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DEPARTMENT OF THE AIR FORCE
NATIONAL AIR & SPACE INTELLIGENCE CENTER (AF ISR AGENCY)
WRIGHT-PATTERSON AFB OHIO

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SEP 21 2009

John Greenewald, Jr.
[redacted]

Dear Mr. Greenewald

This letter is in reference to your Freedom of Information Act (FOIA) request for a copy of the document entitled *Status of Chemistry and Chemical Technology In Communist China Part 1*, our case number 2009-01340-F.

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MARK E. HESS, Colonel USAF

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MHR-66-27

802007

FOREIGN TECHNOLOGY DIVISION

STATUS OF CHEMISTRY AND CHEMICAL TECHNOLOGY IN COMMUNIST CHINA
PART I

F. W. DODGE COMPANY
A DIVISION OF McGRAW-HILL, INC.
WRIGHT-PATTERSON AIR FORCE BASE, OHIO
CONTRACT AF 33(657)-14782

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Abstract

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The Chinese apparently have some very able scientists who are quite familiar with Western literature and patents.

The research effort is regimented and directed toward solving problems of immediate urgency and longer range systematic investigation of natural products found in China.

The immediate problems are:

FOOD (fertilizers, insecticides, hormones, seeds)

CLOTHING (synthetic fibers, plastics, cotton, dyes)

DISEASE (medicinal products, antibioltics, tonics, tranquilizers)

PRODUCTION PLANTS (steel, copper, iron, alloys)

The more remote problems:

NATURAL PRODUCTS (alkaloids, proteins, toxins)

The Chemical industry is not yet able to support a high standard of living in China and is far inferior to that of Russia and certainly to Western nations.

China has been definitely handicapped by the withdrawal of Russian support in science and technology, as well as raw materials.

MHR-66-27

STATUS OF CHEMISTRY AND CHEMICAL TECHNOLOGY IN COMMUNIST CHINA

PART I

JUNE 1966

F. W. DODGE COMPANY

DIVISION OF McGRAW-HILL, INCORPORATED

WRIGHT-PATTERSON AFB, OHIO

SUBCONTRACT 171-5000

This report was prepared for the Air Force Systems Command by a U.S. Contractor for use primarily within the Command. Conclusion views contained therein are based on analysis of such information which could be made available to the contractor under the terms of the contract and appropriate security directives and do not necessarily reflect the opinions of the Air Force Systems Command or the U.S. Air Force.

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CONCLUSIONS

1. The Chinese apparently have some very able scientists who are quite familiar with Western literature and patents.

2. The research effort is regimented and directed toward solving problems of immediate urgency and longer range systematic investigation of natural products found in China.

The immediate problems are:

FOOD (fertilizers, insecticides, hormones, seeds)

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The more remote problems:

NATURAL PRODUCTS (alkaloids, proteins, toxins)

3. The chemical industry is not yet able to support a high standard of living in China and is far inferior to that of Russia and certainly to Western nations.

4. China has been definitely handicapped by the withdrawal of Russian support in science and technology, as well as raw materials.

STATUS OF CHEMISTRY AND CHEMICAL TECHNOLOGY IN COMMUNIST CHINA

This evaluation was made from references found in the open literature supplied by PGE. Any such analysis is difficult to make with any high degree of confidence for several reasons which will be discussed.

1. Chinese publications indicate that Chinese scientists must be under great pressure to prove the superiority of the communistic system over that of free enterprise. For example, Wang Ying-lai (3769 2019 4202) kicked off the First National Symposium of Biochemistry (1962) with this: "Under the shining brightness of the main line and through the Great Leap Forward of 1958 and 1959, our country's socialist construction enterprises were proceeding ahead a thousand miles a day, blooming and flourishing as the blossoming of a hundred kinds of flowers."(1) He concluded with: "To summarize, the advancement in biochemistry during the past ten years has been very rapid without comparison and from now on, we must rely on the main line of the party, encourage the masses, proceed with determination and will, and strive forward to reach the scientific peak of the world."(1)

Similar flowery statements are found in many Chinese publications but often more sober statements follow which admit severe shortages of materials, equipment, and trained personnel.

2. It is difficult to determine what is original work and what is merely repeating of work done in other countries. For example, Wu Lung-tsung (0702 7127 1350) claims that he synthesized a new insecticide which he names LO KUO. He says this is O, O-dimethyl-S-(methylcarbamomethyl)-phosphorodithionate.(2) Another Chinaman, Lin Liu (2651/2692) reports on

an insecticide LE KUO which appears to be the same compound but he admits that it was synthesized by an Italian in 1954.(3) This insecticide has been known in this country for many years and is sold under a trade name of Dimethoate.

This might be thought to be due to an ignorance of the Western literature but such is not the case because the Chinese are thoroughly familiar with literature and patents of the United States, England, Germany, and Japan as shown by their references.

Its more likely that they are under pressure to publish without too much regard for originality of the work.

Americans who are familiar with Chinese work in alkaloids say that they are great on reporting a new alkaloid to which they give a new name but when the physical and chemical properties are determined, it turns out to be a familiar alkaloid.

3. It is difficult to estimate Chinese production because of the vague language used. For example, "This plant provides high and medium pressure valves for use in nitrogenous fertilizer factories with an annual capacity ranging from 25,000 to 50,000 tons."(4) This says nothing about how many valves are produced, how many are defective, or how many a plant needs.

Statements are frequently found which state that production has increased 300% over the previous year but unless you know what the previous production was, the statement has little meaning. Raw production figures mean little unless you know something about the quality of the product.

During World War II, Russia was working under a quota system. They made parts for gas masks, inspected them and rejected faulty ones. But if the quota was not met, they went back and used the rejected parts to meet the quota. China may do the same.

4. One must be cautious in weighing information in the open literature. For example, Yao-tung Huang (7806/5069/2639) reports a method for the polarographic determination of methyl E 605 in the presence of p-nitrophenol.(5) In this same article he states that p-nitrophenol is the chief contaminant in commercially produced E 605. One might be tempted to jump to the conclusion that the Chinese are producing E 605 (Parathion) commercially since they know so much about it. One might also imagine that if they produce Parathion, they can produce the oxygen analog, Paraoxon, which is much more toxic.

But let us take a closer look at this. Fletcher et.al. of American Cyanamid reported on the preparation of Parathion in J. Am. Chem. Soc. 70, 3943, (1948), and referred to the previous German work of 1946. They gave the reactions involved:

$$2\ P + 3\ Cl_2 = 2\ PCl_3$$

$$PCl_3 + S = PSCl_3$$

$$2\ C_2H_5ONa + PSCl_3 = (C_2H_5O)_2 - \overset{S}{\overset{\|}{P}} - Cl + 2\ NaCl$$

$$(C_2H_5O)_2 - \overset{S}{\overset{\|}{P}} - Cl + NaO\langle\ 0\ \rangle NO_2 = (C_2H_5O)_2 - \overset{S}{\overset{\|}{P}} - O\langle\ 0\ \rangle NO_2 + NaCl$$

The Chinese are thoroughly familiar with the J. Am. Chem. Soc. and the patent literature and certainly picked this up.

But what would they need to produce Parathion?

Raw Materials: Phosphorus, chlorine, sulfur, ethyl alcohol, phenol, nitric acid, sulfuric acid and sodium.

They must either make these, buy them or buy the intermediates. The intermediates are PCl_3, sodium ethoxide, and sodium nitrophenol. None of these is easy to ship to say the least.

There is evidence that the Chinese have sulfur, ethyl alcohol, nitric acid, sulfuric acid and perhaps phenol.

But if they produce phosphorus in a modern plant, they require an electric furnace which in turn requires high voltage electric current. They could use the antiquated process of treating phosphate rock with sulfuric acid, separating the phosphoric acid and reducing it with coke in a fire clay retort, but the production would be limited.

They could produce chlorine from the old Deacon process for the oxidation of HCl instead of the electrochemical process but again the production would be limited and the purity suspect.

They could not produce sodium except by an electrochemical process.

Even if they produced phosphorus and chlorine, the making of PCl_3 is difficult as our own TVA people can testify. If excess chlorine is fed into the reactor, PCl_5 may be produced. Unless the temperature in the reactor is carefully controlled, the exothermic reaction can become violent and cover many square yards of the glorious Chinese Peoples Republic with a messy product.

The nitration of phenol produces a mixture of ortho and para products which requires steam distillation to separate them. The reactor must be resistent to phenol, nitric acid, and nitrophenols. In a primitive technology, this is no mean feat.

In a country like the United States, it is easy to overlook problems of producing raw materials, materials for plant construction, facilities for heating and cooling reactors, and an abundant supply of AC and DC electric current at required voltages.

On the other hand, one has to give the scientists of another country credit for intelligence, imagination, and ability if there is any information to indicate this.

In this evaluation, I have tried to be cautious in arriving at judgments of the Chinese capability in several fields.

II <u>Scientific Conferences</u>

While conferences often give little detailed information on research, production and technology, they do give some evidence of the degree of sophistication and activity. During the years 1964 and 1965 there are references to several conferences in China and two which were attended outside China. During these years, Russia had presumably withdrawn its scientific support and this Chinese effort entirely.

<u>1964</u>
Ref(6) lists a number of conferences which were held in China:

1. <u>Supersonic Diagnosis Symposium, Shanghai, July 7 - 12th.</u>

Subjects considered were diagnosis of diseases in different parts of the body by new techniques, new instruments, and theories of supersonic effects on the body. 156 papers

2. <u>Joint Conference of Botanical Society and Oceanography Society.</u> was held in Tsingtae, July 20 - August 4th. 144 papers including those on chemistry of algae, nitrogen fixing algae and productivity by algae.

3. <u>Joint Conference on Turbine Boilers and High-power Electric Generators</u> was held in Harbin, August 2 - 10th. The development of high-power generators and large hydroelectric plants was discussed. It is too

bad that so little information is given. As mentioned on page 4, an electrochemical industry is critical if China is to produce phosphorus, chlorine and sodium in commercial quantities. This does not indicate that China has such facilities but certainly shows that they are aware of their importance.

4. Symposia were held on human anatomy, mathematical functions, shipbuilding, hypertension in humans, radio construction, forestry and one on electric lights. Little is said of these except that they were well attended and discussions were interesting.

5. The Pharmaceutical Society of China held a symposium in Shanghai, November 27 - December 5. There were 255 papers including drug safety, improved quality of drugs and drug preparation to replace foreign products such as dibutyl phthalate, contraceptive jelly, and sulfathiazole.(7)

1965

1. National Convention of Design Engineers, Peking, March 16 - April 4, 1965.(8)

This was a very large convention of government officials, engineers and scientists. Of greatest interest was the reported progress in the petroleum industry. Other reports of interest were in metallurgy, and agriculture. Apparently there was a lot of political oratory which amounted to nothing.

2. Scientific Conference on the Use of Bioassay in Medical Entomology Research, Nanning, April 10 - 19, 1965.(9)

This conference was concerned largely with research on control of fly and mosquito populations with insecticides and the use of insects in drug assay. Nothing of great significance is reported.

3. Three accounts are reported of Chinese attending conferences outside of China. Public health officials attended a conference in Bucharest on microbiology, September 1965.(10) Chinese delegation from chemical industry attended a conference in Pyongyang, October 1965 (11). This was apparently a political conference on trade relations with Korea.

Summary:

These conferences show that the Chinese are aware of their basic needs: food, insect control, population control, need for more consumer goods, industrial production of heavy goods, and improved transportation. Whether these conferences are accomplishing anything beyond threatening and encouraging scientists, engineers and workers is not indicated by the reports themselves.

III <u>Basic Research</u>

a) <u>Inorganic</u>

Very little was found in this field. They are working on extraction of uranium (VI) compounds with 8-hydroxyquinoline and tributyl phosphate in benzene.(12)

They are working on chemical nickel plating and this is interesting because no mention is made of electroplating.(13)

The production of salt is still accomplished in a very primitive fashion by evaporation of sea water in open pits.(14)

Improvements in the production of iron and steel are claimed by improving the quality of coke. This improvement is said to be due to abandoning faulty Western theories. It is interesting that the United States leads the world in steel production with these faulty theories.(15)

A recent report states that the Chinese have perfected a method for the extraction of nickel and cobalt from nickel phosphorus iron, a by-product of fertilizer manufacturing. No details are given but the method was the result of research done in the Metallurgical Research Institute of the Chinese Academy of Science.(16)

b) Organic

From the information available to the author, Chinese research in organic chemistry involves a great deal of work in organophosphorus compounds including their polymers and in polymers related to petro-chemicals such as polyethylene and vinyl polymers.

There are specific references to the following areas of research:

(1) Kinetics of polycondensation between diphenyl-dichlorosilane and bisphenol A (17)

(2) Phosphonitrilo chloride-phenol condensations (17)

(3) Condensation of di(p-carbosyphenyl methyl phosphine oxide and 3, 3-diaminobenzidene to form polymers (17)

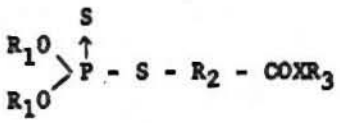
(4) Polymerization of a-olefins in the presence of Zeigler catalysts. (18)

From the literature available from PGE, the Chinese have been very much interested in insecticides for use against insects which attack crops, flies, mites and lice. Whether by accident or design, they have worked principally on those with lower human toxicity values. There seems little doubt that they have synthesized the compounds listed below in the laboratory but whether they are manufacturing any of them in large quantities is much less certain.

The following compounds are definitely identified in the open Chinese literature. Frequently they use the common trade-name of the United States but in some cases they have used a number. For example, they refer to Parathion as E 605(22) and to Ovotran as K 6451(24). In some cases they have merely used a number which the author cannot identify. For example, 1065, 1600(26) and 203(30). The LD_{50} values listed were not mentioned in the Chinese literature but are taken from Ref. 31 to add useful data. They refer to oral administration to white albino rats in milligrams or grams per kilogram of body weight.

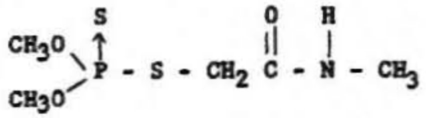
<u>ACETHION</u> (19)

Only vague reference is made to this compound. Its formula is given as:



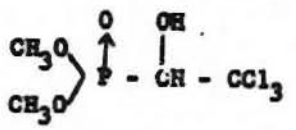
<u>DIMETHOATE</u> (Le Kuo, Lo Kuo) (CYGON, ROGOR) (20) LD_{50} = 245 mg/Kg

0,0 dimethyl-S(N-methyl carbamoyl methyl) phosphoro dithionate



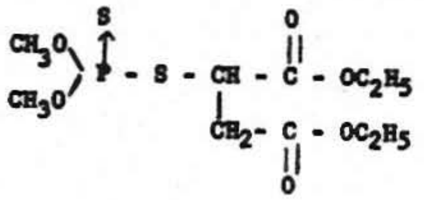
DIPTEREX (DYLOX, NEGUVON) (21) LD_{50} = 225 mg/Kg

0,0 dimethyl-1-hydroxy 2,2,2 trichloroethyl phosphonate



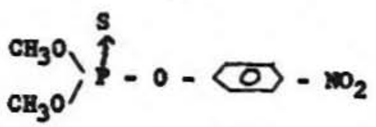
MALATHION (MALAPHOS) (19) LD_{50} = 480 mg/Kg

S(1,2 dicarbethoxy ethyl) 0,0 dimethyl dithiophosphonate



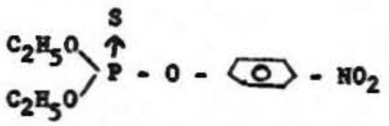
METHYL PARATHION (Methyl E 605, 1605) (22) LD_{50} = 9 mg/Kg

0,0 dimethyl O-p-nitrophenyl thiophosphate



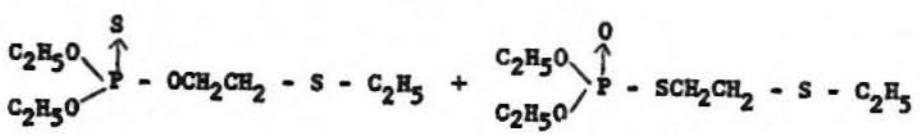
PARATHION (E 605) (22) LD_{50} = 3 mg/kg

0,0 dimethyl O-p-nitrophenyl thiophosphate



SYSTOX (DEMETON, E 1059, Methyl 1059) (20) LD_{50} = 2.5 mg/Kg

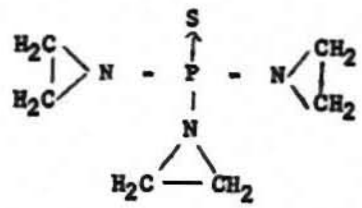
This is a mixture of two isomers:



In addition to the above organo-phosphorus compounds, the Chinese have synthesized in the laboratory several chlorinated organic compounds which have value as insecticides and one herbicide (the familiar 2,4 D).

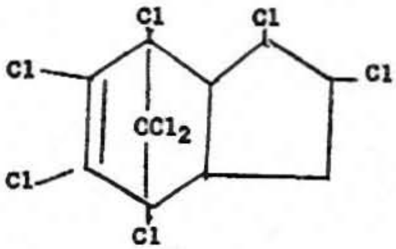
Thio-TEPA (23) LD_{50} - not available

Tris (1-aziridinyl) phosphine sulfide



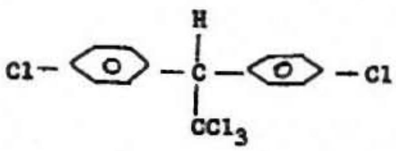
CHLORDANE (Chloricide) (24) LD_{50} = 250 mg/Kg

1,2,4,5,6,7,8,8 Octochloro 2,3,3a,4,7,7a hexahydro-4,7 methanoindene



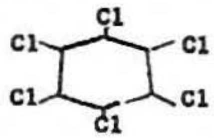
DDT (24) LD_{50} = 250 mg/Kg

1,1,1 trichloro-2,2 bis(p-chlorophenyl) ethane



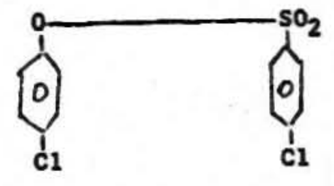
LINDANE (666, BHC) (25) LD_{50} = 125 mg/Kg

1,2,3,4,5,6 Hexachlorocyclohexane



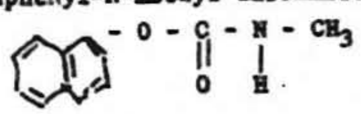
<u>OVOTRAN</u> (K 6451) (24) LD_{50} = 2 grams/Kg

p-chlorophenyl p-chlorobenzene sulfonic acid



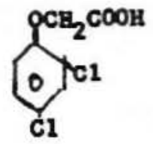
<u>SEVIN</u> (21) LD_{50} = 560 mg/Kg

1-naphthyl-N-methyl carbamate



2,4 D (Herbicide) (24) LD_{50} = 375 mg/Kg

2,4 dichlorophenoxy acetic acid



<u>Phosphorus sulfides</u>, P_4S_3 and P_2S_5 (26)

<u>Unidentified compounds or mixtures</u> (26), (30)

1065, 1600 and 203

Cyclohexylphosphonyl esters (27,28,29)

<u>SUMMARY</u>

There is no doubt that the Chinese are capable of synthesizing in the laboratory most of the common insecticides and herbicides and that they are familiar with the Western literature and patents. Furthermore they have kept up-to-date with this as shown by the knowledge of very recent compounds such as Dimethoate. They do not show the thoroughness and sophistication of Soviet chemists. For example, the very fine work of A. Ye. Arbuzov (32) 1962 and (33) 1963, which show that the Soviets can match anything being done in the United States and Germany.

Perhaps the Chinese are concentrating their efforts on those materials which are of immediate usefulness in improving their farm crops by combating insects and weeds which are harmful to them. It is also likely that they were depending upon Russian chemistry and technology which has now been withdrawn from them.

NATURAL PRODUCTS

The Chinese seem to have an interest in almost every natural product within their borders which has physiological activity on humans. They have been particularly interested in alkaloids and pr(.eins but have also shown interest in psychochemical agents and tranquilizers. This is not unusual when one considers the long history of drug addiction in China and its opium trade. There are also rumors that suicide is on the increase in China and other communistic countries, and this might stir interest in tranquilizers. No attempt will be made to cite every reference to a natural product since this would be extensive, boring, and not very enlightening. (34),(35),(36)

They claim that the number of biological alkaloids which they have investigated now numbers about 1900 but only one percent of these have been found to be useful in medicine (34). They claim further that the number of native amino-acids which they have recently studied has increased from 20 to 250. (34)

I. ALKALOIDS

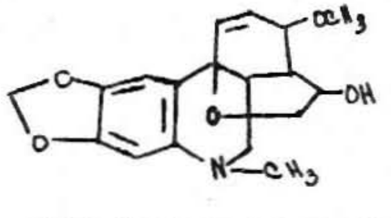
Aconitum bullatifolium var homotrichum (39). Jen-Hung Chu Sheng-Tin Fang and Wei-Kuang Huang claim isolation of four alkaloids from this drug which they name Bullatine A, B, C, and D. They give empirical formulas and some physical constants. The formulas are given as:

Bullatine A - $C_{21}H_{31}O_2N$ Bullatine B - $C_{24}H_{39}O_6N$

Bullatine C - $C_{26}H_{41}O_7N$ Bullatine D - $C_{23}H_{37}O_9N$

They state that bullatine C is identical with the monoacetate of bullatine B. No structural formulas are given.

Amaryllidacea (40). Shan-hai Hung and Kuang-en Ma claim the isolation of lycorine, pseudolycorine, lycorenine, homolycorine, tazzettine, norpluvine, galanthamine, epigalanthamine, vittatine, pluvine, lycoramine, hippeastrine, and a new alkaloid squamigerine from Lycoris squamigera Maxim. Squamigerine is assigned the formula $C_{18}H_{21}NO_5$, m.p. 260°C and $a_D^{34} = +165°$. They state that it contains a CH_2O_2, NCH_3, OCH_3, and OH groups plus a double bond. Merck (37) page 1014 gives the structure of tasettine as:



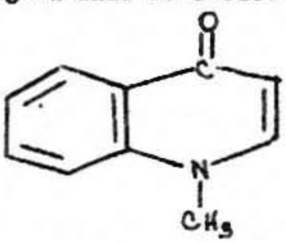
m.p. 210-211°C

$a_D^{25} = +150.3°$

They think it is an isomer of tazzettine but it may be only an impure form of tazzettine rather than a new alkaloid.

Pyrroligidine (41, 42). Yuang-lung Chu, Chih-chen Lu and Jen-hung Chu claim discovery of a new alkaloid, mucronatine, $C_{18}H_{25}NO_6$ from crotularia mucronata devs. However, this is the same formula as that of retrorsine, m.p. 214-215. Both give retronecic acid, $C_{10}H_{16}O_6$ on alkaline hydrolysis so this may not be a new alkaloid.

Echinopsine (43). Dr. T. Kawatani reports on the use of a new drug echinopsine as a cholinesterase suppresent. It is stated that this drug is N-methyl-gamma-quinolone and is more potent than secrenine. However, Henry (38) p. 413 gives the identical structural formula for secrenine and names it 1-methyl-4-quinolone. Here again this so-called new drug is probably an impure form of secrenine:



Ergometrine (44). Chi-Cheng Fang claims a new method for the isolation of ergometrine using a 0.05 N solution of HCl containing the drug and passing it thru an ion exchange rasin of the sulfonated styrene-divinyl benzene type. Stripping was accomplished by treatment with 5% ammonia, followed by acetone-ether (3:7) or acetone-chloroform (7:3).

Rauwolfia alkaloids (45, 46, 47). Several references are given to the rauwolfia alkaloids. Rauwolfia verticillata (Lour) (Baill) is said to reduce serum cholinesterase activity thru action on the blood pressure in a similar way to reserpine. C. Y. Wu claims the same effects from rauwolfia yunnanensis Tsiang var angustifolia.

Miscellaneous alkaloids: Well documented work has been done on four other alkaloids: Gentianidine (48), Sinoacutine (49), Liensinine (50).

II. TOBACCO MOSAIC VIRUS (51), (52)

Yu Shang Chang reports work on tobacco mosaic virus (TMV) and another mosaic virus (YMV_{15}), which he claims is a new strain. This is similar to the common strain and to the HR strain of TMV but differs in the content of threonine, leucine, isoleucine and aspartic acid.

III. ANIMAL TOXINS

Three significant toxins of animal origin have been reported.

Chen-Chung Yang (53) reports on the concentration of a toxin from Formosan cobra venom which he names cobrotoxin. This was accomplished by column chromatography on CM-cellulose. This has a molecular weight of 11,000 and is 6.7 fold more toxic than the original venom. Its LD_{50} to mice is 1.1 gamma/mouse. It loses its toxicity after tryptic digestion. It is apparently of protein nature but no formula is given.

An anonymous doctor of the National Institute of Health, Tokyo reported that a neurotoxin has been obtained from a marine annelid. It is said to be nereistoxin but this report (54) gave no details.

The same doctor reported (55) that Saponin is the toxic principle in starfish toxin. It is stated that an attachment contained results of experiments on its physiological activity but it was not a part of this report (55). It would be interesting to see these data because Sapogenin glycosides are normally nontoxic to man by oral ingestion but toxic to fish and some other lower forms of animals. They are toxic to man when injected into the blood stream.

IV. DRUGS OF PLANT ORIGIN

Benzoin - Wen-yen Lien et.al. (56) made a botanical exploration in Southern China from 1960-62 to find substitutes for imported resin Benzoin. They claim that three plants yielded satisfactory benzoin resins. The usual source of benzoin is Sumatra, Java and Thailand. Benzoin is a drug of minor importance which is normally extracted from plants of the genus Styrax.

Erysimum - Mei-sheng Ho et.al. (57) investigated cardiac effects of erysimum cheiranthoides L. which grew wild in China. They claim the drug is a cardiac stimulant but less powerful than K-Strophanthin. They report an LD_{50} mouse dose for their drug as 5.24 $\pm$ 0.48 g/kg (i.p.). Merck (37) p. 985 gives the LD_{50} rat dose for K-Strophanthin as 15 mg/kg (i.v.). Their claims appear to be reasonable.

Psoralen - Tsu-k'ang Han and Cho-pin Yuan (58) claim a satisfactory polarographic method for determining psoralen. Psoralen is a minor drug used in the treatment of white spots on the skin. Merck (37) p. 670 states that psoralen is 8-methoxyl (furano - 3' .2' : 6.7 - coumarin) and so should be reducible. However, other reducible components might interfere unless the half-wave potentials were very different.

Grifolia umbellata - Li-wen Wang et.al. (59) studied the diuretic effect of Grofolia umbellata on dogs. They found that it produced marked increase in urine output and an increase in excretion of NaCl and KCl. This is another minor drug used in the treatment of certain types of edema.

Oldenlandia - Ch'u-ts'ang Ts'ai et.al. (60) investigated components from the alcoholic extraction of Oldenlandia diffusa (Willd) Roxb I. They claim isolation of four components: hentriaconitine, stigmasterol, ursolic acid, and oleanolic acid. These are all well-known. They also claim three other components as yet unidentified.

Aralia roots - K'o-chih Fu et.al. (61) investigated the products obtained from the root and stem bark of Aralia mandshurica Rupr. et Maxim. These roots have long been used in Chinese medicine in the preparation of general tonics. The root barks are known as Tz'u-lao-ya in China. Very little information is given about this investigation.

Rehmannia - Ming-yu I, Wen Chu and An-k'un Kuang (62) studied decoctions of Rehmannia glutenosa on rats suffering from renal hypertension. They claim reduction of blood pressure with this drug, also improved renal function and decreased mortality. However, no components are identified.

Tea or TEA - Kuo-chu Chao and Ch'ung-chia Hu (63) investigated the effects of four anticholinestarase agents on the hypotensive action of tea or TEA. It is not at all clear whether they were using ordinary tea or tetraethyl ammonium chloride which is a well known hypotensive drug and often listed as TEA chloride (see Merck (37) p. 1022.) At any rate, they found that neostigmine, lycoramine and galanthamine reversed the hypotensive action but eserine had little effect.

Chinese rhubarb - Ch'iung-hua Ch'en et.al. (64) studied the antibacterial action and stability of solutions of rhein and emodin obtained from Chinese rhubarb. Both of these are anthraquinone derivatives and well known. They report on neutral solutions of these compounds but fail to mention the solvent. They are very insoluble in water but soluble in NaOH, Na_2CO_3 and ammonia and sparingly soluble in organic solvents. They found that solutions of rhein and emodin inhibit S.aureus but are not bactericidal. Riboflavin, folic acid, and nicotinic acid are strongly antagonistic to the action of rhein and emodin.

Miscellaneous drugs - Two studies (65, 66) were made on plants used in folk medicine of China. One (65) was on the seeds of oroxyleum indicum (L) Vent. (Bignoniaceae) which have been used in preparation of liniments and the other (66) on the essential oils from Cinnamonum glanduliferum Meissn and Cinnamonium bodinieri Levl. Neither of these uncovered anything new or startling.

SUMMARY

Nothing really significant came out of these studies of plant products. The Chinese are studying all sorts of folk remedies in an attempt to identify the active ingredient or ingredients in roots, stems, and leaves. This is laborious work but may turn up something significant in time, allow the synthesis of a drug usually obtained from natural products, or provide a substitute for imported drugs. Any of these goals might improve the economy of China.

V. PSYCHOCHEMICAL AND BIOCHEMICAL AGENTS

Ju-yun Chi (67) points out that emphasis has shifted in Western and Chinese work from searching for agents to be used against infectious diseases to a search for treatment of psychoses, cancer, and geriatric diseases. For example, he points out that imipramine and amitriptyline are used against depressive psychosis rather than electric shock and insulin therapy, while chlorprothizene and chlopenthixene are used against manic-depressive psychosis. This is very much more optimistic than Western reports because it ignores side effects and effects of prolonged treatment. It is also strange that in a country as overpopulated as China that serious effort is given to geriatric diseases.

Reserpine - Three reports were found (68, 69, 70) dealing with reserpine, its physiological effects, and its therapeutic use as a tranquilizer. One familiar with works such as: Nathan S. Kline, Psychopharmacology, Amer. Assoc. for Adv. of Science, Washington, D. C. 1956 will find nothing new or startling in these reports. The Chinese view that experimental work on dogs, mice and rats may replace clinical studies on humans is perhaps naive.

Diacetylneriifolin - K'ai-li Lo et.al. (71) found that acetylation of neriifolin produced a product that is less potent than neriifolin and it acted more slowly. It is a central nervous system depressant in pigeons but nothing is reported about its effects on man.

Antabuse - Yu-wen Yu et.al. (72) report on the effect of antabuse on the subsequent administration of pentobarbital. Experimental animals (mice and rats) slept longer when they were given a dose of antabuse 2-12 hours before pentobarbital than did the control animals who had no antabuse. Antabuse reduces the hepatic glycogen content but has little effect on liver ascorbic acid level. Antabuse has long been used in the treatment of acute alcoholism but there is no indication in this report that it was concerned with this use.

Derivatives of N-phenylpiperazine - Ch'i-ting Chou and Ju-yun Chi (73) investigated derivatives of N-phenylpiperazine as depressants of the central nervous system. They were interested in a series of indolylalkylphenylpiperazines. Changing the alkyl group on the indole moiety or the phenyl group caused some change in the strength and specificity of the compound but if the phenyl group is removed or replaced by an alkyl group, almost all central nervous system effect is lost. This may be very significant in indicating a sophistication in difficult syntheses of this class of compounds.

CHINESE INDUSTRY

There can be no doubt that Communist China is making every effort to increase its production of food (particularly sugar, pork, rice, and salt), fertilizers and insecticides, fibers (cotton and synthetics), machinery, and ammunition. It has had serious weather problems which have hurt agricultural production and floods have hurt the production of salt.

However, it appears that China is so eager to get into production that it is by-passing adequate pilot plant studies before building plants. Western experience has shown that this can lead to serious delays, products of poor quality, and waste of raw materials and machinery unless they are copying a well-established plant procedure which has already been worked out in Japan, Russia, or the United States.

For example, the Linz Nitrogen Co. of Austria is receiving license fees for production of a new fiber, acrylnetril. The plant is being built in China by LURGI of Frankfurt, West Germany (74). This plant is designed to produce 10,000 tons annually.

Japan is exporting to China a number of raw materials (75):

Benzene, 22,000 tons now and another 30,000 tons later. This is urgently needed for production of polystyrene, paints and cleasing agents.

Polyethylene, high pressure film and resin (1,000 tons). (76) This is the first time Japan has furnished such materials to China. China is shipping sulfur to Japan in partial payment.

Octanol, Japan has shipped already 2,100 tons and is considering an additional order for 500-600 tons. (77)

Dioctylphthalate, DOP, (77) Japan has shipped 1,760 tons of DOP or will have by October 1966. This is needed in the production of vinyl plastics.

SYNTHETIC FIBERS

Chinese claim that a number of synthetic fiber plants are now in production (78). No details are given but it is likely that these are vinyl plastics for raincoats and protective clothing (79), plastic fibers for fishing nets and foam rubber for life preservers (79). They are working on phosphonitrilochloride-phenol polymers and resins (80) but there is no indication that they are in production as yet. They do claim production of polytetrafluoroethylene resin which is sold in this country as Teflon. This is being produced in Shanghai.(81) China also claims production of acrylonitrile, polyacrylonitrile, low-pressure polyethylene and polystyrene in Shanghai (82). They state that these are made from petroleum waste products.

This report may be suspect because it is known that Russia has just concluded an agreement with Japan (83) for export of a large acrylonitrile plant (150 ton/day). This report also states that this is the first time acrylonitrile techniques have been exported by Japan. If the Chinese did not get them from Russia or Japan, where did they get them? The chemical technology of China is certainly inferior to that of Russia and yet Russia has to buy plant and know how from Japan.

COAL TAR CHEMICALS (84)

It is claimed that the Shanghai Coal Tar Chemicals Plant (84) is producing a number of coal tar chemicals:

a-methyl naphthalene for use as dye carrier and for preparation of plant growth hormone, naphthalene acetic acid. They state this is an oily liquid with m.p. less than -20°C. (Correct value is -30.8°C).

b-methyl naphthalene for use in preparation of vitamin K. They do not state which vitamin K they make. (K_1, K_2, K_3, K_4, K_5, K_6, or K_7?).

Carbazole, 9-Dibenzo (b,d) -pyrrole, for use as dye intermediate. They claim 95% purity of the product.

<u>1, 2, 4 trimethylbenzene</u>. This is sold in the U. S. as pseudocumene and is used in manufacturing dyes and perfumes. The Chinese claim the same uses for their product which they say is 98% pure.

<u>Benzene</u> - They claim the following quality standards:

Specific gravity 20/4°C 0.877 - 0.880 (U.S. 0.879)

Crystallization points greater than 5.3°C (U.S. 5.5°C)

Thiophene - less than 0.0005 %

Initial distillation point - over 79.8°C (U.S. 80.1°C).

If this is true, it is equal to the best benzene produced in the U.S.

<u>Phenanthrene</u>, $C_{14}H_{10}$, isomeric with anthracene. They claim their refined product has melting point 98 - 100°C (U.S. 100°C). They state only experimental use of this product.

<u>Quinoline</u> - C_9H_7N, benzo (b) pyridine. This is a commercial grade used as raw material for nicotinic acid synthesis and also as a solvent for resins and oil of turpentine.

<u>Anthracene</u>, $C_{14}H_{10}$, isomeric with phenanthrene. Used for synthesis of anthraquinone dyes.

<u>Acetnaphthene</u>, (?) It is not clear what this compound is. No formula is given and it might be a naphthenic acid: They give melting point 93 - 95°C.

<u>Diphenyls</u>. This is another vague reference. Diphenyl itself is obtained from coal tar and has a melting point of 69°C. They say their product melts over 64°C. They state that they use it as raw material in plastics and for treating paper in which fruit is wrapped.

<u>Indoles</u>. This is another vague reference. They give the melting point as over 45°C. Indole itself has a melting point of 52°C. However,

they say that a purified product has a melting point over 78°C. They say it is used as a perfume stabilizer.

Summary:

It seems evident that the Chinese have a reasonably good coal tar chemicals industry judging from the variety and quality of products which they report. However, no production figures are given and one cannot judge from the references here as to the volume produced. References 85, 86, 87 and 88 give reports on industrial production but all of these cite percentage increases over previous production without giving previous production figures, so they are largely meaningless. It seems that the Chinese give percentage figures when production is small and tonnage figures when it is large. The chances are that coal tar chemicals are in light production.

CHEMICAL FERTILIZERS

The Chinese have a number of chemical fertilizer plants in different parts of the country: Canton, Shanghai, Liaoning province, Lan-chuo, Dairen, Kirin, Peiping. (89, 90, 91, 92, 93).

Urea, they claim that the Shanghai plant is producing 40,000 metric tons annually.(89) Plants are also said to be producing urea in Liaoning province, they claim fifteen new plants have been built since 1958 but give no production figures.

Ammonia. They claim (91) that 14 large and small plants in Lan-Chuo, Dairen and Kirin are producing synthetic ammonia. Only percentage figures are given and so the production is probably small.

Ammonium sulfate and ammonium phosphate. The Chinese appear to be using urea to an increasing extent in place of ammonium salts because of the higher percentage of nitrogen in urea. They are still producing some but no figures are given.

The Chinese proudly claim that 1,870 small plants are producing chemicals in various parts of China but no production figures are given. There are strong indications that this approach to production has been a dismal failure, as it was in the production of steel. It is evident that China is desperately lacking in enough fertilizer for its crops and will have a food shortage for some years to come.

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