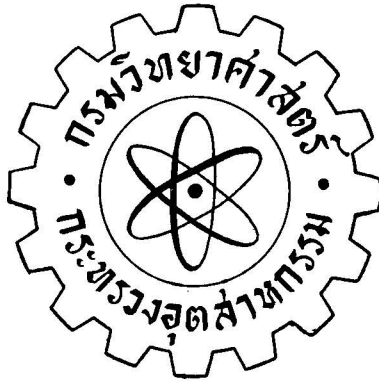


MINISTRY OF INDUSTRY

BANGKOK, THAILAND



DEPARTMENT OF SCIENCE

12th REPORT

FROM 1943 TO 1944

FOREWORD

The twelfth report of the Department of Science is a record of the work done during 1943-1944. Though in this report my name appears as Director-General of the Department, but in fact I took over the office as late as November 1944, hence the work accounted for during this period was mostly under the former Director-General, Dr. Prachuab Bunnag who left to join the Cabinet. I have to admit that the compilation of this report was restricted to records whatever left available, consequently I could not vouch for an absolutely complete information.

During this period Thailand was in a state of war thus the expansion of work was not possible. However, with all the obstacles confronting us we managed to carry on throughout the war years.

Dr. Charng Ratanarat

Director-General

Department of Science
Ministry of Industry
October 1948

STAFF

Director-General

Dr. Charng Ratanarat, Dr. phil. nat. (magna cum laude)

OFFICE OF THE SECRETARY OF THE DEPARTMENT

Assistant-Director Aree Supol, B.Sc.

Correspondence Section

Chief of Section Singto Ratanakasikara

Assistant Ong Thadasih

Assistant Mani Nutaman

Library Section

Librarian Miss Proesiri Bhekanandhana, B.A.

Assistant Phoon Chakrasen

Accounts Section

Chief of Section Siri Juvidya

Assistant Chit Yamaphai

Stores Section

Chief of Section Siri Suvanpatama

Assistant Chemist Santa Lawhabutr

SCHOOL OF PRACTICAL CHEMISTRY

Director Dr. Charng Ratanarat, Dr. phil. nat. (magna cum laude)

Senior Chemist Yos Bunnag, B.Sc., M.Sc., A.R.C.S., D.I.C.

Assistant Director Pue Rochanapuranda, B.S. (Chem.), Dip. Ind)
Chem.

Instructor Miss Proesiri Bhekanandhana, B.A.

Instructor Mrs. Pathum Therawatana, B.Sc.

Instructor Miss Chirapha Chalaragse, B.Sc.

DIVISION OF CHEMISTRY

Senior Chemist Luang Vichien Dhatukarn L.és.Sc., I.C.

Medical Officer Siri Tevayananda, M.B., Dip. Pharm.

Forensic Chemistry Section

Chemist Chiad Aphaiwongse, Dip. Pharm.

Medical Officer Sub.Lt. Thon Jarusara, M.B.

Assistant Chemist Prem Banijpol, B.Sc.

Metallurgy Section

| | |
|--------------------------|---|
| <i>Chemist</i> | Vongse Naewbanij, A.A. |
| <i>Assistant Chemist</i> | Bumpen Savavasu, B.Sc. |
| <i>Assistant Chemist</i> | Miss Khlo-Chai Bunyasingh, B.S. (Chem.) |
| <i>Assistant Chemist</i> | Sompule Suyasintu, Dip. Chem. |

Opium Dross Control Section

| | |
|--------------------------|--------------------------------------|
| <i>Chemist</i> | Surin Milindalekha, Dip. Pharm. |
| <i>Assistant Chemist</i> | Chamnong Pugglanandana |
| <i>Assistant Chemist</i> | Chinda Bunyamit, Dip. Chem. |
| <i>Assistant Chemist</i> | Miss Rungtawan Bunnag, B.S. (Pharm.) |

Water Analysis Section

| | |
|--------------------------|---------------------------------------|
| <i>Chemist</i> | Samroeng Vimuktanandana, B.S. (Chem.) |
| <i>Assistant Chemist</i> | Mrs. Tiraporn Vongsratana, Dip. Chem. |

Fuel Section

| | |
|--------------------------|--------------------------------|
| <i>Chemist</i> | Banbota Sudhikam, B.S. (Chem.) |
| <i>Assistant Chemist</i> | Chong Bunnag |

General Analysis Section

| | |
|--------------------------|---|
| <i>Chemist</i> | Pravat Isarankura Na Ayudhaya, Dip. Ed. |
| <i>Assistant Chemist</i> | Mrs. Būnlom Tevayananda, B.Sc. |
| <i>Assistant Chemist</i> | Miss Snitlagsana Sinatyotharagse, B.Sc. |
| <i>Assistant Chemist</i> | Chalad Virayodhin |
| <i>Assistant Chemist</i> | Miss Charūngechan Phalajivin, Dip. Pharm. |

DIVISION OF INDUSTRIAL CHEMISTRY

| | |
|--------------------------|------------------------------------|
| <i>Senior Chemist</i> | Sangar Sharasuvana, C.D.A. (Hons.) |
| <i>Chemist</i> | Mrs. Chomchai Savasti-Watana, B.S. |
| <i>Chemist</i> | Mrs. Anu Osathanonda, B.S. |
| <i>Assistant Chemist</i> | Mrs. Vilai Devakul |
| <i>Assistant Chemist</i> | Miss Soodchai Dharmasharoen |

Ceramics Section

| | |
|----------------|-----------------------------------|
| <i>Chemist</i> | Manoon Prachankadee, Sc.B. Chem. |
| <i>Chemist</i> | Suebsagdi Punya-upaphat, Dip. Ed. |

Food Section

| | |
|--------------------------|--|
| <i>Chemist</i> | Prathib Prathipasen, B.S.S.T. |
| <i>Chemist</i> | Mrs. Phannipa Paenpatana, B.Sc. |
| <i>Assistant Chemist</i> | Miss Ratsamiepen Siribaed Bisudhhi, B.S.E. (Home Ec.) |
| <i>Assistant Chemist</i> | Miss Virada Vanarak |
| <i>Assistant Chemist</i> | Puan Proysuwana, Dip. Chem. |
| <i>Assistant Chemist</i> | Nimit Vorabandha, Dip. Chem. |

Alcoholic Beverages Section

| | |
|--------------------------|--------------------------------------|
| <i>Assistant Chemist</i> | Chula Kanchanalakashana, Dip. Pharm. |
| <i>Assistant Chemist</i> | Narong Eun-Udom, Dip. Chem. |
| <i>Assistant Chemist</i> | Miss Viengvibha Kanakakara, B.Sc. |

Ores Section

| | |
|--------------------------|-------------------------------------|
| <i>Chemist</i> | Mrs. Sakuntala Bhodhiprasat, B.Sc. |
| <i>Assistant Chemist</i> | M.L. Anong Nila-Ubol, B.Sc. |
| <i>Assistant Chemist</i> | Miss Viyada Punyarjun, B.Sc. |
| <i>Assistant Chemist</i> | Miss Poonsab Paulpuntin, Dip. Chem. |
| <i>Assistant Chemist</i> | Klow Dejdamong, Dip. Chem. |

DIVISION OF INDUSTRIAL RESEARCH

| | |
|-----------------------|-----------------------------|
| <i>Senior Chemist</i> | Nara Boon-Long, B.Sc., M.S. |
|-----------------------|-----------------------------|

Physics Section

| | |
|--------------------------|---------------------------|
| <i>Chemist</i> | Siri Na Nakara, B.Sc. |
| <i>Assistant Chemist</i> | Parl Na Pombejra, B.Sc. |
| <i>Assistant Chemist</i> | Lau Lauhabandhu, Dip. Ed. |

Strength of Material Testing Section

| | |
|----------------|--------|
| <i>Chemist</i> | Vacant |
|----------------|--------|

Workshop Section

| | |
|---------------------------|----------------------|
| <i>Assistant Mechanic</i> | Phud Phagdiwichitara |
|---------------------------|----------------------|

Industrial Process Investigation Section

| | |
|--------------------------|--|
| <i>Chemist</i> | Choo-Sakr Vijierajote, Dip. Ed., B.S. (Ind. Chem.) |
| <i>Assistant Chemist</i> | Miss Nidnoi Sucharitakul, B.Sc. |
| <i>Assistant Chemist</i> | Miss Prija Chandtavekin, B.Sc. |
| <i>Assistant Chemist</i> | Amara Prachankadee |
| <i>Assistant Chemist</i> | Sasi Boonyamanop, B.Sc. |

APPOINTMENTS

1. Choo-Sakr Vijierajote, *January 1, 1943: as*
Chemist,
Industrial Process Investigation Section,
Division of Industrial Research.
2. Siri Na Nakara, *January 1, 1943: as*
Chemist,
Physics Section,
Division of Industrial Research.
3. Amara Prachankadee, *January 1, 1943: as*
Assistant Chemist,
Industrial Process Investigation Section,
Division of Industrial Research.
4. Mrs. Anu Osathanonda, *January 1, 1943: as*
Chemist,
Division of Industrial Chemistry.
5. Mrs. Vilai Devakul, *January 1, 1943: as*
Assistant Chemist,
Division of Industrial Chemistry.
6. Miss Soodchai Dhamacharoen, *January, 1, 1943: as*
Assistant Chemist,
Division of Industrial Chemistry.
7. Miss Virada Vanarak, *January 1, 1943: as*
Assistant Chemist,
Food Section,
Division of Industrial Chemistry.
8. Miss Pathum Dosananda, *January 25, 1943: as*
Assistant Chemist,
Industrial Process Investigation Section,
Division of Industrial Research.
9. Miss Chirapha Chalaragse, *January 25, 1943: as*
Assistant Chemist,
School of Practical Chemistry.

10. Miss Viengvibha Kanakakara, *September 16, 1943: as*
Assistant Chemist,
Alcoholic Beverages Section,
Division of Industrial Chemistry.
11. Sasi Boonyamanop, *November 1, 1943: as*
Assistant Chemist,
Industrial Process Investigation Section,
Division of Industrial Research.
12. Santa Lawhabuta, *November 1, 1943: as*
Assistant Chemist,
Stores Section,
Office of the Secretary of the Department,
transferred from the Department of Agriculture.
13. Miss Rungtawan Bunnag, *November 2, 1943: as*
Assistant Chemist,
Opium Dross Control Section,
Division of Chemistry.
14. Miss Viyada Punyârajun, *September 4, 1944: as*
Assistant Chemist,
Ores Section,
Division of Industrial Chemistry.
15. Nara Boon-Long, *October 1, 1944: as*
Chemist,
Division of Industrial Research,
transferred from the Department of Medical Science.
16. Dr. Charng Ratanarat, *November 25, 1944: as*
Acting Director-General,
transferred from the Military Science Department.

Officials Who have Left the Department of Science

1. Dr. Prachuab Bunnag, October 20, 1944: appointed as Member of Cabinet.
2. Chom Sri-Amphai, January 1, 1943: Assistant Chemist, Metallurgy Section, Division of Chemistry, transferred to the Department of Industrial Promotion.
3. Prasarn Nutaman, March 1, 1943: Assistant Chemist, Stores Section, Office of the Secretary of the Department, transferred to the Department of Animal Development.
4. M.L. Chawiwongse Rongsong, July 12, 1943: Assistant Chemist, Alcoholic Beverages Section, Division of Industrial Chemistry, resigned.
5. Boonsom Saisanit, October 13, 1943: Assistant Mechanic, Workshop Section, Division of Industrial Research, died.
6. Miss Pathum Dosananda, November 1, 1943: Assistant Chemist, Industrial Process Investigation Section, Division of Industrial Research, transferred to the Department of Agriculture.

Official Tour in the Country

1. Arce Supol, January 14, 1943: as a Member of Malaria Control Committee, making a tour of the North-East in search of a site for establishing a hospital and a convalescent quarter for the North-Eastern Army.
2. Sangar Sharasuvana: Touring Amphur Lomsak, Changwad Phojaburana in search of a suitable place in case of evacuation for the Department of Science.
3. Dr. Prachuab Bunnag and Singto Ratanakasukara, March 12, 1944 to March 21, 1944: Members of Enquiry Commission on the damage of the Thai Umbrella Factory, Chiangmai, Department of Industrial Promotion, as the result of bombing on March 5, 1943. Visited the oil well at Muang Phang.

Special Duty

1. Dr. Prachuab Bunnag: Fellow of the Royal Institute in Physical Science.
Member of the Special Imports and Exports Control Committee, according to the Act of 1938.

Member of the National Industrial Construction Committee.

Member of the Industrial Development Committee

Vice Chairman of the Industrial Chemistry Committee

Chairman of the Caustic Soda Equipment and Material Procurement Sub-Committee.

Chairman of the Phosphorus and Potassium Chlorate Manufacture Sub-Committee.

Member of the Board of Directors

Member of the Committee for the Promotion of Match Industry.

2. Aree Supol:

Special Lecturer in the Faculty of Pharmacy, University of Medical Science.

Representative of the Ministry of Industry to the Department of Allies Co-operation Committee.

Member of the National Air Raid Precaution Committee.

Member of the Tobacco Committee.

Member of the Board of Directors, Government Distillery.

Member of the Caustic Soda Equipment and Material Procurement Sub-Committee.

Member of the Wood Distillation Industry Sub-Committee.

Member of the Phosphorus and Potassium Chlorate Manufacture Sub-Committee,

Member of the Committee for the Promotion of Glass Industry.

Chairman of the Committee for the Promotion of Alcohol Industry

Chairman of the Tannin Manufacture Committee

Member of the Glass Research Sub-Committee.

Member of and Secretary to the Industrial Chemistry Committee.

Member of the Malaria Control Committee

3. Yos Bunnag:

As the Science Department Representative joined the Public Health Department in checking equipments sent by the Japanese Government as an aid in the flood disaster.

Special Lecturer in the Faculty of Pharmacy, University of Medical Science.

Member of the Industrial Chemistry Committee.

4. Pue Rochanapuranda:

Member of Information Service Committee, Ministry of Industry.

Member of and Secretary to the Caustic Soda Equipment and Material Procurement Sub-Committee.

Member of and Secretary to the Phosphorus and Potassium Chlorate Manufacture Sub-Committee.

Member of the Committee for the Promotion of Vegetable Oil Industry.

Member of and Assistant Secretary to the Industrial Chemistry Committee.

5. Pravat Isarankura: Secretary to the Wood Distillation Industry Sub-Committee.
Secretary to the Committee for the Promotion of Alcohol Industry.
Secretary to the Tannin Manufacture Committee.
6. Prathib Prathipasen: Member of the Committee for the Promotion of Sugar Industry
7. Prem Banijpol: Member of the Committee for the Promotion of Soap Industry.
8. Manoon Prachankadee: Member of the Committee for the Promotion of Ceramics Industry.
9. Seubsagdi Punja-Uphaphat: Member of the Committee for the Promotion of Ceramics Industry.
10. Vongse Naewbanij: Member of the Committee for the Promotion of Non-Ferrous Metal Industry.
Member of the Committee for the Promotion of Tin Smelting Industry.
11. Miss Rasamipen Siribaed Bisuddhi: Member of the Committee for the Promotion of Food Industry.
Member of the Committee for the Promotion of Canned Food Industry.
12. Siri Tevayananda
and Siri Suvanpathma: Appointed as officers in the First Aid Unit
Attached to the Air Raid Precaution Section, Ministry of Commerce.
13. Siri Na Nakara: Temporarily assigned to work at the Air Raid Precaution Headquarter.
14. Phud Phagdiwichitara: Temporarily assigned to work at the Department of Industrial Works.

GENERAL REVIEW

It is a pleasure to record in this report that Dr. Prachuab Bunnag, successor to the late Dr. Toa Labanukrom, has also been appointed to the rank of a Minister of State. It was the Government's policy to separate political officials from civil servants, consequently Dr. Prachuab Bunnag had to leave the Department after taking up politics.

Dr. Prachuab Bunnag, a member of the 1932 People's Party has an excellent record during the time of his office. He was also Dr. Toa Labanukrom's contemporary for the Dr. Phil. Chem. examination from Switzerland.

During 1943-1944 Thailand was in a state of war, consequently no outstanding progress was achieved. With all the handicap in material and equipment the work of the Department went on unceasingly through Dr. Prachuab's effort.

The site of the Department could be considered situated near to an important military target and when the war situation was getting more critical, an air raid shelter had to be built within the compound of the Department as a precautionary measure. Moreover some sections with analytical equipments were evacuated to the Mater Dei Institute at Ploen Chitr Road, some with valuable materials together with books from the library were moved to Wat Nang, Dhonburi. It was due to the hospitality of the chiefs of those two places that our work could go on. It was, however, very fortunate that neither the Department building nor the mentioned places of evacuation were ever hit.

In 1944, samples sent in for analysis were less than those in 1943, being 2644 in 1944 and 6214 in 1943. Less samples sent by the Customs Department due to the reduction in imports accounted for such a decrease. On the other hand, under the Ministry of Industry, another branch of work developed rapidly in the fields of industrial research and development and many officials were appointed to various working committees and many industrial factories were established with close co-operation of the Department. Some of these factories were:

(1) Wood Distillation Plant at the Agricultural Saw Mill, Dhonburi. This factory was inaugurated on June 24, 1943. It produced good quality charcoal, pyrolygneous liquor and wood tar.

(2) Tannin Extraction Plant at the Leather Factory. Tannin was extracted from betel nuts and various kinds of barks.

(3) Potassium Chlorate Plant built in the vicinity of the Samsen Power Station. It was inaugurated on the June 24, 1943. Potassium Chlorate is an important ingredient for the manufacture of matches.

There were also other scarce materials produced by the Department for its own consumption and for the need of other Governmental Agencies. These were rubber goods, liquid ammonia, hydrochloric acid and others.

The library work was interrupted for a while owing to the lack of communication with foreign countries. Nevertheless the library service was still made available to officials who needed certain books and journals. The publication of "Thai Science Bulletin" and the "Science" magazine was also suspended for the time being. As for the "Science" magazine, its last number was issued towards the end of 1943.

The School of Practical Chemistry was temporarily closed in 1944, owing to the fact that most students were evacuated out of Bangkok.

During this period there were no samples of gold and copper sent in from the Excise Department. On the other hand, tin samples increased markedly. The opium and opium dross samples decreased whereas raw and cooked opium samples increased many times. The amount of narcotic and poison samples seemed to drop. In fire-arm examination it had been requested by the Police Department to identify the types of cartridges apart from the usual practice of ascertaining whether the weapons had been fired after the last cleaning. The fire-arm samples sent for examination were comparable to those appeared in the 11th report.

Besides the routine analysis and the activities already mentioned, the Department made a study of certain natural products such as calorific values of varieties of wood-charcoal, quantities of acids obtained in wood distillation products and chemical analysis of Thai rosin and salt.

THE LIBRARY

The grave situation of the War had a serious effect on our library. The increase in volumes of books at the end of this period (12th report) was very small compared with that of the last period (11th report).

| Items | Number of Volumes at the end of 1943 | Number of Volumes at the end of 1944 | Increase in Volumes | Remarks |
|----------------------------|---|---|---------------------------|---------------------------------|
| 1. Scientific books | 2558 | 2570 | 12 | } Lack of communi- cation |
| 2. Scientific publications | 1807 | 1894 | 87 | |
| 3. Scientific journals | — | none | — | |
| 4. Other publications | 681 | 700 | 19 | |
| 5. Other journals | 129 | 140 | 11 | |

With less books coming in, the library had its system reorganized. Ten thousand index cards were made; books and journals were reclassified and regrouped.

As Bangkok was raided by allied planes more frequently, it was considered best to move some of the rarely-used books away from Bangkok and only essential ones were kept in the Library.

During this period, more outside people made use of our Library. These were mostly officials from the Faculty of Pharmacy, University of Medical Science, Department of Military Science, Department of Industrial Promotion, Department of Vocational Education, Department of Forestry, Department of Ways, Department of Fishery, Department of Military Arsenal, Department of Animal Development, Kasetsart University, Tobacco Monopoly Co., Thai Industrial Promotion Co. Ltd., Thai Industries Co. Ltd., the Rathakan Co. etc.

The Science Magazine

The "Science" Magazine was discontinued in 1944, because of the scarcity of paper. In 1943 only three issues instead of the usual four were printed. At all times the subscription had been kept cons-

tant inspite of the fact that materials used in printing were higher in cost, this was to keep up our purpose of popularizing and encouraging the study of science among the public.

Staff of "Science" magazine for the year 1943:

| | |
|---------------------|-------------------------|
| Editor | : Pue Rochanapuranda |
| Manager | : Singto Ratanakasikara |
| Advertising Manager | : Siri Suvanpathama |
| Treasurer | : Siri Chuvidya |

Although not having the duty of editing the magazine the staff still had to answer questions and problems sent in by readers. Consequently the subscribers of the magazine were not so much at a loss when they still could find ways and means to solve their scientific problems through the staff of the magazine.

Thai Science Bulletin

No Thai Science Bulletin appeared during the period of this report. The publication would be continued after the war came to an end.

CERTIFICATION OF LOCALLY-MANUFACTURED PRODUCTS

During 1943-1944, 35 kinds of merchandise were sent in for approval, only 21 kinds were up to the standards; 12 out of 14 for 1943 and 9 out of 21 for 1944.

Of the total 21 varieties 9 were approved previously, hence only 12 were new products. It was noteworthy to mention that among the merchandise sent in, two were samples of sweetened condensed milk. Normally it was imported. It was due to the shortage of this product that an attempt was made to produce it locally. Unfortunately, they were not approved because of its inconsistency and the unsanitary working condition.

The merchandise approved in 1943:

1. 1.77 Baby powder, 1.77 Factory.
2. Thai Diamond Sand Paper.
3. Suchat Soldering Liquor, Suchat Factory.
4. Loedrod Fish Sauce, Thai Swasdi Factory.
5. 1.77 Hair Tonic, 1.77 Factory.
6. Eagle Shoe Polish, Hongsthong Pradit Factory.

7. Thai Pagoda Hair Oil, Wisuthi Factory.
8. Three Birds Shoe Polish, Bamrung Thai Industrial Factory.
9. Peacock Dusit Sauce.
10. Moon Flour, Thai Phanom Factory.
11. Saman Loed Rubber Glue.
12. Boat Vinegar, Chaithalé Co. Ltd.

The merchandise approved in 1944:

1. Heart Absorbent Cotton, Udom Osodsathan Factory.
2. Rubber Glue, So Damphithag Factory.
3. 1.77 Baby Powder, 1.77 Factory.
4. Naga Distilled Water, Thai Thonburi Distilled Water Factory.
5. Eagle Shoe Polish, Hongsthong Pradit Factory.
6. Peacock Dusit Sauce.
7. Thai Pagoda Hair Cream, Wisuthi Factory.
8. Thai Pagoda Hair Oil, Wisuthi Factory.
9. Supee Face Powder, Supee Factory.

CONSTITUTION FAIR AND NATIONAL DAY EXHIBITIONS

In 1943, the Government decided to hold the Constitution Fair and the National Day Celebration, in both of which the Department participated. But in 1944, the War situation got more serious, so it was deemed best not to hold these Fairs, only State Ceremonies were held.

The 1943 Constitution Fair was held in the buildings of Rajadamnoen Avenue. The Department took part in the division headed by the Under-Secretary of Industry with the Director-General of the Department as one of the committee members. This division was called the Division of Industrial Self Promotion. Yos Bunnag headed the Science Section with Pravat Isarankura Na Ayudhya as secretary. The purpose of this exhibition was to show how the people could set up home industries during emergency period. The show comprised of :-

1. Rubber goods: displaying various products made from latex for instance gloves, rubberized canvas, rubber sponge, etc.
2. Dyestuff: showing the efficient and scientific method of indigo extraction from Thai indigo plant; indigo carmine, the soluble derivative, was also shown with various textile materials dyed with it.

3. Products from wood-ash: showing how to make soap using lye from wood ash.

4. Manufacture of paints and drying oils: showing how to prepare drying oils from Thai vegetable oil seeds; samples of seeds, extracted oils, and paints made from them were displayed.

5. Production of vinegar: showing various equipment used in the production of vinegar: open tank, horizontal tank, rotating tank column, etc.

6. Scientific equipments: showing samples of equipment made by the Department's Workshop for use in the Department.

7. Products of wood distillation: showing various products as the result of wood distillation e.g. charcoal, pyroligneous liquor, wood tar, and cinder.

8. Tannin industry: showing how to extract tannin from local betel nuts; samples of leather and leather products were also displayed.

The "Science" magazine was advertised and sold as in the previous year. Subscriptions were also taken.

The 1943 National Day Celebration was held in Suapa Field, Dusit Park during June 23-30. The Department of Science took part in the exhibition jointly with the Department of Medical Science, the Department of Military Science and the Thai Weaving Factory, in the Chemical and Medical Section of the Division of Industrial Products and Handicraft. Yos Bunnag was head of the section with Pravat Isarankura Na Ayudhya as Secretary. The committee consisted of 12 other members. The aim of the exhibition was the same as that of the Constitution Fair Exhibition, namely to encourage the public to produce certain essential goods themselves.

There were some additional displays:

1. Preparation of saltpetre from bat's guano and the preparation of barium chloride from Thai barite ore.

2. Making of refractory crucibles, whetting stones, and polishing stones.

3. Preparation of wine from glutinous rice according to an improved method. The type of yeast used in fermentation was also shown.

Both exhibitions proved to be very interesting to the public. Many inquiries were sent in even after the shows were over. No public survey was made, but it was thought that many of the methods were adopted by local manufacturers.

THE SCHOOL OF PRACTICAL CHEMISTRY

In October 1943, the School of Practical Chemistry admitted the fourth preparatory group of 16 students selected from 141 candidates. The decrease in the number of candidates was due to the difficulties of transportation and communication, since a great number of the population was evacuated from Bangkok. In the same year the fifth group of 10 students were graduated from our School and they were the first lot to start from our preparatory course.

In 1944, the situation of the War was so acute that we found it hard to keep the school going while performing other essential duties as well, so it was decided to close the school for the time being.

Towards the end of 1944 Dr. Charng Ratanarat, who succeeded Dr. Prachuab Bunnag as the Director-General, became-ex officio-the director of the School of Practical Chemistry.

DIVISIONS OF CHEMISTRY, INDUSTRIAL CHEMISTRY AND INDUSTRIAL RESEARCH

The work of the three Divisions during the period of this report could not be entirely separated from one another, because of the limited number of personnel, equipment and chemicals. The following is a record of some important undertakings performed by these Divisions.

METALS:

In 1943, the Department of Finance, Ministry of Finance sent for analysis 3530 samples of tin used in making coins. Another 900 samples were sent in the following year. For certain reasons silver and copper were not employed in making coins during the war, only tin was used.

OPIUM:

The regulation and control of opium dross were changed by the Excise Department, as a consequence the Excise Department did not have to send in such samples for analysis. Only 6 samples of opium dross were sent in 1943 and only 1 sample in 1944. According to the new regulation, the Excise Department bought raw opium within the country and had it cooked for distribution. So the number of samples of raw and cooked opium sent in for analysis increased a great deal over this period.

| Year | Samples of Raw Opium | Samples of Cooked Opium | Total |
|------|----------------------|-------------------------|-------|
| 1943 | 84 | 236 | 320 |
| 1944 | 35 | 340 | 375 |

ILLICIT OPIUM:

In 1943 the Division of Chemistry received from the Excise Department for analysis 36 samples suspected to be illicit opium or opium dross. The findings were positive in 5 cases. In 1944, 34 samples were sent in, and 4 were found positive.

HARMFUL HABIT-FORMING DRUGS:

In 1943 the Department received 15 specimens which were suspected to contain harmful habit-forming drugs sent in by the Departments of Police, Public Health and Customs. Two specimens were found to contain opium, and eight were found to contain morphine hydrochloride. In 1944, no specimens were sent in.

POISONING CASES:

During this period there were two interesting cases of poisoning, sodium cyanide was used in one case and Lampong, (*Datura* sp.) a local plant, in the other.

SODIUM CYANIDE

The police of Amphur Yasothon, Ubol, sent about 3 c.c. of a liquid sample for analysis for the presence of a poison. The police investigation revealed that the liquid was mixed in a liquor taken by 2 persons and one was dead. The symptom described was a burning

pain in the gullet followed by vomiting and unconsciousness. The result of analysis showed the presence of 0.2235 g. of Sodium Cyanide in 2.2 c.c. of the sample. The deceased victim must have taken more than the fatal dose of 0.3 g. of Sodium Cyanide.

LAMPONG (DATURA SP.)

An alcoholic liquor specimen suspected to contain a poison was sent in by the police of Mahasarakham. Symptoms observed were unconsciousness, dilation of the retina, vomiting, spasm, convulsion, dryness of the throat and reddening of the face. Fortunately the victim had been promptly treated. The result of analysis showed the presence of atropine. The amount of 0.012 g. of atropine was found in the specimen, the fatal dose of atropine being 0.130 g. That Lampong, (*Datura* sp.) a native plant, was suspected seemed to be well founded since it contains a certain amount of atropine.

BLOOD STAINS.

58 and 35 specimens were sent in for the identification of human blood in 1943 and 1944 respectively. A case from Khonkaen was of particular interest. A man was beaten up and robbed of his belongings. During the struggle, the victim tore a piece of cloth from the robber's sweater. Later on, the culprit in possession of the same coloured slip-over was arrested. It was found that the sleeves of the sweater had been cut off and discarded on the road side. The sleeves were recovered and blood-stains were found on them. The result of analysis indicated that the fibre of the torn-off material was identical with that of the sleeves and stains were of human blood.

FIRE-ARMS.

The routine work concerning fire-arms was to ascertain whether they had been fired after the last cleaning. There were 33 and 34 specimens in 1943 and 1944 respectively. Of these, there were two interesting cases:

1. At Phrae, a man was killed by gun-shot from a home made cap gun. The police arrested a man found in possession of similar lead shots. A piece of metal removed from the leg of the victim was sent to the Department together with the suspect's lead shots. The samples were examined spectroscopically and found to be identical.

2. Concerning murder case, the Head Quarter of the Division of Central Investigation, Department of Police sent samples consisting of a bullet and two metallic amulets in the form of small images of the Buddha, one had a bullet hole and the other was broken. It was requested whether the metal from the amulets could be found on the point of the bullet. The investigation proved uncertain since the outer shell of the bullet was broken and lost and the amulets and the inner core of the bullet were all made of lead.

3. A case of an attempt to murder happened in Amphur Phanomthong, Kanchanaburi. The culprit was seen by eye witnesses to raise his cap-gun and pull the trigger. The spark of the flame was also observed but it was a dud. The gun was sent in for examination. The examination showed that the gun was still loaded and the ignition channel contained some soot with traces of gun powder. The mis-fire may be due to the fact that the ignition channel was blocked by rust. This seemed to be in agreement with the testimony given by the witnesses.

FIRE FROM MOTION PICTURE FILM.

In April 1944, a fire broke out in the glass cupboard of a tailor shop in Samranrad Precinct, Bangkok. The glass case contained three reels of motion picture film, one of which was completely burnt. Arson was being suspected though no one was present at the time. Upon investigation no trace of fuel oil was found. The police enquired whether a film could catch fire under such a condition. An experiment was conducted and it could be ascertained that spontaneous combustion could take place if air circulation was prevented and there was sufficient heat.

FIRE FROM THE MIXTURE OF YANG OIL AND MAYAU OIL

The Department of Industrial Promotion reported that they rendered canvas waterproof by soaking in a solution containing equal parts of Yang oil and Mayau oil. The treated canvas was dried, folded and put in a store room. Twice the canvas was found scorched. The Department of Science had been asked as to the cause of the damage, and it was found that heat was accumulated in the canvas stack and scorching took place. Consequently, the Department advised them to let the canvas get completely dried before storage and the room should be well ventilated.

COAL.

A sample of coal, said to be found in Amphur Mae Ta, Lampang, was sent in by the Department of Military Arsenal for analysis. The results were as follows:—

| | |
|---|---------------------|
| Moisture | 16.9 % |
| Ash | 9.9 % |
| Volatile matter | 41.8 % |
| Fixed carbon | 31.4 % |
| Calorific value (as received) | 4,879 Cal./gm. |
| | or 8,766 B.T.U./lb. |
| Calorific value (calculated on dry basis) | 5,859 Cal./gm. |
| | or 10,546 B.T.U./lb |

CALORIFIC VALUES OF CHARCOAL.

The calorific values of charcoal from various kinds of wood, which were sent in by the Department of Forestry were as follows:—

| Thai | Botanical Names | Calorific Values (Calculated on dry basis) Cal./gm. |
|------------------|---|---|
| Krabog | <i>Irvingia malana</i> , Oliver | 7,076 |
| Kradugkharng | <i>Diospyros lucida</i> , Wall. | 7,547 |
| Khohaeng | <i>Carallia brachiata</i> , Merr. | 7,111 |
| Khaefoi | <i>Dolichandrone crispa</i> , Seem. | 7,335 |
| Chae | <i>Padbruggea atropurpurea</i> , Craib. | 7,485 |
| Taeo | <i>Cratoxylon</i> spp. | 7,376 |
| Tachai | | 7,447 |
| Tung | <i>Litsea grandis</i> , Hook f. | 7,556 |
| Non | <i>Vitex pubescens</i> , Vahl. | 7,525 |
| Nuan | <i>Garcinia merguensis</i> , Wright. | 7,072 |
| Prasag | <i>Bruguiera conjugata</i> , Merrill. | 7,137 |
| Phayung | <i>Dalbergia cochinchinensis</i> , Pierre. | 7,385 |
| Mangtan | <i>Schima noronhae</i> , Reinw. | 7,430 |
| Rangkathae | <i>Bruguiera cylindrica</i> , Blume. | 7,376 |
| Som or Miang-arm | <i>Crypteronia Griffilhii</i> , C.B. Clarke. | 7,362 |
| Larn | <i>Rhizophora mucronata</i> , Lamk. | 7,278 |

Samples sent in by the Wood Distillation Factory:-

| Thai | Botanical Names | Calorific Values (Calculated on dry basis) Cal./gm. |
|-------------|--|--|
| Tabag | <i>Lagerstroemia calyculata</i> , Kurz. | 7,524 |
| Sakae | <i>Combretum quadrangulare</i> , Kurz | 7,363 |
| Chabog | <i>Irvingia malana</i> , Oliver. | 7,147 |
| Takhro | <i>Scheuchera trijuga</i> , Willd. | 7,128 |
| Taeo | <i>Cratoxylon</i> spp. | 7,836 |
| Dangrabaeng | <i>Schoutania hypoleuca</i> , Pierre. | 7,384 |
| Makhamthed | <i>Pithecolobium dulce</i> , Benth. Syn.- <i>Inga dulcis</i> , Willd. | 7,284 |
| Tengrang | <i>Shorea obtusa</i> , Wall ex Blume. | 6,247 |
| Thinthon | <i>Albizzia procera</i> , Benth. | 7,370 |
| Salau | <i>Lagerstroemia tomentosa</i> , Presl. | 7,185 |
| Kathon | <i>Sandoricum indicum</i> , Cav. | 7,896 |
| Pho | <i>Ficus religiosa</i> , Linn. | 6,950 |

PYROLIGNEOUS ACID FROM WOOD DISTILLATION

Pyroligneous acid was obtained as a by-product in wood distillation. Acetic acid, a more valuable product, could be obtained from this acid. The mentioned factory had not yet further developed in this direction and the by-product was sold as such. The pyroligneous acid was used chiefly in local rubber industries, where it was used as a coagulating agent in place of acetic acid or formic acid, which were unavailable during the period.

The acetic acid contents of distillation products of various kinds of wood are as follows:

| Thai Names | Botanical Names | % Acidp Calculated as Acetic Acid |
|------------|--|---|
| Salau | <i>Lagerstroemia tomentosa</i> , Preol. | 3.9 |
| Kathon | <i>Sandoricum indicum</i> , Cav. | 5.6 |
| Tengrang | <i>Shorea obtusa</i> , Wall ex Blume. | 4.4 |
| Makhamthed | <i>Pithecolobium dulce</i> , Benth. | 6.5 |
| Yang | <i>Dipterocarpus</i> spp. | 3.5 |
| Taboon | <i>Xylocarpus obovatus</i> , A. Tuss. | |
| | Syn.— <i>Carapa obovatu</i> , Blume & A. Tuss. | |
| | <i>C. moluccensis</i> , Hiern. & Craib. | |
| Tabag | <i>Lagerstroemia calyculata</i> , Kurz. | 4.8 |
| Sakae | <i>Combretum quadrangulara</i> , Kurz. | 5.2 |
| Krabog | <i>Irvingia malana</i> , Oliver. | 5.0 |
| Takhro | <i>Schleichera trijuga</i> , Willd | 5.9 |

GUM TURPENTINE AND ROSIN.

The Department of Science with the cooperation of the Department of Forestry obtained many samples of gum turpentine from various parts of the country, with a view to study the properties of its distillation products, turpentine and rosin.

The results of analysis :

| | AR. 476 Chiengrai | AR. 477 Chiengrai | AR. 478 Chiengrai | AR. 479 Chiengmai | AT. 430 Nan | AT. 431 Lampang | AT. 432 Lanchang | AT. 436 Prae |
|--|----------------------|----------------------|----------------------|----------------------|-----------------|--------------------|---------------------|-----------------|
| 1. Quantity of Turpentine and Rosin | | | | | | | | |
| % Turpentine | 21.4 | 32.5 | 25.7 | 24.8 | 30.0 | 25.7 | 25.7 | 27.4 |
| % Rosin (by diff.) | 78.6 | 67.5 | 74.3 | 75.2 | 70.0 | 74.3 | 74.3 | 72.6 |
| 2. Properties of Turpentine | | | | | | | | |
| Colour | colourless | colourless | colourless | colourless | colourless | colourless | colourless | colourless |
| Reaction in Alcohol | slightly acidic | slightly acidic | slightly acidic | slightly acidic | slightly acidic | slightly acidic | slightly acidic | slightly acidic |
| Sp. gr. 25°C. | 0.851 | 0.850 | 0.853 | 0.852 | 0.844 | 0.845 | 0.850 | 0.845 |
| Refractive index | 1.4655 | 1.4670 | 1.4655 | 1.4640 | 1.4688 | 1.4678 | 1.4683 | 1.4677 |
| Optical rotation | -32.75° | +40.09° | +2.75° | -34.34° | -13.40° | -37.82° | -32.14° | -8.25° |
| % Residue | 0.98 | 2.50 | 2.33 | 0.70 | 1.96 | 1.76 | 1.67 | 1.96 |
| 3. Properties of Rosin | | | | | | | | |
| Sp. gr. 25°C. | 1.07 | 1.07 | 1.07 | 1.06 | 1.07 | 1.07 | 1.07 | 1.07 |
| % Ash | 0.03 | 0.04 | 0.03 | 0.01 | 0.03 | 0.03 | 0.02 | 0.05 |
| Acid number | 188 | 178 | 187 | 186 | 179 | 163 | 168 | 162 |
| Melting point (°C.) | 66-67 | 66-67 | 66-67 | 66-67 | 66-67 | 66-67 | 66-67 | 66-67 |

IRON ORE.

Three samples of iron ore from Tub Kwai Mountain, Lopburi, were analysed. The results of analysis were as follows :-

| Content % | A Top Layer | B Granular Ore | C Solid Ore |
|--|----------------|-------------------|----------------|
| Moisture | 4.3 | 3.2 | 0.5 |
| Loss on ignition | 7.2 | 2.3 | 1.3 |
| Iron | 17.9 | 48.4 | 66.4 |
| Calculated as Fe ₂ O ₃ | 25.6 | 69.2 | 94.9 |
| Manganese | 0.22 | 0.39 | 0.36 |
| Phosphorus | 0.02 | 0.05 | 0.06 |
| Sulphur | 0.03 | 0.03 | 0.08 |
| Silica | 39.0 | 15.5 | 1.8 |
| Alumina | 17.6 | 4.7 | 0.62 |
| Lime | 5.33 | 3.15 | 0.13 |
| Magnesia | 4.52 | 4.7 | 0.39 |

SOUR EARTH OR ALUM EARTH

During the War, alum used in the purification of city water was unobtainable, so substitutes were looked for. Many samples of natural alum earth occurring in different parts of the country were sent in for analysis by the Bangkok Water Works. Of these the one from Tambon Bangnamprio, Chachoengsao, could serve the purpose though the amount used would be five times that of the commercial alum.

From analytical results, silica, iron, aluminum, chloride and sulphate, were found to predominate. The amount of calcium, magnesium and potassium were small. SiO₂ 43.55%, Al₂O₃ 9.65% and Fe₂O₃ 14.95%.

Assuming that aluminium present as determined as Al₂O₃ was solely derived from alum, then the alum earth contained about 18% aluminium sulphate. The Department also furnished further information to the effect that the efficiency of this alum earth could be

increased by leaching it with water and then use the leached water containing soluble alum. It should be noted that the place was called Bangnamprio which means sour-water, therefore the villagers must have noted some time ago that the water was sour.

Another good sample containing Al_2O_3 14.34%, Fe_2O_3 4.73% and insoluble 63.62% was sent from Loey. This was found to contain even a higher percentage of alum than that from Bangnamprio; but the transportation proved so difficult that it was considered uneconomical to utilize the earth from Loey in Bangkok.

IODINE FROM SEA WEED.

Sea weed samples were sent in by the Department of Fishery for the determination of iodine content.

| Lab. No. | From | Iodine % |
|----------|---|----------|
| AS.961 | Ban Paknam Kadae, Amphur Kanchanadit Surat Province | 0.027 |
| AS.962 | Ban Pumriang, Amphur Chaiya, Surat Province | 0.033 |
| AS.963 | Paknam Langsuan (coarse fibre, bleached) | 0.025 |
| AS.964 | " " " " | 0.013 |
| AS.965 | „ (fine fibre, bleached) | 0.013 |
| AS.966 | „ (coarse fibre, unbleached) | 0.007 |

The sea weed was of shallow water species having low iodine content varying from 0.007% to 0.030%. Usually a deep sea weed contains around 0.2-0.5% iodine, which is high enough for the production of iodine. These shallow water weeds were consumed locally after turning them into a kind of jelly.

KACHIO

The root of a plant called Kachio or Dog Kachio, grown abundantly in the Northeastern part, was reported from Amphur Muang, the province of Sakolnakorn, utilizable as starch producing material. Usually it is taken raw with chilli sauce by local inhabitants.

It was found to be a round rooted galangale in the family Zingiberaceae of *Kaempferia rotunda*, Linn. It is sometimes known as Kachio or Dogdin. It has a special taro-like rhizome storing starch. The odour is pleasant. The skin is brown or greenish yellow segmented with dark rings. Around the rhizome are small tubers and at the end is a tuber root about 1-2 inches long. Inside the rhizome is a light coloured starch with yellow oil cells. The people of Java use it for food, either taken raw or cooked with rice. The oil can be used in the preparation of cosmetics.

The results of chemical analysis :-

| Lab.No. | Items | Moisture % | Ash % | Fat % | Protein % (N x 5.7) | Crude fibre % | Carbo- hydrates % |
|---------|---|---------------|----------|----------|---------------------------|---------------------|-------------------------|
| AR.595 | Locally prepared starch | 13.03 | 0.41 | 0.38 | 0.25 | 0.28 | 55.65 |
| AR.596 | Peeled rhizome | 57.28 | 2.33 | 2.06 | 5.10 | 1.36 | 31.87 |
| AR.597 | Unpeeled rhizome with skin, tuber roots, and roots. | 50.02 | 3.19 | 2.38 | 5.58 | 2.84 | 35.99 |

The rhizome starch was fed to the guinea pigs with no result of poisoning.

As far as we know, the inhabitants of other countries use the raw rhizome as food as well. It has been found that the flour made from it could be used in the preparation of various kinds of food. To encourage the people to plant more Kachio might prove to be of a great advantage, for its flour might turn out to be of some commercial value.

LAND SALT AND SEA SALT

As had been reported in the Tenth Report, the Department of Science with the cooperation of the Excise Department investigated the sources of salt and also had done a lot of analytical work on brine and salt and sea salt. During the period of this report, more samples, from different sources were analysed.

Land Salt

| Lab.No. | Source | Insoluble matter % | CaSO ₄ % | CaCl ₂ % | MgCl ₂ % | NaCl % | Other salts % |
|---------|---------------|-----------------------|------------------------|------------------------|------------------------|-----------|------------------|
| AG.695 | Loey | 0.59 | 1.52 | 0.21 | 0.06 | 95.05 | 2.57 |
| AG.697 | Roi-et | 0.82 | 1.89 | 0.05 | 0.07 | 95.33 | 1.24 |
| AG.708 | Surin | 0.25 | 1.98 | 0.24 | 0.09 | 95.52 | 1.92 |
| AG.710 | Nakhon Phanom | 0.57 | 1.61 | 0.13 | 0.07 | 95.57 | 2.05 |
| AG.713 | Sri Saket | 0.36 | 0.85 | 0.20 | 0.03 | 96.73 | 1.83 |
| AG.714 | Sakol-nakorn | 0.22 | 0.94 | 0.46 | 0.24 | 96.74 | 1.31 |
| AG.716 | Nong Khai | 0.16 | 1.37 | 0.23 | 0.04 | 95.14 | 3.06 |

Computations were based on moisture-free basis.

Sea Salt

| Lab.No. | Source | Insoluble matter % | CaSO ₄ % | CaCl ₂ % | MgCl ₂ % | NaCl % | Other salts % |
|---------|-------------------------------|-----------------------|------------------------|------------------------|------------------------|-----------|------------------|
| D.143 | Kalong, Thachin | 0.33 | 0.32 | - | 0.45 | 98.19 | 0.71 |
| D.147 | Banbo, Thachin | 0.16 | 0.28 | - | 1.42 | 95.43 | 2.71 |
| D.149 | Banbo, Thachin (good quality) | 0.28 | - | - | 0.31 | 99.27 | 0.14 |
| D.153 | Sakhla, Paknam | 0.36 | 0.12 | - | 0.37 | 98.62 | 0.53 |

Computation were based on moisture-free basis.

WATER

During 1943-1944, the Water Analysis Section analysed nearly 2,000 samples of water from Chao Phya River, the sea, and rivers of other provinces as shown below:-

| Source | No. of Samples | |
|--------------------------|----------------|------|
| | 1943 | 1944 |
| City Water Works | 177 | 197 |
| Chao Phya River | 754 | 48 |
| Sea Water | 591 | 132 |
| Miscellaneous localities | 60 | 15 |
| Total | 1,582 | 392 |

The two following pages contain average results of analysis of samples of water from various provinces. They are expressed as parts per 100,000. Hardness is expressed as parts of CaCO₃ per 100,000. The temperature at the time of analysis for Oxygen consumed was kept at 100°C. for 10 minutes.

**Provincial City Water
1943**

| | Bangkok | Lopburi | Nakon Savan | Nakon Rajsima | Phitsanuloke | Nakon Pathom | Ayuthya |
|--|---------|---------|-------------|---------------|--------------|--------------|---------|
| pH Value | 7.0 | 7.5 | 7.0 | 7.1 | 7.1 | 7.2 | 7.0 |
| Electrical Conductivity | 160 | 419 | 138 | 252 | 885 | 293 | 148 |
| Total Solids | 14.6 | 39.8 | 12.6 | 21.2 | 102.4 | 23.7 | 13.6 |
| Suspended Solids | 0.2 | 3.6 | - | - | 18.8 | - | 0.2 |
| Dissolved Solids | 14.4 | 36.2 | 12.6 | 21.2 | 83.6 | 23.7 | 13.4 |
| Total Hardness | 8.7 | 28.9 | 9.0 | 12.3 | 18.0 | 13.5 | 9.0 |
| Temporary Hardness | 5.8 | 28.6 | 6.9 | 10.8 | 8.6 | 12.4 | 6.6 |
| Permanent Hardness | 2.9 | 0.3 | 2.1 | 1.5 | 9.4 | 1.1 | 2.4 |
| Chlorides expressed as Chlorine | 1.1 | 0.7 | 0.4 | 3.0 | 35.8 | 2.6 | 0.8 |
| Chlorides expressed as Sodium Chloride | 1.8 | 1.2 | 0.7 | 5.0 | 59.0 | 4.3 | 1.3 |
| Oxygen Consumed | 0.17 | 0.09 | 0.13 | 0.28 | 0.39 | 0.06 | 0.16 |
| Saline Ammonia | 0.001 | 0.002 | 0.001 | 0.002 | 0.010 | 0.001 | 0.002 |
| Albuminoid Ammonia | 0.011 | 0.008 | 0.010 | 0.017 | 0.026 | 0.007 | 0.012 |
| Nitrates expressed as Nitrogen | 0.031 | 0.016 | 0.021 | 0.028 | 0.085 | 0.015 | 0.028 |
| Nitrites | - | - | - | - | - | - | - |
| Loss on Ignition | 1.6 | 1.3 | 1.3 | 2.1 | 2.6 | 0.9 | 1.4 |
| Iron | - | - | - | - | 3.53 | - | 0.01 |

**Provincial City Water
1944**

| | Bangkok | Lopburi | Nakon Sawan | Nakon Rajsima | Phitsanuloke | Nakon Pathom | Ayuthya |
|--|---------|---------|-------------|---------------|--------------|--------------|---------|
| pH Value | 7.0 | 7.5 | 7.0 | 7.5 | 7.1 | 7.5 | 7.0 |
| Electrical Conductivity | 163 | 410 | 140 | 412 | 937 | 407 | 152 |
| Total Solids | 14.1 | 33.5 | 12.5 | 34.1 | 84.8 | 33.7 | 13.9 |
| Suspended Solids | 0.1 | 0.1 | - | - | 1.2 | - | 0.3 |
| Dissolved Solids | 14.0 | 33.4 | 12.4 | 34.1 | 83.6 | 33.7 | 13.6 |
| Total Hardness | 8.7 | 28.2 | 9.0 | 26.8 | 18.2 | 26.4 | 8.8 |
| Temporary Hardness | 6.2 | 27.4 | 7.1 | 25.0 | 8.3 | 25.1 | 6.8 |
| Permanent Hardness | 2.5 | 0.8 | 1.9 | 1.8 | 9.9 | 1.3 | 2.0 |
| Chlorides expressed as Chlorine | 1.1 | 0.7 | 0.3 | 3.5 | 35.7 | 2.6 | 0.8 |
| Chlorides expressed as Sodium Chloride | 1.8 | 1.2 | 0.5 | 5.8 | 58.9 | 4.3 | 1.3 |
| Oxygen Consumed | 0.15 | 0.06 | 0.14 | 0.28 | 0.16 | 0.04 | 0.18 |
| Saline Ammonia | 0.001 | 0.001 | 0.001 | 0.002 | 0.056 | 0.001 | 0.002 |
| Albuminoid Ammonia | 0.009 | 0.005 | 0.009 | 0.015 | 0.009 | 0.005 | 0.011 |
| Nitrates expressed as Nitrogen | 0.022 | 0.014 | 0.019 | 0.027 | 0.036 | 0.012 | 0.023 |
| Nitrites | - | - | - | - | traces | - | - |
| Loss on Ignition | 1.3 | 0.9 | 1.1 | 2.3 | 1.4 | 0.7 | 1.4 |
| Iron | - | - | - | - | 0.13 | - | - |

Appendix
Analysis Statistics
(A) Source Classification

| From | Items | Number of Samples | |
|-------------------------|----------------|-------------------|------|
| | | 1943 | 1944 |
| Prime Minister's Office | Lubricant | - | 2 |
| | Metal | - | 1 |
| | Chemical | - | 1 |
| | Gum | - | 1 |
| | | - | 5 |
| Ministry of Defence | Water | 592 | 132 |
| | Fuel Oil | 48 | - |
| | Lubricant | - | 2 |
| | Poison Suspect | 2 | - |
| | Metal | 5 | 1 |
| | Ore | - | 2 |
| | Chemical | 7 | 6 |
| | Liquor | 2 | - |
| | Food | 6 | - |
| | Drug | 2 | - |
| | Earth and Rock | 35 | - |
| | Gum | - | 1 |
| | Ink | - | 1 |
| | Miscellaneous | 8 | - |
| | | 707 | 145 |

| From | Items | Number of Samples | |
|---------------------------|---------------------------|-------------------|-------|
| | | 1943 | 1944 |
| Ministry of Finance | Water | - | 1 |
| | Fuel Oil | 47 | 26 |
| | Lubricant | 2 | - |
| | Opium or Morphine suspect | 1 | 38 |
| | Counterfeit Coin | - | 1 |
| | Alloy for making coin | 998 | 638 |
| | Chemical | 2 | - |
| | Opium | 927 | 628 |
| | Opium dross | 5 | 1 |
| | Oil and Fat | 6 | - |
| | Alcoholic liquor | 21 | 5 |
| | Food | 14 | - |
| | Drug | 13 | - |
| | Fabrics | 41 | 4 |
| | Miscellaneous | 2 | 1 |
| | | 1,979 | 1,343 |
| Ministry of Communication | Water | - | 1 |
| | Fuel Oil | 23 | 3 |
| | Lubricant | - | 24 |
| | Charcoal, Coal | 2 | - |
| | Metal | 12 | 12 |

| From | Items | Number of Samples | | |
|---------------------------------|--------------------------|-------------------|------|-----|
| | | 1943 | 1944 | |
| Ministry of Justice | Chemical | 24 | 9 | |
| | Vegetable oil | - | 23 | |
| | Soil, Rock | 2 | - | |
| | Miscellaneous | 11 | 1 | |
| | | 74 | 73 | |
| | Document | 1 | - | |
| | Liquor | 8 | - | |
| | | 9 | - | |
| | Ministry of the Interior | Water | 145 | 165 |
| | | Blood Stain | 65 | 35 |
| Fire-arm and Ammunition | | 33 | 34 | |
| Opium or Morphine suspect | | 17 | - | |
| Poison suspect | | 20 | 7 | |
| Seminal stain | | 2 | 1 | |
| Document | | - | 1 | |
| Counterfeit coin and note | | 3 | - | |
| Other objects under question | | - | 99 | |
| Metal | | - | 3 | |
| Ore | 9 | 12 | | |

| From | Items | Number of Samples | |
|------------------------------|------------------------------|-------------------|------------|
| | | 1943 | 1944 |
| Ministry of Public Health | Chemical | 2 | - |
| | Vegetable oil | - | 1 |
| | Food | 18 | 1 |
| | Drug | 30 | - |
| | Soil, Rock | 2 | 1 |
| | Gum | - | 4 |
| | Miscellaneous | 31 | - |
| | | 377 | 364 |
| | Water | 801 | 59 |
| | Opium or Morphine suspect | 5 | - |
| | Poison suspect | 2 | - |
| | Other objects under question | - | 12 |
| | Chemical | 2 | - |
| | Food | 147 | 13 |
| Drug | 20 | - | |
| Miscellaneous | 11 | 1 | |
| | 988 | 85 | |
| Ministry of Economic Affairs | Water | 1 | - |
| | Metal | 8 | 1 |
| | Chemical | 3 | - |

| From | Items | Number of Samples | |
|-------------------------|-------------------|-------------------|------|
| | | 1943 | 1944 |
| Ministry of Agriculture | Vegetable oil | - | 1 |
| | Food | 1 | 2 |
| | Drug | 3 | 2 |
| | Rock | - | 1 |
| | Miscellaneous | 2 | 1 |
| | | 18 | 8 |
| | Water | 2 | - |
| | Food | 4 | - |
| | Gum | - | 2 |
| | Miscellaneous | 58 | - |
| | 64 | 2 | |
| Ministry of Industry | Lubricant | - | 9 |
| | Charcoal and Coal | 9 | - |
| | Metal | 5 | - |
| | Ore | 11 | 100 |
| | Chemical | 39 | 12 |
| | Vegetable oil | - | 10 |
| | Alcoholic liquor | 2 | - |
| | Food | 17 | 5 |
| | Drug | 1 | - |
| Soil, Rock | 20 | 13 | |

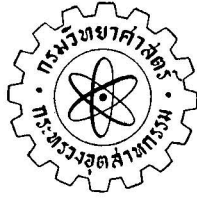
| From | Items | Number of Samples | |
|---|-------------------------------|-------------------|------|
| | | 1943 | 1944 |
| Bangkok Municipality and Other Provinces | Fabrics | - | 4 |
| | Gum | - | 3 |
| | Soap | - | 5 |
| | Miscellaneous | 33 | 12 |
| | | 137 | 173 |
| | Water | 22 | 35 |
| | Specimen of internal organ | - | 1 |
| | Chemical | 27 | 6 |
| | Drug | 1 | - |
| | Rock | - | 1 |
| | Miscellaneous | - | 1 |
| | 50 | 44 | |
| Semi-official Companies | Charcoal, Coal | - | 6 |
| | Fuel | - | 10 |
| | Metal | 9 | - |
| | Ore | 972 | 101 |
| | Chemical | 7 | 5 |
| | Soil, Rock | - | 3 |
| | Tannin | - | 7 |
| | Miscellaneous | 10 | - |
| | 998 | 132 | |

| From | Items | Number of Samples | | |
|-----------------------------------|---------------------------|-------------------|-------|-------|
| | | 1943 | 1944 | |
| Public (Firms and Individuals) | Water | 13 | 8 | |
| | Fuel Oil | 1 | 1 | |
| | Lubricant | 1 | 10 | |
| | Charcoal, Coal | - | 2 | |
| | Document | - | 1 | |
| | Metal | 435 | 90 | |
| | Ore | 193 | 67 | |
| | Chemical | 84 | 18 | |
| | Vegetable oil | - | 20 | |
| | Non alcoholic beverage | - | 1 | |
| | Food | 11 | 22 | |
| | Drug | - | 7 | |
| | Soil, Rock | - | 13 | |
| | Fabrics | - | 3 | |
| | Shellae, Seed lac | - | 3 | |
| | Gum, Para rubber | - | 3 | |
| | Medicinal plant | - | 1 | |
| | Miscellaneous | 75 | - | |
| | | | 831 | 270 |
| | | Total | 6,214 | 2,644 |

(B) Kind Classification

| Items | | Number of Samples | |
|----------------------------|-----------------------------------|-------------------|-------|
| | | 1943 | 1944 |
| Water | | 1,576 | 401 |
| Fuels | { Fuel oil | 119 | 30 |
| | { Lubricant | 3 | 47 |
| | { Charcoal and Coal | 11 | 8 |
| | { Other Fuel | - | 10 |
| Exhibits in forensic cases | { Blood Stain | 65 | 35 |
| | { Fire-arm and Ammunition | 33 | 34 |
| | { Opium or Morphine suspect | 23 | 38 |
| | { Poison suspect | 24 | 7 |
| | { Seminal stain | 2 | 1 |
| | { Document | 1 | 2 |
| | { Viscera | - | 1 |
| | { Counterfeit coin and note | 3 | 1 |
| | { Other objects under question | - | 111 |
| | Metal | | 1,472 |
| Ore | | 1,185 | 282 |
| Chemical | | 197 | 57 |
| Opium | | 827 | 628 |
| Opium dross | | 5 | 1 |

| Items | Number of Samples | |
|---|-------------------|-------|
| | 1943 | 1944 |
| Edible vegetable oil, Fat | 6 | 55 |
| Alcoholic beverage and Non-alcoholic beverage | 33 | 6 |
| Food | 218 | 43 |
| Insecticide | 70 | 9 |
| Soil, Rock | 59 | 32 |
| Fabrics | 41 | 11 |
| Shellac and Seed lac | - | 3 |
| Gum, Para rubber | - | 14 |
| Medicinal plant | - | 1 |
| Soap | - | 5 |
| Ink | - | 1 |
| Tannin | - | 7 |
| Miscellaneous | 241 | 17 |
| Total | 6,214 | 2,644 |



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