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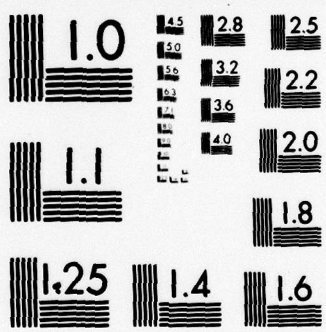

MICROCOPY RESOLUTION TEST CHART

JANUARY to MARCH 1979 VOL. 4, NO. 1

SCIENTIFIC BULLETIN

DEPARTMENT OF THE NAVY OFFICE OF NAVAL RESEARCH TOKYO

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This is a quarterly publication presenting articles covering recent developments in Far Eastern (particularly Japanese) scientific research. It is hoped that these reports (which do not constitute part of the scientific literature) will prove to be of value to scientists by providing items of interest well in advance of the usual scientific publications. The articles are written primarily by members of staff of ONR Tokyo, with certain reports also being contributed by visiting

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Marine Habitats
Oyashio Current
Tsushima Current
Liman Current
Lake Suwa
Kuroshio
Lake Biwa
Niigata
Sado Island
Sea of Japan
Piscine Endocrinology
Parasitic Copepods
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Yoko Maru
Yellow Sea
East China Sea
Red Tide Studies
Zooplankton Culture
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Kakuyo Maru
Nagasaki Maru
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Marine Chemistry
Air Sea Interactions
Tropical and Subtropical Ecosystems
Submarine Geology and Geophysics
Japan Trough
Marine Biological Stations
Freshwater Biological Stations

20. Abstract (cont'd)

stateside scientists. Occasionally a regional scientist will be invited to submit an article covering his own work, considered to be of special interest.

CONTRIBUTORS

Maurice M. Tatsuoka is Professor of Educational Psychology and Psychology, University of Illinois at Urbana-Champaign. His interests are in experimental design and statistics. He is the author of a textbook and several booklets on multivariate analysis.

Mitchel Weissbluth, currently on the staff of ONR Tokyo, is on leave from his position of Professor of Applied Physics, Stanford University. His research activities include the development of liquid propellant rockets, meson production, linear accelerators for medical use, biological effects of high energy radiation, electron spin resonance in biological molecules, Mossbauer resonance in heme proteins and other related fields.

Oleg D. Sherby is a Professor at Stanford University in the Department of Materials Science and Engineering. His interests include theoretical and experimental aspects of mechanical behavior of solids and diffusion in solids.

Kenneth J. Wynne is a member of the Chemistry Program of the Material Sciences Division, Office of Naval Research. He currently administers a contract research program in polymer science. Other interests include chemical synthesis, structural studies, and inorganic polymers.

Francis A. Richards, presently on the staff of ONR Tokyo, is on leave from his position of Professor of Oceanography and Associate Chairman for Research, Department of Oceanography, University of Washington, Seattle. His research interests in chemical oceanography include analysis of sea water, plankton pigments, oxygen deficient and sulfide-bearing environments in the ocean, interrelationships among the branches of oceanography through chemistry.

Seikoh Sakiyama, Scientific Affairs Specialist of ONR Tokyo, has had considerable industrial experience in laboratory chemistry, electronic instrumentation and quality control methodology. His interests include computer science, linguistics, and energy technology.

CONTENTS

Cover: A brush painting (sumi-e) of Japanese garden by Tori Hashizume, artist and teacher.

RECENT PSYCHOMETRIC DEVELOPMENTS IN JAPAN: ENGINEERS TACKLE EDUCATIONAL MEASUREMENT PROBLEMS

Maurice M. Tatsuoka

INTRODUCTION

An interesting thing about psychometric research in Japan today is that a substantial portion of it is being carried out by a group of engineers affiliated with the Institute of Electronics and Communication Engineers of Japan (IECE)–specifically, the Technical Group on Educational Technology (TGET) of the Institute, which was organized in 1967. With a background quite different from that of traditional psychometricians, these engineers (trained primarily in computer science) often produce work of a type not found in the mainstream of psychometrics.

I was vaguely aware of these facts since 1975, when Dr. Takahiro Sato of Nippon Electric Company (NEC)–who is one of the leaders of TGET along with Professor Kunihiro Suetake of the Tokyo Institute of Technology and Professor Hiroichi Fujita of Keio University–visited the Computer-based Education Research Laboratory (CERL) of the University of Illinois where my wife works. The scope and vigor of the activities of this group were forcibly brought home to me only last summer, however, when my wife and I made a three-week trip to Japan, in the course of which we attended one of the monthly two-day meetings of TGET (She presented a paper, while I was a spectator and curious questioner–emboldened, no doubt, because the meeting happened to be held at my alma mater, Nagoya University.) The monthly frequency of the meetings as well as their geographical spread–from Sapporo in the north to Fukuoka, on the southernmost island of Kyushu–reflect the enthusiasm and widespread extent of TGET.

As to the quality of the papers presented at these meetings, Dr. Sato is the first to admit that they range from good to mediocre–which is not surprising when one considers the frequency of the meetings. If the one I attended in Nagoya is at all representative, I would say that the vast majority of the papers are fair to quite good, with a few outstanding and a few at the other extreme. The topics covered include instructional design, data management and analysis, evaluation and measurement, and psychometrics (i.e., the theoretical aspects of psychological and educational measurement) especially as these pertain to CAI (computer-assisted instruction) and CMI (computer-managed instruction), as well as research on CAI and CMI systems themselves.

What brought about the spectacular growth of interest among electronic engineers in educational technology in general, and testing, measurement and even psychometrics in particular, in the short span of a decade or so? I have not made a systematic study of the history of this development, but from my conversations with Dr. Sato and other members of TGET it seems that the sequence of events is somewhat as follows. In 1963 Dr. Sato (then a fresh graduate of Tokushima University with a bachelor's degree in electrical engineering) developed an instrument known as the Response Analyzer (RA) at NEC. In its original, rudimentary form, this consisted of a response keyboard at each student's desk plus a console at the teacher's desk capable of displaying mean class performance and mean response time for multiple-choice questions presented by the teacher upon completion of segments of the lecture. The feedback thus given the teacher assisted him or her in deciding whether to go on to the next segment or present a review of the one just completed, with emphases on the poorly understood parts.

The instrument caught the attention of Professor H. Fujita of the Keio University Faculty of Engineering and Professor K. Hirata of Tezukayama Gakuin University, and they involved Dr. Sato in a project for improving the design and adding greater sophistication to the output by interfacing the RA with a central computer. With these advances came the need to develop new analytic methods especially of response-time data, for traditional psychometric methods at that time offered no help. Even for the analysis of performance data, new non-parametric methods appeared preferable to the traditional test-score theory with its reliance on the normal (Gaussian) distribution of errors of measurement or the more recent latent trait theory involving normal- or logistic-ogive models.[1]

With the rapid increase in use of the RA in public schools throughout Japan (it must be remembered that Japan is a small, densely populated country whose people have a group-oriented psychology conducive to the rapid spread of innovations), the number of electronic engineers who became interested in educational technology and measurement increased by leaps and bounds. The situation was ripe for the creation of a TGET within IECE.

Further spreading of the movement was enhanced by the subsequent sponsorship by TGET of seven or eight regional Educational Technology Discussion Groups that hold periodic meetings in which elementary and secondary school teachers interact with researchers to their mutual benefit. The former are introduced to innovative methods and techniques much sooner than if they had to await their publicizing in journal articles, and the latter are provided with means of field-testing their ideas and putting them to widespread, practical use, as well as becoming apprised of problems that are faced by the classroom teacher and thus gaining new research ideas.

CATALOG OF MAJOR RESEARCH INTERESTS IN VARIOUS SUBGROUPS OF TGET

The TGET is divided into several regional/institutional subgroups, whose primary research interests we catalog here. The subgroups are listed geographically from those in Tokyo southward; information concerning the Hokkaido University subgroup having been unavailable at the time of writing. After the institutional affiliation of each subgroup the name of its leader is given in parentheses.

1. Keio University Group (Professor H. Fujita)
   a. Educational evaluation in CAI
   b. Mathematical properties of the S-P chart[2] based on its marginal distribution
2. NEC Group (Dr. T. Sato)
   a. Response-time analysis using the Weibull distribution
   b. Computerized graphical analysis of test scores using the S-P chart
   c. The effective number, $k = 2^H$, of options in a multiple-choice item (H being the entropy associated with the item): a new index for item analysis
   d. Prediction of test-score distributions, using the beta-binomial distribution together with the S-P chart upon specification of one parameter and the difficulty level of each item. (Joint research with Professor H. Ikeda of Rikkyo University)
3. Tokai University Group (Professor T. Kikukawa)
   a. Development of a test-item-bank system
   b. CAI in computer-science education
   c. Methods for analysis of categorical data in educational research
4. Waseda University and Tamagawa University Group (Professor H. Sunouchi)
   a. Test construction and editing using the CARAT (Computer-Assisted Retrieval and Analysis for Test Items) system
   b. Development of courseware in CAI using the systems analysis approach
   c. Application of ordering theory to the analysis of students' grasp of structural relations among items (Mr. M. Takeya of NEC)

[1] An interesting sidelight is that, about the same time, American psychometricians were searching for and developing new methods for analyzing what are known as criterion- (or domain-)referenced tests for which the score distributions by definition exhibit high negative skewness, with modes close to the maximum possible scores. However, the Japanese engineers-turned-psychometricians were unaware of these developments and went their own way.

[2] The S-P chart is described in the next section.

5. Nagoya University Group (Professor M. Oda)
   a. Measurement and evaluation of students' grasp of learning objectives
   b. Artificial intelligence and its relation to tests
6. Osaka University Group (Dr. H. Fujiwara)
   a. Study of subsets of the S-P chart by use of cluster analysis
   b. Development of data bases for educational evaluation
7. Tokushima University Group (Dr. Y. Yamamoto)
   a. Development of data bases for educational evaluation
   b. Development of an assembler-simulator for an educational mark-card system
8. Kyushu University Group (Professor S. Ohtsuki)
   a. Development and evaluation of engineering courseware
   b. Development of a Computer-Assisted Instructional Management (CAIM) system: a combination of the CAI and CMI models

THE S-P CHART

The S-P Chart (for Student-Problem Chart) was the most frequently mentioned item in the catalog of on-going research by TGET members (except for such general, catchall topics as "development of data bases and/or courseware"). It is safe to infer from this fact that the single development with greatest impact has been that of the S-P chart. This concept also was well received by several of my colleagues at the University of Illinois with whom I chatted about the various things I learned during my trip to Japan. Since there is no self-contained English-language discussion of this S-P chart to date, it is perhaps worth describing it here in as much detail as space will permit.

The basic idea and construction of an S-P chart is relatively straightforward (given a computer, at any rate). It is essentially a binary data matrix in which the students (represented by rows) have been arranged from top to bottom in descending order of their total test scores, and the test items have been arranged from left to right in ascending order of difficulty (i.e., in descending order of numbers of students getting them correct). Thus, starting with a data matrix with 1's (for "right") and 0's (for "wrong") in which the students are arranged perhaps in alphabetical order of their names, and the items in their order of occurrence in the test, it is merely a matter of suitably permuting the rows and columns. But this rearrangement brings about an enormous facilitation of discovery and interpretation of anomalous response patterns in students and items alike, thus making the S-P chart a useful tool in the diagnosis of student performance as well as the quality of a test or an instructional sequence.

A contrived example of an S-P chart for a test consisting of 10 items taken by 15 students is shown in Figure 1. By construction, there is a preponderance of 1's in the upper-left region and preponderance of 0's in the lower-right region of the chart. However, the 1's and 0's would be completely separable by a single step-function curve only in the "idealized" case when each student correctly answers every item up to a certain one and none to the right of it. (In psychometric terminology, such a set of items is said to constitute a "Guttman scale" for the population of which the group of examinees is a sample.) For any real set of items administered to a real group of people, there will be an interspersing, to a greater or lesser degree, of 1's and 0's in virtually every row.

The two-step-function graphs superimposed on the chart are constructed as follows. For the one in dotted lines, a vertical line segment is drawn across each row at the right-hand edge of the column whose number (i.e., the item number shown in the top margin) corresponds to the total test score—shown in the right margin—earned by the student represented by that row. Thus, starting from the lower left corner of the chart, vertical line segments are drawn at the right-hand edges of every column from the second one on, because in this example all test scores from 2 through 10 were earned by someone or another. By its nature, the length of each line segment (measured in row-widths) equals the number of students who earned that particular score. Thus, the segments at the right edges of columns 2, 3 and 4 are each one row-width long, the one at the right edge of column 5 is two

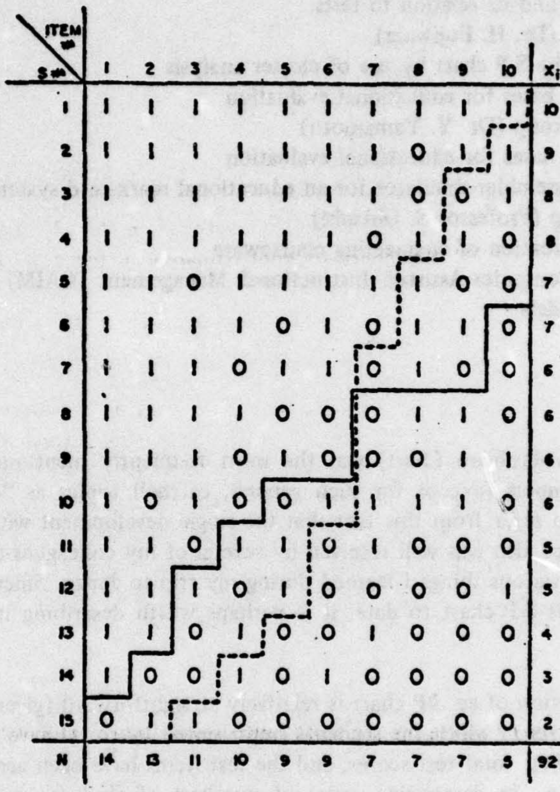


Figure 1 – S-P Chart with D* = .641. The Step Graph in Dotted Lines is the S-Curve; that in Solid Lines is the P-Curve.

row-widths long, and so on. After the vertical line segments have all been drawn, the top endpoint of each is connected to the bottom endpoint of the one to its right, thus completing the staircase-like appearance. The step-function graph is called the S-curve (for "student curve"). From the way it is constructed, it is seen to be the step-function ogive of the cumulative distribution of test scores for the 15 students: the height (from the baseline) of each step shows the number of students whose scores were no more than the score in the right margin at that level.

In the solid-line graph, the roles of students and test items (and hence those of rows and columns) are reversed from the dotted-line graph. Thus a horizontal line segment is now drawn across each column at the lower edge of the row whose number (i.e., the student number shown in the left margin) corresponds to the number of students—shown in the bottom margin—who correctly answered the item represented by that column. Starting from the lower left corner, horizontal line segments are drawn at the bottom edges of rows 14, 13, 11, 10, etc. The length of each line segment (measured in column-widths) is equal to the number of items that were correctly answered by the number of students indicated by the row number. The right endpoint of each line segment is then connected to the left endpoint of one above it to complete the staircase. This step-function graph is called the P-curve (for "problem curve"). This, too, represents a cumulative-frequency ogive of sorts, if we rotate the sheet 90 degrees to the left and then view the graph from the reverse side. It then shows the numbers of items with failure rates no greater than 1/15, 2/15, 4/15, etc.

By the methods of construction described above, it is clear that the S-curve and the P-curve coincide in the case of the idealized S-P chart (i.e., when the set of items forms a Guttman scale for the group of students tested). The common curve is then the boundary between the 1's and 0's in the chart. Hence, the degree to which the two curves are disparate from each other becomes a measure of the extent to which the set of items departs from a Guttman scale for the particular group of students—in other words, the extent of heterogeneity of the items for that group, or, equivalently, the heterogeneity of the students with respect to the abilities tested by the items. (The duality between students and items should be noted.) Sato proposed an index D*, called the disparity coefficient, for quantifying the disparity between the two curves. Its basic definition is

$$D^* = A(N, n, \bar{p})/A_B(N, n, \bar{p}),$$

where $A(N, n, \bar{p})$ is the area between the S-curve and the P-curve in the given S-P chart for a group of N students who took an n-item test and got an average item-passing rate $\bar{p}$, and $A_B(N, n, \bar{p})$ is the area between the two curves as modeled by cumulative binomial distributions with parameters N, $\bar{p}$ and N, $\bar{p}$, respectively. The value of D* ranges from 0 for the ideal S-P chart to approximately 1 for a randomly constructed one. For computational purposes the above formula is very unwieldly and time-consuming to use. Sato provides an alternative, approximate formula for practical use, but we do not display it here since its use requires a special table.

Based on experience with a large number of S-P charts, Sato and his coworkers state, as a rule-of-thumb, that a D* value of around .5 is "about right" for an ability test involving several distinct abilities (or factors), while a value exceeding .6 is a danger signal. It may signify that the set of items is excessively heterogeneous or that the group of students consists of two or more subgroups having varying degrees of exposure to the material being tested for. Thus, D* can serve as a useful tool for trouble-shooting tests and/or evaluating the match between the instructional material and the group being taught. For those who are knowledgeable in psychometrics, it may be noted that D* is related to Cronbach's coefficient alpha and Loevinger's coefficient of homogenity, H.

Another measure which Sato and his coworkers define in connection with the S-P chart is what they call the "caution index" $C(S_i)$ for students S_i and a corresponding one $C(P_j)$ for item j. The former is defined as

$$C(S_i) = 1 - \frac{\text{cov}(x_{ij}, n_j)}{\text{cov}(u_{ij}, n_j)}$$

where x_{ij} is student i's score (1 or 0) on item j, u_{ij} is the item-j score for a hypothetical "ideal" student with the same total score X_i as student i (i.e., $u_{ij} = 1$ for $j \leq X_i$ and $u_{ij} = 0$ for $j > X_i$), n_j is the number of students correctly answering item j, and cov(,) denotes the covariance (over items) between the two variables standing inside the parentheses. This index quantifies the anomalousness of a student's response pattern, and it ranges from 0 (for the "ideal" student) to approximately 1 for a student whose response pattern consists of a random sequence of X_i 1's and $n - X_i$ 0's. It is used for diagnostic purposes by observing whether $C(X_i)$ is below .5 or exceeds .5 and simultaneously noting whether the student's total score is "high" (say, above median) or "low." The four classes of students based on this double-dichotomy are diagnosed as follows:

(1) the low-$C(S_i)$, high-X_i student—"Is doing fine"
(2) the low-$C(S_i)$, low-X_i student—"Needs to study more"
(3) the high-$C(S_i)$, high-X_i student—"Is making careless mistakes"
(4) the high-$C(S_i)$, low-X_i student—"Has sporadic study habits and/or insufficient readiness for the material covered in the test"

Many other uses and properties of the S-P chart, including those listed in the catalog in the preceding section, have been studied, but lack of space forbids my describing them here.

AN APPLICATION OF ENTROPY IN ITEM ANALYSIS

Another, more recent, development also by Sato that is worth a brief description is an application of the concept of entropy in defining a new index for item analysis. Entropy is well known in thermodynamics as a measure of the degree of disorder of a system, and in information theory as a measure of the extent of unpredictability in a message source. If there are k events $E_1, E_2, \ldots, E_k$ that may occur with probabilities $p_1, p_2, \ldots, p_k$, respectively, the degree of uncertainty as to which of them will actually occur can be measured by the average entropy, defined as

$$H = -\sum_{j=1}^{k} p_j \log_2 p_j.$$

Although entropy has been used before in test theory, especially in connection with test reliability, the concept was used in quite a different way by Sato when he introduced what he called the effective (or equivalent) number of options in a multiple-choice item. Suppose an item actually has k options. If the numbers of students choosing the various options are $n_1, n_2, \ldots, n_k$ and $\Sigma n_j = N$, then the entropy associated with the item is

$$H = -\Sigma p_j \log_2 p_j = [N \log_2 N - \Sigma n_j \log_2 n_j]/N.$$

Suppose now that this observed entropy is set equal to the entropy for a hypothetical item with $\hat{k}$ options in which the student responses are uniformly distributed among the options. We would then have

$$H = -\log_2 (1/\hat{k}) = \log_2 \hat{k}$$

and hence

$$\hat{k} = 2^H.$$

This is what Sato calls the equivalent number of options and shows to be a useful new index for item analysis, along with the traditional item difficulty index p (i.e., the proportion of students getting the item correct). Specifically, a plot of $\hat{k}$ against p for the set of items on a test is found typically to form a narrow band sloping downwards from left to right (i.e., $\hat{k}$ and p have a substantial negative correlation). Any item whose (p, $\hat{k}$) plot departs considerably from this narrow band should be viewed with suspicion. Since for each p value $\hat{k}$ has a maximum (attained when $1 - p$ is uniformly distributed among the $k - 1$ incorrect options) that closely borders the band of (p, $\hat{k}$) points, any "maverick" item most likely has a (p, $\hat{k}$) plot toward the lower left portion of the plane. This means that such an item is too hard and tends to have its incorrect responses concentrated on one or two of the distractors (i.e., incorrect options), which makes H and hence also $\hat{k}$ small. Thus, these one or two distractors must be very appealing to the students—they may perhaps not even be strictly incorrect. Hence, such an item is a poor one, but is not easily identified as such by the traditional item-analysis indices of difficulty level and discrimination power. It is readily spotted, however, as an outlier in the (p, $\hat{k}$) plot.

CONCLUDING REMARKS

The flurry of activities by Japanese computer engineers "invading" the field of educational technology in general and measurement in particular seems to reflect a definite felt need for developing a new body of psychometric theory especially adapted to the new era of computerized testing. By comparison, awareness of this need does not appear to be strong in this country. Except for a handful of psychometricians engaged in research on computerized adaptive testing (most of whom, incidentally, are under contract with the Personnel and Training Research Programs, Psychological Sciences Division of ONR), research on traditional psychometrics is the rule of the day. Nor do our computer engineers seem inclined to take the initiative for developing a new, computerized-testing-oriented psychometrics. I examined five recent volumes of the *IEEE Transactions on Education* (for the years 1973 through 1978, with the exception of 1977, the issues for which year were at the bindery) and found only one article dealing with innovative measurement techniques; moreover, this single article was contributed by our Japanese friends, Messrs. Takeya, Sato and Sunouchi ("Measurement and Evaluation Methods of Response Time for Programmed Instruction," in the April, 1975 issue). Only three other articles even had the word "measurement" or "evaluation" in their titles, and they dealt with routine, traditional methods applied to specific curricular programs.

All this strikes one as rather odd in view of the fact that CAI was first developed in this country, which probably still leads the world in this field. Could it be that there is little interdisciplinary interaction between computer engineers interested in the hardware aspects of CAI on the one hand, and educational and psychological researchers specializing in educational measurement and psychometrics on the other? If so, it seems that the time is ripe (or overdue) for us to abandon such isolationism and cultivate cross-disciplinary cooperation toward the development of a new psychometrics for the computer age.

THE INSTITUTE FOR MOLECULAR SCIENCE

Mitchel Weissbluth

One of the newest and most impressive of Japan's many fine research centers is the Institute for Molecular Science (IMS). Now in its fourth year of operation, the Institute is already well known in Japan and, in my opinion, is destined to become highly respected internationally. The following report is based on information acquired during a visit in February 1979 through the courtesy of Professor Hirao Inokuchi whose generous hospitality is gratefully acknowledged.

IMS was established in April 1975 as an inter-university research institute for theoretical and experimental studies of molecular structures and their functions, including the system of disciplines concerned with quantum chemistry, molecular spectroscopy and molecular solids. In the words of the Director-General, Professor Hideo Akamatu, writing in the Annual Review of the Institute for Molecular Science, 1978, "The principal role of IMS is to promote basic and exploratory research in molecular science, covering from simple molecules, free radicals and molecular ions to complex molecules such as porphyrin and cytochrome and also molecular assemblies. IMS is expected to exploit new scientific opportunities for chemistry, physics and related fields of science." Apart from these purely scientific objectives, molecular science, since it "deals with the formation of molecules and their transformation, the elementary processes of chemical reactions and their controls, the interactions between photon(s) and molecules, and the energy transfer and the energy conversion through the molecular process," is expected to play an important role in our efforts to cope with the problems of the rapid increase in energy consumption and the depletion of natural resources. For Japan, in particular, the practical aspects of such research loom large indeed.

The Institute is located in the town of Okazaki (population 0.25 million), about 40 km east of Nagoya or 260 km southwest of Tokyo. Some facilities are still under construction with completion expected in 1979; staffing is approximately 60% of full strength. Ultimately, IMS will consist of 15 research laboratories and five research facilities. The laboratories–each staffed by a professor, two research associates and technicians–are grouped into five divisions (Table I): theoretical studies, molecular structure, electronic structure, molecular assemblies and applied molecular science. In order to enhance the cooperation between IMS and the universities, the chairs in five of the fifteen research laboratories are reserved for adjunct professors invited from various universities.

Professor Akamatu transferred from Yokohama National University when he was appointed Director-General of IMS in April 1975 and at approximately the same time Professor Inokuchi came from the Institute for Solid State Physics, University of Tokyo, to accept the appointment as Professor of the Division of Molecular Assemblies. Since then, faculty selection has proceeded in a very deliberate fashion by the Committee for Faculty Selection under the chairmanship of Professor S. Nagakura, University of Tokyo. During my visit, I had the pleasure of a meeting with Professor Akamatu who was proud to inform me that he had, that day, been re-appointed to another term as Director-General of the Institute.

IMS has an advisory board for the Director-General which is composed of 17 Counsellors appointed by the Minister of Education and Science. The Chairman of the Board is Professor Masao Kotani, President of the Science University of Tokyo. Two of the counsellors are selected from among distinguished foreign scientists. The current members are Melvin Calvin, Professor, University of California, Berkeley, California, and Heniz Gerischer, Director, Fritz-Haber Institute der Max-Planck-Gesellschaft.

Table II gives a brief description of the five research facilities (Computer Center, Instrument Center, Low-Temperature Center, Chemical Materials Center and Development Workshop). Associated with each research facility are technical associates and technicians as well as a scientific staff. The technical employees are organized into a Technical Section under the direction of a Technical Chief and it is claimed that such an organization of technical employees is unique among national institutes and universities in Japan. It is evident that the research facilities are well equipped and have been organized to provide essential services to the research laboratories and to keep up with new technical developments in instrumentation.

To provide the reader with a feeling for the range of activity at IMS, a list of active research areas is given in Table III. Typical of their approach is the research on photochemical energy conversion by thin films of organic semiconductors–an area in which there are important practical implications with respect to solar energy devices as well as fundamental scientific interest. The group consisting of T. Sakata, T. Kawai, K. Tanimura and M. Soma is using thin porphyrin films on metals as electrodes in electrochemical cells. Porphyrins, generally have a strong absorption band (Soret band) in the vicinity of 420 nm and a weaker band (Q band) at about 540 nm. Zinc tetraphenyl porphyrin (ZnTPP) was found to be a favorable material for electrodes. When deposited on platinum, the photovoltage of the ZnTPP/Pt electrode reached 530 mV and the current efficiency (number of electrons/number of absorbed photons) was about 2-6%. The photocurrent and photovoltage showed a marked dependence on the kind of metal substrate on which the ZnTPP was deposited. This property was explained on the basis of a Schottky-type barrier assumed to have been formed at the interface between ZnTPP and the metal substrate. They also observed a close correspondence between the action spectrum of the photocurrent and the excitation spectrum of the fluorescence.

Dynamic behavior is being investigated by means of nanosecond laser pulses from a nitrogen and a dye laser. In the case of ZnTPP/Pt, the photocurrent does not follow the rise and decay of the incident light. Instead the rise profile more nearly corresponds to the integral of the fluorescence. The triplet lifetime appears to be an important factor–long lifetimes being conducive to electron transfer.

The luminescence intensity of ZnTPP/Pt is a function of film thickness - in films with a thickness less than 400 Å, the luminescence is strongly quenched. The data appear to be consistent with the assumptions: (1) the excitation energy is localized, i.e., there is no energy transfer among ZnTPP molecules and (2) energy transfer occurs between the film and the metal at a rate which depends on d^{-4} where d is the distance between the metal surface and an excited ZnTPP. The energy transfer process is thought to be of the Forster type.

A closely related project is one conducted by a theoretical group consisting of H. Kashiwagi, T. Takada, S. Obara, E. Miyoshi, N. Honjo and K. Ohno. Using a computer program known as JAMOL which was designed in Hokkaido University for molecular orbital calculations of large polyatomic systems, *ab initio* molecular orbital calculations were carried out on the cobalt porphine (CoP) complex in various states: $[CoP]^-$, $[CoP]^\circ$, $[CoP]^+$, $[CoP]^{2+}$. This investigation yielded the charge distribution, the character of the ligand bonds, the d-d transition, the π-π excitation and several ionization potentials. Configuration interaction (CI) calculations within the framework of ligand field theory were also performed. They concluded that (1) the bonding between Co and N (porphine) is essentially ionic, (2) in the five lowest states ($^4B_{2g}$, $^4A_{2g}$, ^4E_g, $^2A_{1g}$, and ^2E_g in D_{4h} symmetry) the net charge distribution is almost independent of the state. Co has a net charge of about +1.8 and N has –0.6, (3) the calculated first two ionization potentials which correspond to the removal of an electron from the two highest occupied orbitals ($1a_{1u}(\pi)$ and $5a_{2u}(\pi)$) are in reasonable agreement with experiment and (4) the calculated ground state is $^4B_{2g}$ and not $^2A_{1g}$ as observed experimentally in Co-tetraphenylporphine.

The founders of IMS also recognized that there is a category of large-scale experimental equipment required by various researchers in molecular science but which is too complex and/or too expensive for individual universities. They decided to install two facilities of this type for general use by scientists at IMS and other institutions. One facility is for time-resolved spectroscopy and the other for high resolution spectroscopy. Both systems use lasers as their primary light sources. For time-resolved spectroscopy, the system contains a repetitive picosecond Nd^{3+}:YAG laser and a high power nanosecond Nd^{3+}:YAG laser. Provision is made for frequency conversion in the visible and near infrared region. The system also contains an ultra-fast streak camera for observation of transient phenomena in the picosecond region. For high resolution spectroscopy, the main components are two dye lasers in the region 550-630 nm and a series of semiconductor diode lasers for the infrared region. In the planning stage is a picosecond continuously tunable laser from the ultraviolet to the infrared and a source of synchrotron radiation for the ultraviolet and soft X-ray region.

As an overall impression I incline toward the opinion that the Institute for Molecular Science at Okazaki has provided a highly favorable physical and intellectual environment for the conduct of scientific research with good expectation for important contributions.

Table I

Organization

Director-General

Hideo AKAMATU

Division of Theoretical Studies	**Theoretical Studies I**	**Professor Keiji Morokuma**
	Theoretical Studies II[1]	**Adjunct Professor Katsunori Hijikata (University of Electro-Communications)**
	Theoretical Studies III[2]	
Division of Molecular Structure	**Molecular Structure I**	**Professor Eizi Hirota**
	Molecular Structure II[2]	**Adjunct Professor Kozo Kuchitsu (University of Tokyo)**
	Molecular Dynamics[1]	
Division of Electronic Structure	**Excited State Chemistry**	**Professor Keitaro Yoshihara**
	Excited State Dynamics[3]	
	Electronic Structure[2,3]	**Adjunct Professor Mitsuo Ito (Tohoku University)**
Division of Molecular Assemblies	**Solid State Chemistry**	**Professor Hiroo Inokuchi**
	Photochemistry[3]	
	Molecular Assemblies Dynamics[1]	
	Molecular Assemblies[2]	**Adjunct Professor Ikuji Tsujikawa (Kyoto University)**
Division of Applied Molecular Science	**Applied Molecular Science I**	**Professor Hiizu Iwamura**
	Applied Molecular Science II[2]	**Adjunct Professor Yoshihiko Saito (University of Tokyo)**
Five Research Facilities are:	**Computer Center**	
	Instrument Center	
	Low-Temperature Center	
	Chemical Materials Center	
	Development Workshop	

[1] **To be established.**
[2] **Professors and associate professors are adjunct professors from universities.**
[3] **Established in 1978.**

Table II

Research Facilities

Computer Center

The center contains two HITAC M-180 computers with an overall processing capacity of over 6 million instructions per second. The processor uses 32 bit words and is essentially IBM-compatible at both the hardware and software levels. It will have an 8 megabyte main memory and a 1750 megabyte disk memory. It will also be equipped with magnetic tape drives, an XY-plotter and a graphic display as well as usual input-output devices. The system is designed to work without an operator. The computer facilities are also available to scientists outside of IMS.

Low-Temperature Center

The building with three liquefaction machine rooms, ten laboratories and a machine shop will be completed in March 1979. The liquefaction of helium will be carried out with a machine of 40 l/h capacity. A room is set aside for the future installation of a hydrogen liquefier. The floor and walls of the machine rooms are separated from the rest of the building to avoid the propagation of vibrations. The laboratories are to be equipped with spectroscopic, magnetic and calorimetric instruments for low temperature measurements. Seven laboratories are located in the basement in order to obtain a well regulated environment. The center presently supplies liquid nitrogen.

Instrument Center

The Instrument Center maintains and makes available instruments for general use, such as NMR, IR, visible-UV, vacuum UV, Raman, emission, and photoelectron spectrometers. The center consists of three rooms for material research (electric and magnetic properties), four rooms for spectroscopy, two rooms for laser research, one room each for magnetic resonance, X-ray diffraction, and electromagnetically shielding measurements. The floors of the laser rooms are separated from the walls in order to avoid vibrations from the building. The turbulence of air from the air conditioning system is minimized. The electromagnetic disturbance in the shielded room is –80 dB.

Chemical Materials Center

The Chemical Materials Center is the preparation center of chemical substances. The scientists and technicians of this facility prepare organic and inorganic compounds by synthesis, purification, and crystallization. As the need arises, they develop new methods for preparing interesting chemicals in high purity and in large quantities. They also carry out research on development of new chemical reactions, elucidation of reaction mechanisms, and analysis of chemical substances. They also participate in disposition of waste chemicals and solvents. The two-storied building consists of the following facilities: four laboratories for organic and inorganic synthesis, a laboratory for high-pressure experiments, four instrumentation rooms, two clean rooms (class 100 and 10000), a laboratory for preparation of pure crystals and a stockroom of chemicals. Each room is provided with tubing for cooling water, city gas, and special gases (argon, nitrogen, oxygen, compressed air, and vacuum pipes, and a recovery tube of helium), distributing box (single- and three-phase current totaling 30 KW), and an emergency shower. About five hundred chemicals and solvents are stored in the stockroom. All hoods are equipped with scrubbers and chemicals can be safely handled in them.

Development Workshop

The Development Workshop consists of a machine shop, an electronic shop and a glass-blowing shop. It designs and constructs instruments and also improves existing research equipment. Technical meetings are held twice per year to provide opportunities for technicians to exchange information and to discuss technical problems with technicians from other institutes and universities.

Table III

Research Areas

RESEARCH ACTIVITIES I THEORETICAL STUDIES

A. LCAO-MO-SCF Scheme with Local Exchange-Correlation Functional Approximation
B. Transition States and Intrinsic Reaction Coordinates
C. Mechanism of Photochemical Reactions
D. Energy and Force Analyses of Molecular Interactions
E. Problems in Molecular Structures
F. Extension of Discrete-Variational Xα Cluster Method and Its Application to the Surfaces of Metallic Oxides
G. Theory of Two-Dimensional Electron System in MOS Inversion Layer
H. Application of the Graph Theory to Chemistry and Physics

RESEARCH ACTIVITIES II MOLECULAR STRUCTURE

A. High Resolution Spectroscopy of Transient Molecular Species
B. Microwave Sprectroscopy of Non-Polar Molecules
C. Anharmonic Potential Function and Equilibrium Molecular Structure
D. Production of Highly Excited Atoms from Molecules

RESEARCH ACTIVITIES III ELECTRONIC STRUCTURE

A. Primary Photochemical Reactions of Organic Compounds
B. Electron Transfer Reactions in Ground and Excited States
C. Laser Induced Selective Chemical Reactions
D. Studies on Transient Phenomena in Biology
E. Photoelectrochemical Energy Conversion by Thin Films of Organic Semiconductors
F. Energy Storage and Solar Energy Conversion by "Layer Compound Electrode"
G. Photocatalytic Effects of Semiconductors

RESEARCH ACTIVITIES IV MOLECULAR ASSEMBLIES

A. Photoelectric and Optical Properties of Organic Solids in Vacuum Ultraviolet Region
B. Photoconduction in Organic Solids
C. Reaction Mechanism of Hydrogenase and Electron Transport Properties of Cytochrome
D. Application of Photoelectron Spectroscopy to the Study of Photochemical Reaction of Solids
E. Studies of Ion-Molecule Reactions by a Threshold Electron-Secondary Ion Coincidence Technique
F. Photoionization Processes in Small Molecules
G. Studies of Formation and Destruction Mechanisms of Interstellar Molecules
H. Effect of Vibrational Energy Transfer and Reactant Vibrational Excitation on the Cross Section of the Vapor-Phase Chemical Reaction
I. Chemistry and Physics of Intercalation Compounds of Graphite

RESEARCH ACTIVITIES V APPLIED MOLECULAR SCIENCE

A. Syntheses and Physico-Chemical Properties of Bridged Aromatic Compounds
B. Structural and Kinetic Studies by Means of NMR of Other Nuclei
C. Spin-State Variations among Nickel(II) Complexes Containing Macrocylic Ligands
D. Electron-Density Distribution in Transition Metal Compounds

RESEARCH ACTIVITIES VI COMPUTER CENTER

A. Development of JAMOL Program System for Molecular Orbital Calculations
B. Ab Initio SCF MO CI Calculations of Metalloporphines

Table III (Continued)

Research Areas

RESEARCH ACTIVITIES VII INSTRUMENT CENTER

- A. Reaction Mechanism of Hydrogenase
- B. Electron Transport Porperties of Cytochrome

RESEARCH ACTIVITIES VIII LOW TEMPERATURE CENTER

- A. Metallic Properties of One-Dimensional Mixed Valence Compounds

RESEARCH ACTIVITIES IX CHEMICAL MATERIALS CENTER

- A. Synthesis of a New Chiral Phosphine Ligand and its Use in Rh(I)-Catalyzed Asymmetric Hydrogenation of α-Amidoacrylic Acids
- B. Nickel(O) Catalyzed Reaction of Methylenecyclopropanes with Electron Deficient Olefins. Mechanistic Aspects

PHYSICS IN TAIWAN AND HONG KONG

Mitchel Weissbluth

I visited Taiwan between November 26 and December 5, 1978. The dates are significant for it was on December 15 that President Carter announced the establishment of full diplomatic relations between the United States and the People's Republic of China (PRC). This event is bound to have significant effects on various aspects of life in Taiwan, including the conduct of science and technology. What follows is therefore a summary of information and impressions–mostly on physics at several Taiwanese universities–pertaining to the period immediately prior to the US-PRC agreements and may serve as a baseline for comparison with whatever changes occur in the future.

Scientific work everywhere is closely intertwined with economic and political considerations. In Taiwan, because of its special circumstances, the mixture is even more intimate. Economically, Taiwan is doing very well. According to the Council of Economic Planning and Development, Taiwan will close 1978 with a 10-12 percent growth rate. Foreign trade is described as "booming," foreign reserves "soaring" and there is an overall improvement in the domestic economy–an achievement all the more remarkable when one considers that Taiwan had hardly any industry until a quarter of a century ago. Comparisons with Japan's modern economic history are not uncommon. The two largest cities–Taipei, in the north, with a population of two million and Kaohsiung in the south, with one million–are connected by a newly completed freeway, 375 miles in length, along the western plain. Parallel to the freeway is the newly electrified west coast railroad, and on the rugged east coast, other railway projects are under construction. A new airport, about 20 miles west of Taipei, has also been completed recently. For the skeptic who lacks faith in statistics there is perhaps no better evidence of industrial growth and economic well-being than the thick layer of smog over Taipei and even to a greater degree over Kaohsiung which operates the biggest port in Taiwan and is the site of a major petrochemical plant. It is expected that the Taiwanese government will continue to place priority on the development of the petrochemical industry and will encourage the import of technology, e.g., electronics. Research and development, however, appear not to have kept pace with economic growth. In a China News editorial (November 28) one reads: "As we approach the 1980's one principal deficiency lies in the absence of research and development. We are still imitators and learners. If we wish to do anything complicated, we must call in the Japanese or the Germans or the Americans to help us. Buyers are rushing here to order our products principally because they are cheap–not because they are of new design or higher quality."

The gradual increase in the number of countries–including the major powers–that have entered into diplomatic relations with the PRC and simultaneously have broken relation with Taiwan–usually at the insistence of both sides–has created serious obstacles for Taiwanese scientists. There have been cases in which prominent foreign scientists who have expressed themselves publicly in a manner favorable to the PRC, but not necessarily antagonistic to Taiwan, have been officially regarded as unfriendly to Taiwan. The net effect is that Taiwanese scientists are becoming more and more isolated and for a small country like Taiwan the deterioration of contact with the world scientific community is a very serious problem.

My visit to Taiwan was arranged by Dr. E. K. Lin, Director of the Division of Natural Sciences, National Science Council (NSC). With aims not too dissimilar from those of the National Science Foundation in the US, the NSC seeks to strengthen pure and applied science, to explore natural resources and to promote independence and creativity in science and industry. Its activities may be grouped under four general headings: (1) support of basic research projects, (2) international scientific cooperation, (3) precision instrument development and (4) science and technology information.

In the 1976-77 fiscal year, 441 projects were supported: natural and mathematical sciences (132), engineering and applied science (83), biological, medical and agricultural science (201) and humanities and social science (25). In conversations with individual scientists, doubts were expressed concerning the wisdom of the NSC policy of spreading its limited resources over many projects, with the net result that hardly any researchers received sufficient support to do their work properly–a complaint not uncommon even in more highly developed countries. With financial assistance from the NSC, six research centers–mathematics, physics, chemistry, biology, engineering science and agriculture–have been established under sponsorship of the major Taiwanese universities. The Science and Technology Information Center, supported by the NSC, collects and disseminates scientific and technical information to and from domestic and foreign countries. Nine periodicals, varying from monthly to annual, are published. Parenthetically, it may be noted that Taiwan does not adhere to the Universal Copyright Convention; hence there is no restraint on the reproduction (but not export) of books (and phonograph records) without the permission of the copyright owners. Whatever the merits of this policy from a world-wide point of view, it must be said that Taiwanese scientists (and others) have a better access to foreign literature than would be the case under adherence to the Copyright Convention.

The NSC provides active assistance to electronic production, the manufacture of electric vehicles and the exploration of geothermal energy. Through the Precision Instrument Development Center, new and special instruments, mainly for industry, are developed and occasionally produced on a small scale. Technical services–calibration, maintenance, literature, etc.–are also available. Finally, the NSC sponsors over 30 projects in cooperation with the United States, including the exchange of professors and students.

My itinerary included visits to National Taiwan University in Taipei, National Tsing Hua University in Hsingchu and National Cheng Kung University in Tainan–mostly in the physics departments–with shorter visits to the Academia Sinica and the National Defense Medical Center.

To gain admission to a university in Taiwan, a student must satisfy certain secondary school requirements and must compete successfully in the Joint Entrance Examination held each summer. Successful candidates are admitted to a particular department–not always the student's first choice–to begin training in a particular field; transfer from one department to another appears to be rather restricted. This quite different from the system in most American universities where a student may study for one or two years before embarking on a major field of specialization.

There would seem to have been an increased emphasis in recent years on the training of students in experimental areas. Several reasons for this trend have been voiced: to train students who can accommodate more easily to industrial requirements, to overcome the criticism from abroad–mostly United States–that Taiwanese graduate students were not as well prepared for experimental research as their American counterparts and to de-emphasize the tradition of "book-learning" inherent in Chinese culture and reinforced by the system of competitive examinations. This tradition, one might add, also has positive values as evidenced for example by the high performance of Taiwanese students on the Graduate Record Examinations when applying for admission to United States graduate schools.

Although Ph.D. programs in physics are available in Taiwan, e.g., National Taiwan University, National Tsing Hua University, most students who choose a career in physics go abroad and the vast majority of these elect to go to the United States. Unfortunately for Taiwan, only a small fraction of these students return home. The obvious reasons are the meagerness of research opportunities in Taiwan at the post-doctoral level, the scarcity of academic positions, the lack of interest on the part of industry in physicists with advanced training. Other contributory reasons are the uncertainty of Taiwan's political future and the influence of wives who become accustomed to the easier living conditions in the western countries. However, it was somewhat surprising to learn that a social stigma is attached to a person who had studied in a foreign country and had subsequently returned to Taiwan; the implication is that he could not make it abroad and hence was forced to return. There is evidence that the government is cognizant of the problem and that some remedies are being developed in the form of transportation allowances and job placements. In this connection I would comment that of the physicists I met–most of whom were fairly young and had been trained in United States–quite a few impressed me as being of an idealistic stripe with a sincere interest in the welfare of their country and who, in all likelihood, could have found equally satisfactory or superior positions in the United States.

Under the circumstances–severely limited financial support for research and the scarcity of graduate students above the Master's level–one cannot be too sanguine about the outlook for academic research in Taiwan. Nevertheless, there are a few bright spots which will be indicated below.

The National Taiwan University in Taipei, with 36 departments, 7 schools, 46 graduate institutes and 13,000 students, is the largest university in Taiwan. The Physics Department–under the chairmanship of Professor P. K. Tseng who, by his own admission, has a reputation of being "tough"–has 130 undergraduate students, 7 in a Master's and 1 in a Ph.D. program (1977-78).. The student laboratories are not impressive in their appearance but it was pointed out that although equipment is in short supply and not always in the best working condition there is nevertheless some advantage to adversity in that students are forced to improvise and to acquire various mechanical and electrical skills.

Of the research projects in the Department I was particularly impressed with the work of Professor S. Y. Chuang, who was using positron annihilation techniques to investigate various kinds of phase transitions. He has concentrated on the annihilation rate of ortho-positronium (^3S) to study solid-solid phase changes including glass transitions in polymers. Together with Professor Esther I-hsin Chow of the Biochemistry Department in the School of Medicine, an experiment is being instrumented to investigate phase transitions in biological membranes by an extension of the annihilation technique. It would appear that this type of experimentation in which the outlay in equipment is relatively modest and which has a wide range of applications, e.g., solid state physics, polymer science, biophysics, would be particularly appropriate under the condition prevailing in Taiwan.

National Tsing Hua University in Hsingchu, 72 km southeast of Taipei, is situated on 210 acres of partly wooded land; the campus is spacious and modern and gives evidence of careful attention to the intellectual and physical needs of students and faculty. Although the university was founded in 1955, primarily for nuclear science research, undergraduate teaching did not begin until 1964. The Physics Department was organized in 1965, an Institute of Physics in 1966 and an Institute of Applied Physics in 1972. There are now 2000 students in the university and a permanent faculty of 225. Master's programs are offered in most fields, Ph.D. programs in physics and chemistry. In physics there are 160 undergraduate students, 30 in the Master's and 5 in the Ph.D. programs; an additional 14 students are in the applied physics Master's program. The recently appointed chairman of the Physics Department is Professor Edward Yen, a young theoretician in high energy physics, who received his Ph.D. at the State University of New York at Stonybrook, under the direction of the Nobel laureate C. N. Yang.

National Tsing Hua is regarded as the foremost technical university in Taiwan. The Institute of Nuclear Science Research operates a 1.5 MW research reactor and engages in cooperative projects with the United States National Argonne Laboratory and the Japan Atomic Energy Research Institute. Under the auspices of the National Science Council and with the cooperation of the Institute of Physics of Academia Sinica and National Taiwan University, Tsing Hua was selected as the site of a National Physics Research Center to promote the development and research in pure and applied physics. The facilities are gradually being enlarged; at the present time they contain items such as a 3 MeV van der Graaf, a 14.1 MeV neutron generator, multi-channel analyzers, Ge(Li) α-ray detectors, a nitrogen and helium liquefier, a high-vacuum evaporating system, a sputtering system, an IBM/130 computer.

National Cheng Kung University in Tainan bears the same relationship to engineering science as Tsing Hua does to physics. In 1965, Cheng Kung was accredited to establish the Engineering Science Research Center in cooperation with Taiwan University and Chiao Tung University. The purpose is to upgrade the training and research programs in the fields of engineering science and to provide industry with support and service in science and technology. As a result, Cheng Kung probably has the closest ties with industry of any Taiwanese university. There are now 4 colleges with 26 departments, 11 graduate schools and one undergraduate evening school. The College of Engineering requires all of its students to spend two months in industrial plants during vacations in order to obtain on-the-job experience prior to graduation. Master's programs are offered in physics and Ph.D. programs in all the major branches of engineering.

The Academia Sinica is the top-ranking academic body in Taiwan to which academicians–currently approximately 100 in number–are elected for life by an advisory council. Research in science and the humanities is conducted in 9 institutes.

The Chinese University of Hong Kong reflects the international character of the city–the principal language of instruction is Chinese; the general organization resembles that of a British University and a large fraction of the faculty has received advanced training abroad. In physics, about 30% of the professional staff have graduate degrees from American universities. The campus was established in 1963 and is situated in the scenic mountainous terrain of the New Territories. Most of the buildings are therefore of recent origin and give evidence of attention to aesthetic qualities.

The university operates on the college system, of which there are three, and admission is conditional upon passing the Matriculation Examination. Students are admitted on a Faculty basis–Arts, Business Administration, Science and Social Science; a Faculty of Medicine is underway. The selection of a major may be postponed until the end of the first year; the total enrollment is 4500. The Science Faculty is divided into departments of biochemistry, biology, chemistry, computer science, electronics, mathematics and physics. There are about 200 physics majors.

Graduate degrees are of two types: Master of Science, obtainable after one year of fulltime study, and Master of Philosophy which requires two years. Both degrees are offered in electronics and the Master of Philosophy in physics. There are also several Institutes–among them the Institute of Science and Technology with the stated purpose "to promote interdisciplinary research in the Science Faculty with particular emphasis on projects with long-term regional significance of applied value." The two major research units of the Institute are Chinese Medicinal Material and Food Protein Production from wastes.

The Physics Department appears to be well-equipped particularly in regard to the undergraduate laboratories which are spacious and modern. Among the research activities there are projects on viscoelastic and thermal properties of polymers, electrical and optical properties of amorphous semi-conducting films, ultrasonics in polymers, Mossbauer effect, neutron activation analysis, laser holography, theory of disordered systems and theory of electron-atom and electron-molecule collisions.

The Royal Observatory in Hong Kong is primarily a center for meteorological and geophysical services. It receives and analyzes data from meteorological satellites, weather radars, upper atmosphere detectors, seismographic stations, etc. The Director is Gordon J. Bell who also serves as the Chairman of the Committee for Scientific Co-ordination and Policy for Science and Technology in Hong Kong. Among the terms of reference of the Committee: to advise on scientific problems; to recommend new scientific and technological programs and policies; to disseminate the results of scientific and technological research; to advise on the conduct of surveys of scientific manpower, facilities and other resources; to prepare and maintain a directory of scientific personnel and facilities. Not all of these activities have as yet been fully implemented. However a particularly noteworthy contribution has been the publication of the Scientific Directory of Hong Kong, now in its fourth edition (1978). The Directory provides (1) a list of scientists, with their academic and professional qualifications, fields of expertise and current projects and interests and (2) a list of scientific facilities, including libraries and precision measurement instruments in Hong Kong.

A REVIEW OF SOME HIGH TEMPERATURE METALLIC MATERIALS RESEARCH IN JAPAN

Oleg D. Sherby

A six-week visit to Japan (September 1-October 11, 1978) gave me an opportunity to learn of some Japanese work on mechanical behavior of metallic materials at elevated temperature. My visit was arranged by the JSPS (Japan Society for Promotion of Science). In this report, I discuss some of my observations on high temperature materials research I observed. Prior to some specific comments on this subject I give some background remarks to my very pleasant and productive visit.

During my stay in Japan I interacted principally with my host Professor, Dr. Tadahisa Nakamura, and his colleagues, Professor Soekichi Umekawa and Associate Professor Toomoo Suzuki of the Tokyo Institute of Technology. Thus my stay was centered at TIT where I gave seminars to the graduate students and faculty. I also interacted with many other faculty and students there and discussed in-depth research of mutual interest.

Professor Nakamura arranged a large number of visits for me to other universities and industrial laboratories during my stay in Japan. In all places visited I gave seminars on my work at Stanford (a choice of three subjects was given). A high level of mutual exchange of ideas was accomplished during each of the visits. The work I lectured on and discussed in detail was my current research at Stanford, and not yet published; this was especially true of our work on ultrahigh carbon steels and ultrahigh carbon steel laminated composites. In turn, I learned much about on-going research at the universities and industrial laboratories I visited. Most of our discussions centered on high temperature mechanical properties, on superplasticity, and on ferrous metallurgy studies. Specifically I visited the metallurgy departments of Kyoto and Tohoku Universities, the National Research Institute for Metals in Tokyo, and the research laboratories of Nippon Steel, Nippon Kokan, Kobe Steel, Sumitomo Metal Industries, and Mitsubishi Heavy Industries. I also attended (and participated in) the annual autumn meeting of the Japan Institute of Metals and the Japan Iron and Steel Institute at Toyama.

Very high research activity exists in Japan in the area of mechanical behavior and mechanical properties of materials at elevated temperature. This was certainly true for the universities, research laboratories of private companies, and government laboratories that I visited. A possible notable difference in emphasis between work at universities in the United States and Japan is the following. In Japan, very basic as well as engineering-oriented research is conducted in materials departments at universities. Thus, considerable research is found in creep of single crystals of pure metals, solid solution alloys, and dispersion hardened materials, in deformation of bicrystals of pure metals and two phase alloys, and in other similar related topics. Often model metal systems are chosen (e.g., zinc, α-β brass, and aluminum). This type of basic research has diminished considerably in the United States, where research emphases are now more commonly in programmatic areas with often short-term goals. If this difference in emphasis continues between the two countries, it would be most important for American researchers to pay close attention to the results of basic work in Japan through their publications. Truly novel material developments are generally dependent on new concepts, which arise more from basic research utilizing simple and complex model systems than from short-term engineering-oriented research.

Another observation is that Japanese researchers work very hard. Work on Saturdays is a normal routine at universities. Most graduate research students, and many faculty, work regularly in the evenings. This high driving force for work and accomplishment is to be admired and respected. A new trend in Japan is that the number of doctoral candidates has decreased considerably in recent years. This is due principally to the job market; there is very little demand for Ph.D. graduates in materials and metallurgy in Japan at the present time. Although a similar trend exists in the United States it is much less extreme. The number of M.S. candidates in Japan remains high; a thesis is required for this degree, and considerable research is achieved in this manner.

I noted, with interest, that a large number of Japanese scientists and professors spent one or more years in foreign countries for special technical studies. The majority of those I met studied in the United States, with a number also in Great Britain and West Germany. Undoubtedly, this foreign experience is very healthy for enhancing the strength of science and technology in Japan. Young Americans are not nearly as active in such practices, at least not for long-term visits.

Elevated temperature mechanical property research at Tokyo Institute of Technology, Kyoto University, and Tohoku University and at various other government and industrial research laboratories is described in the following sections. Those who are interested in the more general aspects of materials research at the above places should read Dr. George Sandoz' excellent report entitled "An Overview of Materials Science and Engineering in Japan," 1977, ONR-38.

TOKYO INSTITUTE OF TECHNOLOGY

Professor Tadahisa Nakamura of the Materials Science Department was my host during my stay in Japan (September 1 to October 11, 1978). He was head of the department last year (a rotating position) and is currently very active in a number of national materials committees; his research interests are in mechanical metallurgy with special emphasis on understanding deformation under hot and warm working conditions. His efforts on my behalf made my stay in Japan productive, superbly pleasant and very stimulating. Professor Nakamura will be sixty years old next year, which is the compulsory retirement age at the Institute; he will therefore leave Tokyo to become a professor at the Technological University of Nagaoka in north central Honshu.

Graduate teaching and research is at a high level in the Materials Science, Metallurgy, and Ceramics departments. The President of the Institute, Dr. S. Saito, was formerly head of the Ceramics Department. There are two campuses. One is in Tokyo at O-Okayama and the other one (a new campus) is in Yokohama at Nagatsuda. Graduate science education will be centered at the Nagatsuda campus and the Materials Science Department will be moved, almost entirely, to the new campus next year. High temperature metallic materials research is being conducted by a number of faculty members at the Tokyo Institute of Technology which includes Professor T. Nakamura, Professor S. Umekawa, Associate Professor T. Suzuki, Professor R. Tanaka, and Professor T. Mori (currently head of the Materials Science Department).

Professor Soekichi Umekawa (one year at Stanford University and two years at NASA Ames Laboratory) is studying the high temperature mechanical behavior of composite materials. Two types of fiber composites have been studied. One is a natural grown type, $NiAl_3$ in an aluminum matrix, and the other is a powder metallurgy product, W fibers in copper. Umekawa is also currently studying carbon fibers in a commercial aluminum alloy (Al-Mg). His major recent discovery is that such oriented composites will exhibit severe distortion and dimensional change under thermal cycling conditions. He attributed this undesirable effect to interphase boundary shearing, and excellent evidence for this proposal is shown by structural changes on the surface of the tungsten fibers. There is no change in specimen dimensions if the second phase fibers are distributed randomly in the metal matrix. Room temperature properties are shown to be influenced by thermal cycling. If a sample is cooled below room temperature and then heated to room temperature, the yield strength is increased; samples cooled to room temperature sometimes exhibit a decrease in yield strength. He could explain these effects from the development of internal stress. Composites with a random configuration of fibers again showed no change in room temperature yield strength from such thermal history effects. Some of these results have been published in *Metallurgical Transactions* and in the *Transactions of the Japan Society for Composite Materials.* Another aspect of Umekawa's work is his synthesis studies of fiber composites. Two recent methods of composite preparation are by (1) casting of superalloys (or stainless steel) in bundles of W fiber and (2) solid state bonding by hot swaging 0.5 mm fibers of superalloy or stainless steel and 0.5 mm fibers of tungsten. Special attention to the interphase boundary region by x-ray probe microanalysis is being made. Property evaluation of these composites is being made by impact flexure bend tests as a function of temperature (up to 1100°C).

Associate Professor T. Suzuki (one year at Stanford University) is investigating the temp ture dependence of the strength and phase stability of $L1_2$ ordered alloys. The experimental study involves determining the strength (hot hardness and creep strength) of polycrystalline and single crystalline samples of such compounds. He is developing a classification of such compounds into those that have positive temperature dependence of strength and those that have negative temperature dependence. From this initial work, he is now studying the influence of composition on the mechanical behavior of pseudobinary systems of $L1_2$ compounds, where one has a positive temperature dependence of strength and the other a negative temperature dependence. Examples of two such systems studied are Ni_3Ge-Fe_3Ge and Pd_3Pb-Pd_3Sn. Suzuki has clearly embarked on a difficult and very basic study of potentially useful intermetallic compounds. In another related study, he is investigating the mechanical properties of Cu_3Au and Ni_3Fe ordered alloys. Whereas some investigators consider that these two ordered compounds should behave similarly, Suzuki thinks that this may not be the case. The configurations of anti-phase domain boundaries in these two compounds are different (maize-like for Cu_3Au and swirl-like for Ni_3Fe), and he believes this difference in boundary morphology should have an effect on mechanical properties.

Professor Ryohei Tanaka has an excellent creep laboratory where he is conducting basic research with strong emphasis on improving the high temperature creep resistance of austenitic stainless steels and superalloys. Associate Professor M. Kikuchi (two years at Argonne National Laboratory) is working closely with Professor Tanaka. One of Tanaka's important findings has been published in collaboration with T. Matsuo and T. Shinoda (Trans. Jap. Iron and Steel Institute, *63*, *1977*, *980-989*). These authors showed that a 17Cr-14Ni austenitic stainless steel can be increased in strength by a fourth element solute addition. Large additions (up to as much as 10 atom-percent) of W, Mo, Al, Mn and Cu were considered. It was shown that the steady state creep rate could be decreased by a factor as high as 100 in studies performed at 700°C. The improvement could not be accounted for by a change in atom mobility, modulus, or stacking fault energy. The authors attributed the improvement in strength to a lattice distortion factor and showed a common linear relation between lattice distortion induced by the solute elements and the logarithm of the steady state creep rate. Tungsten and molydenum were the most potent solute hardeners. The authors received the 1977 Henderson Award of the Iron and Steel Institute of Japan for their work. One is tempted to consider the possible contribution of solute atmospheres on the motion of dislocations as a possible factor since the temperature of testing, 700°C, is not a very high homologous temperature ($0.55T_m$).

Professor T. Mori (four years at Northwestern University) is investigating the influence of stress on precipitation (or transformation) in Al-Cu and Fe-N alloys (Acta Met. publications, 1978). These thorough studies, using single crystals, reveal the complex nature of nucleation and growth of precipitates as influenced by stress. Currrently, Mori is studying the steady state creep behavior of copper single crystals containing silica particles. He finds steady state creep to occur at strains (= 0.1 to 0.2) considerably smaller than those found in pure polycrystalline copper (= 1 to 2). A unique observation by Mori is that the stress dependence of the creep rate is linear and the activation energy for creep is about that for dislocation pipe diffusion. He has developed a creep model based on the climb of piled-up loops at particle sites as the rate controlling process in creep. The creep expression developed from the model agrees quantitatively with the experimental data. It predicts a linear stress dependence of the creep rate, an activation energy for pipe diffusion, and no effect of interparticle spacing on the creep rate. This work is currently under preparation for publication.

Professor T. Nakamura's current research is on understanding the factors affecting hot workability of materials and on the influence of thermal mechanical processing on mechanical properties. His principal experimental method is use of a hot torsion testing machine wherein samples can be heated rapidly to the test temperature and also cooled rapidly after torsion testing. Hollow cylindrical samples are used to permit study of uniform plastic strain during torsion testing to determine microstructure and property changes. Strain rates can be made to vary from 10^{-3} to 10^{2} per second. Thus, Nakamura is able to simulate most normal forming operations (extrusion, forging, and rolling). With the able assistance of his technical associate, S. Horie, he is doing work in the following areas:

1. Recovery and recrystallization mechanisms during hot working in Cu-Al alloys (1, 2, and 5% Al); a major objective here is to determine the influence of change in stacking fault energy on recovery and recrystallization processes during hot working.
2. Hot workability of aluminum and aluminum-magnesium solid solution alloys in the temperature range 350-500°C; an objective here is to determine the microstructural differences (dislocation density and subgrain structure) in aluminum as influenced by magnesium at large plastic strains, where considerable strain induced recovery effects can occur. Magnesium is known to alter the rate controlling process during plastic flow under creep conditions.
3. A study of the effect of various thermal mechanical processing treatments on the properties and structure of high strength low alloy (HSLA) steels is being made. The torsion test machine will be used to evaluate the optimum thermal mechanical processing treatment for attainment of desirable microstructures and mechanical properties.

KYOTO UNIVERSITY, KYOTO

My hosts at Kyoto University were Professor I. Tamura (one year at Northwestern University) and Associate Professor T. Maki (two years at University of Illinois). They are in the Department of Metal Science and Technology, and both are renowned experts in phase transformation with special interest in martensitic transformation in ferrous materials. A new interest of Tamura and Maki is the mechanical behavior of materials at high temperature and high strain rate, with special interest in the importance of recovery and recrystallization during plastic deformation. They are using a high strain rate, induction heated, tensile test unit (Gleeble) for study of three high temperature alloys: Fe-25Ni-0.4C, 18-8 stainless steel, and Fe-12Mn-0.5C. These alloys have dissimilar stacking fault energy (given above in order of decreasing stacking fault energy). Studies of the mechanism of recrystallization during hot working are currently in progress. Two of the three alloys investigated have the additional feature of permitting studies of martensitic transformation after high strain rate mechanical working (the M_s temperature of Fe-12 Mn-0.5C is below room temperature).

Dr. Tamura is a member of a national committee (about 20 members) on superplasticity. It is the function of this committee to survey trends in this area and to indicate specific research areas where fruitful research may be done. A national symposium was held three years ago on superplastic alloys and the proceedings were published in the Journal of the Japan Society for Technology of Plasticity (1975, *16*, 907-1036). The symposium was organized by Professor M. Miyagawa of the University of Tokyo and a large fraction of the papers presented were on the superplastic Zn-22Al monotectoid composition alloy. One paper was on ferrous alloys by Kobayashi, Kamada and Takeoka (Hitachi, Ltd., Yokohama). These authors revealed that Fe-P alloys could be made superplastic in the temperature range 800-900°C (>400% elongation, with a strain rate sensitivity exponent equal to 0.5). The phosphorus content was typically in the range of 1 weight-percent (with ~1.5%Mn, 0.1%V, and 0.13%Al). In discussions with Professor Tamura I was under the impression that very limited studies on superplasticity were underway at the present time in Japan, but that they (the scientists making up the committee on superplasticity) were watching closely developments in this area in the United States and Europe. A company called Tamagawa supplies superplastic Zn-22 Al in Japan (TAMA Spz). I attended the annual meeting of the Japan Institute of Metals (JIM) and Japan Iron and Steel Institute (JISI) in Toyama (October 3-5, 1978) and noted that no papers on superplastic deformation were presented.

Professor Tamura organized an afternoon symposium (Fourth Ferrous Materials Conference) on superplasticity sponsored by the Iron and Steel Institute of Kyoto on September 20, 1978. Three invited speakers included Tamura himself, who presented an overview on superplastic material behavior, this author, who spoke on superplasticity in ultrahigh carbon steels, and Dr. K. Itayama of Kobe Steel (in collaboration with Y. Ashida) who spoke on phase transformation (internal stress) superplasticity and grain refinement. Dr. Itayama showed results of thermal cycling through the alpha-gamma phase transformation region (690-765°C) on the superplastic properties of a 3.5Ni-1.7Cr-0.3Mo-0.1V steel (0.26%C). The results revealed that the strain rate during transformation varied linearly with stress and that this led to high ductility of the material under multiple phase transformations. The heating rate influenced the results such that less superplastic transformation strain was observed with increase in heating rate; this was attributed to the influence of strain rate during transformation on the normal yield strength of the material (i.e., the yield strength without internal stress). Itayama found good correlation between his results and those predicted from the Greenwood-Johnson model for phase transformation superplasticity. Multiple thermal cycling led to a grain refinement in the steel (e.g., at a heating rate of 500°C/min and under a stress of 5 kg. per mm^2, the grain size decreases from 26μm to 9μm after one cycle, 5μm after two cycles, 2μm after five cycles, and 1μm after 10 cycles). Grain refinement enhanced the amount of phase transformation strain; presumably this is due to a decrease in the inherent strength of the matrix material (without internal stress) as the grain size is refined. The Itayama-Ashida work was very thorough, yielding data amenable to a more quantitative development of the original Greenwood-Johnson model (which contains a yield strength term I_0 not readily calculated theoretically or determined experimentally).

Professor M. Adachi of the Structural Metallurgy Laboratory, in the Department of Metal Science and Technology, has been very active on mechanisms of high temperature plastic flow in metallic materials for a number of years. His most recent publications, in collaboration with his research associate, Dr. S. Kikuchi, describe the creep behavior of copper base solid solution alloys. High temperature deformation (600-700°C) of Cu-Mn and Cu-Sn polycrystalline alloys is controlled by solute dragged dislocation motion (stress exponent, n, equals about three). Cu-Sn alloys creep about ten times more slowly than Cu-Mn alloys and this is attributed to a difference in size factor between these two alloy systems. In work on Cu-15%Al single crystals oriented for single slip initially, Adachi, Kikuchi and their colleagues find two steady state creep regions (T = 700°C). In the first stage, only isolated dislocations are observed and the stress exponent for creep is three. In the second stage, a well defined subgrain network is established and the stress exponent is about 4.5. Adachi believes solute drag dislocation motion is the rate controlling mechanism in both cases and attributes the differences in stress exponent to a difference in internal stress for the two structures. The ratio of internal stress, τ_i, to applied stress, τ_a, was found to be a constant in the case of the first steady state region, but τ_i/τ_a was found to decrease with increasing applied stress for the second steady state region. The internal stress was obtained by the Nix dip-test (stress-drop test). A plot of steady state creep rate versus effective stress, ($\tau^* = \tau_a - \tau_i$) revealed superposition of the results for the two stages, suggesting evidence for a single dislocation mechanism. [Another possible explanation is that when n = 3, a solute drag effect controls the creep rate whereas when n = 4.5, a diffusion controlled dislocation climb process controls the creep rate (author's suggestion)].

A short visit with Professor Shuji Taira* of the Engineering Science Department (formerly called the Mechanical Engineering Department) indicated that he is still keenly interested in high temperature creep and fatigue behavior of materials. He remains among the top leaders in the world in combining applied mechanics and materials science to predict creep, fatigue, and fracture behavior of materials. Some of his recent work on low cycle fatigue and thermal fatigue is described in several papers published in the *Journal of the Society of Materials Science* (May 1978 issue). Taira and his colleagues performed experiments which showed the importance of grain boundary sliding in initiating fatigue failure in 304 stainless steel by thermal fatigue (400-700°C) and by isothermal fatigue (700°C).

Professor J. Takamura (one year at University of Chicago) of the Metal Science and Technology Department is emphasizing studies, as in the past, on influence of lattice defects, especially vacancies and solute atoms, on mechanical properties. A recent paper by Takamura and his colleagues on Ni-Ge alloys has permitted estimating the stacking fault energy of pure nickel. Stacking fault energies were evaluated by determining the deformation stress for twinning at 4.2°K and the results on the Ni-Ge alloys were extrapolated to 0% Ge. A value of 149 ± 3 mJ/m^2 was determined for nickel. This result helps to decide the true stacking fault energy for nickel, a factor known to influence high temperature creep of materials. Currently, Takamura has shown that the Hall-Petch relation is valid for pure polycrystalline nickel only when the yield strength is used in the relation. When the flow stress at large strains is used, the strength varies inversely with grain size rather than its square root. He has developed a relation based on dislocation density variation with strain as influenced by grain size which agrees with the experimentally observed formula.

*This writer received word from Japan that Dr. Taira passed away unexpectedly (heart attack) on October 23, 1978.

TOHOKU UNIVERSITY, SENDAI

The largest university materials group in Japan is located at Tohoku University. There are three departments (Metallurgy, Materials Science and Metal Processing) comprising about 65 faculty members. In addition, another group of professors work at the Research Institute of Iron, Steel and other Metals; one-half of these professors (about 25 out of 50) give materials courses at the graduate level at Tohoku University resulting in close collaboration between University and Institute faculty.

During my two-day visit, I visited Professor Karashima's group in the Materials Science Department at Tohoku University and Professor Izumi's group at the Metals Institute. I also visited the Metals Museum, whose director, Dr. Yunoshin Imai, is an emeritus professor of Tohoku University. At the metals museum I saw examples of the steps used in making ancient samurai swords as well as early steel making ("Tatara") processes. I noted with interest that the initial material for making samurai swords and other tools was a high carbon steel containing 1.7-2.0% carbon. The museum is financially sponsored jointly by the Japan Institute of Metals and the Japan Iron and Steel Institute.

Professor Izumi and his colleagues are very active in three areas: superconducting materials, intermetallic compounds, and interface effects in solid solution and two phase alloys. He and his colleagues are investigating the temperature dependence, ductility, and strength of a number of intermetallic compounds such as beta brass, Ti-Al compounds and Ni_3Al-type compounds. One objective is to learn about the factors (such as third element addition and grain size) influencing the ductility of compounds. Improvement in ductility can lead to the development of economical processing of intermetallic compounds for use as high creep resistant materials. Dr. Izumi's group is also performing *in situ* SEM studies of the deformation of bicrystals consisting of alpha and beta brass. This work centers on an understanding of the complex deformation occurring near and at the phase boundary. Their research on this and other systems suggests that many intergranular boundary failures are initiated not by grain boundary sliding but by slip modes occurring near the boundary region.

Professor Karashima of the Materials Science Department and his two principal colleagues, Associate Professor Hiroshi Oikawa and Assistant Professor T. Watanabe, have been extremely active in studying mechanisms of deformation at elevated temperature (about 15 publications per year come from this group). Watanabe (two years at Swansea, Wales) is currently investigating grain boundary sliding and grain boundary fracture in materials. He has shown that grain boundary sliding in zinc bicrystals is not only a function of misorientation angle (increasing sliding rate with increasing misorientation) but also of its nature. Grain boundary sliding occurs readily when the boundary is of tilt nature (edge dislocations) but with great difficulty when it is of twist nature (screw dislocations). Also, the orientation of slip systems to the grain boundary plane plays a role in determining the ease of grain boundary sliding; this effect is observed even at large misorientations. H. Oikawa (two years at University of Florida) is studying mechanisms of deformation in solid solution alloys. He is currently studying creep behavior of Al-Mg and Fe-Mo solid solution alloys. In an aluminum-2-atom-percent magnesium alloy, Oikawa has shown that, whereas subgrains will form at intermediate stresses (where the stress exponent $n = 3$), they will not form at high stresses (where $n = 6$). He has concluded that the nature of deformation is viscous glide (Weertman's micro-creep model) in both regions. He makes this conclusion by determining the nature of creep deformation from stress-change tests. The change in value of the stress exponent with stress is attributed to the change in dislocation density, ρ, with stress (ρ is proportional to stress to the 1.2 power at intermediate stresses and to the third power at high stresses). At very low stresses the Al-2%Mg alloy exhibits a stress exponent of five; he is currently doing microstructural and creep tests to determine the mechanism of plastic flow in this range. In the Fe-Mo system, Oikawa finds the stress exponent to change from five to three with increasing molybdenum additions, showing typical transition from diffusion controlled climb creep to viscous glide creep. He finds, however, that subgrains form in all alloys studied in contrast to the case of Al-Mg alloys where subgrains do not form when the magnesium content in solution is high (about 5 atom-percent magnesium). Clearly much needs to be done in understanding why subgrains form in some systems and not in others. He is attempting to understand the function and importance of subgrains when they appear to contribute to the strengthening process. New work by Oikawa is centered on the creep behavior of low stacking fault energy materials like lead and Cu-Al solid solution alloys.

A visit to the high voltage electron microscopy laboratory (1 million volts) permitted observation of a movie on dislocation motion in silicon and germanium at elevated temperature. This interesting movie, prepared by Professor K. Sumino, revealed dramatic operation of Orowan's Z-Mill type dislocation sources as a very common occurrence; that is, a dislocation is seen to whip around repeatedly as the dislocation origin remains attached to an immobile dislocation segment below it.

Short visits were made at several industrial laboratories and at one government laboratory. Some general observations of these laboratories are briefly given in the following.

NATIONAL RESEARCH INSTITUTE FOR METALS

The National Research Institute for Metals (NRIM) is located in Tokyo. There are approximately 500 researchers, technicians and support staff. The laboratory is directed by Dr. Toru Araki (currently President of the Japanese Institute for Iron and Steel). Considerable research on high temperature materials is under investigation at NRIM. Many of the research papers on creep and fatigue behavior of high temperature materials are published in the Transactions of the NRIM (a bimonthly journal) and in the well publicized NRIM Creep Data Sheets. Dr. Renpei Yoda is in charge of the creep testing division (there are over 1100 creep units in operation) and much of the data is being analyzed and computerized in a most thorough and impressive way. Predictive aspects for extrapolation of stress-rupture data are being done by Mr. Yoshio Monma (one year at Stanford University) who was my host for the afternoon visit. Dr. M. Yamazaki (two years at Massachusetts Institute of Technology) is performing research on development of new superalloys for high efficiency gas turbines. His methods in alloy design utilize a mixture of good physical and chemical metallurgy knowledge as well as knowledge of existing creep property-chemical composition correlations. Considerable emphasis is being placed on creep of nickel-base superalloys for Japan's HTGR program. Dr. Tomoyuki Takeuchi does experimental and theoretical studies on time dependent plasticity. His recent papers relate to the elevated temperature mechanical properties of Cu-10% Al alloy single crystal as a function of crystal orientation. Takeuchi described to me some of his past considerations on the influence of cell structure on the creep behavior of pure BCC and FCC single crystals. His theoretical treatment led to some rather remarkable predictions on the nature of stress-strain and creep curves as influenced by previous strain rate and temperature history (Jnl. Phys. Soc. of Japan, *32*, 1972, 677-693). Thus, Takeuchi joins that small group of theoreticians and phenomenologists who are attempting the difficult task of describing and predicting stress-strain-strain rate-temperature history effects on plastic flow of crystalline solids. Dr. S. Takahashi recently described the influence of melting under low gravity conditions on the microstructure and properties of a silver-silicon carbide (whiskers) composite (AIAA Journal, 1978, *16*, 452-457). These experiments were performed in NASA's Skylab program. Dr. Araki and Professor S. Umekawa (of the Tokyo Institute of Technology) are members of a joint Japan-U.S. committee whose function is to determine additional experiments on NASA's manned space shuttle program for 1982.

FUNDAMENTAL RESEARCH LABORATORIES (FRL) NIPPON STEEL

At the Fundamental Research Laboratories of Nippon Steel (largest private steel company in the world) we were hosted by Dr. H. Okada (Director of Research) and his colleagues, S. Abe, Y. Hosoi and T. Murata (two years at Ohio State University). Professors T. Nakamura and S. Umekawa of TIT accompanied me. It was an especially touching visit for me since a number of FRL staff studied a videotaped course on time-dependent plasticity that I had prepared at Stanford University. My lectures were transcribed into notes written in Japanese and my lectures apparently were found very useful as a means of learning conversational English; the notes even contained a glossary of "American colloquial remarks" that I had used in giving my lectures. High temperature materials research at FRL is pursued extensively, including alloy development work on HTGR materials. *In situ* observations of structural changes in ferrous materials at elevated temperatures are being performed with the one million volt electron microscope located at the laboratory; some of the many important and interesting observations are described in several recent papers by M. Tamino, S. Sakata, H. Komatsu, H. Morikawa and T.

Sato (Fifth International Conference on High Voltage Electron Microscopy, Kyoto, 1977).

TECHNICAL RESEARCH CENTER
NIPPON KOKAN

My hosts at the Technical Research Center of Nippon Kokan in Kawasaki City (near Yokohama) were Director of Research G. Suzuki, Emeritus Director K. Horikawa and Dr. K. Kinoshita. My visit was centered on discussions with Dr. Kinoshita on their high temperature materials research and with Dr. Horikawa on our mutual interest in early Japanese steel making (Dr. Horikawa is currently a full-time consultant to NKK although retired as director of research last year). I also visited the Ohgishima steel plant of NKK. This new plant is a fully integrated steel plant constructed on the man-made island of Ohgishima in Tokyo Bay adjoining Kawasaki and Yokohama. It is a phenomenal engineering feat; I saw the BOF operation and the continuous casting slab mill operation. Dr. Horikawa is a member of the Committee for Restoration of the Tatara Iron Making Process. This committee was responsible for creating a new Tatara shop (near Yasugi, Shimane, west coast of Honshu island), which is Japan's only existing cultural treasure of this ancient art. Details of this restoration process are given by Y. Matsushita, Emeritus Professor of Metallurgy at the University of Tokyo (Proceeding ICSTIS, Suppl. Trans., JSIJ, *11*, 1971).

CENTRAL RESEARCH LABORATORY
SUMITOMO METALS INDUSTRIES, INC.

The Central Research Laboratory of Sumitomo Metals Industries, Inc., is located in Amagasaki City (near Kobe City). There are about 800 employees. My principal host was Dr. Tatsuro Kunitake (two years at Carnegie Institute of Technology) who leads the fundamental research department and also assists Dr. T. Shiraiwai in the advanced planning department. Considerable research and development work is being done on heat resistant materials. Among the principal alloys recently developed and manufactured by Sumitomo are: (a) HCS steel, a carbon steel containing 1.2%Mn used up to 450°C, (b) HCMV, a 0.2Cr-0.3Mo -.05V steel used up to 525°C, and (c) 9Cr-2Mo ferritic steel for use up to 625°C (this is a very new steel). They have also developed a highly alloyed steel for use at 1000°C (two years service) for cracking or reforming tubes in the petroleum industry. This material is designated HK 4M (25Cr-25Ni-.3Ti-.3Al, plus boron, balance Fe), and is a wrought product that rivals the cast material HK 40 which has less ductility. It is principally a solid solution hardened material which is strengthened at the grain boundaries by the presence of boron nitrides. New hot working slabbing rolls have been developed by Sumitomo which are highly resistant to thermal cracking as well as to wear. It is known as NS steel and contains typically 2.2%C, 2%Si, 0.4%Mn, 0.3%Cr, 0.349%Mo and .044%Mg. The micro-structure consists of globular graphite in a matrix of pearlite (of about eutectoid composition). Apparently the presence of the graphite globules inhibits crack propagation.

CENTRAL RESEARCH LABORATORY
KOBE STEEL

The Central Research Laboratory of Kobe Steel comprises a staff of about 350 employees. My two hosts were Dr. Sadao Ohta and Assistant Manager Eiichi Sato. Research programs that were undertaken at the Laboratory were chosen in a rather special way. About thirty percent were selected from proposals submitted by individual researchers, about thirty percent were determined by the assistant manager and general manager, and another thirty percent were from requests by the various divisions of Kobe Steel. The remaining ten percent represent programs in cooperation with other societies or institutes (such as high temperature materials research with NRIM). High incentives for patenting were given including sharing of royalties by the inventors. About 100 patents are issued per year (the company objective is about 200). Kobe Steel is a major producer of ferrous powders and has developed a number of high speed tool steels through powder metallurgy and hot isostatic pressing. A new alloy is M2N (0.9%C, 4.12%Cr, 4.98%Mo, 6.6%W, 2%V, 0.035%Co and 0.4%N); the primary hardening agents are vanadium carbides and nitrides in a fine grained ferrite matrix (about 5μm). Dr. Ohta is doing considerable studies on the creep behavior of highly alloyed austenitic stainless steels (used up to 1000°C). The Laboratory is also engaged in research on mechanical properties of Zircalloy and titanium alloys, including super plastic forming of the latter materials.

NAGASAKI TECHNICAL INSTITUTE
MITSUBISHI HEAVY INDUSTRIES

At the Nagasaki Technical Institute of Mitsubishi Heavy Industries, I was hosted by Dr. S. Ueda, Vice Manager of the Institute and Mr. T. Daikoku, Manager of the Materials Research Laboratory. The Institute is a large research and development laboratory dedicated to studies of ships and prime movers (boilers, steam turbines and diesel engines). During my visit of the several laboratories comprising the Institute I was very impressed by the unexpectedly good speaking knowledge of English by the engineers I met. Apparently, it is Mitsubishi's policy to give lessons in English conversation during the first three to six months of the trainee's initial program at the Institute. Shipbuilding is Mitsubishi Heavy Industries main business. I was immensely impressed by the high technology used in the building of the new Nagasaki Shipyard Koyagi Works completed in October 1972; the Mideast oil crisis, alas for Mitsubishi, changed the demands for construction of large vessels. In an attempt to diversify, Mitsubishi is entering into the field of nuclear power plants. This new policy is reflected in new research on materials for HTGR and in studies of coal gasification and liquefaction. Creep test facilities for studies of nickel-base super-alloys at 1000°C in a pure helium environment are nearly completed. A pilot coal gasification and liquefaction plant is also nearly completed and will soon be operational.

U.S.-JAPAN JOINT SEMINAR ON MULTICOMPONENT POLYMERS

Kenneth J. Wynne

My visit to Japan was primarily arranged in response to an invitation to attend and chair a session at the U.S.-Japan Joint Seminar on Multicomponent Polymers, 17-22 December 1978 in Kyoto. This meeting was the fourth in the series which began in 1965. Of these meetings two have been held in Japan.

At this meeting there were 39 attendees/participants from Japan, 14 from the U.S. and 5 from "third countries" including A. Eisenberg, Canada, G. Reiss, France, V. Privalko, USSR (on leave of study in Tokyo for one year), and J.L. Duda and C.C. Lin, Taipei.

The program began on Sunday, 17 December, with a registration/organization session. The formal papers began on Monday morning and approximately 45 minutes were allotted to each of the 30 papers. Because of the specialized nature of the meeting considerable discussion followed many of the papers. Below, a brief summary is given for a number of talks to give a general idea of the content of the Seminar. No attempt is made to be comprehensive as the papers will be published as a group in the *Journal of Macromolecular Sciences and Physics.*

Dr. D. Meier, Midland Macromolecular Institute, led off the program and outlined the general background and theory for block copolymers. He described the general morphological features observed for such polymers, i.e., lamellar and cylindrical or spherical structures. Lamellar or alternating layer structures are observed when the number of A and B units are approximately equal, while cylindrical or spherical structures develop when A and B chain length differ substantially. While the ratio of components determines morphological shape, chain length of the blocks determines domain size. Such morphological characterization is necessary for understanding physical and mechanical properties. Meier further described a theoretical approach to the description of swelling equilibria in A-B-A block copolymers. This theory was applied to swelling data on a styreme-isoprene-styrene triblock copolymer where iso-octane was used to preferentially swell the B block (Uchida, 1972). Using these data M_c, the molecular weight between crosslinks, may be calculated to be 8,030 as compared to the known molecular weight of the B block (24,800). The less than expected swelling is explained by invoking chain entanglements, i.e., about two or three per chain. In contrast, there is an order of magnitude difference between these results and those obtained from the Flory-Rehner equation (M_c=700) where upwards of 30 crosslinks per chain must be postulated. Whether chain entanglements are the real reason Meier's results are off by a factor of three is unknown, as a quantitative method for determination of chain entanglements is not available.

Professor H. Inagaki of Kyoto University described the problems involved in the measurement of molecular weight vs composition distributions (MWD vs CD) in block copolymers. Block copolymerization generally proceeds to give narrow MWD's, but this does not mean CD's are narrow as well. Rather, broad CD's are expected. There are few methods for determining CD's, yet this knowledge is important to the quantitative description of domain structures in block copolymers. Progress in the development of an improved chromatographic method for the determination of CD's was described as applied to a polystyrene (PS)/poly-(methylmethacrylate) (PMMA) diblock copolymer. A special segmented column was used to separate polymer fractions. Analysis of the fractions demonstrated considerable compositional heterogeneity. These results were independently confirmed by light scattering experiments on copolymer solutions.

Monday afternoon's session was devoted to the viscoelastic properties of block and graft copolymers. Professor M. Shen (University of California, Berkeley) presented an extension of his theoretical work to include a molecular theory of viscoelasticity for homogeneous block and graft copolymers. Maximum relaxation times were calculated using a modified Rouse, Bueche and Zimm bead and spring model for graft copolymers and radial block copolymers with different numbers of side chains, various side chain lengths and spacings between grafts.

Professor Stuart Cooper (University of Wisconsin) spoke on the viscoelastic behavior of short segmented block copolymers. Small angle X-ray scattering (SAXS), small angle light scattering (SALS), infrared dichroism and stress-strain experiments were used to characterize the structure-property relationships in a series of polycaprolactam polyurethanes and a series of polyether-ester-copolymers. Dr. Cooper made the point that microphase separation influences the properties of these materials to a much greater degree than hydrogen bonding which frequently has been invoked incorrectly to rationalize properties.

The sessions on Tuesday morning and one on Tuesday afternoon concerned the morphological behavior of block and graft copolymers. Dr. G. Reiss (Ecole Nationale Superieure de Chemie de Mulhouse, France) discussed the emulsifying effects of block and graft copolymers in the case of model systems like polyblends of polystyrene (PS) and polyisoprene (PI). He discussed new approaches to impact-resistant polymeric materials and the design of new morphologies for two-phase systems. Thus, for example, he presented the design and synthesis of an unusual "onion" morphology in a PS/PS-PI(1)/PS-PI(2) polymer blend. Here, PS-PI(1) is a block copolymer forming the dispersed phase and must have a composition around 50/50, leading in the pure state to a mesomorphic phase of lamellar type and PS-PI(2) is a block copolymer acting as an emulsifier having a similar composition but higher molecular weight than PS-PI(1).

In this same session, Professor K. Kurita (Nihon University) presented SAXS results on styrene-butadiene-styrene (SBS) block copolymers. In particular, the effect of 1,2 addition (vinyl) component in polybutadiene and the effects of casting solvent on the formation of various domain structures in SBS copolymers were established using SAXS and electron microscopy. Thus electron micrographs of methyl ethyl ketone cast films of "SBS-2" which contained 12% vinyl groups showed a granular PB phase embedded in a PS matrix due to the selectivity of the solvent for PS. In contrast, the PB domains are larger and continuous in films cast from benzene.

Continuing with this theme Professor H. Kawai (Kyoto University) gave a paper on the microdomain structure and related properties of block copolymers. He focused on the plastic deformation behavior of di- and tri-block copolymers. He utilized electron microscopy and stress/strain measurements to further elucidate the nature of the plastic-to-rubbery transition that occurs in certain SBS/PS polymer blends studied earlier by Shen. Structural reformation of original lamellar domains disrupted by extension was demonstrated at temperatures as low as 60°C in ten minutes. How this remarkable super-macromolecular mobility takes place well below T_m is not completely clear and is worthy of additional study.

Professor R.S. Stein, University of Massachusetts, spoke on scattering studies from polymer blends on Thursday morning. Dr. Stein is clearly a reigning dean of the polymer science community and gave an incisive and authoritative lecture on the use of scattering studies to define and measure inhomogeneities in polymer blends. It was pointed out that polymer blends can exist in various morphologies ranging from a completely mixed amorphous system (e.g., PS/PoCLS, where PoCLS=poly(orthochlorostyrene)) below its lower critical solution temperature to a system containing mixed crystals as in polyethylene terephthalate (PET)/polybutylene terephthalate (PBT) blends. SAXS, small angle light scattering (SALS) and small angle neutron scattering (SANS) were used to examine mixtures of a number of polymer blends including PVC in (ε-caprolactone), isotactic PS in atactic PS, PS in PoCLS, and poly(paraiodostyrene) in PS.

Dr. R.E. Cohen (Massachusetts Institute of Technology) presented his recent research on multiphase rubbery polymers including synthesis, characterization and physical properties. He described the synthesis of polybutadiene (BR) and polyisoprene (IR) homopolymers and diblock copolymers and studies on blends of various compositions. This system was somewhat unusual in that the homopolymers formed heterogeneous blends, while three diblocks with mole ratios of BR/IR of 2:1, 1:1 and 1:2 were homogeneous. Various binary blends of one of the diblocks and one homopolymer were also homogeneous as were a few ternary blends.

The session which I chaired on Thursday morning included a paper presented by Dr. Y. Osada (Ibaragi University) on the formation of interpolymer complexes. An example of such a "complex" or blend or "coacervate" would be the product of the interaction of a polycation with a polyanion. Others are formed through hydrogen bonding, e.g., those between poly(carboxylic acids) and poly(N-vinyl pyrrolidone). Dr. Osada reported a study of the effect of increasing oligo cation chain length vs. complex stability which showed that stability increased markedly with increasing cation oligomerization. This increased stability with increasing connectivity of cation sites may be likened to the chelate effect in metal coordination chemistry. In both cases increasing coordinating site connectivity causes a more favorable entropic term leading to overall greater complex stability.

On Friday, Dr. K. Shibayama of Mitsubishi Electric gave a talk on new heterophase polymer systems. His presentation centered on a study of the dynamic mechanical properties of interpenetrating polymer networks formed from UV-polymerization of a monomer in an existing polymer framework. Such interpenetrating polymer networks (IPN's) exhibit good damping behavior over broad frequency ranges and are potentially of use for the isolation of electronics and mechanical equipment.

MARINE SCIENCES IN THE NIIGATA AND SADO ISLAND AREA

Francis A. Richards

Various aspects of marine and other aquatic research are carried out in the Niigata region on the Japan Sea Coast. The Japan Sea Regional Fisheries Research Laboratory of the Fisheries Agency is there and the Faculty of Science, Niigata University, operates the Sado Marine Biological Station on Sado Island. The Department of Biology of the Faculty of Science is also involved because it is the home department of Professor Yoshihara Honma, the Director of the Sado Station. Sado Island is also the site of the Niigata Prefectural Fishery Cultivation Center, which, although not a research organization *per se* does experimental work and collects statistical information of scientific value.

Niigata is a new university, founded in 1949, which occupies a handsome, spacious campus on the edge of Niigata City. It now has a student body of about 7000, admissions being limited to 1600 each year on the basis of stiff entrance examinations–the standard Japanese procedure. There are faculties of Agriculture, Science, Engineering and Technology, General Education, Literature and Law, and Medical and Dental schools. The latter are older than the rest of the university and are the only two units that offer doctor's degrees. These schools are in the city, not on the main campus, and have descended from the old Imperial Medical School. It is planned to separate the Literature and Law faculties and to add a Faculty of Economics.

So far as I could determine the only research in aquatic sciences is in the Department of Biology, which offers Master's degrees in both Zoology and Botany. Within the department there are specialists in immunology, comparative endocrinology, animal physiology, cytology, and physical chemistry.

Dr. Honma is a specialist in the endocrinology of cyclostomes–lamphreys and hagfish. However, he has also worked on the taxonomy of fish, the fish fauna, and the zoogeography of the Japan Sea. He has described some 550 species of fish from the sea, specializing in the cyclostomes around Niigata.

The Sado Marine Biological Station was mentioned by Gorbman in his article on Japanese Marine Laboratories (Scientific Bulletin, Vol. 3 No. 2, 1978). The Station has research laboratories, a small library, a research museum containing thousands of specimens collected from the waters adjacent to Sado Island, seawater aquaria for both teaching and research, and several small boats and a jeep for collecting.

The Japan Sea is calm in summer but not so in winter, and most collecting must be done in the calm season. In spite of this limitation, there is a wide variety of fauna and flora. The warm Tsushima Current flows along Sado Island as a surface current but the deeper water is cold. Thus the upper benthos tends to include temporal and subtropical species while the deeper-living animals are boreal and subarctic.

There are only two members of the permanent staff, Dr. Honma and his assistant, Mr. Takehiko Kitami, but the laboratory is visited by over 1000 students and researchers each summer. Thirty overnight visitors can be accommodated in the domitory and lodge, both buildings having three Japanese style rooms.

The research in progress at the laboratory tends to reflect Dr. Honma's specialities, including piscine endocrinology, reproductive biology of marine invertebrates, and ecology of sedentary animals, especially barnacles and tunicates.

A somewhat different line of research was being pursued by a visiting scientist, Dr. Ju-Shey Ho of the Department of Biology of California State University at Long Beach. His specialty is the zoogeography of marine parasites, using the parasites as an indicator of the phylogeny or racial history of the host organisms. He is particularly interested in parasitic copepods and has published on the taxonomy of these organisms from New Zealand, Australia, West Indies, Galapagos Islands, Peru, Chile, Venezuela, and Formosa in addition to the United States. He prefers to work on the parasitic copepods (sea lice) of fish, because they are quite common and in addition they are good indicators of the food source of the fish–that is they can indicate whether the fish are benthic or pelagic feeders. Ho is also studying the parasites of molluscs such as limpets, snails, nudibranchs, and abalone.

Ho is completing a study of the host-specific parasitic copepods of seven species of hake distributed from the North Atlantic to the North Pacific. The number of species of such parasites infesting the fish decreases from three or four in the North Atlantic to only one or two in the Pacific species. Ho reasons that this indicates that the Pacific species have evolved more recently than the Atlantic species. Because parasites have both a macro and microenvironment, they tend to evolve one step behind their hosts, and this conservative evolution helps establish the phylogeny of the hosts.

Ho's interest in the Japan Sea arises because only a few studies of the parasites in the sea have been carried out by Russian scientists from Vladivostok. The Japan Sea is a young sea, so there are many host-specific relationships, and Ho is making a general survey. The museum collection has been helpful in his studies, and fish specimens are also gathered from local fishermen, who are willing to give him the kind of fish he is most interested in–"sick" fish debilitated by parastic infestation.

The Faculty of Science publishes the *Annual Report of the Sado Island Marine Station Niigata University*. Vol. 1 appeared in March, 1971. The *Reports* include original research papers, tabulated oceanographic observations, and a list of the publications from the station. The papers are in English, except species lists, which of course use Latin designations along with the Japanese names when such exist. The 1978 *Report* (No. 8) has an article by Honma and Kitami on the flora and fauna of the waters adjacent to the station that lists 2125 species.

The oceanographic observations are made at three stations and include temperature at seven to nine depths, water color, and transparancy, observed generally three times a month throughout the year. The first such observations were reported in No. 2 (1972) and included the period January 1967 to December 1970.

The Japan Sea Regional Fisheries Laboratory is one of the eight regional research laboratories of the Fisheries Agency under the Ministry of Agriculture and Forestry. Founded in 1949, the Laboratory is at 5939-22 Nishifunami-cho, Hamaura, Niigata-shi, Niigata-ken (Post code 951, Telephone 0252-28-0451). It has approximately 20 scientists supported by a staff of 21 and a crew of 12, which operates their research vessel, the *Mizuho-maru*. The Director is Motosugu Hamabe; the organization contains an Administrative Assistance Office, a Division of Resources Research headed by K. Saishu, and a Division of Coastal Fisheries Development.

As with all the Fishery Agency Laboratories the objective is to improve the catch of fish. With the general imposition of 200-mile economic zone limitations, it behooves the Japanese to improve their coastal fishing. With this highly practical aim, much basic research is carried out in marine biology, ecology, and oceanography.

The Division of Resources Research has sections for pelagic fish, bottom fish, and descriptive oceanography. They are mainly concerned with the population dynamics of fish, molluscs, and shrimp. The Division of Coastal Fisheries Development has sections for plankton (mainly zooplankton) studies, fish nutrition, and aquaculture. Sometimes the names fail to reflect accurately the activities of the sections, and special projects are assigned to the laboratory by the central Fishery Agency. The long-term work of the section is concerned with problems of the diet of fish in culture; the ecology of sandy and rocky beaches and its relationship to oysters and other bivalve flat fish, and rock fish; and studies of plankton and its role as food for both wild and cultured fish. At present the laboratory is working on special projects on the propagation of *tai* (sea bream or red snapper) and of salmon, especially the "Japanese" salmon *Oncorhynchus keta.* There are about 100 salmon hatcheries on each of Honshu and Hokkaido islands, so improved methods of cultivation are important. The work of the laboratory is directed toward such matters of husbandry as improving hatchery methods, improved nutrition, and improved techniques in general. However, the studies also include basic matters of river mouth ecology and studies of the natural enemies of the salmon in rivers and coastal waters. This work is in cooperation with the prefectural fishing station at Nagaoka.

The *tai* fishery and culture are important sources of this choice fish (*Pagarus major*). Although the fish are grown extensively in culture, their life history in nature is essentially unknown. A network of 40 stations has been occupied to help determine spawning grounds and times, growth dynamics, and reproduction. Many *tai* are cultured in hatcheries and laboratories, and the studies have been aimed at determining their distributions after release to the environment.

Japan Sea fisheries for common squid *Todarodes pacificus* (*Surume-ika*) have usually been along the coast, but recent surveys have shown that there are good stocks offshore. Studies at the laboratory have helped establish some relationship between the hydrography of the Japan Sea and the life history of the squid.

The upper layers of the Japan Sea are dominated by the Tsushima warm current from the south. Analyses of long term temperature data had led to the conclusion that there are three main branches of the current. More recent, more synoptic observations suggest that the current actually meanders.

The squid have a life history from spawning to commercial size of about one year. The Japan Sea population spawns off the southern Japanese island of Kyushu. The larval squid are planktonic and are carried northward by the Tsushima warm current to off the coast of Hokkaido, where they grow to a length of about 20 cm. In September they begin to migrate back south to spawn and are caught in the coastal fisheries of Honshu. Although it is difficult to get good biological data in the field, it appears that the main food of the squid is amphipods, small sardines, anchovies, mackerel and other fishes.

The main function of the section on Descriptive Oceanography is the monthly publication of charts of the horizontal distribution of temperature in the Japan Sea at the surface, 50, 100, and 200 m. The data on which the charts are based come from a variety of sources. Their own ship makes regular observations, occupying conventional hydrographic stations with samplings at 0, 10, 20, 30, 50, 75, 100, 150, 200, and 300 m with Nansen bottle casts. These observations are compiled along with data from 12 prefectural fishing stations, the Marine Observatory at Maizuru, the Defence Agency, and the Maritime Safety Agency. Some of the agencies also observe salinity, but the data are usually not very coherent and are not included in the monthly publication. Some bathythermograph (BT), expendable bathythermograph (XBT), and salinity-temperature-depth recorder (STD) data are used in preparing the maps. Occasionally nutrient observations are made by the laboratory.

The Japan Sea Regional Fisheries Research Laboratory occupies a modern, well-kept two-story building built in 1965. There are auxiliary tanks, aquaria, and a running seawater system. It has much new and modern equipment, including particle counter equipment and associated computer, capable of counting particles down to the micron size range. I was shown a Nikon microscope especially equipped for color microphotography with automatic exposure metering, and a Softex type CSM soft X-ray machine, useful for checking fish anatomy without dissection.

In addition to the *Illustrated Hydrographic Report of the Japan Sea* (monthly), the laboratory also publishes the *Bulletin of the Japan Sea Regional Fisheries Research Laboratory,* biannually in Japanese with English abstracts and in English; and the *Japan Sea Fisheries Research News,* published seasonally in Japanese.

MARINE SCIENCES IN NAGASAKI

Francis A. Richards

SEIKAI REGIONAL FISHERIES RESEARCH LABORATORY
FISHERIES AGENCY, MINISTRY OF AGRICULTURE AND FORESTRY

Each of the eight regional research laboratories of the Fishery Agency has its own territory within which it is responsible for providing advisory services to commercial fishermen and for establishing catch levels for maximum sustainable yields. Much of the work of the laboratories consists of standard statistical studies based on catch records and involves little basic research. On the other hand, the laboratories have special problems characteristic of the specific flora, fauna, and environmental conditions in their regions. Thus basic oceanographic observations and studies, fundamental marine biology, geological, and chemical studies may be a part of the program of a laboratory.

The principal territory of the Seikai Laboratory is the Yellow Sea (between Korea and China) and the East China Sea north of 25° N latitude, eastward from the China coast to longitude 133° East. The area is commercially important, being responsible for 20% of the total Japanese fishery. The annual catch is some 230,000 tons of demersal fish and 600,000 tons of pelagic fish. About 20% of the value of the fishery comes from aquaculture, about one-half of which is due to the production of *Porphyra* sp. (*Nori,* widely used in Japanese cuisine). Sea bream, yellowtail, and pearls are also cultured in the area.

Oceanographically the area is complex. The main current of the north-flowing Kuroshio turns right along the Pacific Coast of the Japanese islands, but a branch, the warm Tsushima Current, continues on a more northerly course into the Sea of Japan (between Japan and Korea). The warm current brings with it warm water species and, in the East China Sea, meets and mixes with cold waters flowing southward from the Yellow Sea. This leads to a complicated and interesting frontal system, the position of which can be expected to change seasonally and secularly in response to variations in the flow and meandering of the Kuroshio. The frontal system is not only an interesing physical phenomenon but it is also a favored spawning place, nursery ground, and the site of the fishing grounds for mackerel and jack mackerel.

The Seikai Laboratory has divisions for pelagic and demersal fish resources and for oceanography. There are also two laboratories (pelagic fish and demersal fish) at the Shimonoseki branch. The main laboratory operates the Research Vessel *Yokc Maru,* 213 tons, which will be replaced in 1979 or 1980 by a new 500 tonner. The laboratory was founded in 1949 and has 40 research personnel, 24 research vessel crew members, and 20 technicians and other employees. The address is 49 Kokubu-cho, Nagasaki, Japan 850.

As part of the function of the Oceanography Division, extensive long-term regional studies of physical oceanography, bottom sediment distributions, and phytoplankton and zooplankton distributions have been carried out. Because of the importance of the demersal fishery, special emphasis has been put on the relationships among the bottom fauna, environmental factors, and demersal fishes. Bottom drifters have been used to investigate bottom currents, and there have been extensive sediment samplings, sediment size distribution determinations, and compositional analyses. Various temperature and salinity functions have been determined from 10 years of data, as have wind speed and direction, velocity sections, surface current maps, and water transport through selected sections. The oceanographic data come from their own observations, from the Nagasaki Marine Observatory (Meteorological Agency), the Nagasaki Prefectural Institute of Fisheries, other prefectural laboratories, and the Korean Institute of Fisheries.

Another program of the Oceanography Division is concerned with red tide studies in coastal waters, the long term object being to learn how to control and treat these outbreaks. Laboratory experiments are being carried out to learn how to inhibit the growth of a dinoflagellate of the genus *Olisthodiscus*. It has been learned that the introduction of clay particles can precipitate plankton cells, and one experiment has been carried out in nature at a prefectural fishery laboratory. The bloom organism was *Cocolodinium* sp. and 200 to 400 grams per square meter of montmorillonite or kaoline clay were introduced. A question raised by this experiment concerns the events accompanying the decomposition of the cells so precipitated. The long term efficacy of the method and its eventual effects on the benthos need to be determined.

The Demersal Fish Resource Division is concerned with fishery biology and community ecology. Most of the fishery biology effort is directed toward the evaluation of populations and fishing management. Some life history studies are carried out, but little is done on physiology. The ecology group has come to realize that it is necessary to work with groups of species as a whole, rather than with single species. They are mainly concerned with groups of fin fish, squid, and shrimp. Their data come largely from reports from commercial fishermen; they conduct little or no experimental fishing. Because the main purpose of the laboratory is to determine how to use the fish population effectively, the more basic problems of the limitation placed on fish production by the amount of primary production (photosynthesis) and secondary production (zooplankton growth) have not yet been systematically approached.

The Pelagic Fish Resources Division is doing conventional fishery studies of mackerel, jack mackerel, and sardines. They are also investigating the effects of warm water effluents on plankton growth and distribution. Scientists from this division are involved in a project aimed toward mass production of zooplankton organisms to be used as food for fish larvae in culture. Scientists from the Seikai Laboratory, prefectural laboratories at Nagasaki, Fukuoka, and Kumamoto, Kagoshima University, Mie University, Kumamoto University, and Hiroshima University are cooperating on this project. At Mie University they have succeeded in producing a sustained yield of 2 to 4 kg wet weight per day of the semi-benthic copepod *Tigriopus* sp. *japonicus* per 200-ton tank for an indefinite period.

The Laboratory publishes the *Bulletin of the Seikai Regional Fisheries Laboratory* semiannually in Japanese with English summaries. No. 51 was published in March 1978 and included articles on chemical and physical oceanography, studies of benthic organisms and pelagic fish, and on the use of echo sounders in fish finding.

NAGASAKI MARINE OBSERVATORY
METEOROLOGICAL AGENCY, MINISTRY OF TRANSPORT

The Nagasaki Marine Observatory is now 100 years old and has been making oceanographic observations in the Yellow Sea and East China Sea continuously for 30 years. Its organization under the Director, Kojiro Yamagishi, is similar to that of the other three Marine observatories of the Meteorological Agency, Ministry of Transport, with sections for oceanography, weather forecasting, marine meteorology, and weather observation. The Observatory operates the 267-ton *Chofu Maru* and has a branch at the Nagasaki airport. The Chief of the Oceanography Section is Hideo Akamatsu. There are 84 staff members, of which 12 are in the oceanography section.

The *Chofu Maru* occupies a grid of oceanographic stations in the East China Sea north of 24° N latitude, east of the Chinese coast to 130° E. longitude, and south of 34° N latitude four times a year. The observations include physical, chemical, meteorological, and biological variables, and pollution by hydrocarbons, floatables, and heavy metals are monitored. The area includes one of the ocean data buoys of the Meteorological Agency at 28°20'N, 126°05'E in 115 m of water. The bouy transmits data to Tokyo every three hours–except for one interruption when the transmitter was stolen and for a brief annual period for servicing.

The *Ten-day Marine Report of the East China Sea* is distributed by the Observatory to about 150 users–fishing companies, government and university laboratories, branches of the Meteorological Agency on shore, the Maritime Safety Agency, and the Fishery Agency. The sea surface temperature maps are based on data from ships at sea, airborne infrared thermometry, Japan's meteorological satellite, the data from the *Chofu Maru*, and an accumulation of 30 years' observations at the Nagasaki Observatory. They also publish *Oceanographic Prompt Report of the Nagasaki Marine Observatory*, which contains two months of observations from the sea west of Japan and is published two months following the last observations.

The program of the observatory is part of the function of the Japan Meteorological Agency, which was described in the *Scientific Bulletin* 3 (2), 27-30.

NAGASAKI UNIVERSITY

Nagasaki University was founded in 1949 by combining colleges of medicine, pharmacy, and economics with two normal schools. When constituted there were five faculties: education, economics, medicine, pharmaceutical sciences, and fisheries. Most of the research in marine science at the university is carried out by the Faculty of Fisheries, which has 40 members including 10 assistants and around 500 undergraduate and 40 graduate students. The graduate work leads to the M.S. Degree; the first Master's degrees, 12, were awarded in 1971; 88 had been granted through 1976. Unlike the faculties of fisheries at some of the national universities, this one is not departmentalized, but a wide variety of specialties is provided in the course work, which includes such diverse topics as fishing oceanography; fishery operation, gear, and methods; mariculture; ecology; physiology; fish diseases and pest control; propagation of marine algae; microbiology, chemistry, biological and food chemistry; navigation; seamanship; and business economics.

The Faculty operates two fishery training ships, the *Kakuyo Maru* and the *Nagasaki Maru*. The former, 1045 gross tons, built in 1975, is 64 m long, has a cruising range of 14000 nautical miles and carries a complement of 12 officers, 20 crew, 4 scientists and 42 cadets. The *Nagasaki Maru*, built in 1963-64, is 563 gross tons, 47 meters long, and carries 13 officers, 20 crew, and 48 cadets. Her crusing range is 9,000 nautical miles.

Research interests in the Faculty emphasize environmental pollution studies, plankton studies–particularly phytoplankton and primary production–and the more specific subject of red tides.

One of the chemists on the Faculty, Shojiro Miyahara, has been following pollution in Nagasaki Bay, mercury and cadmium in the sediments of Yatsushiro Bay (or Sea), and has published on fundamental studies of the thickness of crude oil films on seawater surfaces. In the Nagasaki Bay studies he has followed pH, chlorinity, chemical oxygen demand (COD), suspended matter, n-hexane extracts, cadmium ion (Cd^{++}), lead (Pb^{++}), chromium (Cr^{6+}), total mercury, arsenic (As^{3+}), and cyanide (CN^-), although cyanide has not been detected. From 1975 to 1977 there appeared to be a decrease in the arsenic and total mercury, although both cadmium and lead ions were detected in 1976 and 1977, whereas they were not in 1975. Perhaps unexpectedly, the pollution appeared to be heavier at the entrance to the bay than at the inner or outer stations.

The Yatsushiro Sea sediment studies are particularly interesting because it was here that the ill-famed Minamata disease occurred. It is now well established that industrial dumping of mercury wastes into the bay at the city of Minamata was followed by bacterial uptake and production of methyl mercury. Entering the food chain, the organo-mercury compound ended up in the local human diet, causing the terribly painful, disfiguring and sometimes fatal condition known as the Minamata disease.

Miyahara and Hidenori Ohno collected samples at 23 stations in the sea in 1975. Total mercury and cadmium were determined using atomic absorption spectrophotometry. Although the introduction of mercury wastes has been stopped, by far the highest concentrations of mercury in the sediments were at the two stations nearest Minamata–concentrations were 0.74 and 0.62 $\mu g/g$ of dried sediment. Cadmium levels were similarly elevated near Minamata, but they were much lower, on the order of 0.01 $\mu g/g$.

The red tide studies are being carried out as part of a larger program now funded by the Ministry of Education, Science, and Culture. Scientists from several laboratories are working on various aspects of the problem. In the past, red tide research has been carried out under the auspices of the Fisheries Agency (1966-68), Ministry of Education (1969-71), and the Science and Technology Agency (1967-69).

The coast of western Kyushu in the Nagasaki region is highly irregular with many indentations, islands, semi-enclosed bays, and seas. There are widely differing circulation patterns, and much of the region has unusually large tidal ranges. In some areas the deep-water circulation is poor and these tend to become oxygen-deficient or oxygen-free and sulfide bearing, particularly in summer. In several cases distinct correlations between oxygen deficiency and red tide outbursts have been observed.

Omura Bay, which lies south of Sasebo, has only a small opening to the Japan Sea and a maximum depth of about 21 meters. The salinity is low and the bay was formerly used for pearl oyster culture. Although there are not many red tides in the bay—perhaps one a year—there was a serious outbreak in 1965 that virtually wiped out the pearl oysters, although the exact mechanism of the damage remains unknown. A research program on the red tides of Omura Bay is continuing. There have also been red tides near Imari in Saga Prefecture, Tachibani Bay, and other areas along the west coast of Kyushu. There have been various causative organisms, including species of *Gymnodinium, Mesodonium,* and *Trichodesmium.* One red tide in Omura Bay was caused by the silicoflagellate *Dictyocha fibula.* Others involved *Gonyaulax poligramma, Gymnodinium* type 65, *Eutreptiella* sp. and *Gymnodinium nelsonii,* but not by *Skeletonema costatum* nor *Olisthodiscus,* which are common red tide organisms in other bays.

Other work on red tide organisms is designed to identify substances that stimulate their growth. It has been found that products of the decomposition of diatoms of the genus *Chaetoceras* can stimulate the growth of *Gymnodinium* type 65. There may be a difference in the effect that depends on whether the decomposition takes place aerobically or anaerobically.

Professor Shojiro Miyahara of the Faculty of Fisheries has been studying water quality in various systems in the region. He has had extensive experience in Canada, where he worked on the content of mercury and cadmium in the Ottawa River. He is now using thin layer chromatography and atomic absorption spectrophotometry to investigate the mercury and cadmium contents of algae, benthic organisms, and sediments. He has found that less than 1% of the total mercury in seawater from the local region is organically combined.

NATIONAL MARINE AND INLAND WATER BIOLOGICAL STATIONS IN JAPAN

Francis A. Richards

There are 22 marine and freshwater biological stations operated by national universities in Japan. The directors of these stations form the Director Council of Japanese National Marine and Inland Water Biological Stations. The stations are described in some detail in a 1975 pamphlet issued by the Council and edited by Professor Hideshi Kobayashi, who is associated with the Misaki Marine Biological Station of the University of Tokyo (address: Misaki, Miura-shi, Kanagawa-ken, 238-02, Japan). A new edition of the pamphlet is being planned, but it will not be forthcoming until Professor Kobayashi's successor as editor is appointed after Kobayashi's retirement.

The laboratories have access to a rich variety of aquatic habitats, flora, and fauna. The facilities and amenities offered vary widely, but most laboratories will welcome foreign investigators although living accommodations may present a problem at some of the stations. Most of the stations are geared to intense teaching programs in the summer, when there will be little, if any, time or space for foreign visitors.

The existence of these laboratories seems not to be well known in the United States, so the following summary is offered. Personnel are not named, because they may change, and it is suggested that the Director be addressed for additional information.

1. Akkeshi Marine Biological Station
Faculty of Science
Hokkaido University
Mailing Address: Akkeshi, Hokkaido, 088-12
Telephone: 015352-2056

On Akkeshi Bay 50 km east of Hokkaido. In cold Oyashio waters, the region has a rich boreal flora and fauna. In addition to the usual equipment there is an array of equipment for electrophysiology.

2. The Institute of Algological Research
Faculty of Science
Hokkaido University
Mailing Address: Bokoi Minami-machi 1-13, Muroran, Hokkaido, 051
Telephone: 0143-22-2846

In southern Hokkaido on Uchiura (Funka) Bay. Devoted to taxonomy, embryology, physiology and ecology of marine algae. The bay is influenced by both the Oyashio and Tsugaru currents—the former cold, the latter warm. The area supports extensive commercial culturing of *Laminaria* sp.

3. Asamushi Marine Biological Station
Faculty of Science
Tohoku University
Mailing Address: Sakamoto 9, Asamushi, Aomori City, 039-34
Telephone: 017752-3388

On Mutsu Bay, northern Honshu, near Asamushi Hot Spring. Animals from the bay are cultured in an aquarium with about 40 tanks; the aquarium is open to the public from April to November. Waters of the Bay are influenced by both the cold Liman and warm Tsushima currents. Snow and winds prevent much collecting from December to early March.

4. Sado Marine Biological Station
   Faculty of Science
   Niigata University
   Mailing Address: Tassha, Aikawa-machi, Sado Island, Niigata-ken, 952-21
   Telephone: 02597-5-2012

On Sado Island in the Sea of Japan. A list of over 2000 species has been compiled from the region; many are represented in the research museum collection. Laboratories are equipped mainly for morphology, systematics, ecology, and routine physiology. Research in progress includes piscine endocrinology, reproductive biology of marine invertebrates, and ecology of sedentary animals. Weather conditions prevent collecting during much of the winter.

5. Noto Marine Laboratory
   Faculty of Science
   University of Kanazawa
   Mailing Address: Ogi, Uchiura, Suzu-gun, Ishikawa-Ken, 927-05
   Telephone: 07687-4-1151

The laboratory is on the Noto Peninsula on the *Japan Sea* Coast and its waters are influenced by the warm Tsushima Current. The Tsukumo Bay area has varied and abundant marine life, which has not been fully surveyed.

Research at the Laboratory is concerned with the reproductive biochemistry of marine invertebrates and the biochemistry of their glycoproteins and with physiological studies of the change in coloration of seaweeds with the tidal rhythm.

6. Itako Hydrobiological Station
   Faculty of Science
   Ibaraki University
   Mailing Address: Ohu, Itako-machi, Ibaraki-ken, 311-24
   Telephone: 02996-7-5549

This freshwater laboratory is on the southwestern side of Lake Kita-ura, which has an area of 39 km^2 and a maximum depth of 7 m. A new building with dormitories for 20 was built in 1975. Some cooking and dining facilities are available. Research is on the taxonomy and ecology of the local fauna. The lake is eutrophic and develops blooms of the blue-green alga *Microcystis* sp. in the summer.

7. Suwa Hydrobiological Station
   Faculty of Science
   Shinshu University
   Mailing Address: 5-2-4, Kogandori, Suwa-shi, Nagano-ken, 392
   Telephone: 02665-2-1955

Lake Suwa, in the central part of Honshu, is a small eutrophic lake at an altitude of 759 m. It has a maximum depth of 6.5 m and an area of 14.5 km^2. Industrial pollution has accelerated its eutrophication in recent years and the summers are dominated by blooms of blue-green algae although the lake is bordered by dense growths of hydrophytes.

There are limited dining and dormitory facilities although there is a bath with hot spring water. Limnological, geochemical, and geological research is carried out.

8. Misaki Marine Biological Station
   Faculty of Science
   University of Tokyo
   Mailing Address: Koajiro, Miura, Kanagawa-ken, 238-02
   Telephone: 0468-81-4105, 4106

The Misaki Laboratory is at the southern tip of the Miura Peninsula, on the Pacific Ocean between Tokyo and Sagami bays. It is the oldest of the 22 laboratories. A variety of habitats are near the station and winter winds drive surprising tropical plankton forms into the inlets, carried in Kuroshio water. Research areas include studies of invertebrate embryology (mostly sea urchins), comparative embryology, ecology, taxonomy, and histology, especially wound healing in animals. Considerable sophisticated instrumentation is available for qualified investigators.

9. Tateyama Marine Laboratory
   Faculty of Science
   Ochanomizu University
   Mailing Address: 11 Nagadori, Koyatsu, Tateyama-shi, Chiba-ken 295-03
   Telephone: 04702-9-0838, 0839 (dormitory)

This Laboratory on the Chiba Peninsula is on the opposite side of the entrance to Tokyo Bay from the Misaki Laboratory, and it also enjoys an unusual environment because a small branch of warm Kuroshio water enters the eastern part of Tokyo Bay. A surprising number of species of corals are thus found far north of their normal habitat. The rocky shore of the Pacific Coast is also within easy access of the station, which is equipped for general biological studies. Dormitory and dining facilities are available.

10. Shimoda Marine Biological Station
    Faculty of Science
    Tsukuba University (formerly Tokyo Kyoiku University)
    Mailing Address: Shimoda-shi, 5-10-1, Shizuoka-ken, 415
    Telephone: 05582-2-0346

This Station is on the tip of the Izu Peninsula, which extends into the Pacific Ocean and is influenced by the Kuroshio. Easily accessible environments range from exposed rocky shores to sandy beaches. The station has a variety of laboratory and special purpose rooms. There are general biological equipment, special centrifuges, and electron microscope and electro-physiological equipment. Research areas include the development and physiology of marine invertebrates and algae and ecological studies on productivity. It also has an offshore observation tower. There are dining and dormitory facilities and living accommodations are available within walking distance.

11. Otsu Hydrobiological Station
    Faculty of Science
    Kyoto University
    Mailing Address: Shimosakamoto, Otsu, Shiga-ken 520-01
    Telephone: 0775-78-0579, 0580

The Otsu Hydrobiological Station is on the shores of Lake Biwa, the largest lake in Japan. Not far from Kyoto, it is probably also Japan's best known lake, having been the subject of monographic studies in many fields. Researches at the Laboratory are largely hydrobiological and oriented toward productivity. Recent outbreaks of red tides in the lake have attracted the attention of a large group of scientists.

Well equipped for general limnological and biological work, the Laboratory has neither dining nor dormitory facilities. Visiting foreign scientists have found university housing in Kyoto and commuted to the station.

12. Sugashima Marine Biological Station
    Faculty of Science
    Nagoya University
    Mailing Address: 63-429, Murayama, Sugashima-cho, Toba-shi, Mie-ken 517
    Telephone: 059934-6

This Station is east of the famous city of Toba, where cultured pearls were developed, on an island lying between Ise Bay and the Sea of Enshu-Nada. A good supply of several species of sea urchins is available, and sea urchin embryology is a major research interest at the Station, as is the metamorphosis of ascidian tadpoles. The laboratories are well equipped for physiological, biochemical, and morphological research. A limited number of cottages are available for investigators who wish to bring families.

13. Seto Marine Biological Laboratory
    Faculty of Science
    Kyoto University
    Mailing Address: Rinkai, Shirahama, Wakayama-ken 649-22
    Telephone: 07394-3515

The Shirahama area has hot spring spas, sandy beaches, rugged sandstone shorelines, and a wide variety of flora and fauna, including tropical and subtropical species, thanks to the influence of the Kuroshio. The Station has a good library and aquarium, the latter open to the public. There is also a small laboratory on Hatakejima Island, a small island near the head of the bay. Dining and limited dormitory accommodations are available.

14. Iwaya Marine Biological Station
    Faculty of Science
    Kobe University
    Mailing Address: Iwaya, Awaji-cho, Tsuna-gun, Hyogo-ken, 656-24
    Telephone: 07394-2-3515

This Station, near the junction of Osaka Bay and the Seto Inland Sea, was established for instruction in marine phycology, and the main work at the laboratory is on the culture of benthic algae. There are limited dormitory facilities and a dining room but no cook.

15. Tamano Marine Laboratory
    Faculty of Science
    Okayama University
    Mailing Address: 2-3-3 Shibukawa, Tamano, Okayama 706
    Telephone: 0863-81-7262

On the west central coast of the Seto Island Sea, this Laboratory has access to a large number of small islands and a correspondingly wide variety of habitats, although the flora and fauna are less rich than in the open ocean. Specialized equipment is available for research in morphology, physiology, and biochemistry. There are dining and limited dormitory facilities.

16. Oki Marine Biological Station
    Faculty of Literature and Science
    Shimane University
    Mailing Address: Department of Biology, Shimane University, 1060 Nishi-kawadzu-cho Matsue, Shimane-ken 690

Telephone: 08512-2-1814

This Station is on Oki Island in the Sea of Japan. A new station (opened in 1973), it has access to a wide variety of aquatic environments–different depths, temperatures, and substrates. General biological and teaching equipment are available and one research room is for visitors. It is one of the three stations in or on the Japan Sea. Dining and dormitory facilities are available.

17. Mukaishima Marine Biological Station
Faculty of Science
Hiroshima University
Mailing Address: Mukaishima-cho, Mitsugi-gun, Hiroshima-ken, 722
Telephone: 0848-44-1143

Like Tamano Marine Laboratory, Mukaishima Marine Biological Station is on an island in the Seto Inland Sea and has access to many neighboring islands and marine environments, varying from muddy to coarse sandy bottoms. There are rapid tidal currents and small bays and inlets with sandy beaches or rocky shores. The 250- to 390-cm tidal range provides a large intertidal zone. The buildings include three graduate student and visitor laboratories, an electron microscope room and a dark room. There are kitchen and dormitories.

18. Usa Marine Biological Station
Faculty of Literature and Science
Kochi University
Mailing Address: Usa-inoshiri, Kochi-ken, 781-04
Telephone: 08885-6-0268

This Station is on Tosa Bay on the Pacific Ocean coast of Shikoku Island, thus also under the influence of the Kuroshio. It is at the mouth of a 12-km long inlet in which pearl oysters, fishes, and seaweeds are cultivated. There are sandy, gravelly, and rocky shores within the intertidal zone. In addition to seven research rooms and special laboratories, there is a 160 m^2 rearing house with 12 pools and three aquatrone systems. Many species of echinoderms, crustaceans, protocordata, algae, and fish are available for laboratory studies. Limited dining and dormitory facilities and general equipment for biology and oceanography are available.

19. Nakajima Marine Biological Station
Faculty of Science
Ehime University
Mailing Address: c/o Biological Institute, Faculty of Science, Ehime University, Bunkyo-cho Matsuyama, 790
Telephone: 0899-41-7111

This Station is also on an island (Nakajima) in the Seto Inland Sea. It has access to environments ranging from rocky shores with a *Sargassum* belt to sandy beaches with a *Costera* belt. The waters are relatively unpolluted and have a rich variety of invertebrates and fishes. There are dining and limited dormitory facilities. The laboratories are equipped for chemical and biological analyses of water and sediments.

20. Aitsu Marine Biological Station
Faculty of Science
Kumamoto University
Mailing Address: Aitsu, Matsushima-machi, Amakusa-gun, Kumamoto-ken, 861-61
Telephone: 09695-6-0277

The Station is on an island along the irregular west coast of Kyushu Island. Next to Ariake Bay, it has one of the largest tidal ranges (about 4 m for the average spring tide) in Japan. It is near a large variety of environments and the marine life is abundant and varied. The research is centered on the relationships between the environment and zooplankton and the biology of the fiddler crab. Dining and limited dormitory facilities are available.

21. Amakusa Marine Biological Laboratory
Faculty of Science
Kyushu University
Mailing Address: Tomioka, Reihoku-cho, Amakusa, Kumamoto-ken, 863-25

Like the Aitsu laboratory, Amakusa Marine Biological Laboratory is on an island off the west central coast of Kyushu Island. It thus receives warm currents and the flora and fauna are largely subtropical. Research interests of the staff are in animal ecology, especially population dynamics and the ecology of benthic invertebrates. The laboratory has ordinary collecting gear and oceanographic instruments but little equipment for physiology or biochemistry. Meals and limited dormitory facilities are available.

22. Sesoko Marine Science Laboratory
College of Science and Engineering
University of the Ryukyus
Mailing Address: c/o Department of Biology, University of the Ryukyus, Naha, Okinawa 903
Telephone: 0988-34-0101

This is the most southerly of the laboratories. It is on a small island near the west coast of the main island of Okinawa. The environment is tropical and the coral reef habitats range from moderately sheltered to well exposed. A wide variety of habitats is within 30 km, including mud flats, sand flats, sea grass beds, estuaries, mangrove forest, and rocky beach coasts. The main building was completed in 1975 and since then a set of large outdoor tanks and a new research building have been added.

Little specialized equipment is available. Dormitory space and cooking facilities are available.

Some general statements can be made about the laboratories:

1) They generally have some small boats available for collecting and for getting about. Few if any of the boats have any laboratory capability. Most of the stations have SCUBA equipment, rowboats, etc. At some of the stations specimens can be acquired from local fishermen.

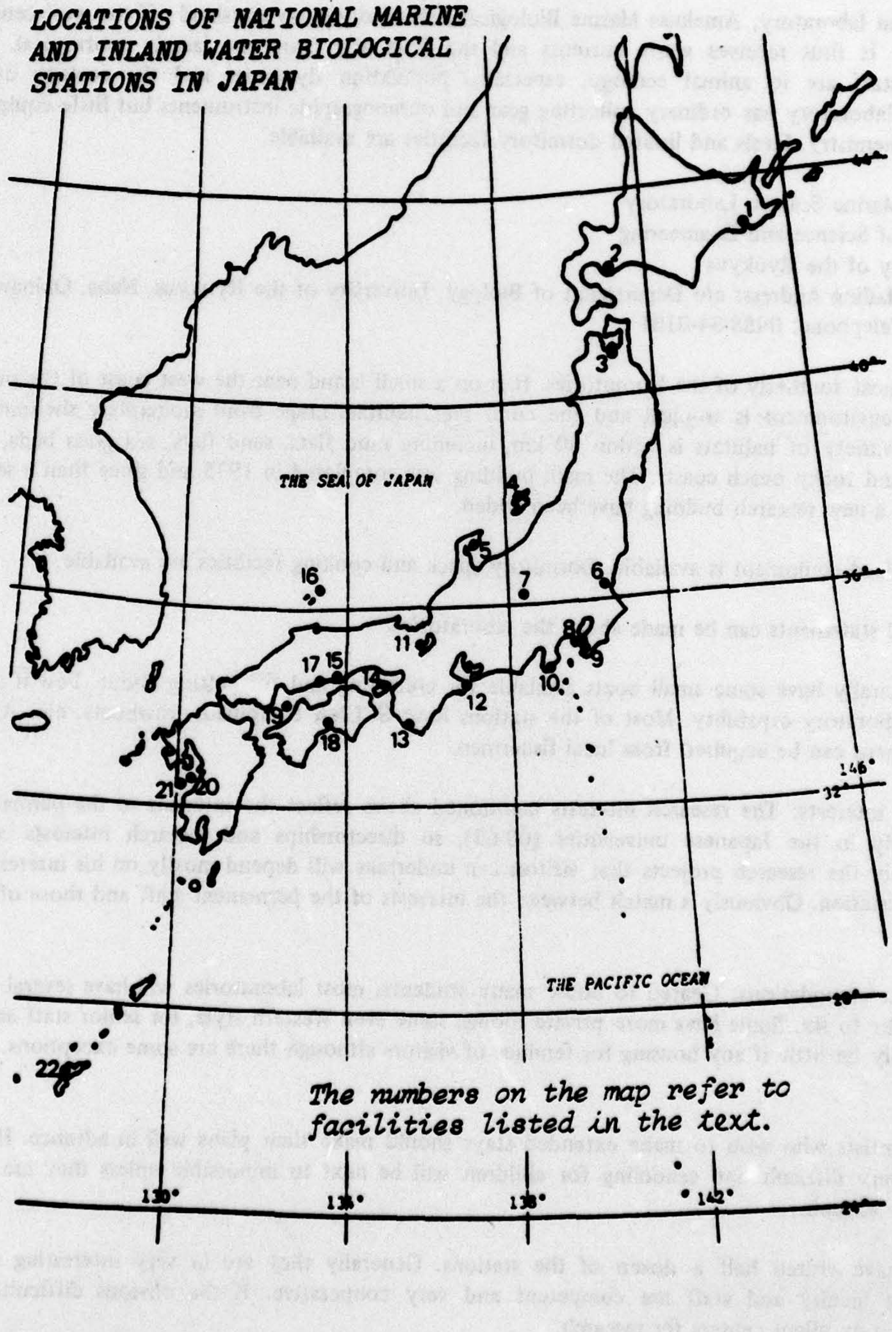
2) Research interests: The research interests mentioned above reflect the interests of the permanent staff. Retirement is early in the Japanese universities (60-63), so directorships and research interests can change quickly. Presumably the research projects that visitors can undertake will depend mostly on his interests and the capabilities of the station. Obviously a match between the interests of the permanent staff and those of visitors is desirable.

3) Living accommodations: Geared to house many students, most laboratories will have several dormitory rooms sleeping four to six. Some have more private rooms, some even Western style, for senior staff and visitors. There will generally be little if any housing for families of visitors although there are some exceptions. Food will be Japanese style.

Foreign scientists who wish to make extended stays should make their plans well in advance. Housing for families will be very difficult and schooling for children will be next to impossible unless they are willing to enter the Japanese schools.

Finally, I have visited half a dozen of the stations. Generally they are in very interesting and scenic environments, the faculty and staff are competent and very cooperative. If the obvious difficulties can be overcome, these are excellent centers for research.

LOCATIONS OF NATIONAL MARINE AND INLAND WATER BIOLOGICAL STATIONS IN JAPAN



The numbers on the map refer to facilities listed in the text.

THE SCHEDULE OF THE *HAKUHO MARU* FOR 1979-1981

Francis A. Richards and Seikoh Sakiyama

Vol. 3, No. 1, pp. 8-9, 1978, reported on the characteristics of the *Hakuho Maru*, oceanographic research vessel of the Ocean Research Institute, University of Tokyo, and gave her schedule for fiscal year 1978-1979. Professor Akihiko Hattori of the Institute has kindly made available the schedule for 1979-1981. We wish to thank Professor Hattori for his help. The ship is well equipped for oceanographic research and is capable of operation in all oceans. She is 3200 tons and can accommodate a scientific party of 32. Berths for visiting scientists may be available on some or all of the cruises. Further information can be obtained from the Chief Scientist or the Director, Ocean Research Institute, University of Tokyo, 15-1, 1-chome, Minamidai, Nakano-ku, Tokyo 164.

KH-79-2: Studies on the structure of tropical air boundary layer and air-sea interaction.

Purpose:

Part of the special activities in NONEX of the First GARP Global Experiment (FGGE) of the GARP (Global Atmospheric Research Project), observations designed to clarify the mechanisms and variations of the tropical air boundary layer. Observations will elucidate the formation of the boundary layer between air and ocean and the transfer of energy and momentum.

Survey Items:

Observations of the turbulent air flow structure and turbulent vortex transfer over the ocean using ultrasonic anemothermometer, of the vertical structure of the low troposphere using lower layer sonde, captive balloons, and acoustic radar, of the upper weather over the ocean using omega sonde, and observations of ocean waves and current speed using the CTD (conductivity-temperature-depth recorder) and expendable bathythermograph (XBT).

Area:

140°E equatorial area

Schedule:

40 days, 1 May-9 June 1979

Chief scientist:

Dr. Tomio Asai, Professor of Marine Meteorology

KH-79-3: Chemical research on diffusion and circulation in the Sea of Japan and adjacent areas.

Purpose:

To repeat analyses made on a previous cruise, KH-77-3, to investigate the distribution of chemicals in the area using radioactive nuclides, and modeling the mechanism of diffusion and circulation of seawater.

Survey Items:

Large volume sampling of seawater from different layers.

Area:

The Sea of Japan and the northwest Pacific west of 160°W.

Schedule:

39 days, 26 June-3 August 1979

Chief Scientist:

Dr. Yoshio Horibe, Professor of Marine Inorganic Chemistry

KH-79-4: Studies of tropical and subtropical ecosystems.

Purpose:

To establish a specific "biology" in the ecosystem of the western Pacific Ocean by identifying the integrated movement of the biomass through the analysis of such systems as the food web, biological interactions, physiological activation, and distribution and grouping of organisms in relationship to environmental factors.

Survey Items:

Sampling plankton, microorganisms, and benthos; experimental studies of ecological and physiological aspects using these samples, and measurements of the physical and chemical environment of the biomass.

Area:

The western Pacific Ocean

Schedule:

74 days, 28 August-9 November 1979

Chief Scientist:

Dr. Nobuo Taga, Professor of Marine Microbiology

KH-80-1: Geological, geophysical, and bioecological research in the area of the Japan Trough.

Purpose:

To improve our understanding of results obtained on previous cruises by *Hakuho Maru* and *Glomar Challenger*, scheduled as one of the links of IPOD (International Program of Ocean Drilling).

Survey Items:

Sampling of seabed deposits, sedimentary rock, continuous acoustic monitoring using air-gun, and measurement of gravity, earth magnetism, and submarine topography. Sampling of microorganisms and benthos and experimental ecophysiological research.

Area:

The Japan Trough

Schedule:

42 days, 1 February-13 March 1980

Chief Scientists:

Dr. Noriyuki Nasu, Professor of Submarine Sedimentation, Dr. Nobuo Taga, Professor of Marine Microbiology.

KH-80-2: Chemical approach to mixing processes in the northwest North Pacific Ocean.

Purpose:

To clarify the vertical transport of materials from the behavior of very small quantities of such materials as stable heavy metal isotopes, radioactive nuclides, and synthetic materials.

Survey Items:

Conventional and large volume sampling of seawater, precise and continuous measurements of vertical distributions of temperature and salinity, nutrient analyses, and biomass determinations.

Area:

Northwestern North Pacific Ocean

Schedule:

55 days, 25 April-18 June 1980

Chief Scientist:

Dr. Yoshio Horibe, Professor of Marine Inorganic Chemistry

KH-80-3: Geological and geophysical research in the northwestern and central North Pacific Ocean

Purpose:

Detailed geophysical research on mechanisms of the formation of the seabed, seamounts, atolls, and records of variations in sea levels.

Survey Items:

Measurements of geographical features of the sea bed, gravity, earth magnetism, acoustics, deep-sea bed photography, sampling of the biota of the deep-sea bed by piston cores and dredges.

Area:

Northwestern and central North Pacific Ocean

Schedule:

55 days, 14 July-6 September 1980

Chief Scientist:

Dr. Kazuo Kobayashi, Associate Professor of Submarine Geophysics

KH-80-4: Study of the transport of seawater and the circulation of chemical constituents in the deep sea.

Purpose:

To investigate the flow of seawater and the circulation of materials in the deep sea.

Survey Items:

Measurements of such items as variations of flow, temperature, salinity, and other chemical materials in the deep sea.

Area:

Eastward of the main islands of Japan.

Schedule:

20 days, 17 September-6 October 1980

Chief Scientist:

Dr. Toshihiko Teramoto, Professor of Physical Oceanography

KH-80-5: Studies of the dynamic peculiarity of the Kuroshio and interactions between the Kuroshio and other currents.

Purpose:

To investigate the actual flow and variations of the Kuroshio and the interaction at the front between the currents of the East China Sea and the Kuroshio.

Survey Items:

Measurements of temperature and salinity.

Area:

The area of the Nansei Islands and the East China Sea.

Chief Scientist:

Dr. Toshihiko Teramoto, Professor of Physical Oceanography

KH-81-1: Studies of the environment and biological production in the area of the Kuroshio and its extensions.

Purpose:

Extension of project KH-77-2 carried out in 1977. It is intended to clarify the relationships between the structure of ocean and the distribution of marine organisms.

Survey Items:

Observations of biological materials such as eggs and young fish will be made from the viewpoint of their transportation, supply, and distribution.

Schedule:

35 days, 18 February-24 March 1981

Chief Scientist:

Dr. Toshiyuki Hirano, Professor of Resources and Environment.

MULTILINGUAL MEETINGS
organized by
Japanese Scientific Societies*
1979-1982
compiled by Seikoh Sakiyama

*It is intended to update and augment this list in future issues of the *Scientific Bulletin.*

1979

Date	Title	Site	For information, contact
April 1-5	International Meeting of Catalysis Society of Japan	Hawaii	Prof. T. Takagi Tokyo Institute of Technology 1-12-2, Ookayama Meguro-ku, Tokyo 152
April 1-6	The ACS/CSJ Chemical Congress 1979	Hawaii	Prof. O. Kammori The Chemical Society of Japan 5-1, Kanda-Surugadai Chiyoda-ku, Tokyo 101
April 8-11	Fifth International Conference of Positron Annihilation	Yamanashi	Prof. K. Fujiwara Conference Secretary Institute of Physics College of General Education University of Tokyo 3-8-1, Komaba Tokyo 153
April 10-13	International Symposium "Molybdenum Chemistry of Biological Significance"	Shiga	Prof. S. Otsuka Department of Chemistry Faculty of Engineering Science Osaka University 1-1, Machikaneyamacho Toyonaka-shi, Osaka 560
May 13-19	The Sixth International Congress of Radiation Research (ICRR)	Tokyo	Prof. S. Okada Hongo P.O. Box 152 Bunkyo-ku, Tokyo 113-91
May 28-June 1	IXth International Symposium on Cerebral Blood Flow and Metabolism	Tokyo	Prof. F. Gotoh Dept. of Neurology, School of Medicine, Keio University 35 Shinanomachi, Shinjuku-ku Tokyo 160

Date	Title	Site	For information, contact
June 4-7	1979 International Physical Distribution Conference (IPD Tokyo)	Tokyo	J.P.D.M.A. c/o Japan Management Association Kyoritsu Bldg., 3-1-22, Shiba-koen, Minato-ku, Tokyo 105
July 17-19	1979 International Symposium on Circuits and Systems	Tokyo	Prof. K. Horiuchi Dept. of Electronics and Electrical Communication Engineering, Waseda University 4-170, Nishi-Ohkubo Shinjuku-ku, Tokyo 160
July 22-27	2nd Meeting of WFUMB (The World Federation for Ultrasound in Medicine and Biology)	Miyazaki	W.F.U.M.B. Crescent Plaza 103 2-4-6, Minami-Aoyama Minato-ku, Tokyo 107
July 27-31	Third International Congress of Sleep Research	Tokyo	Dr. K. Azumi Tokyo Metropolitan Institute for Neurosciences 2-6, Musashidai, Fuchu-shi Tokyo 183
August 6-18	16th International Cosmic Ray Conference	Kyoto	Prof. S. Miyake Institute for Cosmic Ray Research University of Tokyo 3-2-1, Midori-cho, Tanashi Tokyo 188
August 16-17	AIC (Association Internationale de la Couleur) Midterm Tokyo Symposium '79	Tokyo	AIC c/o Japan Color Research Institute 3-1-19, Nishi-Azabu, Minato-ku Tokyo 106

Date	Title	Site	For information, contact
August 20-24	Sixth International Joint Conference on Artificial Intelligence	Tokyo	Information Science Division Electrotechnical Laboratory 2-6-1, Nagata-cho, Chiyoda-ku Tokyo 100
August 29-Sept. 4	11th International Conference on the Physics of Electronic and Atomic Collisions	Kyoto	Prof. K. Takayanagi I.S.A.S., University of Tokyo 4-6-1, Komaba, Meguro-ku Tokyo 153
October 29-Nov. 3	The 3rd International Congress of Quantum Chemistry (ICQC Kyoto '79)	Kyoto	Secretariat of ICQC Kyoto International Conference Hall Takara-ike, Sakyo-ku, Kyoto 606
November 13-16	IMEKO (International Measurement Confederation) Symposium on Flow-Measurement and Control in Industry	Tokyo	IMEKO The Society of Instrument and Control Engineers, Japan Kotohira Annex, 1-15-5 Toranomon, Minato-ku Tokyo 105

1980

Date	Title	Site	For information, contact
April 7-10	International Conference and Exhibition on Liquefied Natural Gas	Kyoto	Dr. Y. Shibazaki The Japan Gas Association 38, Shiba-Kotohira-cho Minato-ku, Tokyo 105
May 12-15 (tentative)	The 3rd International Meeting on Radiation Processing	Tokyo (undecided)	Secretariat, The 3rd International Meeting on Radiation Processing Research Corporation Section Japan Atomic Energy Takasaki Research Institute 1233, Watanuki-cho Takasaki-shi Gumma 370-12
May 19-22	4th International Conference on Titanium	Kyoto	Secretariat, 4th International Conference on Titanium c/o The Japan Institute of Metals Aramaki Aoba, Sendai 980
June 1-3	The 8th International Conference on Oral Biology	Tokyo	Secretariat, the 8th ICOB c/o Association of Oral Hygiene 1-38-6, Komagome, Toshima-ku Tokyo 171
June 2-6	Joint Conference of Fourth International Congress on Waves and Instabilities in Plasmas and Fourth Kiev International Conference on Plasma Theory (International Conference of Plasma Physics)	Tokyo	Prof. K. Nishikawa Faculty of Science Hiroshima University 89-1-1, Higashi-Senda-cho Hiroshima 730
June 5-8	Congress of the International Association for Dental Research	Osaka	Prof. Y. Kawamura Dental School, Osaka University 32, Joan-cho, Kita-ku, Osaka 530

Date	Title	Site	For information, contact
June 23-26	3rd World Hydrogen Energy Conference	Tokyo	Secretariat, 3rd W.H.E.C. c/o Japan Convention Service, Inc. Nippon Press Center Bldg. 8F 2-2-1, Uchisaiwai-cho Chiyoda-ku, Tokyo 100
June 30-July 4	The Seventh International Congress on Catalysis	Tokyo	Prof. I. Yasumori Dept. of Chemistry, Faculty of Science Tokyo Institute of Technology 2-12-1, Ookayama, Meguro-ku Tokyo 152
August 3-9	XVI International Congress of Entomology	Kyoto	Organizing Committee of 16th ICE c/o Kyoto International Conference Hall Takara-ike, Sakyo-ku, Kyoto 606
August 24-31	The 21st Congress of International Association of Theoretical and Applied Limnology	Kyoto	Assistant Prof. T. Miura c/o Otsu Hydrobiological Station Kyoto University Shimosaka-Honmachi, Otsu 520-01
August 31-Sept. 5	General Assembly, the 15th International Geographical Union, and the 24th International Geographical Congress	Tokyo	Prof. S. Yamamoto Rissho University 16-2-4, Ohsaki, Shinagawa-ku Tokyo 141
Sept. 1-5	15th International Conference on the Physics of Semi-conductors	Kyoto	Assistant Prof. K. Kamimura Dept. of Physics, Faculty of Science University of Tokyo 1-3-7, Hongo, Bunkyo-ku Tokyo 113

Date	Title	Site	For information, contact
Sept. 29-Oct. 3	10th Symposium of the IAHR Section for Hydraulic Machinery, Equipment and Cavitation	Tokyo	Prof. M. Shirokura Faculty of Engineering University of Tokyo 1-3-7, Hongo, Bunkyo-ku Tokyo 113
Sept. 29-Oct. 4	The 3rd World Conference on Medical Informatics (MEDINFO 80)	Tokyo	MEDINFO 80 Organizing Committee c/o MEDIS-DC, Hongo P.O. Box 40 Bunkyo-ku, Tokyo 113-91
Sept. 30-Oct. 3	The 3rd International Conference on Ferrites	Kyoto	Prof. M. Sugimoto Dept. of Electronics, Faculty of Engineering Saitama University 255, Shimo-Ohkubo, Urawa Saitama 338
October 6-9	The 8th World Computer Congress I.F.I.P. (The International Federation for Information Processing) Congress '80	Tokyo	Information Processing Society of Japan, Kikai Shinko Kaikan 3-5-8, Shiba-Koen, Minato-ku Tokyo 105
October 8-14	The 12th CODATA General Assembly and the 7th International CODATA Conference	Tokyo	Prof. T. Shimanouchi College of Science Tsukuba University Saiki, Sakura-mura, Niihari-gun Ibaraki 300-31
October 12-17	10th World Congress on Metal Finishing (INTERFINISH '80)	Kyoto	The Metal Finishing Society of Japan Kyodo Bldg. 2, Kanda-Iwamoto-cho Chiyoda-ku, Tokyo 101

Date	Title	Site	For information, contact
October 13-17	The 6th International Symposium on the Transport of Dangerous Goods by Sea and Inland Waterways	Tokyo	Japan Marine Surveyors and Sworn Measurer's Association Kaiji Bldg., 1-9-7, Hatchobori Chuo-ku, Tokyo 104
November 10-19 (tentative)	Xth International Conference on Lighthouses and Other Aids to Navigation	Tokyo	Navigation Aid Dept. Maritime Safety Agency 2-1-3, Kasumigaseki, Chiyoda-ku Tokyo 100

1981

Date	Title	Site	For information, contact
May 16-22	The 12th IAPH (International Association of Ports and Harbors) Conference	Nagoya	Nagoya Port Authority 1-8-21 Irifune, Minato-ku Nagoya 455
August 24-28	International Federation of Automatic Control (IFAC) 8th Triennial World Congress	Kyoto	Prof. Y. Sawaragi Dept. of Applied Mathematics and Physics, Faculty of Engineering Kyoto University Yoshida-Honmachi, Sakyo-ku Kyoto 606
Sept. 12-18	The 10th International Congress of Electro-encephalography and Clinical Neurophysiology	Kyoto (undecided)	Secretariat, The 10th ICECN c/o International Conference Organizers, Inc., Crescent Plaza 103 2-4-6, Minami-Aoyama Minato-ku, Tokyo 107

1982

Date	Title	Site	For information, contact
May 23-28	16th International Congress of Dermatology (CID)	Tokyo	Secretariat, 16th CID c/o Japan Convention Services, Inc. Nippon Press Center 8F 2-2-1, Uchisaiwai-cho Chiyoda-ku, Tokyo 100
Mid-July	The 5th International Congress of Plant Tissue	Yamanashi	Assistant Prof. A. Komamine Dept. of Botany, Faculty of Science University of Tokyo 7-3-1, Hongo, Bunkyo-ku Tokyo 113
Aug. 9-Sept. 3	The 5th International Congress of Pesticide Chemistry, IUPAC	Kyoto	Rikagaku Kenkyusho 2-1, Hirosawa, Wako Saitama 351
undecided	International Conference on Mass Spectroscopy	Hawaii	Prof. T. Tsuchiya Basic Science Lecture Room Chiba Institute of Technology 1-17-2, Tsudanuma, Narashino Chiba 275

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