hectar) of sandel trees semiparasitic on a species of *Albizzia*. Time did not permit us to see the herb garden which was said to contain 5oo species of herbs used in southern China. Herbs play a major role in traditional Chinese medicine which is given equal status with western medicine; the herb garden is still being developed and is likely to become an important reference collection.

The Botanical Garden was associated with an arboretum some 1oo km outside Kwangchow.

INSTITUTE OF ENTOMOLOGY, KWANTUNG PROVINCE, CANTON

Dalgaard-Mikkelsen, Fenchel, and Kjeldgaard visited this institute in the morning of October 3o. The introduction to the institute and its research programme was given by *Lang Shih-cheng*, vice-director of the revolutionary committee of the institute and by *Li Li-ying*, responsible person of the Biology Control Department. The institute, which was founded in 1958 during the "great leap forward" comprised a staff of 13o, of which 95 were research workers or technicians. It was stressed that the work of the institute was within the framework of "fighting revisionism" and the principles of "three in one", the cooperation with "poor and middle peasants", and the "connection between theory and practice". We were also informed that the institute worked with pest control. It was divided into departments for *biological control, termite control, animal ecology,* and *entomology*.

We were given lectures, illustrated with slides, describing four projects. The first was the *integrated control of rice paddy diseases*. This project was carried out on a lo7 hectar plot in a local commune. The rice paddies are threatened by a number of insect pests and fungi. The principle of the pest control was that representatives of the production brigade and the production teams had the responsibility to make field surveys and to monitor the development of the various diseases and pests. These were then controlled by a variety of methods including raising of ducks on the paddies (according to tests these were insectivorous!), the protection of frogs, the culture and release of parasitic wasps, the culture and release of *Bacillus thuringensis*, and the application of polyxin for controlling the fungus *Pollicularia sasakii*. The mass production of parasitic wasps was based on silkworm eggs and we were told that 3 men could grow lo mill. wasps per day and that about 5oo.ooo wasps were required per hectar. We did not get a clear picture of the success of these attempts but were told that biological control programmes of this sort were extended to about 6o communes in the province.

Another project concerned the elimination of rodent pests (*Rattus losea, R. norvegicus, Bandicola indica, Mus musculus*) which destroy rice and sugar cane crops in the coastal areas. The approach was to poison the rodents with zink phosphide. In the Western world this substance has yielded to anti-coagulants such as coumarin due to its high toxicity for humans and due to its unpleasant smell which makes rats reluctant to eat it. The group tried different mixtures with potatos, rice, or yams to render the poison more attractive. They were also interested in the optimal season for the application of the poison and therefore studied the reproductive cycle of the rodents. It was claimed that the method reduced damage by rodents with 8o%, but we were not informed about the size of the area tested or to what extent the effect was lasting.

The attempts to control the mite *Panychus citri*, which is a pest on citrus, by using organo-phosphorus pesticides had been unsuccessful because these toxins also kill the natural enemy of *Panychus*, the predatory mite *Typhlodromus victoriensis*. Studies on the differential toxicity of different poisons towards these two mites were carried out. It had turned out that some insecticides were low-toxic with respect to *Typhlodromus* (graleoron, tedion, Bordeaux solution) and could therefore be recommended for controlling *Panychus*, whereas organo-phosphorus pesticides and pine-resin extracts were highly toxic for *Typhlodromus* and therefore could not be recommended.

The last project which we were told about consisted of the control of the lepidopteran *Emblemma* which is a pest on *Ficus* and *Dalbergia* trees planted in forests in the Kwantung Province. For this purpose bracyonid eggs (a parasitic wasp) were applied in the field. The project had been started in 1972, when 4oo eggs had been applied locally. In 1973 5o% of the lepidoptera had been parasitized and their number had been reduced from 3o to 5 per meter tree stem. In the first generation the parasite had migrated within a radius of 1.7 km and in the following generation within a radius of 7.5 km. We were informed that in the areas treated in this way production of wood had increased by 2o-3o% and that the method now was employed in several areas within the province.

SOUTH CHINA SEA INSTITUTE OF OCEANOLOGY, ACADEMIA SINICA, CANTON

In the morning of October 3o, Dalgaard-Mikkelsen, Fenchel, and Kjeldgaard visited this institute. At the reception, vice-director *Hwang* informed us that the institute had been founded during the "great leap forward" in 1959, and was occupied with the study of the South China Sea, and had a staff of 3oo persons. The institute comprised departments for *hydrography and meteorology*, for *marine biology*, for *marine geology*, and for *marine physics*. We were further told that the institute had a field station somewhere by the South China coast and also survey boats; at present only the department for marine biology was situated in the building we were visiting. Questioned, Mr. *Hwang* told us that there was one more institute of oceanology in China under the Academy, situated in the Shantung Province, and that there also existed some fishery science institutes; with respect to the latter the information we got was very vague as were answers to questions about commercial marine fisheries and fishery policies in China.

We were shown pickled or dried collections of molluscs, corals, crustaceans, echinoderms, phytoplankton, fish larvae, fish, and algae. All activity was centered on the identification and distribution of littoral species of these groups along Hainan and other South China Sea coasts. There appeared to be little interest in the general biology or natural history of the animals and we saw no facilities for experimental work.

INSTITUTE OF BIOCHEMISTRY, ACADEMIA SINICA, SHANGHAI

During the morning of October 27, Dalgaard-Mikkelsen, Fenchel, Kjeldgaard, Olesen Larsen, and Strid visited the Institute of Biochemistry.

The delegation was received in the tea room by the vice-chairman of the revolutionary committee, professor *Wang Ying-lai*. The Chinese delegation also included the following, among others: *Lui, L.S.*, responsible for research planning; *Lu, C.H.*, from the insulin group; *Choun, Y.T.* and *Li, C.C.*, from the hepatoma group; *Yuan, S.W.*, and *Du, Y.C.*, from the peptide synthesis group; and *Chou, K.Y.*, from microbiological biochemistry.

Professor *Wang* gave a brief introduction to the history and the research of the institute, before representatives from each group gave short lectures with slides about their research projects. The spirit in which these lectures were given and the discussions they sparked not only with the delegation but also among the Chinese scientists present gave a clear impression of the very high scientific standard prevailing at this institute.

The institute was founded in 195o as a joint biochemical and physiological laboratory, which in 1958 was divided into two institutes. We were told that during the cultural revolution work was more directed towards practical applications, but at the same time attention was paid to basic aspects of research.

The following aspects of biochemistry were studied:

1) *Peptide synthesis*. Relationship between structure and function of insulin. Studies of luteinizing release hormone, hormones from the pituitary and hypothalamus. Synthesis of glucagon and development of new methods of polypeptide synthesis.
2) *Nucleic acids*. Synthesis of oligonucleotides. Agricultural application of nucleotides.
3) *Studies of immobilized enzymes*, e.g. phosphodiesterase.
4) *Studies of early diagnosis of liver cancer.*
5) *Studies of plant viruses* of citrus, rice and mulberry.

6) *Biochemical reagents factory* was started in 1958 with the purpose of supplying amino acids for the synthesis of insulin. The factory had a production list of about 4oo reagents including amino acids and derivatives, nucleotides and derivatives, enzymes and coenzymes; it employed about 8o workers.

The institute is famous for the *first chemical synthesis, in 1965, of insulin,* a small protein with two polypeptide chains of 21 and 3o amino acids. The institute which had been collaborating for the establishment of the crystal structure with the Institute of Biophysics in Peking was now involved in the analysis of structural functional relationship. With pepsin the B-chain can be split at arginine 22 with loss of biological activity (DOI). After the addition of two amino acids gly-phe activity is restored (DHI). If the glycine is replaced by any other amino acid in the l-form, no activity is seen. However, if a d-amino acid is used an active product is obtained.

Trypsin digests 5 amino acids also from C-terminal end (DPI) with maintenance of activity. The binding to the receptor has been measured and it is observed that DHI has some binding activity whereas DPI binds almost as good as the whole molecule. In the crystal structure insulin is seen as a dimer with two antiparallel hydrophobic regions. It was suggested that the receptor binding was an analogous hydrophobic binding. It was also suggested that the insulin monomer was the active component, since DPI was found by Sephadex G5o filtration at pH 7.o and o.2M KCl to exist as a monomer in solution.

Besides insulin derivatives, the *synthesis of polypeptide hormones* was performed: angiopression, oxytocin, vasopressin, luteinizing release hormone (LRH) and thyrotropin release factor.

Modification of the Merrifield method of solid phase polypeptide synthesis was used. Especially it was mentioned that the use of the potassium salt of the butyloxycarbonylated amino acids greatly improved the esterification of the polymer. For the oxytocin the overall yield was 62%, for vasopressin 71%.

The LRH analogue was synthesized with d-ala replacing the C-terminal glycine. This analogue had a much higher biological activity than the natural product.

In the grass carp spawning was produced by LRH at 15oo μg/kg but with the analogue at 5-1o μg/kg. As the grass carp does not normally spawn in ponds, injection of LRH in the carp is of economical importance.

The synthesis of glucagon of 29 amino acids was studied starting with a tripeptide met, asn, thr bound to the resin, which in this case was a thin layer resin. The next step involved condensation to a pentapeptide, then a nonapeptide and finally two hexapeptides. The overall yield of the process was 85%.

In cancer research efforts were concentrated on the early diagnosis of liver cancer by measuring α fetal protein (AFP) in the blood using radio-immune electrophoresis as an assay.

The values obtained were:

	nos. cases	2o μg/ml	2o-3oo μg/ml	3oo μg/ml
normal	2oo	2oo	o	o
hepatomas	3o	4	1	25

The assay was used for screening about 5oo.ooo individuals:

	nos. examined	nos. AFP + cases
normal	417.644	57
persons with liver disease	76.66o	5oo

It was furthermore found that 7o% of liver cancer patients had antibodies against β-hepatitis.

Evidence was also obtained showing that the AFP from hepatoma patients was identical to the AFP from the fetus.

INSTITUTE OF BIOPHYSICS, ACADEMIA SINICA, PEKING

During the afternoon of October 22, Dalgaard-Mikkelsen, Fenchel, Kjeldgaard, and Meyer visited the Institute of Biophysics and were received by *Pei Shih-Chang*, director of the institute, *Shing Ray*, officer in charge of research programme, *Chu Liu-Chin*, member of the nucleic acid research group, and *Ku Shiao-Cheng*, member of the crystal structure analysis group.

Professor *Pei* gave an account of the work of the institute which was established in 1958. It had about 4oo research and technical workers. In the very scattered buildings of the institute there were 7 divisions, a large workshop and an animal farm.

The research covered five main areas:

1) *Radiation biology.*

A) Long term exterior radiation: Monkeys and rats were irradiated by Co-6o γ or X-rays. The biological effects and mechanisms of action were studied. Monkeys kept in tiny cages now had received an accumulated dose higher than 4ooo rad.

B) Long term interior radiation: The general expression of lesions, the biochemical and cytological effects of irradiation was studied in dogs, rats and cultured cells following irradiation by Strontium-9o, Iodine-131, Calcium-45, Polonium-21o, or fission products.

C) Radiation dosimetry: Measurements of total body radioactivity by thermoluminescence.

D) Radioactive pollution: A broad social investigation of environmental radioactivity in the suburbs had just been started.

The radiation biology group had at its disposal two radiation rooms, one high dosage room with a source of 3o.ooo g radium equivalents and one low dosage room with 5 point sources Co of 8 µC each.

2) *Molecular biology.*

A) Structure of biomacromolecules. In collaboration with the Physics Institute the structure of pig insulin was determined by X-ray crystallography to a resolution of 1.8 Å. Derivatives of insulin were studied to elucidate the relationship between structure and function.

B) Nucleic acid studies, sequence analysis, and small scale production of tRNA, nucleotides, polyIC and enzymes, polynucleotide phosphorylase, RNaseI, RNaseT from *Neurospora*, phosphomon- and diesterases.

C) Enzyme studies of cyclicAMPphosphorylase and glyceroaldehydephosphate dehydrogenase.

D) Structure of biomacromolecules in solution, e.g. by ESR.

3) *Submicroscopic structure of cells by EM.*

A) Fine structure of the oocyte of *Chirocephalus*.

B) Relationship between structure and function of the mitochondria from yeast.

4) *Biophysics of receptors.*

A) Mechanical receptors in the leg of the pigeon, studies of fine structure, physiological function, and frequency range selectively to vibrations. In collaboration with earth quake researchers a vibration detector had been designed.

B) Studies of visual receptors, biocular depth perception and formulation of mathematical models of the retina.

C) Biophysical studies of acupuncture, electrophysiological and thermoepidermal changes.

5) *Biophysics of technological projects.*

Design of new instruments and manufacture of waste water radioactive detectors and radioactive counters, Geiger counters and large area gas flow counters. Design of a scintillation counter with loo samples, 3 channels, 2 external standards with a counting efficiency for C-14 of 9o% with a background of 25 cpm. and for H-3 an efficiency of 54% with a background of 22 cpm. Also design of a spectrofluorometer and of ESR equipment.

This large institute gave the general impression of being very efficiently operated. However, as usual it was difficult to get but a very superficial impression after being presented to such a large number of different areas of research in just one short morning.

On October 23 during the afternoon Kjeldgaard gave a very well visited lecture at the Biophysics Institute about the use of radioactive labelling techniques and of one and two dimensional acrylamide gels for the analysis of regulatory processes in bacteria. The lecture was extremely efficiently translated by a member of the nucleic acid research group.

INSTITUTE OF CHEMISTRY, ACADEMIA SINICA, PEKING

In the afternoon of October 23, Olesen Larsen made an improvised visit to this institute. He was received by the following:

Shi Wei-min, Scientist,

Chian Ken-yuan, Professor,

Wu Nai-tie, Chairman of the revolutionary committee of the institute,

Shi-Lian-he, Assistant researcher,

Liu shi-Hung, Scientist,

Li Che F eng, Assistant researcher.

The institute, which in 1956 employed less than 2oo persons including less than loo research workers, now employed about 6oo, more than 4oo of them belonging to the research staff. It was divided into six laboratories covering *polymer chemistry, polymer physics, elementary organic analysis,* and *fundamental research*. The main emphasis was on applied research, but recently also fundamental research had been taken up. According to the principle of self reliance much effort was put into the development and construction of equipment.

After an introduction laboratories in the following fields were visited:

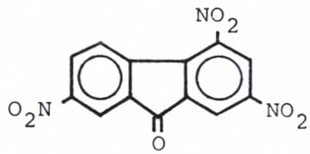
1. *Organic crystals*. Work here was started in 1971. At present Cu-phthalocyanine was studied. Purification was performed by vacuum sublimation. Attempts were made to produce a Sandwich cell by deposition at lo^{-5}mm Hg. The structure and properties of Cu-phthalocyanine, especially the $\alpha \rightarrow \beta$ transition and photoconductivity, were reportedly studied by X-ray and electron diffraction methods and IR spectroscopy.

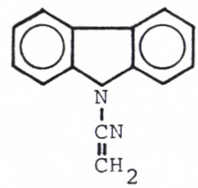
2. The *synthesis of caprolactam*.

3. *Gas chromatography*. An instrument had been developed mainly to be used in enviromental studies. The instrument had four different detection systems including thermoconductivity, electron capture, and argon flame ionization detectors. Hydrogen to be used as a carrier gas was produced in a special gas ge-

nerator. Production of packing materials had been going on since 1967.

4. Production and properties of *photoconductive materials*. The following compounds were studied:





partly for the purpose of electrostatic photocopying.

5. *Adhesives*. The types of compounds studied included α-cyanomethacrylic acid polymers, organosilicon polymers for high temperature adhesives, phenol-formaldehyde epoxy resin adhesives, butadiene acrylonitrile adhesives, carboxy-terminated polybutadienes for liquid rubbers, and polyamides. Molecular weight determinations of polymers were carried out on a home-build instrument using gel-filtration techniques. Infrared spectroscopy was performed on Perkin-Elmer and Zeiss, Jena (East Germany) instruments.

6. *X-ray crystallography*. Presently the structure of an antihelminticum was studied. Part of the work was made with the X-ray diffractometer at the Institute of Biophysics, Academia Sinica.

7. The institute had a French *RMN 25o NMR-instrument*. This 25o MHerz-instrument was said to be available for scientists from all over the country. It was not made clear, however, exactly what problems were studied with the aid of this instrument. Questioning whether they contemplated to study insulin in solution in cooperation with other institutes I was given an affirmative answer. Surprisingly, this big instrument was the only NMR-instrument in the whole institute. Consequently there was no possibility to screen problems before using the big instrument, and they must be forced or tempted to use it in many tasks for which a small instrument would have been sufficient. The instrument was said to be the first outside France

and was recently installed, which may partly explain the fact that the activity around it seemed rather low.

The general impression of the institute was that the main or only emphasis was on applied research. The work seemed of reasonable quality but by no means remarkable. The laboratories looked old but were of an acceptable standard. Also the equipment was reasonably good but certainly not outstanding - except for the NMR-instrument. Obviously much effort had been put into the production of instruments.

INSTITUTE OF ORGANIC CHEMISTRY, ACADEMIA SINICA, SHANGHAI

In the afternoon of October 27, Dalgaard-Mikkelsen, Fenchel, Kjeldgaard, Olesen Larsen, and Strid visited this institute. The following Chinese scientists received us and introduced the work of the institute:

Wan-Yu, Professor,
Liu Chu-tsin, Professor,
Chou Wei-shan, Professor,
Ku Li-zen, Secretary,
Lee F ang-lin, Professor,
Gi Ching-shuen,
Hsu Ti-chen,
Chian-Yen-long.

Especially professor *Liu Chu-tsin*, who had spent several years in the United States, returned to China in the nineteen fifties and spoke fluent English, was very helpful. *Liu Chu-tsin* also assisted the delegation during the other activities in Shanghai.

The visit took place according to the traditional program: Introduction, visit to laboratories, and final discussion.

The institute was founded in 195o. Before that time there was no institute outside Peking specializing in organic chemistry, only four specialists in natural products chemistry, and less than 2o organic chemists in the whole of China. Today the institute had a staff of more than 1.1oo, about 6oo of these being scientific or technical research workers. The institute also included a pilot plant in a suburb of Shanghai; thus combining research with production. From 1968 not only natural products chemistry but also fundamental organic chemistry was studied.

Some of the research fields were as follows:

1. *Steroids including oral contraceptives.*
2. *Other oral contraceptives.*
3. *Synthesis of prostaglandin.*
4. *Insect hormones and pheromones.*

5. *Total synthesis of polypeptides* (in cooperation with the Institute of Biochemistry in Shanghai and the Department of Chemistry at the University of Peking the synthesis of insulin was reported in 1965).
6. Initial studies on the *synthesis of proteins*.
7. Initial studies on the *synthesis of nucleic acids*.
8. *Oil fermentation by microbial oxidation*.
9. *Fluorine-containing compounds*, including polymers, teflon, and fire-extinguishers.
10. *Boron compounds*.
11. *Metal-organic compounds for use as catalysts*.
12. *Extractants for wet metallurgy*.
13. *Treatment of phenol-containing waste water*.
14. *Synthesis of liquid crystals* of interest for display techniques.
15. *Instrument production*.

The visits to the individual laboratories were well organized. The scientist had prepared posters and gave short introductions to their work. Laboratories in the following fields were visited:

1. *Fluorine-compounds*. Partly basic research, partly with the purpose of finding useful fire-extinguishers.

2. *Gas chromatography*. Service and instrument development.

3. *Petroleum fermentation*, with the purpose of producing foodstuffs from oil. Pilot plants were operating.

4. *Insect hormones and pheromons*. Synthesis of silkworm juvenile hormone, with the purpose of increasing silk production. Synthesis of the pheromone gossypol, for use in fighting cotton pests. Part of the work described seemed similar to or identical with work carried out at the Institute of Zoology, Academia Sinica, Peking.

5. *Extractants for metal ions* from mine sludges and for treatment of waste water. The work here seemed rather primitive with regard to basic complex chemistry.

6. Study of a new naturally occurring *cucurbitacin* (previously known synthetically) from *Hemsleya amabilis* Diels, useful for treatment of bacterial dysentery and tuberculosis.

7. *Nucleotide chemistry*. Work on introduction of protecting groups. Benzoylation with benzoylimidazole.

8. *Peptide synthesis.* Some very interesting ideas on variations of the solid-phase method using polyethyleneglycol as carrier. New methods for activation of carboxyl groups in amino acids.

9. *Laser pyrolysis of polymers* followed by gas chromatography.

The general impression of the institute was very favourable. The quality of the work was good and some of the problems, especially in peptide synthesis, really interesting. There seemed to be a fair balance between fundamental and applied research. But even if the visit had been very carefully planned, it was obvious that the younger scientists had very little or no experience in talking English and in discussing chemistry with visitors. Presumably the quality of the institute depended very much on a number of senior people.

PEKING VETERINARY STATION

By special arrangement Dalgaard-Mikkelsen visited the Peking Veterinary Station in the morning of October 23.

The station is located in the northern outskirt of the city, and specialized in diseases in horses, mules, and donkeys, which are represented in large numbers in the heavy and very mixed road traffic.

I was kindly received by Mr. *Hsie Chi-Lao*, head of the station, the deputy director, and three veterinarians. None of them were speaking English.

In addition to about 8.ooo out-patient treatments a year the staff worked experimentally to improve their technique for acupuncture anaesthesia in horses. They had localized three determinant insertion points for the needles and tested the optimal current to apply through the needles to obtain adequate analgesia for surgery on the head, neck, chest, forelegs, and even laparotomy. Unfortunately, there was no patient available for demonstration. The insertion points were shown on a drawing: 1. On the chest at the level of the shoulder joint; 2. On the same side foreleg just below the elbow; 3. On the opposite foreleg medially a hand's breadth over the foreknee. The current applied should be 8-1o volts, 1oo milliamperes, 8o to 1oo cycles. Since 197o more than 4oo successful operations had been made on horses anaestheticed by the method.

The station had a well equipped dispensary where the request to combine traditional Chinese medicine with the best of modern western treatments was obeyed. Numerous drugs of mineral, vegetable or animal origin for preparation of multicomponent remedies were stored, and on the other hand penicillins, prometazin, isoprenalin a.o. - all produced in China - were seen on the shelves.

INSTITUTE OF MATERIA MEDICA, ACADEMIA SINICA, SHANGHAI

October 29th in the afternoon Dalgaard-Mikkelsen, Fenchel, and Kjeldgaard visited this institute. The following Chinese staff members received us:

Kao Yi-sheng, Professor, director,

Chou Yi-chang, Deputy director,

Meng Cheng, Head of administration,

Chu You-cheng,

Li Ming-ming.

About 5oo people were employed at the institute which was divided into five departments:

1. *Synthetic drugs*,
2. *Plant chemistry*,
3. *Pharmacology*,
4. *Antibiotics*,
5. *Analytical chemistry*.

Besides, a common library, animal stables and workshop were available, and the institute was associated with a pilot plant located in another part of the city for production of drugs used in clinical trials.

The research included: *Antineoplastic drugs, contraceptives, drugs against coronary diseases, psychopharmacology, drugs against liver diseases, and drugs against chronic bronchitis.*

Since 1958 about 2.ooo compounds had been screened for antineoplastic effects. After preliminary testing for acute toxicity the experimental models used were inhibition of development of transplantable tumours in rodents such as Ehrlich carcinoma in mice and Walker carcinosarcoma in rats. Among the compounds investigated Actinomycin D, Vinblastine, and Vincristine were mentioned. After screening of long series of synthetic chemicals a few had passed through further toxicological tests to clinical trials. Side effects, however, had often been severe, and research had been started to develop antidotes.

In the field of oral contraceptives a weak estrogenic steroid called Anordrin had shown pronounced antifertility effect in experimental animals and low toxicity. By investigations with the C-14 labelled compound absorption as well as elimination was found to be rapid, and since 1969 clinical trials had been performed successfully by using one dose postcoitally.

As a preliminary screening method in the search for drugs active against bronchitis, the antitussive effect on sulphurdioxid-induced cough in mice was used. An active compound from *Rorippa montana* was utilized in therapy. Studies were made on the isolation, identification, and synthesis of this compound.

It was the common denominator of the departments that great efforts were made to isolate the active principles in herbs used traditionally in Chinese medicine not only to make standardized extracts but to produce the compounds synthetically and dispense them in different pharmaceutical preparations.

The institute had facilities for high pressure liquid chromatography, a laboratory for NMR, and a service unit for electron microscopy.

INSTITUTE OF PHYSICS, ACADEMIA SINICA, PEKING

Meyer visited this institute on October 22, and was received by *Shih Ju-wei* (Professor, Vice-chairman of the revolutionary committee of the Institute of Physics) and *Wang Ju-ching* (responsible for academic affairs).

General information

The Physics Institute had 7oo staff members, about 6o per cent of whom had university degrees. It was divided into 8 departments:

1) *Plasma physics*
2) *Magnetism*
3) *Lasers*
4) *Crystallography*
5) *Low temperature physics*
6) *High pressure physics*
7) *Acoustics*
8) *Theory*

Crystal growth

$LiIO_3$ crystals were grown from solution in typical sizes of 2 x 3 x 4 cm. The growth mechanisms were studied - also in relation to different structural phases. The crystal were used for frequency doubling in laser experiments.

The growing of YAG-crystals in a two-oven set-up with programmed temperature regulation ($\pm$ 1° C) was also demonstrated.

Low temperature physics

The institute had a home-built helium liquifier with a capacity of 2o liters per hour. The total consumption of liquid helium amounted to about 4oo l so the liquifier was only working two days a week. The evaporated helium was recollected. It was estimated that there were about 12 helium liquifiers in China.

The superconducting properties of Nb_3Sn were studied - especially the influence of additional Cu.

Superconducting magnets had been produced for the past 4 years using looμ wire in tape form. Fields up to lo4 k Gauss were produced with a magnet opening of 15 mm diameter and a length of 9o mm.

Magnetic bubbles

Experiments were made with magnetic bubbles of epitaxial $Eu_2ErGa_{o.7}Fe_{4.3}O_{12}$ on substrates of $Gd_3Ga_{o.5}O_{12}$ with photo-etched permaloy strips controlling the path of the bubbles. Apparently no practical bubble devices had been developed so far.

Concluding remarks

The Physics Institute was in general well equipped with modern oscilloscopes and other electronic measuring apparatus. In several cases oscilloscopes and other equipment were found stored in piles under plastic cover - apparently in surplus. The research projects I saw were concerned with modern solid state problems, although perhaps not of a very original nature.

Lecture by NIM on "Conduction in 1-dimensional organic crystal"

After the visit to the Physics Institute, NIM gave a one hour lecture on electrical and optical properties of 1-dimensional organic crystals of the TTF-TCNQ type. The audience consisted of about 3o persons mainly from the Physics Institute. Present was also professor *Chien Jen-yuau* from the Institute of Chemistry, where they were growing TTF-TCNQ crystals. Professor *Chien* seemed to be well acquainted with the international development in this field.

INSTITUTE OF SEMICONDUCTORS, ACADEMIA SINICA, PEKING

Meyer visited this institute on October 21, and was received by *Liu Ta-ming* (Director) and *Cheng Chung-chih* (Professor; had studied at Harvard and Brooklyn Polytechnique).

The Semiconductor Institute was situated in a small side street about 1o minutes drive from Peking Hotel. It was founded in 196o with about 1oo people. It now had a total staff of 9oo including 5oo scientific workers. The institute consisted of a number of rather old buildings with a total area of 2o.ooo m^2 (two of the buildings used to be dormitories).

The institute had four main fields of research:

a) *Materials*

b) *Integrated circuits*

c) *Microwave components*

d) *Semiconductor physics.*

It was divided into seven laboratories:

1) *Mainly concerned with preparation of GaP, GaAs,* $GaAl_xAs_{1-x}$

2) *Bipolar integrated circuits*

3) *MOS integrated circuits*

4) *Reliability of integrated circuits*

5) *Microwave devices*

6) *Instruments and equipment*

7) *Semiconductor lasers.*

It was rather surprising for this type of work to find that there were no "clean rooms". I was told that they were planning to build some. They claimed to concentrate on basic research and related development and to transfer their results at an early stage to external semiconductor factories.

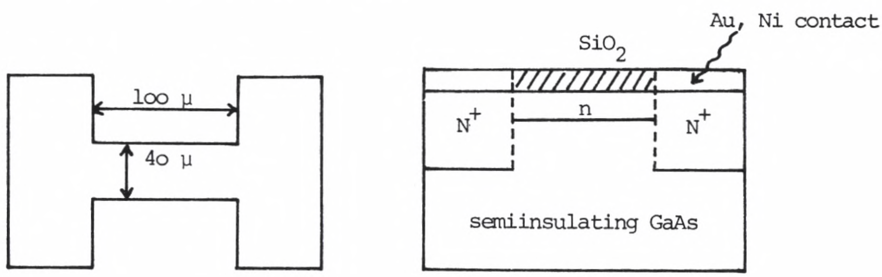
<u>Materials evaluation</u>

A 3 point probe was used to measure conductivity. Capacitance-voltage measurements and diode break-down results were used to determine the concentration of impurities. They also used a spreading resistance plotter. Some of the standard instruments were from Marconi. The set-ups were rather standard, not automated and not very advanced.

Microwave experiments

They were producing *Gunn-devices* based on GaAs. These devices were driven in a special mode where the field in the domain was sufficiently high to yield a strong avalanche effect. The electron-hole pairs created by the avalanche effect are retained in the bulk behind the domain and influence the oscillation period of the device. The recombination radiation from the surplus electron-hole pairs was detected by a photomultiplier.

A typical device was made by planar techniques with dimensions as shown in the figure:



The electrical signals from the device were studied by a Japanese sampling oscilloscope. They claimed a theoretical efficiency for the device of about 36%.

They were producing silicon *IMPATT-diodes* for the 4 mm wave region and claimed to have reached an output power of loo mW at 75 GHz, c.w., with an efficiency of 2.8%. They used a circular configuration with a dot-diameter of about 3oμ, or alternatively a strip configuration with the dimensions 2o x 5oμ. The diode capacitance at zero bias was given as o.2 pF. They showed an experiment with 15 mW out at 4 mm. The noise figures were said to be rather high.

They also produced Shottky-barrier mixer diodes for 4 mm waves on epitaxial GaAs. The metal was evaporated or electroplated Ni with a pressure point contact. They claimed to reach conversion losses of about 6 dB. Equipment for noise measurements was under construction, but no results had been obtained so far.

Crystal growth

GaAs crystals were grown in a *horizontal Bridgeman set-up* with 3 temperature zones. The temperature was controlled within $\pm$ o.5^{o} C. They were producing undoped and doped crystals (Zn for p-type, Te for n-type). Typical dimensions were lo x 2 x 1 cm. Room temperature mobilities of around 7.ooo cm^2/V.s. and mobilities at 77 K of about 3o.ooo cm^2/V.s. were quoted. They used dislocation free seed crystals. They were also growing GaAs from vapor phase (Ga - $AsCl_3$ - H_2) at a rate of about 4oμ per hour on <211> substrates. Mobilities at 77 K were quoted as 7o.ooo - 8o.ooo cm^2/V.s.

Semiconductor lasers

They were producing semiconductor lasers with hetero-structures using liquid phase growth techniques. A typical structure would have 4 layers on an n-type GaAs substrate:

1) 1 μ n-GaAs doped with Te
2) o.3μ p-GaAs doped with Si
3) 1 μ p-GaAlAs doped with Ge
4) 1.5μ p-GaAs doped with Ge

They quoted the following data for a structure with an area of 2o x 2ooμ: Threshold current equal to loo mA. CW-operation was obtained at 3oo K, but they had serious lifetime problems. As far as I understood a typical lifetime would be of the order of a few minutes.

Photographic equipment for integrated circuits

There was not time for a detailed discussion but I was shown a computerized pattern generator that could provide a number of standard geometrical patterns on tape. Their step and repeat equipment was run automatically using tape. As a circuit example they showed a rather simple MOS shift register.

The visit to the Institute of Semiconductors took place in the morning. In the same afternoon Meyer gave a lecture on "High field effects in silicon". The lecture took place in a seminar room at Hotel Peking from 3.3o to 6 p.m. Professor *Cheng Chung-chih* acted as interpreter, and the audience consisted of about 4o scientists engaged in semiconductor research, including a few from semiconductor factories. After the lecture about 15 persons stayed behind for half an hour's extra discussion. A few of these were well acquainted with Meyer's publications and other references related to the subject of the lecture. Some of the questions were very relevant.

The same lecture was given at the Canton Science Center on October 31 from about 2.3o to 4.3o p.m. Present were about 4o people who were mainly experimentally oriented. Nearly all questions were concerned with experimental details.

DEPARTMENT OF PHYSICS, SUN YAT-SEN UNIVERSITY, KWANGCHOW

On the return from Kweilin on November 3 Meyer visited the Department of Physics, Sun Yat-sen University. (For general information about the University and an account of the Biology Department, see under the heading Universities).

The reception committee consisted of Professor *Li Tian-ching* (responsible member of the educational revolution group), Professor *Chang Chung-haiang* (nuclear physics), and Mr. *Chou Yun-biao* (head of the semiconductor laboratory).

The Department of Physics had 4 divisions:

1) *Optics*
2) *Radio physics*
3) *Semiconductor physics*
4) *Nuclear physics*.

Semiconductor workshop

There were lo senior students working on semiconductor thesis projects (4 months period).

Their equipment was of medium to low standard. They had diffusion ovens for B and P, but the equipment was rather simple (homemade). An example of a more advanced set-up was RF-sputtering of Si_3N_4 and ultrasonic bonding equipment.

They produced a number of different circuits and devices, e.g. Shottky-barrier varactor diodes for the frequency range from loo MHz to 2ooo MHz. Smallest line width in their integrated circuits was quoted as 5μ. They did not put much effort into the clean room standards.

Optical division

I was shown a *holographic set-up* with a He-Ne laser as light source. Under-water measurements were mentioned as a possible application.

The division also had a homemade *CO_2-laser* (5o cm in length). This laser was used, among other things, for irradiation in connection with rice breeding.

An *Argon-ion laser* (1 m) was under construction. They planned to use it in connection with experiments on colour TV.

Two students in the optical laboratory had built a *dye-laser* (Rhodamin 6B) which was tuneable in the range from 57oo-62oo Å. They were talking about applications for optical spectroscopy and laser radar.

Small series of He-Ne lasers were also produced after order. Typical applications were alignments in large constructions (ships, buildings, etc.).

The efforts in *semiconductor physics* seemed rather modest. They were interested in I-V characteristics for different types of pn-junctions. About 3o students per year were taking this speciality. I was told that there are about 2o semiconductor factories in the Canton area, but that none of them produce LSI-circuits.

Planned projects

Ion-implantation for shallow pn-junctions. They were buying an accelerator from Peking.

An investigation of gravitational waves was also planned.

Concluding remarks

The general standard of research seemed to be rather low compared with the activities we saw at the institutes in Peking and Shanghai.

PEKING UNIVERSITY

Peking University is situated in a walled area which used to be the private garden of a wealthy court official. The settings are beautiful with small lakes, weeping-willows, carved marble bridges, and a tall pagoda (now used as a water tower). The university was the scene of some of the more dramatic events during the cultural revolution. At the crisp autumn morning of our visit (October 24) everything was peace and tranquility, however. As usual we were received by a welcoming committee. This included the following:

Chang Lung-hsiang; Professor of biochemistry, responsible person of the revolutionary committee of Peking University, in charge of work in educational revolution,

Chen Yueh-tsen; Professor of zoology, Chairman of the revolutionary committee of the Department of Biology,

Chu Sheng-lin; Professor of physics, Chairman of the revolutionary committee of the Department of Physics,

Sheng Tung; Professor of biochemistry,

Yang Li-ming; Professor of nuclear physics.

General information

Peking University (P.U.) was founded in 1898, and *chairman Mao* worked in the library here in 1918-2o. The May 4th movement was started at P.U. in 1919.

The changes introduced as a consequence of the cultural revolution were described to us in much the same way as at Tsinhua University. Peking University now has 2.7oo teachers and 7.5oo students. All students live in dormitories on the campus - four in each room.

The university is divided into 2o departments with 75 specialities. As an example, natural sciences are divided into mathematics, physics, chemistry, biology, geology, geography, geophysics, and radioelectronics.

P.U. runs seven small factories including one in the field of electronic instruments and one manufacturing pharmaceutical products.

Transformed educational system

The university is run according to the "open door system", i.e. one third of the students' time is spent on manual work in factories, communes, etc.

Chemistry students work in chemical factories and the like; they also get some theoretical teaching in the factories. First year students mainly work in the factories on campus (one third of the year). The duration of the study is 3½ years for natural scientists (up to 4 years for theoretical physicists). The speciality is determined at the beginning of the study. The first class of students (2.3oo) educated according to the new principles graduated in 1974. They have been well received. The "new" students and graduates were said to differ from the "old" in the following respects:

1) They now study for the benefit of the people. They have a clear goal: The people sent them to university - therefore they study for the people.
2) They have practical experience - this is a useful basis, also for theoretical work.

   16o of the first class of students continued at P.U. as post-graduates or teachers. They were selected according to political and professional criteria - after permission was obtained from the local units to keep them at the university.

Scientific research work

Some of the teachers were engaged in research work (we did not find out how many). Research projects were of the following types:

1) *Unified programmes* coordinated by Academia Sinica (e.g. the insulinproject, work on nuclear models, elementary particle physics, etc.).
2) *Projects defined by central ministeries* (e.g. petroleum chemistry, electricity, water conservation). Examples quoted were research on new energy sources (e.g. geothermal power stations) and catalysts.

3) *Projects defined by Peking municipal authorities*, e.g. development of new products as semiconductor lasers for use in industrial production.
4) *Internal university projects* (selected by the university itself).

The distribution of different types of research was given as: 12-15% for fundamental research, 12-15% for development of new products, and the rest for applied research.

Computer center

We were shown a computer built by the students. It was based on 6 layer prints with integrated circuits and operated with batch processing. There were no outside terminals connected to the computer. The data quoted for the computer were as follows: 15o.ooo (?) operations per second, 65.ooo word memory with 48 bits per word. Bigger types (lo^6 operations/sec) were also produced for outside users.

Physics

We were shown a 4 layer GaAs (GaAlAs) laser that had worked more than 2.ooo hours c.w. at 3oo K. The diameter was 3oμ and the isolation was produced by proton-bombardement. Another activity was production of He-Ne lasers (by the students).

TSINHUA UNIVERSITY

Olesen Larsen, Meyer, and Mottelson visited Tsinhua University on October 23, in the morning, and were received by the following:

Professor *Chang Lee*; Department of Engineering Physics,
Chou Chi-hsiang; Department of Chemical Engineering,
Hsii Hsia-sheng; Department of Electronics,
Ai Hsian-chen; English language,
Liang Kwei-min; female student, computer hardware.

General information

Tsinhua University is situated in a suburb about 3o minutes drive from the center of Peking. It has a teaching staff of 3.ooo and 11.ooo students. Spare time courses are given for 1.7oo workers from factories in the neighbourhood.

The university is mainly concerned with science and engineering subjects; it is divided into 11 departments with 55 specialities. Due to the limited time available we were only able to visit the Electronics Department, the Department for Mechanical Work, and the Library.

The university buildings were rather new (from the 195o'es). A supplementary branch of the university is situated in the countryside, where 5oo students are studying farming machinery etc.

Educational development

A number of changes have been introduced as a consequence of the cultural revolution.

Students can no longer go directly from high school to the university. They must have at least two years of experience in productive labour (factory, farming etc.) before they may be considered for university study. Some have four tc six years in production. The potential students first send their applications to the local units. Selection criteria are the applicant's political moral, his health, and his intellectual ability. The university accepts almost one third of those recommended by the local units.

The duration of the study has been cut down from five to three years. More than 8o per cent of the time was said to be used on subjects of direct relevance for the technical studies (including practical work within the speciality), 11 per cent was used on political studies, 2.5 per cent on farm work and 2.5 per cent on military training. The university has contacts with some 7o factories where teachers and students assist in solving problems. The factories on the other hand send experienced workers to assist as teachers in special courses at the university. The first class after the cultural revolution graduated in the spring of 1974.

The explanation for the educational changes introduced after the cultural revolution was the same as given to us at other universities:

Before the cultural revolution the students were divorced from the broad mass of the people. They were looking down upon peasants and workers and did not want to work in the provincial areas. Nor were they interested in practical production problems. After the cultural revolution this had been changed in accordance with *chairman Mao's* recommandation: *education must follow production.*

In case of divergence of opinion between teachers and students in academic matters, the final decision is made by the revolutionary committee of the university. According to *chairman Mao* the teachers are "key persons" and should be strengthened in several ways. Thus the (older) teachers are sent on supplementary education in factories and in 7th of May schools for 6 to 12 months.

Integrated circuits laboratory

The staff at the integrated circuits laboratory consisted of 2o teachers and 4o technical assistants. There were only 4o students.

The general standard seemed to be quite high - approximately equal to that of similar laboratories at Stanford and M.I.T. in the U.S. They had modern dustfree rooms for diffusion and photographic work, large modern diffusion ovens, and a loo keV ion implanting accelerator. We saw only a few examples of circuits produced in the laboratory, e.g. a circuit for shift registers with 1 MHz clock frequency.

Mechanical workshop

All students have a five week course in the workshop where they produce machine parts. Students who specialize in this field carry out projects of a more advanced nature, e.g. digitally controlled machine tools. Experienced factory workers assisted as instructors.

The machines were subsequently produced in small series. The workshop building had been constructed as a project by the civil engineering students.

Library

The library covered on area of 7.ooo m^2 and included 1.3 million books and 2.ooo foreign journals. As far as we could judge they were well supplied with Western journals in the technical and natural sciences fields (e.g. IEEE, Phys. Rev. etc.). The journals were up to date (the most recent issues were only two to three months behind).

We had opportunity to interview a second year female student of computer handware about her theoretical studies. She had, among other things, studied Boolean algebra, ordinary differential equations, and semiconductor devices, but she did not know the Schrödinger equation. We were told that students of semiconductor physics read Kittel's introductory book on solid state physics.

Concluding remarks

The courses seemed to be quite specialized and directed towards a rather narrow professional activity. This is consistent with the short duration of study (3 years). The limited number of laboratories we were shown were well equipped and operated at a professional level comparable to that of Western university laboratories. There is strong emphasis on creating close ties to practical production work and practical problems both in teaching and research.

FUDAN UNIVERSITY, SHANGHAI

Meyer and Mottelson visited Fudan University on October 27.

General information

Fudan is a general university covering both science and letters with 7 departments in each field. In letters these are: *Chinese*, *History*, *Philosophy*, *Journalism*, *Economy*, and *International Politics*. In science they are: *Mathematics*, *Computer Science*, *Physics*, *Optics*, *Atomic Energy*, *Chemistry*, and *Biology*.

The university had 4.ooo staff members of which 2.ooo had university degrees. The number of students was 3.5oo of which 4o% were in letters.

As in the other universities much emphasis was put on "educational revolution" according to *chairman Mao's* recommandations and the conclusions of the cultural revolution. Education should serve proletarian politics and aim at integration of students with workers, peasants, and soldiers.

In the science departments the new students were taking refresher courses of 3-6 months duration in mathematics, physics, and languages.

Attempts were made to evaluate the results of the new educational principles by interviewing the local units. 5o units had been interviewed this year and we were told that the students were now more responsible and showed more solidarity with the working people. Some of the factories had recommended that the students should have more soft-ware courses. This recommandation would now be followed.

It was estimated that 8o% of the graduating students would return to their original units.

The university was running three factories within the fields of Electrical Equipment, Petro-chemistry, and Optics. In addition the university had close connections with about 8o factories involved in the teaching programme.

The duration of the studies was three years. There were also short courses directed towards problems in society. New light sources for photographic printing was mentioned as an example. The enrolment in the short courses was 6.ooo students per year.

In addition they offered correspondance courses especially for young people who had followed *chairman Mao's* recommandation to go out and work in the provinces - with Tachai as the great example. 17.ooo students per year were taking correspondance courses.

Post-graduate research class

113 students (divided equally between science and letters) were carrying out two-year post-graduate studies. Of these one third had graduated from Fudan University while the rest had been selected from factories and farms - with academic background though.

Integrated circuits laboratory

They were producing bipolar transistor circuits only and had two production lines, one for digital circuits and one for linear circuits. As an example they showed an operational amplifier with 6o dBs (?) gain using super-beta transistors. Some of their circuits were made in small scale production. About 4o students were working in the integrated circuits laboratory.

They used manual cutting for the first lay-out of circuit masks, but had a rather advanced step and repeat system. It was computer controlled and exposed 6 masks simultaneously with a He-Ne laser as a light source. Line widths of 3µ were quoted.

Thin film research

They were experimenting with RF-sputtering for production of thin films. An example was RF reactive sputtering of Si_3N_4 for passivation. They also had a large DC-sputtering equipment for basic research on metal films.

Department for light sources

A considerable amount of research was carried out on strong light sources. This was obviously due to a very active professor with an industrial background. A new building was being constructed for this department which had a staff of more than 3oo.

The department produced prototypes of lamps in the 1 kW to 3 kW range for illumination of airports, stadions, etc. and for movie projectors. They acted as a center in China for this development and the production was later transferred to different factories. Examples of materials used in the lamps were NaI and TlI(?) as well as high pressure Xe-lamps. They had some standard set-ups for measuring the flux (2 m integrating sphere and small angle recording).

Concluding remarks

It was obvious that Fudan University (as other Chinese institutions) gave high priority to solid state electronics. The special activity in the field of light sources seemed to have a historical background.

SUN YAT-SEN UNIVERSITY, CANTON

Dalgaard-Mikkelsen, Fenchel, Kjeldgaard, Olesen Larsen, and Strid visited the university in the morning of October 29. In the afternoon of November 3, Meyer visited the Department of Physics.

The delegation was received by the following persons:

Prof. *Huang You-Mon*, Vice-president, revolutionary committee,

Prof. *Li Tian-Ching*, Responsible member, educational revolution group,

Prof. *Pu Chi-Lung*, Biology department, insect ecology,

Prof. *Chang Chun-haiang*, Nuclear physics (had spent 2 years at the Niels Bohr Institute and acted as interpreter at NIM's lecture).

Mr. *Lo Chin Shien*, Biology department, biochemistry division,

Mr. *Hwang Yat Ming*, Responsible member of biology department.

We were given an account of the history and structure of the university. It was founded in 1924 by the "great bourgois leader" *Sun Yat-sen*, and the university was named after its founder in 1926. In 1952 considerable changes in the structure of the university were made. Thus a number of already established scientific institutions in the Canton area were included in the university. To-day there are 11 departments covering the following subjects: *Chinese language and literature, history, philosophy, economics, foreign languages, mathematics and theoretical mechanics, physics, chemistry, biology, geography,* and *metal sciences*.

There were 1.ooo teachers and only about 3.5oo students. Two reasons were given for this unusually high teacher/student ratio. First, during the cultural revolution no immatriculation took place for several years, and the number of students still had not reached the normal level. Second, in addition to the full-time students about 1o.ooo persons per year followed short courses, and 2.ooo were on correspondence courses. The staff also gave teaching assistance to "community universities" (colleges?).

For the university the cultural revolution has obviously been a traumatic experience. The changes which took place during and after the cultural revolution were described to us in the following way:

Before the cultural revolution *Chairman Mao* had described the correct policy for education. However, due to the undermining of *Liu Shao-chi*, *Mao's* instructions were not enforced. Not until the counter revolutionary line had been criticized was the line of *Mao* carried out in practice. Four points were emphasized:

1) To *strengthen the leadership of the party*. Before the cultural revolution the university was dominated by bourgois intellectuals. In 1968 the "three in one combination" was introduced. At all levels revolutionary and party committees consisting of cadres, workers, and teachers/students were established. In this way the leadership of the party was ensured.

2) A *reform in the enrollment procedure for students*. Before the cultural revolution students were admitted after senior middle school according to the marks of their school exams. This was disgusting for workers and peasants. Now, in accordance with the teaching of *Mao*, students are recruited from among workers and peasants with a rich experience of practice. To be considered for enrollment a student still must have high school marks as well as two years of practical experience from a commune or a factory. Persons fulfilling these requirements can submit an application accompanied by an endorsement from "the masses". This application is subject to acceptance by the authorities and finally by the university. All expenses for students are paid by the state. Students take part in the leadership of the university at all levels.

3) Before the cultural revolution the universities were divorced from society and from proletarian politics. Now an *open door policy* is followed. There are every-day contacts with factories and communes. Thus, in biology there are constant contacts with a people's commune, and students and teachers regularly work and teach there. The main project, biological

pest control, had been applied on 4.000 hectars and had "achieved remarkable results" (visiting the department later we got the impression that this statement may have to be qualified). The department of chemistry worked together with a Canton perfume factory which synthesized menthol. It was stressed, that the main goal was to change the attitude of the students through contacts with workers, peasants and soldiers.

4) *Changes in curricula and examination procedures.* Old teaching material had been revised or purged. Students were previously forced to learn everything by heart, thus becoming "book worms" without true insight. Now the ability for analysis and for solving practical problems are stressed. The students spend only 3½ years at the university. In research problems were previously chosen according to the interests of students and teachers, and subjects were taken from articles in scientific journals. By choosing subjects from "dead documents" science became divorced from socialist construction. Now, in accordance with the new constitution, research should serve the dictatorship of the proletariat and be combined with production in order to strengthen the national economy. We were told, however, that attention was also paid to fundamental research (e.g. study of elementary particles). Somewhat surprisingly, it was said that a project for studying gravitational waves was planned.

Department of Biology

After the introduction we were taken to visit the Department of Biology. At the first floor of the building a class of students (and these were practically the only students we saw) were practicing the latin alphabet.

We were shown the laboratory for *ecological entomology*. The leader of the group was studying the growth rate of a leafhopper living on rice, as a function of temperature. The goal of this work was to optimize insecticide treatment and biological control. In the discussion it became clear that the group was hardly aware of any Western literature on the subject of insect population biology or predator-prey systems from the last 3o years. Another project was concerned with biological control of the hemipteran *Tessaratoma* on *Litchi* trees. Attempts were made to control it with a parasitic wasp grown in the laboratory and released every year in a commune. A similar project for controlling a moth parasitizing rice was also carried out. The laboratory had rather primitive equipment, and the level of activity seemed relatively low.

We were shown a *herbarium* which was said to comprise 14o.ooo specimens (1oo.ooo from China, the rest from S.E. Asia). There were 14 staff members in the herbarium, working on the indigenous flora and the geobotany of the region. They were participating in the Flora Sinica project, doing the families Hammamelidaceae, Theaceae, and Pittosporaceae. There was said to be some exchange of specimens with the Phillipines and Indonesia. The herbarium library had about 1o.ooo volumes including recent issues of some Western journals like Kew Bulletin, Journal of the Linnean Society, Botanical Register, Hedwigia, and Feddes Repertorium. Richard's Tropical Rain Forest had recently been translated to Chinese by Mr. *Chang Hung-ta*, a staff member of the herbarium.

LIBRARIES

At the *Tsinhua University* we visited the *main library*. It contained 1.5 million books and had a current stock of 2.ooo journals in foreign languages. We saw a large number of these journals in one of the big reading rooms. Nearly all the journals were Chinese copies and the method of copying (probably offset) indicated that they were produced in rather large editions. The journals were available to all students, the opening hours of the reading rooms being 7.3o to 11.3o a.m., 12.oo to 5.oo p.m., and 7.oo to 9.3o p.m. We also saw some of the book shelves. The books seemed somewhat outdated, but we were told that there were reading rooms in the individual departments of the university, and probably the more recent literature could be found there.

Also at *Peking University* we saw the *main library*. The new building, completed in May 1975, had a floor area of 24.5oo square meters. The library possessed 3 million books, the capacity being 4 million. 2.2 million books were in Chinese, the rest in foreign languages. The library had a stock of more than 1o.ooo periodicals, and 3o reading rooms with a total of 2.4oo seats. We saw some of the book shelves, again giving the impression of not containing the books from the last years. Some main handbooks as for example Beilstein obviously had been printed in pirate editions.

The conclusion from these two main libraries is that *a fair amount of scientific literature is available*, not only to scientists at "centres of excellence" but to the whole scientific community and to students at least in the big cities. It is not possible to ascertain to what extent the literature was being used, but generally the scientists we met were rather well at home in the scientific literature of their fields.

The pirate editions of journals seemed to be rather widely distributed but perhaps somewhat haphazard. In the Botanical Institute in Kwantung (under the directorship of the Bureau of Science and Technology in the Province of Kwantung) we also visited the library. Among the many journals there we observed *Tetrahedron*, a journal specializing in organic synthesis and probably of no use to the scientist in this institute.

The good library facilities somewhat contrast to the scarcity of Chinese scientific publications and the lack of personal contacts with foreign scientists. We were rarely given reprints, and when inquiring about coordination of work or communication of results between different institutes in the same field we were told that this took place through meetings and correspondence. It was our impression, however, that coordination could sometimes have been better.

To rely solely on importing scientific results from foreign countries through books and periodicals without establishing personal contacts on a broad scale will probably prove unsatisfactory in the long run. Making Chinese scientific results known abroad through publication in international journals would certainly also be mutually beneficial.

PING CHOW PEOPLE'S COMMUNE NEAR KWANGCHOW (CANTON)

In the morning of October 31 the whole delegation visited the Ping Chow People's Commune in Nan Hai County 25 km SW of Kwangchow, which was said to be representative for the communes in the area. We were received and shown around by Mr. *Chen Rong-kwang*, vice-chairman of the revolutionary committee.

The commune was situated in a marshy flatland area which formerly suffered much from seasonal droughts and floods. To overcome this an extensive *water conservancy programme* had been carried out. Irrigation canals with a total length of 160 km had been dug and 83 km of water conservancy embankments had been constructed. 9.2 million cubic meters of soil and stones had been moved in the course of this project, presumably without any earth moving equipment.

The commune covered an area of 76 km^2 and consisted of 92 natural villages comprising 16.400 households with a total population of 68.200. *The main crop was paddy rice*, which was now being harvested. Water was taken to the fields by means of a network of 23 electrical pumping stations and over 700 pumps. Practically all agricultural machinery was produced in the commune's own workshops. There were also small factories for cement, brick-making etc. The commune was running primary and middle schools with a total of 14.000 pupils, as well as a hospital.

Harvesting of the late crop of rice had just started. The expected yield was said to be 9 tonnes per hectar, a remarkably high figure. Thrashing was carried out in the fields by means of small, foot-powered thrashing machines operated by two persons. We saw a large store-house filled with bags of polished rice and were told that 60% was exported to various countries in South East Asia.

Besides rice the commune grew sugar cane, fruits, and vegetables. Bananas, papaya, *Litchi*, *Ricinus*, and sweet potatos were frequently seen on embankments or fringes of fields. *Eichhornia crassipes* was cultivated in ponds and used to feed pigs. We also saw small ponds covered with *Azolla* which was used as green manure.

The commune raised pigs on a large scale and now had 9o.ooo of them, thus overfulfilling the target of one pig per person. There were also 5oo milk cows and 2.ooo water buffalos (used for ploughing).

The delegation got a favourable impression of the commune. Crops generally seemed fine and people looked healthy and hard-working. The housing standard was still poor, however, and the degree of mechanization fairly low. Machines for transplanting and harvesting rice, such as seen by the delegation at the Shanghai industrial exhibition, had not been introduced so far. There appeared to be good prospects for investment in new machinery as well as for raising the general standard of living.

SUMMARY AND CONCLUSIONS

The knowledge we obtained during 16 days is of course limited in relation to the volume and diversity of scientific research in China. However, it is certainly possible to form at least some tentative conclusions about the Chinese research system. It should be stressed that these conclusions are not only based on our own observations but have also been influenced by available literature and by reports from other recent scientific delegations to China.

The motives for research

An evaluation of the Chinese research system requires an understanding of its basic goals. What are the Chinese needs and demands in research? It seems reasonable to assume that the general objectives or motives for research in China are the same as elsewhere, for example in Denmark. However, it is obvious that China will have different priorities, partly because of differences in size and state of development and partly for ideological reasons.

The motives for research in Denmark may (with a large degree of simplification) be listed as the following five:

1. Research is part of our cultural tradition.
2. The national research system is a prerequisite for understanding the research of other countries, and thus for importing and making use of results obtained elsewhere.
3. The national research system provides us with a basic store of knowledge which can be used according to the changing conditions and demands.
4. The research system, especially the research in universities, provides a necessary basis for an up-to-date educational system.
5. Research may provide answers to immediate problems facing society in production, health service, etc. It should be observed that most of the production-oriented research in Denmark is carried out in the private sector.

Even if the same five objectives may be relevant in China, some remarks can be made about their priorities.

1. Presumably the Chinese will not emphasize the first motive, research as part of the cultural tradition. One of their main desires is to break with part of the cultural tradition of the past. They do not want to support or create an intellectual elite which may be necessary to keep up with the traditions in science.

2. China knows that a research system is a necessity for importing results from abroad. Their efforts in this respect may, however, be balanced by an aspiration for self-reliance. At the present stage, China wants to be able to import necessary knowledge from abroad, but the explicit goal for the future is to make China independent of import.

3. Even if China acknowledges that science can provide stores of knowledge for use in the future, the pressure to obtain solutions to immediate problems is likely to be so high that long-term goals will tend to be under-emphasized.

4. There is not likely to be any particular emphasis on research as a prerequisite for a high level in education. This partly reflects the fact that the general educational level in China is still comparatively low. There is still so much common knowledge that needs to be utilized in the educational system that the introduction of the most advanced knowledge from contemporary research seems less important. The low priority may also indicate the fact, that China does not want the appraisement system of international scientific research to gain influence on education.

5. The highest priority is certainly put on the solution of short-term problems. This is to be expected considering China's position as a developing country and also as a consequence of the official ideology. It is also in line with Chinese history and utility philosophy.

<u>The factors in Chinese research</u>

Before attempting an evaluation of the Chinese research system it will be appropriate to describe the elements of this system. This description will naturally suffer from the limitations of our observations and knowledge.

Research in China can be described as taking place in five different settings.

1. The institutes of Academia Sinica (and of other academies). Even if several institutes were transferred from the Academy in the wake of the cultural revolution, the remaining 3o certainly serve as centers of excellence. This is the only sector we have studied closely.

2. Research institutes of the provincial governments. In principle these institutes perform the same duties as the academy institutes although most likely on a lower scientific level and with an even stronger emphasis on applied research.

3. Research at universities. Our impression is that this research is of limited importance in most fields.

4. Military research. We have no information on this sector, but undoubtedly it is of considerable significance.

5. Research connected with production in agriculture and industry. We have but little knowledge of this sector. It is difficult to make a sharp division between research and development. Many activities may be going on in factories and people's communes which in the Western world would be labelled research. Such activities seem necessary to explain the development in China. The academy institutes and provincial research institutes are not able to take care of all problems in research and development facing such a large and diversified country.

The selection of research problems and the management and coordination of research

According to the official policy and ideology problems are selected on the basis of the needs of society and production. This is not only official phraseology but at least partly reflects a close coupling of research and productior. This coupling represents an important element in Chinese research management, and may be partly responsible for certain coordination problems. We frequently observed similar or identical research programs in different institutes, indicating some lack of coordination.

Some central planning and political control must exist. The high priority given to physics and electronics and the high level obtained in these fields must depend on central decisions. Very little is known about the process of decision-making. We do not even know if the allocation of funds to the various institutes is made on the basis of approval of individual projects or on the basis of size, standard, and importance of the institute as a whole. It may be stressed, however, that all known elements in Chinese research management operate on short terms.

In Western countries a large part of the steering of research is performed by the scientists themselves. As Western scientists are highly international-minded, this steering will reflect the international scientific development. It is also influenced by the meritocratic system of science and the pressure for publication. This element of research steering is likely to be less important in China, probably with a resulting lack in originality (in the Western sense).

Research management and evaluation of research

Very little is known about the Chinese methods for evaluation of research. It may be presumed that the strong emphasis on the connection between research and production has weakened and distorted the traditional sense for quality in research. It is not known whether the academy institutes work according to fixed project plans and time-schedules, and whether the results obtained are compared with the plans. The central research administration is not likely to have detailed information on the use of resources in the research system, especially in connection with individual projects. Generally it seems likely that the evaluation and control of research is a somewhat neglected field.

Communication, information, and publication

One may distinguish between three different levels with respect to both incoming and outgoing communication and information: 1) Between members of the Chinese scientific community, 2) between the Chinese scientific community and Chinese society and authorities, and 3) between the Chinese scientific community and the international scientific community. At all levels communication and information will to a large degree depend on library facilities and publication patterns.

Chinese scientific publications were nearly all discontinued for several years during the cultural revolution. Now publication has started again but so far on a very restricted scale compared to the Western world. The volume of publication does not seem to be sufficient to cover the demand for communication between the Chinese scientists themselves and from the scientists to the Chinese society, or, in other words, to cover the demand for distribution of knowledge within China. We were often told, that communication between scientists took place at scientific meetings, but it seems rather doubtful if this activity is extensive enough to be of decisive importance.

All scientists below the age of 55 are - at least in principle - supposed to do practical work at regular intervals in factories or people's communes. This system may ensure a certain flow of information from science to production, but it seems doubtful whether the efforts are systematic enough to compensate for lack of other means of communication.

The extent of communication with the external scientific world is small. As far as influx of information is concerned, a fair number of international scientific journals are available in the country. But in the long run China's ability to import scientific knowledge will depend on its ability to reciprocate. The Chinese scientists or science administrators seem to believe that exchange of official delegations as such is an important contribution to scientific communication and somewhat an end in itself. We think, however, that exchange of delegations is only a preamble to deepened and more specialized communication by means of exchange of scientists and scientific knowledge.

The system for obtaining information from the outside world seems at first sight to be fairly satisfactory (as described under the heading libraries). However, it is an open question whether there is made full use of the imported books and journals and whether this is indeed possible. First there is the language problem - many Chinese scientists seem to read the major foreign languagies only with difficulty or not al all. But even more important may be the following question: Is it possible to understand and utilize scientific literature without knowing anything about the people who wrote the literature, without knowing the thougths and intellectual climate which made possible the production of the results? Or, to put it differently, is it possible to understand scientific literature without some knowledge of the value systems of the authors?

The system for disseminating information from the Chinese society to the scientists seems efficient and interesting. The close links between research and production, the principle of sending scientists on manual work, and the general philosophy and policy of the society all help to ensure a free and constant flow of information to the research system.

The scientists themselves

On several occasions we experienced that high quality research was closely correlated with the presence of elderly Chinese scientists who had been trained in the West, especially in the United States, and returned to China in the nineteen fifties. These well qualified scientists are nearly all more than 6o years old and will have to be replaced in the near future. The presence of an intermediate generation of scientists trained in the Soviet Union in the fifties was not so obvious. The younger generation is presumably bright and devoted, but it is difficult to form any definite opinion because of the language barrier. Very few of the young scientists had any knowledge or experience of research outside China.

It seems important for Chinese science that this situation is remedied fast. Young scientists should go abroad in substantial numbers for prolonged periods. This idea was also generally accepted by the scientists and science administrators we met. But first, it may be an expensive venture for China and other problems may be considered to deserve a higher claim on the limited resources. Secondly and possibly more seriously, the Chinese definitely do not want to create a new intellectual elite. To avoid this the political leaders may be quite reserved to the idea of sending thousands of young Chinese scientists out of the country.

The internal mobility of Chinese scientists seems rather low. The majority of the scientists we met had spent most or all of their carreer in a single institute. Transfer between academy institutes and universities seemed to be rare.

The recruiting system of Chinese science is not well known. In universities bright graduates may get the chance to continue in a sort of graduate training but probably they are registered as teachers and from the beginning are helping older and experienced teachers in a sort of apprenticeship relation. It must also be assumed that the academy institutes still recruit university graduates. Scattered remarks indicated that the academy institutes were not altogether happy with the standard of the present graduates, mainly because of the shortened curricula emphasizing application of knowledge that were introduced after the cultural revolution. It is not known whether there are any formal programs for graduate studies.

<u>The technical background for science</u>

As mentioned before, library facilities seemed to be sufficient. However, in other respects Chinese science lacks background facilities that are taken for granted by Western research workers. Many academy institutes produced their own chemicals, also for use outside the institute. Instrument production was also emphasized in several institutes. Many practical problems may be solved in the course of this work, although not necessarily in the most economic and efficient way. Certainly, conditions must be very different in China with no laboratory dealers, no easy access to commercial fine chemicals and instruments, etc. Foreign currency is spent only on very special instruments.

<u>Research and higher education</u>

As mentioned above, the links between research and education are weak and probably were further weakened during the cultural revolution. If this trend is not reversed, it will presumably have deleterious long-term effects on Chinese university education.

Conclusion

The main emphasis is clearly on the solution of problems of immediate concern to production. The Chinese research system is concentrated on short-term objectives. The research needed for import of foreign knowledge and for the creation of stores of knowledge is given much lower priority. China's development in the coming decades will depend on the application of much more advanced technology and production methods than today. It seems therefore necessary rather soon to modify the present research policy and to introduce more long-term goals. If no changes are introduced the situation in the research sector may be a course for stagnation rather than a leading factor in the development of the country.

The change should also involve a greater degree of openness. Even if independence is an important and justified goal in Chinese policy, the concept of self-reliance in science seems disadvantageous and wasteful. Science is an international endeavour, and if a country seeks development through science it will have to contribute part of the international framework of science.

BIOGRAPHICAL DATA FOR MEMBERS OF THE DELEGATION

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