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FLY CONTROL IN EGYPT

Riassunto. — Diverse preparazioni di DDT, di BHC e di chlordane, e diversi metodi per l'applicazione di questi prodotti sono stati studiati per la lotta contro le mosche nelle condizioni che si riscontrano in Egitto, nelle regioni rurali.

Il chlordane e il BHC si sono mostrati più efficaci del DDT.

Per l'applicazione del DDT sui muri di mota delle case rurali le polveri in sospensione acquosa hanno dato migliori risultati delle soluzioni od emulsioni. Si è constatato che era possibile combattere efficacemente le mosche sia con il BHC, sia con il chlordane applicando questi prodotti unicamente sulle superfici ove l'insetto depone le uova e sul terreno.

Ceppi di mosche resistenti alle azioni degli insetticidi sono apparsi nei dodici mesi che hanno seguito la prima applicazione di BHC. In seguito ad applicazioni ripetute di BHC e di chlordane in diversi villaggi durante tre anni, le mosche sono diventate estremamente resistenti a questi insetticidi.

Le popolazioni di mosche non sono notevolmente diminuite in un villaggio ove le materie sulle quali questi insetti potevano deporre le uova furono evacuate due volte la settimana.

Nel 1953, quando già da due anni erano stati introdotti i trattamenti insetticidi, si è proceduto in Egitto ad un'inchiesta sulla resistenza delle mosche domestiche rispetto a questi prodotti; si è constatato che non vi era nessuna resistenza seria. In un villaggio, si è effettuata recentemente una polverizzazione di superfici sulle quali queste mosche possono deporre le uova, con lo scopo di accertare se la distruzione di questi insetti sia ancora possibile per mezzo del BHC.

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(2) **The opinions or assertions contained herein are the private ones of the writer and are not to be construed as official or reflecting the views of the Navy Department or the naval service at large.**

Uno studio è attualmente in corso sui prodotti suscettibili di attirare le mosche domestiche e sui mezzi pratici di distruggere gli insetti così richiamati.

Il Ministero egiziano della Sanità ha iscritto nel suo programma l'organizzazione di campagne di bonifica e di educazione sanitaria con lo scopo di lottare contro le mosche domestiche.

Résumé. — Différentes préparations de DDT, de BHC et de chlordane, et plusieurs méthodes pour l'application de ces produits ont été étudiées en vue de la lutte contre les mouches, dans les conditions qui se rencontrent en Egypte dans les régions rurales. Le chlordane et le BHC se sont montrés plus efficaces que le DDT. Pour l'application du DDT sur les murs de boue des maisons rurales, les poudres mouillables en suspension aqueuse ont donné de meilleurs résultats que les solutions et les émulsions. On a constaté qu'il est possible de combattre efficacement les mouches soit par le BHC soit par le chlordane, en appliquant ces produits uniquement sur les surfaces où l'insecte dépose ses oeufs et sur les sols.

Des souches de mouches résistant à l'action des insecticides sont apparues dans les douze mois qui ont suivi la première application du BHC. A la suite d'applications répétées du BHC et de chlordane dans plusieurs villages pendant trois ans, les mouches sont devenues extrêmement résistantes à ces insecticides.

Les populations de mouches n'ont pas notablement diminué dans un village où les matières sur lesquelles ces insectes pouvaient déposer leurs oeufs furent évacuées deux fois par semaine.

En 1953, après que les traitements par les insecticides ont été interrompus pendant deux ans, on a procédé en Egypte à une enquête sur la résistance des mouches domestiques à l'égard de ces produits: on n'a constaté aucune résistance sérieuse. Dans un village, on a récemment effectué un poudrage des surfaces sur lesquelles ces mouches sont susceptibles de pondre, afin de déterminer si la destruction de ces insectes est encore possible au moyen du BHC.

On procède actuellement à une étude sur les produits susceptibles d'attirer les mouches domestiques et sur les moyens possibles de détruire ces insectes ainsi appâtés.

Le Ministère égyptien de la Santé a inscrit à son programme l'organisation de campagnes d'assainissement et d'éducation sanitaire en vue de lutter contre les mouches domestiques.

Summary. — Different formulations and methods of application of DDT, BHC, and chlordane have been evaluated as fly-control measures under rural conditions in Egypt. Chlordane and BHC were more effective than DDT, and DDT suspensions sprayed on the mud walls of rural dwellings were superior to solutions or emulsions of this insecticide. It was found that effective control could be achieved with either BHC or chlordane by applying these materials only to breeding areas and floors.

Strains of insecticide-resistant flies appeared within one year after the first application of BHC had been made. After BHC and chlordane had been applied repeatedly in several villages for three years, flies were highly resistant to these insecticides.

Fly populations were not effectively reduced in a village where fly-breeding materials were removed twice weekly.

In 1953, after a two-year lapse of insecticide treatments, a survey of insecticide resistance of Egyptian house flies (*Musca domestica vicina* Macq., and *d. cuthbertsoni* Patton and *sorbens sorbens* Wied.) indicated no serious resistance. Breeding areas in one village were dusted to determine whether control is still possible with BHC. Effective control was not achieved and the resistance of flies in this village immediately increased.

A study of house fly attractants and possible means of destroying flies coming to them is underway.

The Egyptian Ministry of Health has on its agenda programs of sanitation and education for house fly control.

Zusammenfassung. In Anbetracht der Fliegenbekämpfung hat man bei den in Ägypten herrschenden Verhältnisse in den ländlichen Gegenden verschiedene DDT, BHC, und Chlordane-Mischungen und auch viele Methoden für die Anwendung dieser Produkten studiert. Chlordane und BHC haben sich wirksamer als DDT erwiesen. Bei der Anwendung von DDT auf den Kotmauern der ländlichen Häuser, waren es die nassen in wässerige Suspension verdünnten Pulver die bessere Ergebnisse als die Lösungen und die Emulsionen gegeben haben. Man hat festgestellt, dass es möglich ist die Fliegenwirksam durch BHC oder durch Chlordane zu bekämpfen, indem man diese Produkten nur auf die Oberfläche, worauf das Insekt seine Eier niederlegt und auf den Boden, anwendet.

Einige der Wirkung der Insektiziden resistenten Fliegenstämme sind während 12 Monaten nach der ersten Anwendung von BHC zur Erscheinung gekommen. Infolge der wiederholten BHC- und Chlordane-

Anwendungen in verschiedenen Dörfer während drei Jahren sind die Fliegen gegen diese Insektiziden äusserst resistent geworden.

Die Fliegen-Bevölkerung hat bei einem Dorf keine bedeutende Verminderung erlitten, wo die Stoffe, worauf diese Insekten ihre Eier niederlegen konnten, zweimal in der Woche abgeführt wurden.

Nachdem die Insektizide-Behandlung während zwei Jahren aufgehoben wurde, hat man in Ägypten, im 1953 eine Untersuchung über die Resistenz der Hausfliegen gegen diese Produkten vorgenommen; es wurde dabei keine bedeutende Resistenz festgestellt. Neulich hat man in einem Dorf die Oberflächen worauf diese Fliegen gewöhnlich ihre Eier legen mit Pulver bestäubt um ermitteln zu können ob die Vernichtung dieser Insekten durch BHC noch möglich ist.

Jetzt hat man einen Versuch unternommen über die Produkten die fähig sind Hausfliegen anzuziehen und über die möglichen Mittel diese so angelockten Insekten zu vernichten.

Das ägyptische Gesundheitsamt hat vorgenommen eine Landreklamierung zu organisieren und eine allgemeine Gesundheitsschulung zu führen, um die Bekämpfung der Hausfliegen vorzunehmen.

Fly control is one of the most serious public health problems in Egypt. Despite this, the only basic work on flies in this area before 1947 was that of Hafez (1941-a, b). In that year the cholera epidemic sharply focused attention on the house fly problem and activated intensive studies on the bionomics and control of this pest.

The most prevalent forms of *Musca* in lower Egypt are *domestica vicina* Macq., *domestica cuthbertsoni* Patton, and *sorbens sorbens* Wied. (Sabrosky 1952).

The climate around Cairo, with mean monthly temperatures ranging from 50° to 90° F. (Hurst 1944), is favorable for fly development throughout the year. The favorable breeding months are April, May, June, September, and October. Fly-density curves clearly show two seasonal peaks, thought to be due largely to temperature rather than to moisture relationships.

In addition to favorable climatic conditions, there is in the villages an abundance of fly-breeding material due to lack of adequate sanitary facilities and to the natives' habits and customs. Families keep domestic animals within their homes, and dirt from stable floors is utilized as agricultural manure. Thus an extensive breeding area is present in each

house. This is supplemented by manure heaps in streets, dung cakes and pit latrines in some houses, and damp waste-disposal areas in and outside houses. In cities, garbage and refuse dumps and poor sanitation in slum areas provide the principal breeding places.

Ideally, control of the house fly could be effected by the proper application of basic sanitary principles and adequate disposal or storage of breeding materials. Unfortunately, the difficulties encountered in these respects are so many that officials have tackled the problem of fly control principally with insecticides.

Control during Cholera Epidemic of 1947

During the cholera epidemic, September to December 1947, it was imperative to obtain the most rapid reduction of flies possible. This was achieved by aerial spraying, residual spray painting, ground fogging, and car spraying. The Ministry of Public Health, the Rockefeller Foundation, the U.S. Naval Medical Research Unit No. 3, and the U.S. Air Force cooperated in this effort (General Report - Anti Fly Program. Ministry of Public Health, Cairo, 1948). Fortunately from a public-health standpoint, the epidemic occurred as the normal fly density was decreasing. This coincidence, however, made it difficult to evaluate the effectiveness of the various chemical measures.

Aerial spraying was done over the metropolitan areas of Cairo and Alexandria and over infected villages. Twenty percent of DDT in oil was used in BT-13 type planes for fogging (approximately 1 ounce of DDT per acre) and 8 to 10 percent of DDT in kerosene was sprayed from C-47's (over ½ pound per acre). An attempt was made to spray every three days, but for various reasons strict adherence to this schedule was impossible. Caged flies in different situations in and outside buildings were exposed during the applications. About half the flies so exposed were killed, the highest percentage (72 percent) in open streets. Grid counts after spraying were lower in sprayed than in unsprayed areas.

Residual sprays containing 5 percent of DDT in kerosene or an emulsion were applied with hand-operated pressure sprayers. Emphasis was placed on treating specific infected sites such as houses of cholera victims, cholera hospitals, and isolation shelters. I have found no record of the rate of application or any evaluation of this program, but we now know that effective DDT residues are not obtained on the surfaces of village dwellings when the insecticide is applied in a solution or an emulsion.

Ground fogging was done in the same areas where residual sprays were used. Fog was produced by volatilizing a DDT-oil solution in the exhaust system of a jeep. This method killed flies but needed repeating every few days.

During the month of October all vehicles entering Cairo from the direction of infected areas were sprayed with pyrethrum. In spite of this precaution cases of cholera appeared beyond the attempted barriers and spraying was discontinued.

Studies on Control with Insecticides

Laboratory studies.

Since 1947 those agencies that had cooperated in the antifly campaign during the cholera epidemic have continued studies in *M. d. vicina* and its control. Different insecticides, formulations, and methods of application have been tried.

In laboratory tests conducted by Gahan (1953-b), residues from suspensions of certain wettable powders sprayed on plywood were compared. A dieldrin residue of 25 mg per square foot was the most effective, causing 100 per cent mortality for 28 weeks after a 2-hour exposure. BHC and chlordane residues of 200 mg per square foot were effective for 24 and 4 weeks, respectively. Results with similar residues of DDT and of methoxychlor varied in different series of tests, some being effective for 4 weeks and others up to 16 weeks. Aldrin was the least durable insecticide.

No synergism was shown by combinations of any two of the three insecticides chlordane, DDT, or methoxychlor.

Water suspensions of DDT were markedly superior to emulsions or kerosene solutions on clay surfaces such as are found in rural dwellings. The choice of carriers for chlordane and dieldrin was unimportant, because of vapor toxicity.

Field Studies.

Water suspensions of DDT and dieldrin and kerosene solutions of chlordane were compared under rural conditions. Chlordane and DDT were applied at about 200 mg and dieldrin at 50 and 100 mg per square foot. DDT and dieldrin gave noticeable control, but chlordane was more effective, causing an immediate 90 per cent reduction which lasted for 8 to 16 weeks.

In other field tests the walls, ceilings, and floors of all buildings and

outdoor breeding areas were sprayed with 100 mg of chlordane per square foot (Gahan 1953-a). This treatment reduced the fly population for 8 months. During the first 6 months control was approximately 90 percent; for the following 2 months it was 75 per cent. During the first 3 months the fumigating action of chlordane was toxic to flies, as observed under controlled conditions.

In yet another village only floor surfaces were sprayed. Sufficient chlordane suspension was used to give a deposit of 1500 mg per square foot. Control remained over 80 percent for 17 weeks.

Since there was so little difference in control achieved by wall and floor spraying, the latter method seemed preferable because of economy and ease of application. However, the safety of chlordane treatments should be carefully considered by toxicologists before they are adopted for general fly control.

One of the preferred night-time resting places of flies during summer is the foliage of trees and shrubs. All vegetation of this type in one village was thoroughly sprayed with a DDT suspension. This treatment, without further control measures, reduced the fly population by about one third for 7 weeks (Gahan, unpublished data).

Thermal-generated DDT sprays as applied from a jeep were evaluated in several villages (Connell and Lowry 1948). The sprays were directed into open windows and doorways, against compost and refuse heaps, and on outer wall surfaces and other places where flies were concentrated. Large numbers of flies were killed, but there was apparently no residual effect, because after a day or two fly populations were reestablished. This method of application promises to be useful only under emergency conditions. Treatments would have to be made daily or every other day.

Control Measures Other Than Chemicals

In a village clean-up program (Weir et al. 1952) rubbish, fecal material, and other wastes were removed twice weekly. This program had no appreciable effect on fly reduction or on human mortality rates. It was therefore considered that the costs were excessive.

Villagers were at first uncertain about the installation of bored-hole latrines in their houses, but after the first few were installed everyone wanted them and readily used them when convenient. When they were properly cared for, as during the period of observation, no fly breeding occurred in them (Weir et al., loc. cit.).

To eliminate moist fly-breeding areas around water pumps, drainage was employed (Weir et al., loc. cit.).

Other sanitary measures that have been suggested from time to time could be practised in Egypt. Some of them may be impracticable in this country. Because flies tolerate a limited amount of moisture in breeding media, any treatment of these materials that will make them either too dry or too moist should eliminate breeding.

Hafez (1941-a) found that spreading fresh manure in a 2-inch layer in the sun was one of the most successful methods of eliminating fly breeding. However, it requires much space, labor, and prolonged supervision for good results. Moreover, farmers object to it.

Fuel cakes made of cow and buffalo dung are an important source of certain species of flies. Hafez suggested that fresh dung be used for making fuel cakes instead of dung that had been stored for several days. He found that larvae were unable to complete development in fuel cakes made of fresh dung, whereas many developed in those made of older dung. He added, however, that any sanitary method would have to be carried out by trained personnel, not left to uneducated and indifferent farmers and villagers.

Control of flies by excess moisture in the breeding media is practised at the Cairo Sewage Farm. A mixture of dried scum and sludge from sewage is a valuable source of organic fertilizer in Egypt. However, as it dries this material becomes a favorable medium for fly breeding. As described by Wasfi and Raef (1946), control consists in alternately flooding and drying successive thin layers of scum and sludge from sedimentation tanks. The larvae and pupae present are drowned in the water, which stands for several hours and gradually seeps into the previous layers and sand bottom. This method of control also requires close supervision, as excess moisture must be present long enough to kill larvae. As sludge dries flooding must be repeated before larvae can complete development.

Development of Resistance to Insecticides

The development of flies' resistance to insecticides under Egyptian conditions can best be shown by describing their use in three villages (Sindbis, Quaranfil and Aghour El Sughra) where the Ministry of Health and the International Health Division of the Rockefeller Foundation made intensive studies to improve health and environmental sanitation (Weir et al. 1952).

In 1948, 5 per cent DDT emulsions and suspensions sprayed on walls at the rate of 2 grams of DDT per square meter in Sindbis and Aghour El Sughra proved of little value. The first spray was applied in March before the heavy breeding season; others were applied in June and August. After the first spray, fly populations remained lower in these villages than in an untreated village for about 1 month; then they rose to comparable levels. The June spray reduced fly densities throughout June and July. The third application, in August, had no appreciable effect on the fly population. Although residues of DDT on walls caused some reduction, it was not enough to indicate satisfactory control. It was concluded that reduction could be obtained only through treatment of breeding areas.

In October 1948 all outdoor and indoor breeding areas in Sindbis and Quaranfil were dusted with 20 per cent of BHC in talc. As technical BHC containing 12 per cent of the gamma isomer was used, the dust actually contained about 2.5 per cent of the active ingredient. The dosage was not determined, but floors and breeding sites were covered with a white dust film. The fly population was reduced to a low level, which was maintained throughout the remainder of the season.

Dusting for the 1949 season was started in January and was repeated whenever the fly population showed a tendency to increase. In general it was found necessary to repeat the dusting at monthly intervals. By August of that year the response to BHC was not as marked as in previous months. There was a fall in the fly population after dusting, but it was less than in spring and early-summer dustings. As a check Aghour El Sughra was dusted with BHC. The fly index in this village immediately dropped to a very low level, but in Sindbis and Quaranfil, which were also dusted at this time, it remained about the same. It was suspected that the flies in Sindbis and Quaranfil had become resistant to BHC. Laboratory tests in which these and previously unexposed strains were compared on BHC residues confirmed this suspicion (Gahan and Weir 1951). Dusting was therefore immediately stopped in order to determine whether resistance might disappear in subsequent generations. At the year's end the flies were still resistant.

Early in April 1950 the breeding places in all three villages were sprayed with a 5 per cent chlordane suspension at the rate of 2 grams of active ingredient per square meter. An immediate and striking reduction in the fly population followed. It was necessary to repeat the spraying in May, August and late September.

In 1951 a new schedule was developed for fly control to determine

whether resistance to BHC had disappeared during the previous year. In Sindbis and Aghour El Sughra the use of chlordane was continued, but in Quaranfil a suspension of BHC was sprayed at the rate of 2 grams of active ingredient per square meter.

In Quaranfil the first application of BHC in April promptly reduced the fly population to a low level, which was maintained, with a second treatment in June, until mid-July. Additional applications at this time failed to lower the fly population. Laboratory tests confirmed the fact that resistance of flies to BHC had again developed.

In Sindbis the application of chlordane in April reduced the fly population, and the low level was maintained by a second treatment in May. In July the fly population began to increase and the application of chlordane failed to reduce it. Laboratory tests of these flies confirmed the development of resistance to chlordane. Subsequent applications of BHC gave only slight and temporary decreases in the fly population, and it appeared that the flies were resistant to both BHC and chlordane. A similar resistance was encountered in Quaranfil when chlordane was applied after BHC treatments.

During the summer, when fly densities in check villages were declining, those in the treated villages were increasing. By September the fly populations in treated villages were actually higher than in the check villages and remained so until December. The high fly populations in treated villages suggested that, in addition to developing resistance to insecticides, the flies had also become more tolerant to natural factors that normally destroy them at the end of the fly season. It was recommended at that time that insecticide treatments be discontinued.

Current Studies

Since 1951 the Insect Eradication Section in the Department of Endemic Diseases in the Egyptian Ministry of Health has applied insecticides for fly control in only one village. Late in 1952 the writer began a survey to determine the status of insecticide resistance in Egyptian house flies. Particular emphasis was placed on sampling fly populations from localities where proved insecticide resistance had previously developed. During collections it was noted that flies were more numerous and therefore easier to collect in previously treated villages than in untreated ones.

Topical applications of DDT, lindane, pyrethrum, and parathion in acetone were made to female flies with a microsyringe. The dosages that gave 50 per cent mortality were determined from 24-hour mortality

records. For comparative purposes a previously unexposed laboratory strain was included in all tests. It was expected that resistance would still be apparent in several strains, but no serious resistance was indicated.

With DDT field strains were two to four times as resistant as the laboratory strain.

With lindane there was little difference between field and laboratory strains with the exception of strains from two villages that were untreated checks in field experiments. Flies from these two villages were of about equal resistance. This resistance was one-fifth to one-fifteenth that of flies from villages previously treated with BHC.

With pyrethrum there was no difference in resistance between field and laboratory strains.

With parathion field strains were slightly more resistant than the laboratory strain.

Musca sorbens was considerably more susceptible to the four insecticides than was *vicina*.

It is of considerable interest that the degree of resistance in areas treated previously but not for two years did not appear to be very high. It was therefore decided to evaluate the effectiveness of insecticide treatments in the summer of 1953.

With the cooperation and facilities of Dr. A. A. Shawarby, head of the Insect Eradication Section in the Department of Endemic Diseases in the Egyptian Ministry of Public Health, a BHC dust containing 1.3 per cent of the gamma isomer was applied with small hand dusters to all potential breeding areas in the village of Konayesa. The village was dusted once every week for six weeks from middle of June until the end of July.

The fly population was reduced during the first two weeks of treatment, but satisfactory control was not achieved. By the third week the fly population began to increase as that in an untreated village was decreasing. A downward trend of the fly population is normal at this time of the year in Egypt.

Topical applications of lindane in acetone were made to flies collected in Konayesa 2, 4, and 7 weeks after the first dusting. The dosage required to cause 50 per cent mortality by the 7th week was three times that required before treatment.

Since insecticides eventually lose their effectiveness, studies of substitute control measures are imperative.

The need for using attractants as a control method is readily apparent. It is conceivable that locally available attractants can be used

to supplement other control measures in reducing house fly populations. A study of this problem has recently been started at the U.S. Naval Medical Research Unit No. 3 in Cairo. It is planned to incorporate the most attractive materials in baits, and to use traps or poisons as means of destroying flies attracted to the baits.

Another study is under way to test the pathogenicity of various organisms recovered from dead or dying flies. If any of these organisms show promise, they may also be used with attractant baits or applied to breeding areas.

Sanitation, the lack of which is responsible for the tremendous numbers of flies in Egypt, should also be considered as a fly-control measure. The handling of animal wastes, garbage, and other refuse is of utmost importance in the elimination of fly breeding. The Ministry of Health has on its agenda a project on the evaluation of strict sanitary practices on house fly populations. In spite of Dr. Weir's discouraging conclusion that his clean-up program had no effect on house fly densities (Weir et al., loc. cit.), it is imperative that further studies be undertaken.

Only slight mention has been made of *Musca sorbens*. This species breeds primarily in human feces in Egypt (Peffly 1953). It is also present in greater proportion than *vicina* in collections of flies from the faces of children. Therefore, this species may be largely responsible for the tremendously high incidence of various eye infections in Egypt. Elimination of the breeding source of this pest would be of inestimable value as regards eye infections alone.

The Ministry of Health has recently inaugurated a program designed to increase fly consciousness among Egyptians. Groups of responsible people from every section of Cairo are being informed about flies and fly-breeding sources. Each person in these groups is requested to pass this information on to at least 10 other people in his section of the city. Once there is widespread fly consciousness in Egypt, a good start will have been made toward fly control.

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