UNITED NATIONS

ECONOMIC AND SOCIAL COUNCIL

Distr.
GENERAL

E/CN.7/278
22 March 1954

ORIGINAL: ENGLISH

COMMISSION ON NARCOTIC DRUGS
Ninth session
Item 18a of the provisional agenda

# REPORT OF THE COMMITTEE OF CHEMICAL EXPERTS ON THE UNITED NATIONS PROGRAMME FOR DETERMINING THE ORIGIN OF RAW OPIUM BY CHEMICAL AND PHYSICAL MEANS

Note by the Secretary-General

In accordance with paragraph 5 (b) of resolution 477 (XV) of the Economic and Social Council, the Secretary-General has the honour to submit the following report of the Committee of Chemical Experts on the United Nations Programme for determining the origin of opium by chemical and physical means to the Members of the Commission on Narcotic Drugs.

54-08027

TABLE OF CONTENTS

I. ORGANIZATIONAL AND ADMINISTRATIVE MATTERS



II. CONSIDERATION BY THE COMMITTEE OF THE UNITED NATIONS PROGRAMME

# I. ORGANIZATIONAL AND ADMINISTRATIVE MATTERS

## A. Composition of the Committee

1. The Committee was composed of the following experts, serving in their personal capacities and not as government representatives:

Professor Axel Jermstad, formerly Director of the Pharmaceutical Institute of the University of Oslo;

Mr. Palamarneri S. Krishnan, Chief Chemist of the Central Revenues Control Laboratory, Revenue Division of the Ministry of Finance, Government of India;

Dr. Lyndon F. Small, Chief of the Laboratory of Chemistry, National Institute of Arthritis and Metabolic Diseases, Public Health Service, Department of Health, Education and Welfare, United States Government.

2. Dr. O. Braenden and Mr. F. Lister were joint secretaries of the Committee and Mrs. G. Lopez-Rey was assistant secretary.

## B. Opening of the session and election of officers

3. The Committee convened for the first time at 10 a.m. on 1 March 1954, and the meeting was opened by Mr. G.E. Yates, Director of the Division of Narcotic Drugs, on behalf of the Secretary-General. The Committee named Professor A. Jermstad as its Chairman and Dr. L. Small as its Rapporteur.

## C. Terms of reference and work of the Committee

4. The Committee's terms of reference were resolution 477 (XV) which was adopted by the Economic and Social Council on 10 April 1953. The relevant parts of this resolution have been reproduced below:

"The Economic and Social Council

.....

"5. Requests the Secretary-General:

"(a) To appoint an international committee of three chemical experts with a view to evaluating the progress made in developing methods to determine the origins of raw opium by chemical or physical means, and to arrive at conclusions as to whether the methods have been advanced to a point where they can be given practical application in the international field;

"(b) To submit the above-mentioned report to the Commission on Narcotic Drugs for its consideration;

....."

5. The Committee held a total of fourteen meetings on the following days: 1, 2, 3, 4, 5, 8, 9, and 10 March 1954, and two meetings were held on each of these days except that on 2 and 8 March there was only one meeting. On 2 March the Committee inspected the facilities of the Secretariat chemists which are located at 641 Washington Street, New York City, in the Laboratory of the Internal Revenue Bureau of the United States Government.

D. Material considered by the Committee

6. The Committee had before it for consideration a large group of technical papers which have been listed in Annex A of the present report. The Committee also received several communications from various national scientists working in the field indicating the progress that had been made in their work.

7. The Committee also had available for reference purposes those resolutions, reports, and summary records of the Economic and Social Council and the Commission on Narcotic Drugs which were relevant to the Committee's work. In addition, the Committee was able to study certain miscellaneous papers on this question prepared from time to time for the Council and the Commission by the Secretariat.

8. The Committee likewise received the following working papers prepared especially for it by the Secretariat:

(1) Draft headings for the report of the committee of chemical experts on the United Nations programme for determining the origin of raw opium by chemical and physical means.

(2) Opium producing areas and opium samples.

(3) Technical procedures used in the determination of opium origins.

(4) The background and scope of the United Nations programme of opium research.

(5) Methods for the determination of origin.

(6) Report on the chemical examination of opium samples taken from two seizures made in France.

9. The Committee also received other working papers and heard oral accounts of certain aspects of the Secretariat's work which were still in progress.

## II. CONSIDERATION BY THE COMMITTEE OF THE UNITED NATIONS PROGRAMME

### A. The background and scope of the programme

10. While certain preliminary research on methods for determining the origin of opium by scientific means had been conducted under the auspices of the United States Government, it was noted by the Committee that the actual research conducted by the United Nations began in February 1950, and the researches of most of the national chemists started only late in 1950 or in 1951. This research was authorized by two resolutions of the Economic and Social Council - 159 II C (VII) of 3 August 1948 and 246 F (IX) of 6 July 1949 - draft texts of which had been proposed a few months earlier by the Commission on Narcotic Drugs.

11. The first of these resolutions invited governments having the necessary experts and laboratory facilities to participate in a joint programme of research on methods to determine the origin of opium by chemical and physical means and asked the governments of opium-producing countries to furnish samples of their opium for this purpose.

12. The second resolution authorized the Secretariat to carry out similar researches, to co-ordinate the research activities undertaken by governments in this field, and to maintain a centre for receiving opium samples furnished by governments and for distributing such samples to the various national scientists and scientific institutions participating in the joint programme. The Government of the United States of America having offered the United Nations space for the purpose of conducting research and storing samples in one of its laboratories convenient to United Nations Headquarters, the Council authorized the Secretary-General to accept this offer, and this was done early in August 1949.

13. The Committee also noted that during the period from February 1950 to March 1952, the Commission and the Council confined themselves for the most part to an annual review of the progress of the international programme, although in December 1950 the programme was broadened so that the Secretariat could particularly study procedures for assaying opium for morphine and codeine. In 1953, however, instructions were given that the Secretariat should give precedence in its research to the problem of origin.

14. During the past two years, the question of when the methods being developed would reach the stage when they could be put to practical use has increasingly occupied the attention of both the Commission and the Council. At the seventh session of the Commission, it was resolved by a vote of 8 to 5, with no abstentions, that a beginning should be made in putting the tests to practical use and that a United Nations laboratory should be established. It was also resolved that the Council should be requested to solicit additional samples of opium which were needed in connexion with the research programme.

15. The Council did request governments to furnish further samples, but deferred action on other parts of the Commission's resolution. At its next session, the Council again deferred decision on the changes in the existing arrangements proposed by the Commission and asked that body to submit recommendations by the time of the Council's seventeenth session regarding the future of the United Nations narcotics laboratory, taking into account the whole of the scientific work undertaken by the Secretariat in this field. The Council also requested the Secretary-General to submit the report of the Committee of chemical experts (which was provided for in the same resolution) to the Commission.

## B. Opium-producing countries and opium samples

16. The Committee reviewed the countries and territories throughout the world where opium is produced either licitly or illicitly to determine how fully they were represented among the samples used for the research programme. In view of the inherent importance of this question, it was decided that the situation as regards each country should be indicated in the present report.

### (1) Yugoslavia

17. There is considerable licit production in the country. The Secretariat has nine samples of Yugoslav opium, mostly of different years. Two of the samples which were supplied officially by the Government of Yugoslavia consisted of several small lumps of differing composition, but the Government had not furnished any information as to whether these lumps came from differing producing areas or seasons.

(2) Greece

18. There is a small amount of licit production. The Secretariat has one sample from Greece which was provided by the Government for the Opium Distribution Centre. It consists of several separate lumps having somewhat different compositions. There is, however, no indication as to whether they originate from the same district or from different districts.

(3) Bulgaria

19. Although there is some licit production in Bulgaria, the Secretariat has received no samples of Bulgarian opium.

(4) Turkey

20. Turkey is one of the chief producers of licit opium. Production is in fifteen different districts, some of them very far apart.

21. The Secretariat has more samples of Turkish production than from that of any other country. Fourteen large samples representing opium produced in various provinces were provided by the Government of Turkey for the Opium Distribution Centre. Each of these samples consisted of three to eight separate lumps sometimes showing large differences in composition, but no indication has been furnished as to whether the different lumps were from different producing areas of a particular district or were of the same or different crops. One of these lumps was found to be adulterated with starch. Counting these lumps separately 87 samples are available for the research work.

(5) Lebanon

22. The Secretariat has no definite information, and if there is illicit production, the Secretariat has no corresponding samples.

(6) Syria

23. The Secretariat has no definite information, and if there is illicit production, the Secretariat has no corresponding samples.

## (7) Iran

24. Iran is one of the chief producers of licit opium. There is reported to be production in most parts of the country. The Secretariat has 27 samples including two samples of the sticks produced some years ago. The total includes samples of legal export shipments and samples furnished by the Government for the Opium Distribution Centre representing production in different provinces.

## (8) Afghanistan

25. Licit opium production was prohibited in Afghanistan some years ago. It is reported that there used to be two separate areas of production. The Secretariat has six samples of Afghan opium which were legally exported by Afghanistan to the United States about ten years ago and made available to the Opium Distribution Centre by the Government of the United States.

## (9) U.S.S.R.

26. There is understood to be considerable licit production in central Asia in the region known as Semirechie, which forms part of the Kirghiz S.S.R. and the Kazakh S.S.R. The Government of the U.S.S.R. has not furnished any samples to the Opium Distribution Centre.

## (10) Pakistan

27. There is experimental licit production and some production near the northwest frontier. The Government has furnished the Secretariat with one sample of the experimental opium.

## (11) India

28. India is one of the chief producers of licit opium. Production is chiefly in two areas - Uttar Pradesh and the Malwa area southwest of Uttar Pradesh. There is also a little production in Himachal Pradesh.

29. The Secretariat has 31 samples of Indian opium. This includes seven large samples contributed by the Government to the Opium Distribution Centre, representing excise opium and farm opium from each of the main producing regions that have already been mentioned. It also includes sixteen samples previously sent by the Government to the United States Narcotics Bureau representing production in the former United Provinces (now Uttar Pradesh) and fifteen Indian States which have also been made available to the Secretariat. Most of the remaining samples are from legal exports.

(12) Nepal

30. There is no direct information on production in Nepal, and there are no samples.

(13) Burma

31. There is understood to be a considerable production in the Shan States. The Secretariat has no samples from this production.

(14) Thailand

32. There is some illicit production in the northernmost part of the country, but no samples have been made available to the Secretariat.

(15) Indo-China - Laos

33. There is production in those regions bordering on northern Thailand, the Shan States of Burma and southern China (Yunnan Province). The Government of France has furnished two large samples from two districts of Laos. Each of these samples consists of separate lumps that are virtually independent samples, but without any indication as to whether each of these lumps came from the same or different localities within the district.

(16) Indo-China - Viet-Nam

34. There is production in parts of the country bordering southern China (Yunnan Province). The Government of France has furnished one sample consisting of a number of small lumps which show considerable differences in composition. It is not known whether they all come from the same locality or originate in several localities.

## (17) China

35. As far as is known, there is no licit production in China. Production in the past has been chiefly in the northeastern part, the centre and the southeast, i.e. from Manchuria, Jehol and Inner Mongolia through China's "Middle West" to Yunnan.

36. The Secretariat has six samples, all from northeastern China and produced during the period when that part of the country was under Japanese occupation. This includes four separate lumps (furnished as one sample) and these lumps appear to be of different types. No indication has been given as to the districts from which these lumps come. The other two samples came from Manchuria and Inner Mongolia.

## (18) Korea

37. When Korea was under Japanese occupation, production was licit and was principally in North Korea. The Secretariat has eleven samples, some of them constituting legal production which came into the possession of the United States Army in 1945 and were made available by the Government of the United States or contributed by the Government of Japan. One of the samples (in two lumps) is, in all probability, grossly adulterated.

## (19) Mongolian People's Republic

38. No information was available on production in this region, and no samples have been furnished to the Distribution Centre.

## (20) Japan

39. Licit production was prohibited in 1945 but will be resumed experimentally. The Secretariat has two samples of the former legal production.

40. There was a recent news item in the press that Japan proposes to resume licit production of opium for medicinal purposes, but the United Nations Secretariat has no information on this point.

(21) Peru

41. Production is illicit. The Distribution Centre has one sample furnished by the Government to the United States Narcotics Bureau and then made available to the United Nations.

(22) Ecuador

42. Production is illicit. The Distribution Centre has two samples furnished by the Government to the United States Narcotics Bureau and then made available to the United Nations.

(23) Mexico

43. There is understood to be some illicit production in the western mountain districts. The Secretariat has no samples which appear to represent accurately the Mexican production.

Comments by the Committee

44. The Committee observed that the samples furnished by producing countries direct to the United Nations were large enough to permit a general distribution to all participating scientists, but that most of the other samples mentioned above were too small in quantity for this purpose. Thus far, the distributions have been gauged to the requests received and have actually varied between 7 and 137 samples.

45. The Committee noted with regret that the Governments of Afghanistan, Bulgaria, Mexico, USSR, Burma, and Thailand had not furnished the United Nations samples of their opiums for the programme of opium research. The Committee felt that the absence of a reasonably complete set of opium samples had been a serious handicap in testing the methods to assure that they were universally applicable and considered that any and all courses of action likely to improve this situation deserved serious study.

46. The Committee took account of the possibility that successive opium crops from the same region might have different characteristics, owing to climatic variations, the use of different seed, etc. Mr. Krishnan considered that it would be necessary for tests to be made on crops of some successive years for

each country, but Professor Jermstad and Dr. Small thought it would be sufficient if these tests were made in regard to the production of one or two countries. Mr. Krishnan indicated that he would request the Government of India to make available to the Distribution Centre samples from different opium-producing districts for some successive years.

C. Analytic techniques used in the determination of opium origins

47. The Committee considered very carefully the analytic techniques which have been used or proposed for use in the collection of data for origin determinations. These techniques include both those that are in standard use and others developed by scientists engaged in the United Nations programme. The following techniques were reviewed:

(1) Techniques for evaluating general characteristics

48. The data of general characteristics (colour, texture, wrappings, inclusions, etc.) are established by ordinary, careful observations. (For details, see ST/SOA/SER.K/16.)

(2) Techniques for examining microscopic characteristics

49. In the Secretariat's examination, water is used as a dispersing agent, and the opium deposit is then examined, after the drop dries up, under the polarizing microscope, using crossed nicols. (For details, see E/CN.7/117, parts A and C, E/CN.7/117/Add.2, procedure 1, ST/SOA/SER.K/2, ST/SOA/SER.K/21 and ST/SOA/SER.K/25.)

(3) Techniques for determining the morphine content of opium

50. The pharmacopoeial techniques usually employ lime-water extraction of the opium and precipitation of the morphine, e.g., the International Pharmacopoeia, the British Pharmacopoeia, and the Japanese Pharmacopoeia (the technique of the last-mentioned is given slightly modified in ST/SOA/SER.K/15). The Committee was informed that because of variations in different types of opium and frequent adulteration of illicit samples, the Secretariat uses solvent-extraction techniques, such as the Secretariat's original assay (ST/SOA/SER.K/1, 9, 12 and 13), and Dr. Liang's assay (ST/SOA/SER.K/18 and 22). The assay by the procedure

of Dr. Knaffl-Lenz (ST/SOA/SER.K/3 and 11) also employs solvent extraction. In the Secretariat's new technique, the "Unified Analysis" discussed below, the morphine and other alkaloids are separated by solvent extraction, after obtaining an opium extract in strong acetic acid. This yielded higher values for morphine on certain samples than corresponding extractions with lime-water, plain water, or weak acid.

51. The Committee noted with interest the results achieved with the "Unified Analysis" and considered that a comparative study should be made of this technique and other existing techniques. (For the details of these techniques, see the documents noted above.)

(4) Techniques for determining the codeine content of opium

52. The Committee reviewed the lime-water extraction technique on which the Secretariat results have been based (E/CN.7/117/Add.2, procedure 12 and E/CN.7/202), as well as a modified Rakshit procedure, used in India (ST/SOA/SER.K/20), which has been shown to yield very similar results. The Committee noted that recent Secretariat studies on the extraction of opium for alkaloids with strong acetic acid or even with glacial acetic acid to disintegrate the opium have tended to show that this technique is more successful for codeine than extraction with either lime-water or dilute acids (tenth-normal sulfuric or 5 per cent acetic), it is incorporated in the "Unified Analysis" discussed below (see Section (8) below). The opinion of the Committee as expressed under Section (3) above, morphine determination, applies equally to "Unified Analysis" in estimation of codeine. (For the details of these techniques, see the documents noted above.)

(5) Techniques for determining the "Porphyroxine-meconidine" colour values

53. The acid-colour-development assay used by the Secretariat has been given most recently in ST/SOA/SER.K/4. The results were in general confirmed by the studies of Farmilo and Kennett (E/CN.7/207 and ST/SOA/SER.K/14) and Ulrich and Fuchs (ST/SOA/SER.K/10 and 19). The reading of colour values in the Lovibond tintometer appears to be sufficiently satisfactory when such an

instrument is available, but the Committee recommends the use of a standard spectrophotometer for this type of assay (ST/SOA/SER.K/10 and 14). (For the details of these techniques, see the documents noted above.)

(6) Auxiliary techniques proposed by collaborating scientists

(a) Techniques for determining the narcotine and meconic acid content of opium

54. The studies at the Central Revenues Control Laboratory, India (ST/SOA/SER.K/25), resulted in lower values for meconic acid and higher values for the ratio of narcotine to meconic acid, than those given as illustrations by Nicholls and Kollett (ST/SOA/SER.K/7), although carried out by an identical technique combining water and acetone extraction. The Committee recommends that further study of the analytical technique be made. (For further details, see the documents noted above and ST/SOA/SER.K/5 and 6.)

(b) Techniques for determining and analysing ash

55. The percentage of ash is determined by the standard technique. In Canada ash has been analysed by J.C. Bartlet as follows: potassium, calcium, and sodium were determined with a Beckman flame photometer on solutions of the ash; phosphate was determined colorimetrically by the molybdenum-blue procedure; and silicon, magnesium, aluminum, iron, manganese, titanium, molybdenum, boron, tin, lead, and copper were determined spectrographically. Professor Jermstad had also made a series of experiments on ash constituents by the spectrographic technique, especially on the occurrence of traces of rare elements.

(c) Technique utilizing extract or insoluble matter

56. This is simply a determination of the proportion of the opium that will dissolve in water, or its converse, the insoluble material left from exhaustive extraction with water.

(d) Techniques for establishing the quantities of nitrogen in opium

57. The total nitrogen was determined by the Kjeldahl procedure by the Greek scientists. Nitrogen in morphine was calculated from the morphine percentage. Volatile nitrogen was also determined.

(e) Techniques for determining the principal by-alkaloids (codeine, papaverine, thebaine and narcotine) in one process

58. These have been determined for a considerable number of samples by Mr.Asahina, Japan, using the established Anneler procedure. The Secretariat, however, uses its own "Unified Analysis" for this purpose (see Section (8) below).

(7) Auxiliary techniques studied by the Secretariat

(a) Petroleum ether technique for establishing the fat and wax content of opium

59. This is simply a Soxhlet extraction of the air-dry powdered opium, followed by removal of the small amount of alkaloids extracted, and determination of the extracted fatty substances. The Committee finds this technique to be still in an elementary stage, and no opinion on its value can be expressed until it has been extended on a quantitative basis to include refractive index, saponification value, iodine number and other constants used in fat analysis.

(b) Techniques for establishing the thebaine and papaverine contents of opium

60. The extraction technique described in ST/SOA/SER.K/17 has now been superseded in the United Nations laboratory by the "Unified Analysis" (see Section (8) below). However, with only minor changes, the principles of separation of the alkaloids remain the same.

(8) Unified Analysis for alkaloids

61. The Committee received an oral presentation of the Secretariat's new technique for determining all the important alkaloids in a single process. The "Unified Analysis" is based on the disintegration of the opium with glacial acetic acid and the use of an opium solution in strong acetic acid. The alkaloids are then separated by solvent extraction procedures. Narceine is not at present included in the determination. Very nearly all the alkaloidal material of the opium is accounted for in determinations of the following: Morphine, Minor phenolic alkaloids, Unknown base, Codeine plus cryptopine, Thebaine, Papaverine, and Narcotine.

62. The work done thus far indicates that more of the opium is dissolved by this procedure, and somewhat higher values are obtained for all the alkaloids than in previous analyses with various techniques of extracting the solid opiums. (For the Committee's comments on this technique, see Section (3) above.)

(9) Technique of Partition paper chromatography

63. Paper chromatography has in recent years been developed so far that in many instances it has become quite indispensable in the analysis of natural products.

64. Since the paper chromatographic method has also been applied to the determination of the alkaloids of opium quantitatively, and because of the simplicity and the speed by which it can be carried out, the Committee is of the opinion that study should be made of the practicability of using a paper chromatographic technique in detection of characteristic components of opium.

(10) Technique of spectrography

65. Spectrographic procedures have been used for identifying many of the ingredients that make up opium ash and for establishing on a relative basis their quantity. The Committee believes that this technique indicates the nature of the ingredients, but considers that more work would be required to enable the quantitative relationship to be established with reasonable certainty. (For details on this technique, see the paper of Professor Jermstad (ST/SOA/SER.K/23) and also the preliminary findings of J.C. Bartlet (not yet published).)

(11) Technique of infra-red spectrophotometry

66. The Committee noted that infra-red spectrophotometric procedures have been investigated with a view to finding a new and more rapid way of determining quantitatively each of the several alkaloids present in opium. The Committee considers that an interesting start has been made in developing this technique and that it is apparent that most of the alkaloids have

characteristic absorption bands which make their identification and rough estimation possible. The absorption bands of codeine, however, overlap many of the others, and there is also interference from the solvents used, so that a great deal of research will be necessary before practical results can be expected. (For details on this technique, see the preliminary findings of Professor Jermstad (ST/SOA/SER.K/24).)

D. Methods for the determination of origin

67. The Committee considered each of the methods which it is proposed to use in connexion with establishing the origin of opium both as regards the quantity of data accumulated thus far, the reliability of the techniques used in this laboratory work (see Part II C above), and the inherent importance of the data as an indication of origin. Each method was considered separately and in combination with other methods.

(1) Each method considered separately

(a) General characteristics

68. Distinctions by general characteristics are qualitative, and there are some visible differences between some types. They have been used to some extent by Customs officers for making surmises regarding the origin of seized opium. The Committee examined various examples of opium at the laboratory and, after discussing the reliability of the general characteristics, concluded that this was a rough "sorting-out" test, which gave a preliminary indication of what might be expected from the other methods. (For details see ST/SOA/SER.K/16 and 25.)

(b) Microscopic characteristics

69. The Committee noted that the differentiation by microscopic examination is qualitative and also its general usefulness in relation to origin, and observed that some exceptions will have to be considered. The types of crystals which show the most contract are the participle type as found in most samples from Turkey, and the slender, well-formed rods found in most samples from India. The Committee examined some typical slides at the

Laboratory, as well as a number of photographs furnished by Mr. Krishnan and the the Secretariat. On the basis of the evidence at hand, the Committee considered the test to be of value, although not of itself definitive, and subject always to confirmation by other methods. Above all, more samples from known areas are needed to increase the usefulness of the test. (For details, see E/CN.7/117, parts A and C, ST/SOA/SER.K/21 and 25.)

70. The Committee also noted that the crystallographic tests made thus far at the United Nations laboratory have proved useful for identifying the crystals as narcotine and considered that the possibility of extending the usefulness of this technique might be further studied.

(c) Morphine content

71. The Committee recalled that the morphine content has often been used in the past as a strong indication of the origin of opium. There appears to be a relation, as may be seen in Mr. Asahina's study (ST/SOA/SER.K/15), but there is frequently considerable overlapping. This has also been the experience of the Secretariat (ST/SOA/SER.K/21), especially in using extractive techniques for determining the morphine content. The Committee feels that the morphine content alone should not be taken as proof of origin, but that it should be taken in conjunction with the other determinations. It would also be of value in establishing adulteration. (For details, see the papers referred to above.)

(d) Codeine content

72. The Committee observed the relation of codeine content to origin which is displayed in ST/SOA/SER.K/8 and feels that this particular characteristic of opium is of considerable value in determining the origin of certain types, especially in combination with other tests. The samples received from certain areas such as Greece, Turkey and Yugoslavia show low values in a large majority of cases, while those from India, Iran and Northeastern Asia ordinarily have high values. The method may, therefore, serve to divide opium samples into two large groups to be tested for other known characteristics. (For details, see E/CN.7/202 and ST/SOA/SER.K/8 and 25.)

(e) "Porphyroxine-meconidine" colour values

73. The Committee finds that this is a valuable screening method, Indian samples showing generally high values and Iranian low values. There are enough known exceptions to make it inconclusive for a final decision. It is apparent that the chief value of the test is realized when it is used in conjunction with others, particularly the codeine content. (For details, see E/CN.7/195 and 207; ST/SOA/SER.K/14.)

(f) Auxiliary methods

74. The Committee classified the following methods as auxiliary for the present, because they have not been studied as thoroughly as the preceding methods.

(i) Ratio of narcotine to meconic acid

75. The Committee has considered the reports on the use of this method, which was proposed by the scientists at the British Government Laboratory and further tested at the Central Revenues Control Laboratory, India. It was noted that although the experimental techniques of the two groups were identical, the ratios found were somewhat different numerically; they did, however, give similar indications as to origin. The Committee recommends that work on the method should be refined, and expanded to include many more samples.

(ii) Quantitative and qualitative ash determinations

76. Investigations have been made both by Professor Jermstad and Mr. Bartlet on the quantitative and qualitative composition of the ash and the bearing that these characteristics have for determining the origin. The Committee reports that both of these approaches offer considerable promise, but are only in an exploratory stage. (For details see Professor Jermstad's study (ST/SOA/SER.K/23) and also the preliminary findings of J.C. Bartlet (not yet published).)

(iii) Percentage of extract or insoluble material

77. The Committee received a tabulated comparison of results obtained in the Government Laboratories of Turkey and India. These indicate that certain differences between types are well-marked and that the Iranian samples usually show the smallest proportion of insoluble matter. This determination has been

used in Turkey to distinguish between the "druggist" and "soft" types of opium. The Committee notes that values differ considerably for different types of opium, and considers that the method may be of some use in combination with other methods. (For details, see ST/SOA/SER.K/25 and data from the Government Laboratory of Turkey.)

(iv) Nitrogen percentages

78. Some investigations in this field have been made by the Greek scientists; the Committee has noted the results and believes that, if extended, they might be useful in screening opium sorts, but much additional work is needed before they will be applicable.

(v) Fat and wax content

79. The Committee noted that this method is under study at present, but feels that while it may ultimately prove important, it has not yet reached a stage where its usefulness can be evaluated.

(vi) Papaverine content

80. The Committee noted that certain types of opium are nearly lacking in papaverine. Some of the samples of opium from Afghanistan, from Uttar Pradesh in India, and from Indochina, for example, have been found to be very low in papaverine. On the other hand, Iranian, Greek, and Yugoslav opiums so far analysed, and some of the Turkish samples, show high papaverine.

81. The Committee finds that from results so far available, the papaverine percentage is of considerable diagnostic value, and will probably become more so as additional data accumulate from more samples.

(8) The development of new methods of determining origin through chromatographic and x-ray diffraction techniques

(i) Use of the chromatographic technique

82. The Committee has studied the reports on the paper chromatography technique and has examined the actual chromatogrammes and the coloured reproductions supplied by the Greek investigators. It is of the opinion that chromatography may reveal substances which are probably not detectable in other ways, and

which may be characteristic of the opium for a given area. The method seems to be one of great potential usefulness and warrants further investigation.

(ii) Use of the x-ray diffraction technique

83. The Committee proposes that the possibility of using x-ray diffraction techniques be explored. Every crystalline compound present in the opium should give its own characteristic pattern, and while it might not be possible to determine the nature of the compound responsible, if it were consistently found in one variety of opium and not in others it would supply valuable evidence of origin.

(2) The methods considered in combination

(a) Ratios

84. The simplest way to study a combination of methods is by expressing the values in ratios; the results thus obtained may be of more significance than the methods considered separately. The Committee believes that the ratios have a particular value in the case of adulteration, for then the absolute percentages of the normal constituents are diminished, but the various relations existing between them remain the same. A major reason for determining morphine content is to learn whether the opium is grossly adulterated or subnormal; and if there is adulteration, ratios have to be used instead of the absolute percentages. From consideration of the results so far reported, the Committee finds that the ratios having particular value for origin determinations are the following: codeine to morphine; total of non-phenolic alkaloids to morphine; and papaverine to codeine.

(i) Codeine to morphine ratio

85. The Committee received information on this ratio and its relation to origin from a paper sent in by Mr. Krishnan, and also tabulated data prepared by the Secretariat.

86. The Committee considers that the ratio figures give the same sort of classification as the absolute codeine content (see Section (1)(d) above), but are often clearer, because in many types of opium low codeine is combined with high morphine, or high codeine with low morphine; also the ratios are not affected by adulteration.

(ii) Ratio of the principal by-alkaloids (codeine, papaverine, thebaine and narcotine) to morphine

87. Tabulations based on data obtained in the Government laboratories of Japan and Turkey, and in the United Nations laboratory, were examined by the Committee. Although different analytical procedures were used, the general results were much the same; the Turkish and Balkan ratios were lowest, the Indochinese and Japanese next, then the Indian, with Iranian highest; the ratios for China and Korea cover the Indian range extending from somewhat lower values than those so far determined for India, up into the Iranian range.

88. The Committee, however, in evaluating this method, notes that a number of constituents are lumped together. This ratio may be affected by changes in the morphine content through ageing, humidity, temperature, and acid and enzyme actions to which the by-alkaloids are probably much less sensitive. It appears to the Committee that the percentages of these separate constituents considered either individually or as ratios would give a better picture for the determination of origin.

(iii) Papaverine to codeine ratio

89. The Committee examined the limited amount of data accumulated by the Secretariat so far. There seem to be differences which permit classification of the samples studied into a few groups, and it is the opinion of the Committee that this method is promising and should be extended.

(b) Other ways of combining methods

(i) Codeine-porphyroxine charts

90. Two dimensional charts have been prepared in which the codeine content and the porphyroxine colour values are plotted as co-ordinates. An examination of the charts shows segregation of the samples (so far available) from the principal opium-producing regions. This combination of methods appears to be of considerable value.

91. There is some overlapping. Professor Jermstad and Dr. Small consider that where overlapping does take place a third criterion must be drawn upon. Mr. Krishnan believes that the addition of a third criterion will not suffice and that the values must always be taken in conjunction with other criteria. (For details, see ST/SOA/SER.K/8 and Bulletin on Narcotics, Vol. V, No. 1.)

(ii) Combination of the microscopic method with the codeine and porphyroxine methods

92. A third dimension can easily be added to a two-dimensional chart by the use of colour, in a manner analogous to its use on relief maps. The use of colour is especially appropriate for qualitative distinctions, such as the microscopic test. Coloured charts prepared by the Secretariat, combining the microscopic characteristics with the codeine and porphyroxine data were examined by the Committee and appear likewise to be rather valuable. (For details, see ST/SOA/SER.K/21.)

(iii) Combination of the thebaine, papaverine, and porphyroxine methods

93. Many of the Indian and Iranian samples that have been examined are much alike in some respects, e.g. morphine and codeine contents and microscopic appearance. With some exceptions, Indian samples are much higher in porphyroxine, while Iranian ones are higher in thebaine and papaverine. To supplement the codeine-porphyroxine charts, a thebaine-papaverine chart, with porphyroxine as a colour dimension, may be used to separate the Indian and Iranian samples. Charts of this type were found by the Committee to be of help in the problem of origin.

(iv) Graphical representation of several alkaloidal analyses

94. A unified picture of the composition of each sample of opium may be presented by means of a "curve" based on the amounts of various constituents. The value determined for each of five or six alkaloids is placed on its own vertical scale, and the points thus obtained are then joined by a line or "curve", showing the relation between the various alkaloids. Finally, the shape of the whole "curve" gives a comparison between a given sample and others of the same or a different type. Adulteration, or dilution of the opium with inert material, would lower a curve and flattens it a little, but would not change its basic shape. Thus it would be easy to recognize whether two samples are of the same alkaloidal type or different.

95. The Committee examined a considerable number of charts of this sort, and believes that they can be very effective in showing broad characteristics of various opium types.

## III. GENERAL CONCLUSIONS AND RECOMMENDATIONS

### A. First Part

96. The Committee concludes that representative authentic samples from opium-producing countries which have not yet furnished them for the collection of the United Nations Opium Distribution Centre are urgently needed and recommends that any and all courses of action likely to improve this situation should be actively pursued. The Committee also considers it desirable that each opium-producing country should be requested to make available as promptly as possible to the Distribution Centre samples from each of its growing regions for several successive years.

97. Mr. Krishnan considers that the number of authentic samples available for examination (see Part II B above) is not sufficient and wishes to draw attention to the numerous gaps, e.g. there are no authentic samples for certain opium-producing areas. Further samples from several successive crops from all the opium-producing districts of each country would be necessary to study seasonal variations.

98. Professor Jermstad and Dr. Small agree that further authentic samples are needed, particularly to fill the gaps, but consider that for several countries those presently on hand are sufficient. They believe that seasonal variations are of a minor character and that sets of opium samples from the successive crops of one or two countries would suffice to confirm this.

### B. Second Part

99. The Committee did its best to reach a common evaluation of the progress that has been made in developing the techniques and methods described in parts II C and II D above, but regrets that its efforts did not meet with success.

100. In the opinion of Professor Jermstad and Dr. Small, impressive progress has been made during the past four years in the development of methods for determining the origin of opium and in the advancement of techniques for obtaining accurate and reliable data on which to base the application of these methods. They consider that the following methods of determining origin have been extensively tested and have proved their value: (a) General characteristics, (b) Microscopic characteristics, (c) Codeine content,

(d) Porphyroxine-meconidine colour values. Employed separately and in the form of ratios and combinations, they often indicate the origin with reasonable certainty and in cases of doubt, they may be supplemented by other methods such as the quantitative and qualitative ash determinations, papaverine content, nitrogen percentages and various ratios and combinations of methods, which although most of them are not yet very far advanced offer considerable promise. Furthermore, Professor Jermstad and Dr. Small do not consider that seasonal variations in the opium or the effects of age and storage will appreciably decrease the usefulness of the methods in establishing origin.

101. As regards the techniques, Professor Jermstad and Dr. Small consider that most of the techniques referred to in Section II C above are adequate for the purposes for which they are being used. They believe that certain promising new techniques such as the "Unified Procedure" for analysing opium for the principal alkaloids and the employment of paper chromatography, spectrography and infra-red spectrophotometry and x-ray diffraction procedures for getting the same or similar data more rapidly deserve extensive study.

102. Professor Jermstad and Dr. Small feel, moreover, that the validity of a technique should not be made to depend upon its accuracy in isolating one or more of the various constituents of opium, for if the same technique is used consistently, the data obtained will be comparable and their value for origin determinations undiminished. Owing to the probability that there will be steady progress in perfecting assay techniques, any other course would involve an almost continuous replacement of one set of data by another. They do not on the other hand wish to suggest that newer techniques, if thoroughly tested and representing substantial improvements, should not gradually replace the older ones, but merely that the data collected by means of the latter retain their cogency for origin determinations.

103. For the reasons he has mentioned in Section (1) above, Mr. Krishnan considers that the methods studied so far have not been extensively tested and are therefore not adequate for the determination of the origin of opium. He feels that the study of seasonal variations has not been systematic. Mr. Krishnan also believes that opium undergoes considerable changes with age and conditions of storage, and these too have not been studied sufficiently.

104. Mr. Krishnan considers that the following determinations are of much value: (a) General characteristics, (b) Microscopic appearance, (c) Codeine content, (d) "Porphyroxine-meconidine". They are not, however, sufficient either alone or in various permutations and combinations amongst themselves. Since opium is a complex material containing numerous other important constituents like morphine, papaverine, thebaine, narcotine, meconic acid, fatty and waxy matters, and mineral matters, all these must be determined and taken into consideration in every case.

105. Mr. Krishnan believes that the techniques for the determination or examination of many of these constituents are not far advanced yet. Various workers in this field have advocated new procedures, e.g. the "Unified Procedure" for determining the different alkaloids. These new procedures give results considerably different from those by the older ones. A critical study of the various procedures and techniques for analysing opium for the different constituents is, therefore, a prime necessity to establish the most correct techniques. Data will then have to be collected by such techniques as are established to be the most correct. The possibility of drawing conclusions regarding origin can be considered only after this has been done.

C. Third Part

106. In connexion with the foregoing conclusions and recommendations, the Committee agrees unanimously that it would greatly facilitate the research work of the Secretariat if more ample laboratory facilities in the way of space and equipment could be made available.

D. Fourth Part

107. The Committee was also unable to reach agreement on the important question of whether the methods of determining the origin of opium were sufficiently advanced to enable their practical application in the international field.

108. Professor Jermstad and Dr. Small, while agreeing that the methods were not yet quite ready for practical application in respect of all possible seizures, felt that the time had come for them to be tested on a small-scale practical basis. During this interim period, they thought that the Secretariat should be requested

to make determinations on a limited number of seizure samples from among those furnished by governments in pursuance of resolution 436 F (XIV) of the Economic and Social Council and, in cases that seemed to warrant it, should draw conclusions as to origin. They would propose that all findings made in this connexion should be kept confidential and communicated to the Commission on Narcotic Drugs for consideration by that body in closed session. They considered that the experience thus gained would be most helpful in deciding when and how the methods should be applied more generally.

109. Taking into account the rate of progress of the past four years, Professor Jermstad and Dr. Small believe that the methods will be ready for full-scale practical application in two years time and wish to recommend, therefore, that the situation be reappraised then in the light of their actual performance both in further determinations of known samples and in the practical tests.

110. Mr. Krishnan, on the other hand, is of the opinion that the techniques and methods are not yet ready for any kind of practical application in the international field for determining the origin of opium. He recommends that a collaborative study should be undertaken by all workers connected with the United Nations research programme with regard to the techniques and methods suggested in Sections II C and D of the present report, and that these tests should be performed on samples of raw and manipulated opium drawn from successive crops over several years produced in the various opium-growing districts throughout the world. He considers that simultaneous studies should be made of the effects of age and of the conditions of storage, e.g. temperature, humidity, enzyme action, etc., on the various constituents of opium. He, too, favours a second reappraisal of the methods as regards the possibility of applying them for practical purposes, but feels that three years must elapse before such a step would be warranted.

111. Professor Jermstad and Dr. Small expressed the opinion that Mr. Krishnan's proposal, if adopted, would have the effect of postponing for a very considerable time any practical application of the methods since it was most unlikely that all producing countries would be prepared to furnish such large numbers of samples and, even if they did, the Secretariat would then be faced with the task of making many thousands of determinations, all of which would require confirmation by the national chemists.

112. Mr. Krishnan agreed that the difficulties were quite great but considered that they were inherent in the problem. He did not, however, consider them insurmountable; he is of the opinion that unless the requirements he had outlined were met, no kind of practical application is possible.

E. Fifth Part

113. The Committee desires to record its appreciation of the valuable contributions made by the chemists of the United Nations Secretariat and other scientists working on this problem.

ANNEX A

LIST OF TECHNICAL PAPERS STUDIED BY THE COMMITTEE

| | Symbol | Title |
|---|---|---|
| 1. | E/CN.7/117 | I. Notes on Suggested International Collaboration for Determining the Origin of Seized Opium by Chemical and Physical Means.<br>II. A.. On Determining the Country of Origin of Opium<br>C. Photomicrographs of Opium Crystals<br>D. Some Minor Alkaloids of Opium<br>E. Opium Alkaloids - Narceine<br>F. Opium Alkaloids - Thebaine.<br>By Charles Fulton. |
| 2. | E/CN.7/117/Add.1 | Examination of Opium for Distinguishing Characteristics.<br>By Charles Fulton. |
| 3. | E/CN.7/117/Add.2 | Examination of Opium for Distinguishing Characteristics. |
| 4. | E/CN.7/195 | The Comparative Determination of "Porphyroxine-Meconidine".<br>By United Nations Secretariat. |
| 5. | E/CN.7/202 | Determination of Codeine in the Lime-Water Extract.<br>By United Nations Secretariat. |
| 6. | E/CN.7/207 | Further Data on "Porphyroxine-Meconidine".<br>By Charles G. Farmilo and Patricia M.L.Kenneth. Canada. |
| 7. | ST/SOA/SER.K/1 | The Determination of Morphine in Opium by Extraction: A New Method.<br>By United Nations Secretariat. |
| 8. | ST/SOA/SER.K/2 | The Forms of Crystals in Turkish Opium,<br>By Alaeddin Akçasu, Turkey. |
| 9. | ST/SOA/SER.K/3 | The Determination of Morphine in Raw Opium.<br>By Erich Knaffl-Lenz, Austria. |
| 10. | ST/SOA/SER.K/4 | "Porphyroxine-Meconidine" in Relation to the Origin of Opium.<br>By United Nations Secretariat. |

| | Symbol | Title |
|---|---|---|
| 11. | ST/SOA/SER.K/5 | The Ratio of Narcotine to Meconic Acid in Relation to the Origin of Opium. By J.R. Nicholls and E.G. Kellett, United Kingdom. |
| 12. | ST/SOA/SER.K/6 | The Determination of Narcotine and Meconic Acid in Opium. Second Method. By J.R. Nicholls and E.G. Kellett, United Kingdom. |
| 13. | ST/SOA/SER.K/7 | The Determination of Narcotine and Meconic Acid in Opium. Third Method. By J.R. Nicholls and E.G. Kellett, United Kingdom. |
| 14. | ST/SOA/SER.K/8 | Codeine and Codeine-Porphyroxine Charts in Relation to the Origin of Opium. By United Nations Secretariat. |
| 15. | ST/SOA/SER.K/9 | Elimination of the other Opium Alkaloids in the Assay of Opium for Morphine. By United Nations Secretariat. |
| 16. | ST/SOA/SER.K/10 | The Colorimetric Determination of "Porphyroxine-Meconidine". Communication on Experiments to Find a Relation Between "Red Lovibond Units" and Absorption Intensity Value of the Red "Porphyr" Solution. By L. Fuchs and W. Ullrich, Austria. |
| 17. | ST/SOA/SER.K/11 | Assay of Raw Opium for Morphine. A study of the Method of Professor Erich Knaffl-Lenz. |
| 18. | ST/SOA/SER.K/12 and Corr.1 | Determination of other Titratable Alkaloids in the Morphine of Opium Assays. By United Nations Secretariat. |
| 19. | ST/SOA/SER.K/13 | Exhaustive Extraction of the Opium with Lime-Water in the assay procedure. By United Nations Secretariat. |

| | Symbol | Title |
|---|---|---|
| 20. | ST/SOA/SER.K/14 | The Colorimetric Determination of "Porphyroxine-Meconidine". The Relation between Tintometer and Spectrophotometric Measurements obtained in the Determination of "Porphyroxine-Meconidine" in Opiums. By Charles G. Farmilo and Patricia M.L. Kennett, Canada. |
| 21. | ST/SOA/SER.K/15 | An Assay Procedure for Opium based on that of the Japanese Pharmacopoeia, and Morphine Percentages obtained on Samples from Various Countries. By Haruyo Asahina, Japan. |
| 22. | ST/SOA/SER.K/16 | A Study of the United Nations Samples of Opium. By G. Panopoulos and A. Vassiliou, Greece. |
| 23. | ST/SOA/SER.K/17 | Extractive Determination of Thebaine and Papaverine in Opium. By United Nations Secretariat. |
| 24. | ST/SOA/SER.K/18 | The Assay of Morphine in Opium, and Determination of the Total of Minor Phenolic Alkaloids. By C.K. Liang, China, |
| 25. | ST/SOA/SER.K/19 | The Colorimetric Determination of "Porphyroxine-Meconidine" - Second Communication. Experiments on the Determination of "Porphyroxine-Meconidine" in Small Quantieles of Opium. By L. Fuchs and W. Ullrich, Austria. |
| 26. | ST/SOA/SER.K/20 | Estimation of Codeine in Opium. By C. Parthasarathy and N. Rajagopalan, India. |
| 27. | ST/SOA/SER.K/21 | Classification of Opium Samples by Microscopic Test. By United Nations Secretariat. |

| | Symbol | Title |
|---|---|---|
| 28. | ST/SOA/SER.K/22 | A Study of Dr. Liang's Assay and its Extension to Determination of the Principal Non-Phenolic Alkaloids of Opium. |
| 29. | ST/SOA/SER.K/23 | Preliminary Analyses of Ash from Different Kinds of Opium. By Axel Jermstad and Tor Waaler, Norway. |
| 30. | ST/SOA/SER.K/24 | Preliminary Report on the Quantitative Determination of some Opium Alkaloids by Means of Infra-red Spectrophotometry. By Axel Jermstad and J. Lothe, Norway. |
| 31. | ST/SOA/SER.K/25 | A Preliminary Investigation of Methods for Determining the Origin of Opium. By T.S.T. Chari, C. Parthasarthy, N. Rajagopalan, K.S. Subramanian, India. |
| 32. | Bulletin No. 1 on Narcotics, Vol. I, Pages 14 to 19 and 42 to 47 | Determining the Origins of Opium. By United Nations Secretariat. |
| 33. | Bulletin on Narcotics, Vol. IV, No. 1. pages 15 to 25 | The Story of "Porphyroxine-Meconidine". By United Nations Secretariat. |
| 34. | Bulletin on Narcotics, Vol. V, No. 1, Pages 8 to 14 | Progress in Determining the Origin of Illicit Opium. By United Nations Secretariat. |
| 35. | - | Unpublished report on A Systematic Determination of the Principal Alkaloids in Raw Opium. By C.K. Liang, China. |
| 36. | - | Unpublished report on Opium Ash Analysis. By J.C. Bartlet, Canada. |
| 37. | - | Unpublished report on Methods of Determining the Origin of Opium. Second Study: Chromatograms and Ultraviolet Light. By G. Panopoulos and A. Vassiliou, Greece. |

| | Symbol | Title |
|---|---|---|
| 38. | - | Unpublished report on Observations on the Morphine Assay of Raw Opium. By Professor Von Bruchhausen, Federal Republic of Germany. |
| 39. | - | Unpublished report on A Quantitative Method for the Isolation and Determination of Morphine in Opium and Medicinal Preparations. By Dr. Grosfeld-Nir, S. Gassner and E. Weissenberg, Israel. |

ANNEX B

DIRECTORY OF SCIENTISTS PARTICIPATING IN THE INTERNATIONAL PROGRAMME FOR OPIUM RESEARCH

| | Scientist | Country |
|---|---|---|
| 1. | Açba, Mr. Selman<br>Directeur de la Section d'Opium de l'Office des Produits du Sol,<br>Besiktas, Istanbul | Turkey |
| 2. | Akçasu, Dr. Alaeddin<br>Farmakoloji Enstitusu,<br>University of Istanbul | Turkey |
| 3. | Asahina, Mr. Haruyo<br>National Hygienic Laboratory,<br>Tokyo | Japan |
| 4. | Bartlet, Mr. J.C.<br>Food and Drugs Division,<br>Department of National Health and Welfare,<br>Ottawa | Canada |
| 5. | Braenden, Dr. Olav | United Nations Secretariat |
| 6. | Fabre, Professor<br>Dean, Faculty of Pharmacy | France |
| 7. | Farmilo, Dr. Charles<br>Food and Drugs Division,<br>Department of National Health and Welfare,<br>Ottawa | Canada |
| 8. | Ferreira, Miss Beatriz | United Nations Secretariat |
| 9. | Fuchs, Dr. Leopold<br>Head, Pharmacognostical Institute,<br>Vienna | Austria |
| 10. | Fulton, Mr. Charles C. | United Nations Secretariat |
| 11. | Gassner, Dr. S.<br>Laboratory for the Control of Pharmaceuticals,<br>Ministry of Health,<br>Jerusalem | Israel |

| | Scientist | Country |
|---|---|---|
| 12. | Ginsburg, Dr. D.<br>The Weizman Research Institute<br>in Rehovoth | Israel |
| 13. | Griffon, Professor<br>Director, Toxicological<br>Laboratory of Prefecture<br>of Police | France |
| 14. | Grosfeld-Nir, Dr.<br>Laboratory for the Control<br>of Pharmaceuticals,<br>Ministry of Health,<br>Jerusalem | Israel |
| 15. | Hellberg, Dr. Hans<br>Statens Farmaceutiska<br>Laboratorium,<br>Stockholm | Sweden |
| 16. | Jermstad, Professor Axel<br>formerly Director of the<br>Farmasøytiske Institut,<br>Blindern, Oslo | Norway |
| 17. | Kellett, Dr. E.G.<br>Government Laboratory,<br>London | United Kingdom |
| 18. | Knaffl-Lenz, Dr. Erich<br>Pfeilgasse 21,<br>Vienna 8 | Austria |
| 19. | Krishnan, Mr. P/S.<br>Chief Chemist,<br>Central Revenues Control<br>Laboratory,<br>Agricultural Research<br>Institute P.O.,<br>New Delhi | India |
| 20. | Liang, Dr. C.K.<br>Director, Narcotics Bureau,<br>Taipei, Taiwan | China |
| 21. | Nicholls, Dr. J.R., C.B.E., D.Sc.,<br>F.R.I.C.,<br>Deputy Government Chemist of<br>the Government Laboratory,<br>London | United Kingdom |

| | Scientist | Country |
|---|---|---|
| 22. | Nordal, Professor Arnold<br>Director of the<br>Farmasøytiske Institut,<br>Blindern, Oslo (temporarily in the United States) | Norway |
| 23. | Oestreicher, Mrs. P.M.L.<br>Food and Drugs Division,<br>Department of National<br>Health and Welfare,<br>Ottawa | Canada |
| 24. | Panopoulos, Dr. G.<br>General Chemical<br>States Laboratory,<br>Athens | Greece |
| 25. | Parthasarathy, Mr. C.<br>Central Revenues Control<br>Laboratory,<br>Agricultural Research<br>Institute P.O.,<br>New Delhi | India |
| 26. | Rajagopalan, Mr. N.<br>Central Revenues Control<br>Laboratory,<br>Agricultural Research<br>Institute P.O.,<br>New Delhi | India |
| 27. | Ryan, Mr. Richard<br>Chief of Laboratories,<br>Alcohol and Tobacco Tax<br>Division,<br>Internal Revenue Bureau,<br>Washington | United States |
| 28. | Small, Dr. Lyndon F.<br>Laboratory of Chemistry<br>and Chemotherapy,<br>U.S. Public Health Service,<br>Bethesda, Maryland | United States |
| 29. | Subramanian, Mr. K.S.<br>Central Revenues Control<br>Laboratory,<br>Agricultural Research<br>Institute P.O.,<br>New Delhi | India |

| | Scientist | Country |
|---|---|---|
| 30. | Ullrich, Mr. W.<br>Pharmacognostical Institute,<br>Vienna | Austria |
| 31. | Van Pinxteren, Professor Dr. J.C.A.<br>Pharmaceutisch Laboratorium<br>Der Rijks-Universiteit<br>Utrecht | Netherlands |
| 32. | Vassiliou, Mr. A.<br>General Chemical<br>States Laboratory,<br>Athens | Greece |
| 33. | Von Bruchhausen, Professor Dr.<br>Professor of Pharmaceutical<br>Chemistry, Braunschweig<br>Polytechnic Institute | Federal Republic<br>of Germany |
| 34. | Waaler, Mr. Tor<br>Farmasøytiske Institute<br>Blindern, Oslo | Norway |
| 35. | Weissenberg, Dr. E.<br>Laboratory for the Control<br>of Pharmaceuticals,<br>Ministry of Health,<br>Jerusalem | Israel |

---