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RESISTANCE OF A. STEPHENSI TO DIELDRIN IN IRAN

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When the resistance to DDT appeared in A. stephensi in the Khuzistan Fars and Bandar Abbas area, in 1957, parallel susceptibility tests performed with DLD impregnated papers gave almost 100% kill with 0/4% concentration, using WHO test method. Similarly it produced 100% kill using Busvine and Nash method except in Shush with 97% kill with 0/4% concentration (all one hour contact).

The change of insecticides to DLD and its use over the Stephensi area, resulted in complete disappearance of A. stephensi in Khuzistan for the year 1958 up to now, and a drastic drop near zero in the two other Ostans (Fars and Kerman), after the first spraying.

It remained around zero in the greater area of Kerman and Fars, sprayed twice. However few specimens could be collected in the villages, where only one single spraying was performed in the spring 1958 (about five to six months after the spraying).

In the control unsprayed villages the population of A. stephensi has remained high and followed its natural curve, except in Khuzistan, where it remained zero throughout.

Method of collection is hand capture in indoor shelters. In one village with caves in its surroundings, the population of A. stephensi also became zero after the spraying.

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Thus in latter part of 1958, A. stephensi could be collected only in unsprayed area of Balutchistan, in unsprayed control villages of Balutchistan, Kerman and Fars and in few villages where one single spraying was performed in spring 1958.

Susceptibility tests performed during this period with DID impregnated paper gave 100% kill in never sprayed village of Zakht in Jiroft area, but showed only 78% kill with 4% DDT, sign of natural resistance to DDT.

In January 1959, i.e. before 1959 spring campaign tests were performed in Makian village, Minab, where the population of stephensi was reduced after the spraying with 500 mg in April 4, 1958 close to zero and rose back in September. The results as given in attached tables show only 71% mortality with 1.6% concentration, one hour contact. Similar tests in unsprayed villages with DID, Chahestan and Chelow showed a 100% kill in first and 97.7 in the second.

After the spraying of Makian with 250 mg DID, the density came down from 68 per man per fifteen minutes to around 30 per man per fifteen minutes, but remained there. These tests were continued later by local station and a team sent from Teheran with results showing a very low mortality even after twenty-four hours contact with highest concentration.

Similar reports were received from the villages Sagheri and Rahguerd of Jiroft station, where no Anopheles stephensi were found last year. Tests performed by a special team sent from Headquarters, are given in attached tables. The localities where this observation is found have all the particularity of having a favourable breeding condition (palm-tree plantation, rice fields, water holes for spraying of summer huts, river bed, seepages etc.). In more than thirty localities with unfavourable conditions, either no A. stephensi were caught (hand catch indoor) or very few specimens were collected; so that the spots with this problem are spread over a large area but not interconnected (see map).

The stations in Ahwaz (Khuzistan) and Kazerun (Fars) are asked to survey these two Ostans for the same purpose. In Khuzistan, a survey performed in thirty-three localities all around the Province did not reveal any presence of A. stephensi.

The Kazerun station did not find any locality with high population of A. stephensi during its general survey in Fars, except in Khenj, Lar, where in three villages high population was found. Results are given in attached tables.

Another team was sent to Balutchistan area to survey for the presence of problem areas.

This team, after having surveyed eleven villages in Bam and seventeen villages in Zahedan area, has proceeded to Khash, and Saravan Shahristan.

In the Bakhshes of Khash, Shahristan of Zahedan and Sibe and Buran and Hume of Shahristan of Saravan an addition of thirty-five villages, of which twenty-six being sprayed with DID three times, (last date from 22 March to 4 April) are surveyed.

The team has only found noticeable population of A.stephensi in three villages of Pargan, 174 km. South East of Khash Kuluk, seven km. South West of Saravan and Gharye Deh with relative high density. Results WHO susceptibility test have been given in attached table.

Discussion

At first the quality of test paper was checked with other susceptible mosquitoes (A. fluviatilis, A. d'thali of the area) as well as with a strain of A. stephensi in Kazerun Insectarium. It showed proper potency and activity.

The high temperature prevailing over the area (38°C - 48°C) also was incriminated to have affected in many ways the status of the anopheline population, namely deactivation of DID layer of sprayed surfaces, interference in the action of DID impregnated paper on the mosquitoes.

Only the arrival of cool season and repetition of the susceptibility tests could throw light to this question. However, there are the following evidences that a true resistance has developed in A. stephensi:

1 - The first progeny of A. stephensi of Jiroft area, bred in the Teheran Insectarium, (temp.28 - 32) have shown similar resistance to DID impregnated paper. This test will be performed more fully when the breeding of this strain is established successfully.

2 - All other species, known from some of the problem areas (sprayed with DID) have disappeared and only A. stephensi is captured However last year in the same area no A. stephensi could be found.

3 - In some villages where few specimens of A.fluviatilis and A. d'thali have been tested at the same time as A. stephensi, a 100% mortality is obtained with all other species, showing proper action of test paper under the ambiant heat.

4 - Tests performed in test-huts sprayed freshly with DLD, also have shown similar results. Briefly it seems that A. stephensi has developed resistance to DLD in the South Eastern part of Iran.

A. stephensi mysorensis

Studies on Eggs of numerous A. stephensi collected from Jiroft and Bandar abbas area, as well study of the A.stephensi, of Kazerun Insectarium, have shown that the only variety of the area is A. stephensi mysorensis.

It is interesting to see the exact distribution of the varieties of A. stephensi in Iran, because it is known that A. stephensi exists in S. Arabia, Iraq and South West part of Iran and mostly is found in cities in Pakistan and India. A. S. mysorensis from the other side is found in India and Pakistan in rural areas. The areas observed in Iran are all of rural type.

The hypothesis of work for these studies will be to demonstrate the possibility of difference of existence and nature of resistance in A. stephensi stephensi and A. stephensi mysorensis.

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The transmission of malaria is not yet started in these areas mostly due to the short longevity of A. stephensi and its zoophilic habits. The majority of specimens dissected according to Dr. Detinova's method have been in Nulliparous state or have had one or two cycles. However, it is expected that by the arrival of cool season this pattern will be changed.

The Malaria Eradication Organization of Iran is already recommended to organize proper surveillance and distribution of prophylactic drugs in the problem areas.

Experiments performed in few villages or huts by using Malathion Emulsifiable concentrate, DDT + Diazinon are in progress. The preliminary results are not satisfactory, since bioassay and test hut studies performed in the area have shown a marked decrease below 50% kill in fifteen days.

Summary

A. stephensi mysorensis, found in South East part of Iran, (Baluchistan, Kerman and neighbouring area of Fars) has shown marked decrease of susceptibility to Dieldrin. At the same time, the resistance to DDT, detected in 1957, is still existing without great change in frequency.

TABLE I

Anopheles stephensi: DDT

Locality and area	No. of spray	Test method	Month year	Temp. (C)	Percent Mortalities at following concentrations Control	0.5%	1.0%	2.0%	4.0%	Corrected LC_{50}
Shush, Dezful	4	Busv.	Nov. 57	16	6(348)	-	9(331)	19(300)	36(268)	8,0
Shadegan, Shadegan	5	Busv.	Nov. 57	24	14(359)	-	33(334)	42(335)	50(360)	7,5
Shadegan, Shadegan	6	WHO	Nov. 57	24	8(246)	-	19(208)	31(227)	39(233)	14.0
Salbookh, I'd, Abadan	6	Busv.	Oct, 57	30	16(250)	-	44(258)	49(256)	53(256)	9.0
Salbookh, I'd, Abadan	6	WHO	Oct. 57	30	10(170)	-	28(193)	35(202)	44(193)	9.0
Zeidun, Zeidun	5	WHO	Dec. 57	19	23 (84)	-	58 (95)	64(93)	76(83)	1.6
Zirrah, Borazjan	5	Busv.	May 57	32	7(673)	15(498)	17(815)	22(848)	32(910)	14.0
Halpay, Borazjan	6	WHO	July 57	41	9(337)	-	17(292)	26(275)	37(296)	ca40
Bandar Abbas, B.A.	5	Busv.	Dec. 57	24	6(285)	7(285)	14(252)	19(276)	26(283)	100
Chahestan, Bandar Abbas	4	Busv.	Jan. 58	19	9(286)	28(280)	61(245)	82(272)	94(176)	0.9
Chahestan, Bandar Abbas	4	WHO	May 58	40	5(165)	37(180)	43(154)	58(158)	67(97)	1.5
Sarrigan, Minab	6	Busv.	Jan. 57	18	1(188)	11(252)	41(262)	68(259)	99(98)	1.3
Sarrigan, Minab	7	Busv.	Dec. 57	22	9(292)	21(327)	44(323)	80(332)	94(311)	1.2
Chelow, Minab	7	Busv.	Dec. 57	20	4(342)	16(372)	44(355)	90(362)	99(351)	1.1
Chelow, Minab	7	Busv.	May 58	45	3(202)	36(215)	48(249)	62(264)	75(267)	1.2
Chelow, Minab	7	WHO	May 58	45	5(203)	26(206)	44(200)	55(200)	70(205)	1.8
Minab, Minab	7	Busv.	Jan. 58	20	5(222)	16(253)	34(243)	80(259)	97(253)	1.4

TABLE II

ANOPHELES STEPHENSI: DDT					PER CENT MORTALITIES AT FOLLOWING CONCENTRATIONS							
Locality and area	No. of Spray	Test Method	Month & Year	Temp. ° C	Time Of Expos.	Control	0.25%	0.5%	1.0%	2.0%	4.0%	8.0%	LC_{50} Corrected
Zakht	Unsprayed	WHO	6/58	27-47	1 Hr.	11(126)	-	34(129)	55(128)	60(125)	78(119)	-	-
Zakht(Jiroft)	Unsprayed	"	12/58	11-19	1 Hr.	0.4(250)	8(228)	32(217)	74(218)	96(212)	-	-	-
Chelow	4 DDT	"	5/58	27-46	1 Hr.	5(203)	-	26(206)	44(200)	55(200)	70(205)	-	-
Chelow(Minab)	4 DDT	"	1/59	20-23	1 Hr.	4(192)	-	22(217)	64(209)	95(202)	99(204)	-	0.78%
Makian(Minab)	4 DDT 1 DLD	"	1/59	20-23	1 Hr.	1(212)	-	19(207)	77(188)	94(165)	99.5(207)	-	0.75
Chahestan(B.A)	4 DDT	"	5/58	29-40	1 Hr.	5(165)	-	37(180)	47(154)	58(158)	67(971)	-	-
Chahestan (Bandar Abbas)	4 DDT	"	2/58		1 Hr.	1(212)	-	31(191)	58(200)	82(166)	99(187)	-	0.58%
Makian(Minab)	4 DDT 2 DLD	"	6/59	34-42	1 Hr.	6(143)	-	13(158)	12(146)	36(150)	67(149)	-	-
Siahoo (B. Abbas)	4 DDT	"	6/59	34-42	1 Hr.	6( )	-	16( )	25( )	53( )	95( )	-	-
Baghan(Soghan)	Unsprayed	"	7/59	30-34	1 Hr.	0(151)	-	9(68)	31(90)	38(82)	93(147)	93.6(59)	-
Rahguerd (Jiroft)	3 DDT 3 DLD	"	7/59	35-42	1 Hr.	0.5(220)	-	8(201)	25(215)	52.5(215)	89.5(221)	-	-
Kheirabad (Kahnooj)	3 DDT 3 DLD	" "	7/59 "	32-38 "	1 Hr. 2 Hrs.	0.(108) "	- -	- -	9(87) -	58(106) -	85 (95) -	92(104) 98(46)	-
Konj (Lar)	5 DDT	"	8/59	42	1 Hr.	13.5(59)	-	30(30)	42.4(26)	70(30)	-	-	-
Pergan (Fereve[illegible]	4 DDT 3 DL	"	9/59	39	1 Hr.	0(128)	-	-	-	-	67(35)	100(35)	-
[illegible]							-		[illegible]		70( )	95( )	

TABLE III

ANOPHELES STEPHENSI - DIELDRIN						PERCENT MORTALITY AT FOLLOWING CONCENTRATIONS							
Locality and area	No. of Spray	Test Method	Month and Year	Temp. C.	Time of Exposure	CONTROL	0.05%	0.1%	0.2%	0.4%	0.8%	1.6%	Correction LC_{50}
Rahguerd (Jacoft)	3 DDT 3 DLD	WHO	" "	35-42	2 Hrs.	6 (48)	-	-	4(50)	2(53)	6(51)	11(53)	-
" "	3 DDT 3 DLD	"	" "	"	24 Hrs.	1 (78)	-	-	10(129)	21(159)	29(157)	40(143)	-
Khoirabad (Kahnouj)	3 DDT 3 DLD	"	" "	32-38	1 Hr.	0(108)	-	-	1(94)	0(88)	2(114)	0(84)	-
" "	3 DDT 3 DLD	"	" "	"	24 Hrs.	0(108)	-	-	-	-	14 (83)	34(123)	-
Hajiabad (Bam.)	4 DDT 3 DLD	"	" "	30(34)	1 Hr.	0(10)	-	-	-	-	8(12)	-	-

TABLE III (Cont.)

ANOPHELES STEPHENSI: DIELDRIN						PER CENT MORTALITY AT FOLLOWING CONCENTRATION							
Locality and area	No.of Spray	Test Method	Date Of Test	Temp. °C	Time Of Expos.	CONTROL	0.05%	0.1%	0.2%	0.4%	0.8%	1.6%	LC 50%
Khenj (Lar)	5 DDT 3 DLD	WHO	8/59	42	1 Hr.	7.2(69)	-	23.5(34)	23.3(30)	9(55)	21(51)	33.9(59)	-
Pargan (Saravan)	4 DDT 3 DLD	WHO	9/59	39	2 Hrs. 1 Hr.	- 0 ( )	- -	- -	- -	- -	59.2(27) -	55.5(27) 0 (128)	-
"	"	"	"	"	12 Hrs.	0 ( )	-	-	-	-	-	0 (128)	-
"	"	"	"	"	24 Hrs.	0 ( )	-	-	-	-	-	50 (128)	-
Gharyeh Deh	"	"	"	38	1 Hr.	0 ( )	-	-	-	-	-	3 ( )	
"	"	"	"	"	24 Hrs.	0 ( )	-	-	-	-	-	6 ( )	-
Kuluk (Saravan)	"	"	"	"	1 Hr.	-	-	-	-	-	-	4 (22)	-

TABLE IV

ANOPHELES STEPHENSI- DIELDRIN						PTR CENT MORTALITY AT FOLLOWING CONCENTRATION							
Locality and Area	No.of Spray	Test Method	Date of Test	Temp °C.	Time of Expos.	CONTROL	0.05%	0.1%	0.2%	0.4%	0.8%	1.6%	LC 50%
Chahistan (B. Abbas)	4 DDT	WHO	5/58	29-40	1 Hr.	4(210)	57(204)	84(204)	995(206)	-	-	-	0.04
"	4 DDT	Busv.	5/58	29-40	1 Hr.	7(439)	65(217)	91(358)	996(265)	100(231)	-	-	0.04
"	4 DDT	WHO	2/59	13-23	1 Hr.	5(204)	-	14(209)	59(209)	95(211)	100(211)	-	0,19
Chelou (Minab)	7 DDT	WHO	5/58	29-45	1 Hr.	6(201)	62(205)	96(208)	100(105)	-	-	-	0.04
"	7 DDT	Busv.	5/58	29-45	1 Hr.	3(202)	68(245)	96(250)	-	-	-	-	0.032
"	7 DDT	WHO	1/59	20-23	1 Hr.	2(910)	-	95(187)	72(200)	94.4(197)	97.7(215)	-	-
"	7 DDT	WHO	6/59	32-39	1 Hr.	22(207)	-	-	36(187)	37(214)	29(110)	67(121)	-
Makran (Minab)	7 DDT 1 DLD	WHO	1/59	20-23	1 Hr.	2(222)	-	18(215)	51(206)	59(245)	61(213)	71(190)	-
"	7 DDT 2 DLD	"	6/59	30-41	1 Hr.	13(245)	-	-	22(261)	22.5(248)	24(265)	21(258)	-
"	"	"	6/59	34-42	1 Hr	6(48)	-	-	14(43)	17(46)	19(48)	35(46)	-
"	"	"	6/59	34-42	2 Hrs.	11(88)	-	-	24(103)	30(98)	38(92)	35(102)	-
"	"	"	6/59	34-42	4 Hrs.	9(100)	-	-	21(103)	33(96)	34(102)	42(90)	-
"	"	"	6/59	34-42	8 Hrs.	23(110)	-	-	38(103)	40(95)	45(89)	57(95)	-
"	"	"	6/59	34-42	16 Hrs.	16(133)	-	-	22(143)	39(145)	43(138)	52(140)	-
"	"	"	6/59	34-42	24 Hrs.	22(202)	-	-	27(190)	42(194)	55(185)	61(213)	-

A. [illegible]PHELES STEPHENSI – DIELDRIN						PER CENT MORTALITY AT FOLLOWING CONCENTRATION							
lity Area	No. of Spray	Test Method	Date of Test	Temp. °C	Time of Expos.	CONTROL	0.05%	0.1%	0.2%	0.4%	0.8%	1.6%	LC 50%
an(Minab)	7 DDT 2 DLD	WHO	7/59	30-32	1 Hr.	5(55)	-	27(41)	-	26(43)	23(48)	7(43)	-
	"	"	"	"	24 Hrs.	27(60)	-	43(49)	-	37(63)	43(83)	56(61)	-
	"	"	"	30-41	1 Hr.	5(106)	-	9(107)	-	10(104)	8(106)	10(114)	-
ou(B.Abbs)	1 DDT 1 DLD	"	"	32-39	1 Hr.	2(148)	-	2(107)	-	7(123)	7(115)	8(155)	-
am-Bahmani inab)	7 DDT 3 DLD	"	"	30-32	1 Hr.	19(37)	-	22(55)	-	20(49)	26(35)	30(33)	-
"	"	"	"	30-41	1 Hr.	7(122)	-	8(126)	-	9(109)	14(123)	13(101)	-
t(Jiroft)	Unsp.	"	6/58	27-47	1 Hr.	10(173)	84(195)	100(201)	100(118)	-	-	-	0.041
"	"	"	12/58	11-19	1 Hr.	0(151)	-	13(165)	43(161)	78(185)	100(34)	-	0.22
an Soghan	"	"	7/59	30-34	1 Hr.	0(90)	-	42(43)	69(36)	64(33)	73(74)	83(81)	-
	"	"	"	"	4 Hrs.	0(23)	-	-	-	-	81(27)	98(54)	-
	"	"	"	"	18 Hrs.	0(23)	-	-	-	-	96(24)	100(30)	-
	"	"	"	"	24 Hrs.	0(30)	-	-	-	-	-	100(30)	-
uerd oft)	3 DDT 3 DLD	"	"	35-42	1 Hr.	3.5(58)	-	5(84)	8(58)	2(121)	3(89)	-	-

TABLE V

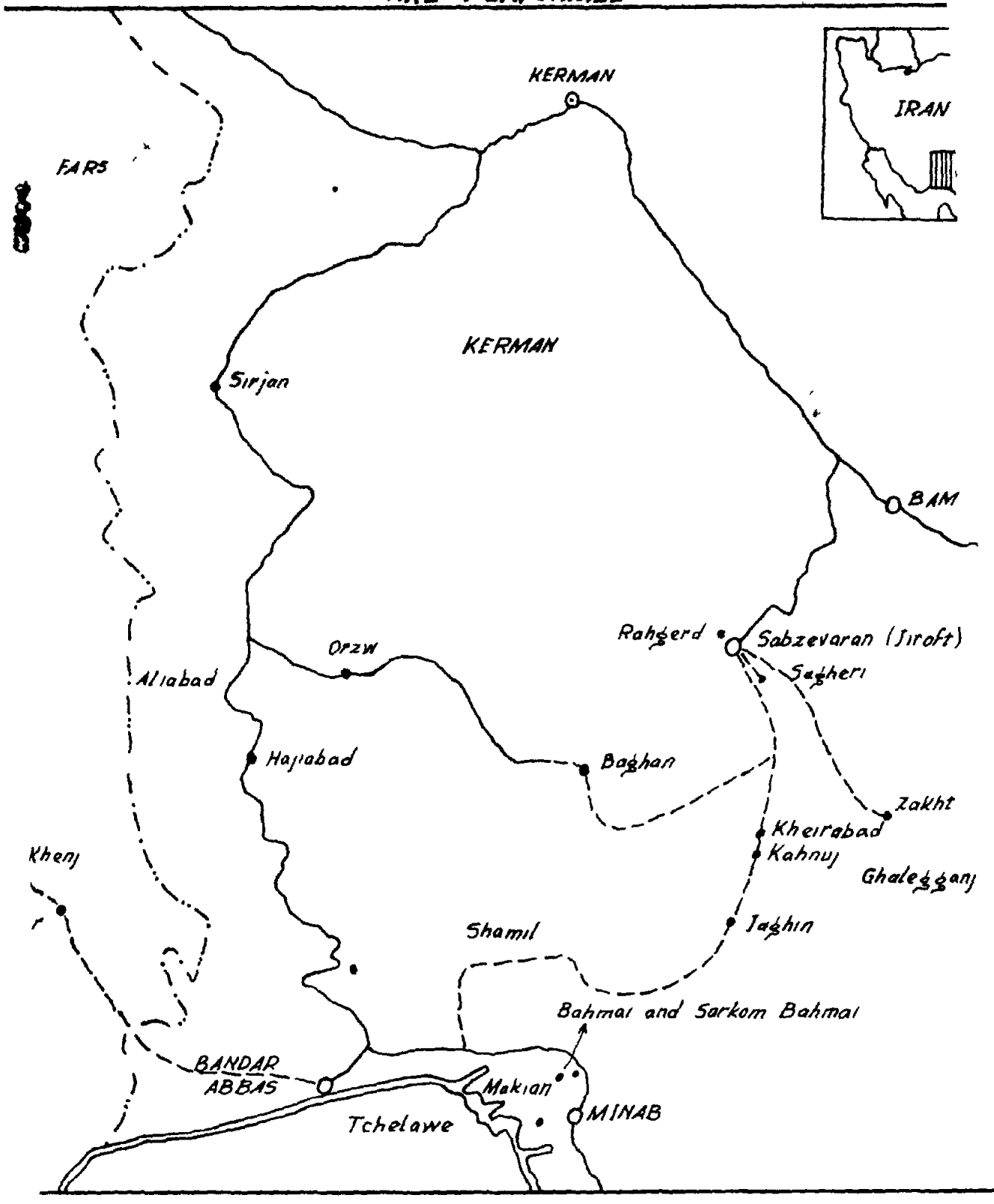
ANOPHELES SUBPICTUS : DIELDRIN					PERCENT MORTALITIES AT FOLLOWING CONCENTRATIONS						
Locality and area	No. of Spray	Test Method	Month & Year	Temp. C	Control	0/025%	0/05%	0/1%	0/2%	0/4%	Corrected LC_{50}
Shush, Dezful	5	Busv.	Nov.57	14	6(248)	-	-	64(202)	78(233)	97(250)	0/08
Shadegan, Shadegan	5	Busv.	Nov.57	24	14(215)	-	-	89(206)	97(202)	99(187)	0/07
Shadegan, Shadegan	5	WHO	Nov.57	24	11(264)	-	-	79(235)	97(300)	100(295)	0/07
Selboudh I'd Abadan	5	Busv.	Oct.57	30	15(250)	-	94(69)	94(69)	98(203)	100(220)	-
Selboudh I'd Abadan	5	WHO	Oct.57	30	14(14)	-	-	100(29)	100(35)	100(25)	-
Chamistan B. Abbas	4	WHO	May 58	40	4(210)	-	57(204)	84(204)	99.5(206)	-	0/04
Chamistan B. Abbas	4	Busv.	May 58	40	7(439)	(35(212)	65(217)	91(358)	99.6(265)	100(231)	0.04
Chelow, Minab	7	WHO	May 58	45	6(201)	-	62(205)	96(208)	100(105)	-	0/04
Chelow, Minab	7	Busv.	May 58	45	3(202)	41(234)	68(245)	96(250)	-	-	0/032

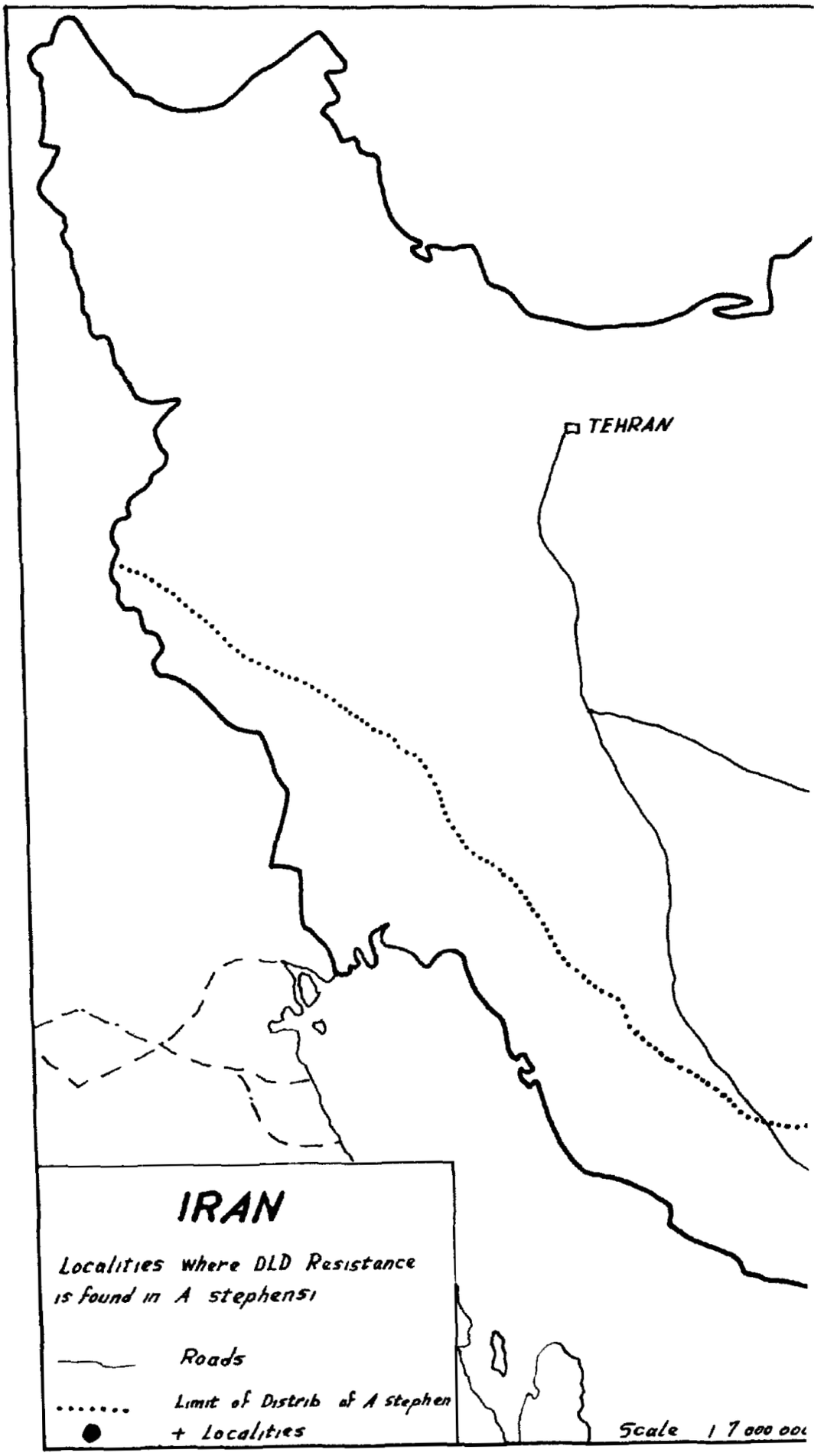
TABLE VI

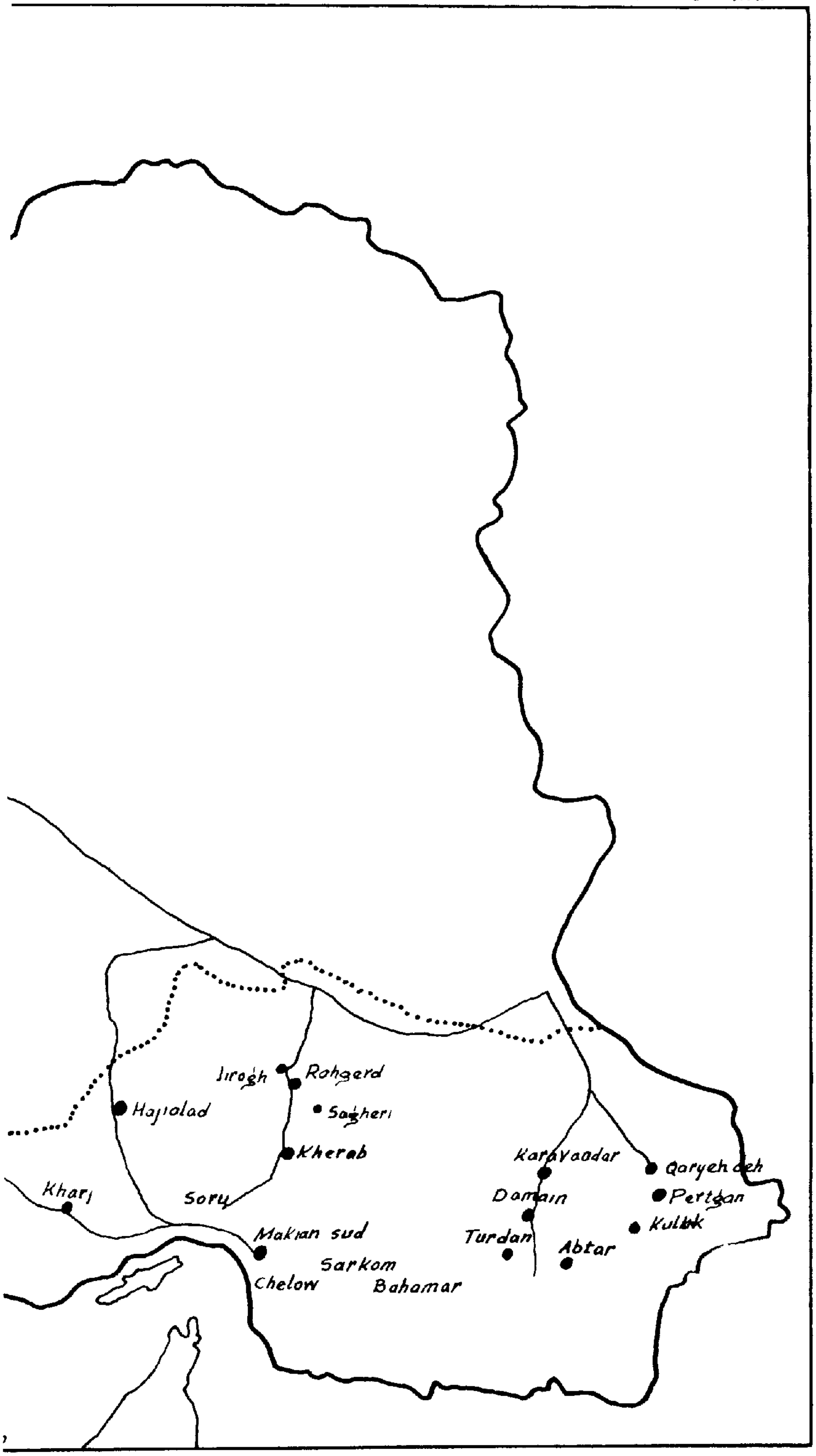
ANOPHELES STEPHENSI : GAMMA B.H.C.

Locality and area	No. of Spray	Test Method	Month and Year	Temp. C.	PERCENT MORTALITIES AT FOLLOWING CONCENTRATIONS								Corrected LC_{50}
					Control	0/0025%	0/005%	0/01%	0/025%	0/05%	0/1%	0/2%	
Salboukh I'a Abadan	5	Busv.	Oct.57	30	15(88)	-	-	-	100(3)	100( )	100(71)	100(71)	-
Chahestan B.Abbas	4	Busv.	May 58	40	4(305)	-	51(166)	95(233)	100(264)	100 (236)	100(251)	-	-
Chelow Hinnab	7	Busv.	May 58	45	3(202)	37(227)	70(207)	95(146)	-	-	-	-	-

MAP OF LOCALITIES WHERE SUSCEPTIBILITY TESTS ARE PERFORMED




TEHRAN
IRAN
Localities where DLD Resistance is found in A stephensi
Roads
Limit of Distrib of A stephen
+ Localities
Scale 1 7 000 00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Rohgerd
Hajiolad
Sagheri
Kherab
KaraVaadar
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Khari
Sory
Damain
Pertgan
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Makian sud
Turdan
Abtar
Sarkom
Chelow
Bahamar