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THE INTER-RELATIONSHIP OF HUMAN AND ANIMAL HEALTH AND DISEASE

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I INTRODUCTION

The biological adventurousness of animal diseases is exceeded only by the insatiable adventuresomeness of man. The struggle of the infectious diseases of lower forms of life to adapt themselves to more highly developed hosts is unending. As these disease agents insure their continued existence by adapting themselves to a broader host spectrum, they become a greater threat to man's well-being. Man, in his most tenuous position on this earth, has been able to protect himself from this biological onslaught only by his skill in developing the preventive medical practices that are the foundation of our present public health practices.

In this century man has made greater progress in holding back or eliminating infectious diseases than he had made before in the eons since he appeared on th s earth. Progress in the control of host specific human diseases, like smallpox, diphtheria, cholera, epidemic poliomyelitis, typhus and syphilis, has allowed more attention to be given to animal disease problems which affect human health.

Animal diseases threaten man's health and well-being in many ways. To examine the importance of animal health to human health it is well for us to consider the WHO definition of health as a guide: "Health is not the mere absence of disease or injury... it is a state of complete physical, mental and social well-being". The contributions that veterinary medicine can make in reaching the WHO objective are succinctly presented in the definition of veterinary public health "... comprises all the community efforts influencing and influenced by the veterinary medical arts and science applied to the prevention of disease, protection of life, and promotion of the well-being and efficiency of man".

The definition of health as established by WHO provides a very broad framework upon which to develop this theme. How veterinary medicine will participate in protecting the public health and welfare is well expressed in the broad definition of veterinary public health - and the inter-relationship of disease and health in man and animals provides a challenge that tests the imagination, ingenuity, and knowledge of man.

Freedom from disease is a goal that man has striven for since the beginning of civilization. The plagues that decimated human populations have been exceeded only by those which destroyed large domestic animal populations. The cause of these various epidemics and epizootics are

not known except for the Black Death or plague of the middle ages. No doubt plague (Pasteurellapestis) was the most serious animal disease that threatened human health. Plague threatened to destroy civilization for a thousand years or more after the fall of the Roman Empire's organized preventive medical efforts.

The elimination of plague from the urban areas of the world has removed probably the most important animal disease threat to man. This was certainly one of the outstanding preventive medical achievements of our times. Success came with the unravelling of the natural history, the epizootiology and the epidemiology of plague and the development of rodent control. At the same time influences which it has not been possible to measure have also been at work: the social advances throughout the world which have resulted in higher standards of living for mankind. Public health has certainly contributed to these advances by the development of environmental sanitation standards, nutrition and health education, but economic conditions have also had their influence. Better housing, more room per family and per individual; availability of hot and cold water within the home; improved clothing including footwear, frequent changing and washing of clothing, better working conditions in industry and on the farm; longer leisure time including vacations - all these influence disease patterns. How have these influences affected other animal diseases that concern man? There are more than 200 diseases of animals that are infectious or communicable. They are variable as to their host specificity but there is evidence that more than 100 of the group are transmissible to man under certain conditions. These include infections caused by viruses, rickettsiae, bacteria, fungi, protozoa, helminths and arthropods. Inasmuch as our time for discussion is limited,an attempt will be made to select prototypes of the various zoonoses that are direct threats to man's health as well as those that limit his advancement and development economically.

II ENCEPHALITIS

The arthropod-borne encephalitides are of great concern to all the world. These infections are a variable health problem both to man and animals but frequently can explode with a devastating biologic effect. Twenty-five years ago there were outbreaks in North America that caused hundreds of thousands of equine cases and hundreds of human infections. More recently there have been epizootics that would have affected just as many animals if it were not for the rapid decline of the horse and mule population. Even though this disease is no longer a major threat to

farm power animals it remains a public health problem. In 1952, California alone had almost a thousand human cases of western equine encephalitis. Only two years ago, Florida had an explosive outbreak of St. Louis encephalitis. This year the incidence of various kinds of encephalitis across the United States, including St. Louis, Eastern and Western, in man and animals may be the highest in years. The discovery of Venezuelan encephalitis virus in 1962 in areas bordering the Gulf of Mexico has raised a new problem. The United States Public Health Service's Communicable Disease Centre has intensified its efforts to unravel the epidemiology of the arthropod-borne encephalitides. Teams of investigators consisting of veterinarians, physicians, entomologists, ornithologists, and engineers have all worked together toward a solution. Kissling[(1)] and Chamberlain[(2)] have developed some new concepts on the epidemiology and kinetogenesis of the disease.

Kissling's investigations point out that mammals, including horses, do not circulate enough virus in their blood during the viremic phase of the disease to be of any importance as a source of virus for arthropod vectors of Western Equine Encephalitis and St. Louis Encephalitis virus. Horses do have a viremia with Eastern Equine Encephalitis infection that may occasionally provide an infective blood meal for mosquitoes. Birds, on the other hand, are an excellent source of virus for mosquitoes when infected with St. Louis, Western and Eastern Equine Encephalitis virus. During endemic phases of the disease the isolation of EEE virus from birds is usually limited to those species preferring moist woodlands: thrushes, catbirds, grackles. Under epidemic conditions the virus is found in birds which usually inhabit open areas and meadows: sparrows, finches, cardinals, pigeons and pheasants. As Kissling points out, surveillance for infection in these open area inhabitants could probably furnish warning that epidemic seeding is occurring.

Proof of such an hypothesis must await an opportunity. In the meantime, there is another question to be considered - the host parasite relationship. What effect the host has on the virus, or the virus on the host during the endemic and epidemic periods may provide public health scientists with an explanation of why the disease changes its character periodically from an endemic to an epidemic form. It is not definitely known whether or not there is a kinetogenic mechanism, which adds to the virulence of invasiveness of the agent favouring epidemic

spread, or whether an epidemic is solely dependent upon favourable circumstances where virus, mosquitoes and birds come together in sufficient quantity to allow a rapid spread of virus. But Kissling has encountered EEE virus under endemic conditions that produced inapparent infection and only titered $10^{3.8}$ to $10^{5.5}$ LD_{50}. Likewise a strain of SLE virus isolated from a bird during an epidemic in Kentucky produced a higher viremia than California strain recovered during an endemic period.

In experimental infections of song birds performed at the Communicable Disease Centre, virus has never been recovered from these birds later than two weeks after challenge except in two instances when the St. Louis virus was used. The antibody response with Eastern and Western Equine Encephalitis virus is good and persists for a long period, but the response to St. Louis virus is poor and has stimulated inquiry on the latency characteristics of this latter virus.

Working on the hypothesis that the latent virus may be masked in some form, a limited experiment was carried out in which the tissues of sparrows which had recovered from St. Louis infection were grown in tissue cultures. This allowed the tissues to free themselves of antibody which in turn would prevent a growth of virus in the proliferating cells. These experiments did not yield virus. The question of latency in the vertebrate host cannot be dismissed until many other possible mechanisms are explored.

In control of the arthropod-borne encephalitides the vertebrate hosts have been overlooked during the past decade, although earlier veterinary epidemiologists had considered the prevention of disease in horses and mules as the only practical measure in the control of the virus level in nature. Kissling now suggests that the habitat of the various encephalitis viruses is such that control by mosquito abatement alone is unlikely. It is only under unusual circumstances that human infection would be expected to result from an exposure to mosquitoes feeding on swamp inhabiting birds. It is those birds which live close to man that are the more likely source of virus for man and his domestic animals. Hence the control of pest and feral birds such as starlings, English sparrows and pigeons is suggested when the disease threatens a community. This procedure must await an opportunity for field tests before it can be applied as an epidemic control measure.

A combined attack on both the vectors and epidemic hosts of the encephalitis viruses should reduce the activity of the virus to levels that would prevent disease in man and horses. Naturally more information on bird populations and virus concentrations is needed to determine what the kinogenesis of an epizootic may be.

Chamberlain[2] has developed a hypothesis that may cast further light on the natural history of St. Louis encephalitis, in which he attempts to explain the difference in the behaviour of the disease in western and eastern North America. He points out that certain mosquitoes such as Culex tarsalis and other Culex species are much more susceptible to St. Louis virus infection than Aedes and Psorophora in which it hardly develops. Hence, there is little natural selection for strains that produce a significantly high level of viremia in birds. As a result the virus strains being distributed in nature by the C. tarsalis etc. produce viremias which are usually at too low a level to infect other mosquitoes. The major outbreaks have coincided with big C. tarsalis populations and most of the cases are in rural areas. This results in pin-pointing the responsibility for St. Louis encephalitis to C. tarsalis.

In the mid-west a different epidemiological picture is encountered. C. tarsalis is scarce or absent. Here St. Louis encephalitis is urban in character and occurs in years when there have been a large number of Culex pipiens or Culex quinquefasciatus. These mosquitoes rarely find suitable conditions for breeding in the rural areas. The kinogenesis of an urban epidemic is quite evident: infected wild birds probably introduce the virus to areas highly populated with C. pipiens or C. quinquefasciatus which rapidly spread it to city-dwelling birds and fowl. These, in turn, serve as a ready source of infection for additional numbers of the mosquitoes. A consequence of the resultant epiornithic is exposure of a large number of people to infection via mosquito bites.

Chamberlain concludes that possibly only St. Louis encephalitis gives promise of inexpensive effective control.

The inter-relationship of the arthropod-borne encephalitis is apparent and it is also obvious that this is a problem that needs continued investigations. There is definite need to obtain further

knowledge that will lead to effective control. Phases which have not been discussed but which are also under study include the overwintering mechanism and the influence of meteorologic and immunologic factors on diseases kinetogeneses.

III TUBERCULOSIS

The arthropod-borne encephalitis which has been discussed is an example of the variables that public health workers throughout the world must face so far as animal diseases are concerned. An animal disease problem which will emphasize the benefits in a positive sense will now be reviewed. Bovine tuberculosis was the first major public health challenge to veterinary medicine, and to the everlasting credit of veterinary medicine it can be stated that they recognized their responsibility and attempted to eliminate the disease. The control of tuberculosis among cattle in the United States is one of the outstanding preventive veterinary medical achievements of our times.

Although the goal of complete eradication has not yet been reached, progress has been noteworthy. About 378 million tuberculin tests have been made on cattle in the past forty years, and just over 4 million reacting animals found and sent to slaughter. In almost every year since the eradication campaign got under way in 1917, the incidence of the disease, as indicated by tuberculin tests results, has been reduced below the level of the previous year. In 1918 - the peak year - nearly 5% of the animals tested were found to be infected with tuberculosis. In some milk sheds the rate of infection at that time ranged from 25 to 50%. By 1956, the rate of infection for the country as a whole had declined to 0.15% - 3 reactors out of every 2,000 cattle tested(3) and in 1964 to 0.10 or one reactor per 1,000 animals tested.

A gradual reduction from year to year, in the number of cattle carcasses that show lesions of tuberculosis under Federal meat inspection (not including reactors sent for slaughter) has coincided with the decrease in percentage of reacting cattle. It has been calculated that close to 100,000 carcasses would have been condemned as unfit for human consumption last year if bovine tuberculosis had remained unchecked since 1917. The actual number so condemned was less than 150. Savings from this source alone are estimated at $150 million annually. The total expenditure for the eradication

programme over the years has been $326 million. Thus, in two years, the programme saves almost as much as has been spent for it in forty years. However, despite these signs of major progress, bovine tuberculosis still occurs in the United States and even though the rate of infection is very low some 15,000 infected animals (reactors) are identified annually in a population of 108,000,000 cattle.

Since the entire nation reached a modified accredited status, a tendency toward complacency among members of the livestock industry in some areas and among some regulatory groups has been deterring the eradication effort. Research, education and improved testing procedures have helped to bring the incidence of tuberculosis among cattle to an extremely low level in this country. Further research and education - particularly the kind of education that counters apathy - will be needed to accomplish eradication.

In many States there is a close working relationship between public health officials and State and Federal livestock sanitary officials, who keep each other fully informed of any possible relationship of tuberculosis in humans and in animals. This close contact should be extended to all States. A sudden realization that a few herds are riddled with tuberculosis alerts the general public to the dangers of allowing a little infection to remain uncontrolled. We are confident that public health groups are aware of and sympathetic to this problem.

The benefits accrue from such a programme to everyone - through better health and nutrition - to those who live in cities as well as those in rural areas. In recognition of this, it was realized that the Government should compensate the farmer and rancher for any diseased animals that were removed, so that the cost is shared by the entire citizenry.

The positive values received by the nation are innumerable. Bovine type tuberculosis in man is almost unknown today in America. Since 1954 only one proved human case has come to our attention. Today, the risk of human tuberculosis being transmitted to cattle is much greater than that of bovine type tuberculosis being transmitted to man. Freedom from tuberculosis in American cattle has also allowed the rancher and farmer to improve his herds to the point where production is the greatest in history. The cattle population of the United States

now exceeds 108,000,000. The increase in recent years has been in meat type animals. Dairy animals have dropped in numbers but their total production has increased. All of this has contributed to the health and welfare of man, not only in the United States but in many other parts of the world. It surely is an outstanding example of the implication of health as defined by WHO "Health is not the mere absence of disease and injury.... it is a state of complete physical, mental and social well-being".

The tremendous strides in the control of bovine tuberculosis in other areas of the world have also furthered the welfare and health of man. Denmark, Finland, Norway and Sweden are to be commended for their achievement in animal tuberculosis control. The rapid advances toward elimination of the disease in Great Britain, Holland, Switzerland, Portugal and parts of Germany and France in recent years are also to be commended and epitomize veterinary medical contributions to the public health. More recently some countries of eastern Europe have developed bovine tuberculosis control programmes.

IV BRUCELLOSIS

Brucellosis is an excellent example of the interrelation of human and animal health and disease. In some countries - Sweden, Norway, Denmark and Finland - it has been brought under control, while in others impressive advances are being made, namely: The Netherlands, Canada and United States. In all of these areas the decline in the infection rate among cattle is reflected in the reduction of reported human disease(4). Up to a decade ago in the U.S.A., it was estimated that the brucella infection rate among dairy herds varied between 10 and 30% involving 5 to 15% of the lactating animals. In 1947 more that 6,000 human cases were reported. This was the highest number ever recorded. Since then there has been a steady reduction in both animal and human infection. During 1963, a total of 1.1 million herds and 15.6 million cattle were blood tested, a decline from 1953 of 2.7 and 8.4% respectively. On the other hand, 1.8 million herd ring tests were performed - an increase of 23.1% over 1955. During the same year 4.9 million government vaccinations were made - an increase of 8.5%(5). The data are cited to reveal the magnitude of the task of eliminating brucellosis. The infection rate among cattle based upon blood tests alone dropped from 2.5 in 1955 to

1.9% in 1956 and the affected herds declined from 14.4 to 11.9%. For the year 1956, 12.6% of the brucellosis ring tested herds were suspicious. This was 6.5% below the 1955 rate. The 1957 and 1958 rates of infection have also continued to decline. There are now 18 States with less than 1% infection rates.

The farmer and rancher receive this service at no expense and are reimbursed in part for any infected cattle that are removed. The benefits to man are obvious.

One may wonder about the prevalence of brucellosis in other domestic animals. The problem in swine (3.3% infection rate) is important and steps are now being taken to eradicate it. This should not be nearly as difficult or expensive as it is in cattle. Fortunately, there is widespread support for a swine brucellosis eradication programme, which means it will move along rapidly. So far as sheep and goats are concerned, there is no brucellosis problem. Twenty years ago the disease was not uncommon in goats, but it was eliminated by slaughtering the infected herds. Fortunately, brucellosis is exceedingly rare among sheep and constitutes no hazard to man from that source. Occasionally evidence of brucellosis has been found in some wild animals, but they are not considered to be a reservoir. The eventual eradication of brucellosis in the United States is a foreseeable objective - 1965 is the goal for modified accredited (less than 0.5% reactors) and 1975 for total eradication. Its conquest will further implement the WHO definitions of health and veterinary public health.

The importance of animal health to the physical, mental and social well-being of man is just as obvious as the control of animal diseases in the prevention of the transmission of certain zoonoses to man. Foot and mouth disease is an example of an infection which rarely threatens the public health directly but can create havoc in any area of the world where it becomes established. It is unfortunate that many areas of the world have developed an apathy toward the infection and are living with it. The elimination of this disease in Europe and Asia would result in many benefits that would further man's position. It certainly is not an impossibility, but leadership must come from the veterinary medical profession.

Next, I would like to touch on a group of diseases that do not have as great an impact on the overall economy and public health as do the problems that have been under consideration. These are the zoonoses that are commonly found among pet animals. Veterinary medicine has made substantial contributions in this area and no doubt will continue to as long as man continues to express his affection to his animal companions.

The dog and cat have both contributed much to the prevention of disease and injury in man as subjects of research. The experimental approach to disease control, the understanding of physiology and pharmodynamics, the development of surgical procedures would have been very difficult without the contribution of these smaller animals. Naturally, when animals are used experimentally, this should be done as humanely as possible. Here again veterinary medicine is responsible for providing leadership and guidance in the humane handling of these valuable research subjects.

Aside from the direct contributions of small animals to medical research and disease prevention, animal pets often contribute substantially to the mental and social well-being of man as a companion. None need look further than their own household to ascertain the impact of the pet dog, cat or bird on the family. Any injury or illness of pets is the concern of everyone. When this is multiplied by millions of animal pets such as exist in the United States one can begin to realize the public health significance. The most recent census estimate in America is:

Dogs	28 million
Cats	20 million
Birds	15 - 20 million

V RABIES

The public health importance of a pet animal reservoir of the above size is significant. By far the most important zoonoses among pet animals is rabies. Rabies has been recognized in North America for at least 400 years. It has been a public health problem during all of this period. In recent years good control has been effected by the use of canine immunizing agents. This is especially true in urban and suburban areas where the greatest number of dogs are found. In rural areas the disease is enzootic in foxes, skunks, raccoons and bats as well as other wild animals.

The eradication of rabies in the United States has been a public health objective for the past decade. Progress has been made in most areas. The United States are relatively free of dog and cat rabies although wild animal rabies is not uncommon and even epizootic in some areas.

Rabies as a public health problem cannot be measured by morbidity and mortality, which are one and the same in this case. It can be measured in part by the mental anguish of all persons concerned, including the patient, the family, the physician and the health authorities. The number of people bitten by animals in a country as large as the United States is difficult to determine, but recently the California State Public Health authorities[6] completed a survey of health and accident problems. They reported that next to non-fatal automobile accidents, animal bites were the most frequent accidents encountered. They estimated that more than 230,000 persons were bitten in 1956. In one county, Los Angeles, 36,000 people received bites. Of this group, 12,000 required investigation by the health authorities. Eventually more than 1,000 were required to take anti-rabies vaccine. The time and expense involved in a community when rabies is rampant is much higher than one would realize. Some local health officials state that as much as 25% of their budget may be expended on rabies during an epizootic period. The anguish that rabies brings to any community does not comply with health according to the WHO definition. Veterinary public health leadership is certainly needed to meet the problem.

VI OTHER ANIMAL DISEASES

There are other animal diseases that affect the pet companions that are also important and that will be discussed by eminent authorities at this meeting. These include leptospirosis, toxoplasmosis and the dermatophytoses. Leptospirosis is a common disease among dogs in the United States, often appearing in epizootic waves. Fortunately it has not spread to man as often as one would expect. This is also true of the leptospiroses among large animals.

The dermatophytoses are a challenging problem because they are so widespread among animals and man. We consider the animal dermatophytes one of the most common zoonoses. As the small animal populations increase these diseases will assume greater importance.

VII CHRONIC DISEASES

The chronic diseases of small animals as well as of large domestic animals have a less direct influence on man's health status but indirectly they may play a very important role in resolving health problems that forestall the fulfillment of our definition of health. The importance of research on chronic diseases including cancer, heart disease, atherosclerosis, and aging process in animals is well appreciated by this audience. The former Surgeon General of the United States Public Health Service, Dr. L.E. Burney, emphasized this in an address a few years ago to the American Veterinary Medical Association as follows:

> "Probably the greatest opportunities, however, can be found in the chronic diseases. Public Health programmes in the chronic diseases are getting under way in many communities. These programmes consist largely of prevention of certain diseases, of retarding the progression of others through early detection and diagnosis, and of mitigating their effects through rehabilitation.
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> "Much work needs to be done in each of these fields and in perfecting the application of new techniques and procedures.
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> "In addition, considerable research - of a basic, clinical, and applied nature - is called for. Such research has expanded greatly, in government laboratories as well as in universities and private research centres. I am sure much of it is known to you, since many of the problems are common to both veterinary medicine and public health.
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> "In the field of heart and vascular diseases, for example, there is a need for comparative study of these diseases in animals. A number of cardiological research projects are now under way in various veterinary medical research centres in the United States. Some of these are supported by research grants from the Public Health Service. Among the projects under study are the extent of atherosclerosis in dogs; the anti-clotting mechanism of various animals which prevents thrombosis; and attempts to simulate rheumatic heart disease in dogs. If veterinary science can gain an

"understanding of the mechanism which prevents experimental heart failure in dogs, this can contribute a great deal to the management of rheumatic disease and its complications in man.

"Practically every type of malignance found in man is encountered in animals. This provides opportunity for epidemiological studies of naturally occurring diseases. Some of these diseases behave in a pattern similar to that in man, while others differ. Leukemia in birds and cattle, for example, seems to show an epidemic pattern. The reported break-through in avian leukemia, with the use of a new immunizing agent, is being watched with increasing attention. The development of these agents can permit research workers to expand their studies on the prevention and treatment of certain forms of cancer under controlled conditions.

"As you know, the problem of the aged in our country today is being viewed with increasing concern by health workers as well as by other groups. How can we extend and enrich the active life of the aging? That question encompasses a host of interrelated problems.

"The basic answers must be sought in better understanding of the biology of aging. The complex nature of the problem of aging, the multiplicity of scientific disciplines involved in their study, and the relative scarcity of trained scientists to work in this field, have absorbed our attention in the Public Health Service.

"Here, indeed, is an emerging field of great promise for the veterinary profession. The study of factors influencing the aging process in animals will add greatly to our knowledge of aging in man. An increasing number of scientists are planning to launch studies in comparative medicine, to include all species of animals in the study of the aging process.

"As you know, research in aging must be sustained and long-range. In plans to augment our own research efforts in the field of aging, the Public Health Service is assisting in the establishment of several large regional research centres operated by universities.

"Such centres for research in aging visualize large-scale and integrated studies, utilizing the skills and knowledge of a variety of disciplines. Undoubtedly, veterinary medicine would have a place in a comprehensive research programme on the problems of aging. Veterinary research centres can contribute a great deal to such a cooperative effort, especially where there are medical centres on the same campus".

The challenge to veterinary medicine in meeting these new areas of operations is obvious. To get on with the task is the immediate problem. This will require mature planning in all fields concerned with these challenges that Dr. Burney has defined so well. No one group can accomplish this alone - to pull together requires a new type of investigator. One who has a broad interest in many aspects of disease and the imagination to translate knowledge into application. Comparative pathology met this challenge very well at the beginning of the age of bacteriology. Theobald Smith, William Osler, Karl Mayer are all legendary medical biologists who had that insatiable interest in everything that was related to disease. The challenge to present investigators is to carry on - not only in communicable diseases but in chronic disease and those that debilitate man. The public health investigator who opens his eyes to these problems will not want. His rewards will be great.

REFERENCES

1. Kissling, R.E. (1957). Host relationship of the arthropod-borne encephalitides in North America. Proc. N.Y. Acad. Sci. Conf. on Animal Disease and Human Health, Vol. 70 Art. 3, p. 320-327, June, 1958.

2. Chamberlain, R.W. (1957). Vector relationships of the arthropod-borne encephalitides in North America. Proc. N.Y. Acad. Sci. Conf. on Animal Disease and Human Health, Vol. 70, Art. 3, p. 312-319, June, 1958.

3. Steele, J.H. & Ranney, A.F. (1957). Animal Tuberculosis. Amer. Rev. Tuberc., Vol. 77, No. 6, June, 1958.

4. Steele, J.H. (1957). Observations on the epidemiology of human brucellosis in the U.S. Proc. Inter-American Brucellosis Congress. In press.

5. Mingle, C.K. (1957). Progress report on Cooperative State-Federal Brucellosis Eradication Programme. U.S. Dept.of Agric. Presented at the National Brucellosis Committee Annual Meeting, Chicago, Illinois, February 14, 1957.

6. California. State Dept. of Public Health (1957). California surveillance report, Berkeley, Calif., April 30, 1957.