Studies on the Possible Attack of the Mediterranean Fruit Fly (*Ceratitis capitata* WIEDEMANN) on the Green Bananas

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I. Introduction

The host fruits of the Mediterranean fruit fly, *Ceratitis capitata* WIEDEMANN, which is one of the most injurious pests of wide host range, are prohibited entry into Japan from the areas where this insect has been known to occur. This step has been taken to preclude the possible introduction of this fruit fly so far unknown in Japan. However, the action that Japan included immature bananas under the list of prohibited fruits has provoked questions from several countries concerned.

Inclusion of the unripe banana in the list of embargo has its basis upon only one report from Australia (JENKINS, 1948) which stated that the green banana was found attacked by this fruit fly. No additional data proving or disproving the fact that has been published ever since. As the argument against the infestation of the Medfly on the green banana had remained unsettled, Japan had to confirm it by her own experiment in order to bring the problem to a solution.

This report contained the results of the experiments which were undertaken by the authors in Costa Rica from December 1968 to February 1969 at the request of the Costa Rican Government.

II. Field Experiments

The purpose of this work is to determine whether the female of the Medfly lay eggs into the green bananas on the growing tree in the field and whether the larvae can grow in the same bananas.

Material and Methods

Fruit fly: The adults of the Medfly were obtained from a mass of approximately 100,000 flies each reared three times separately in the laboratory of OIRSA (Organismo International Regional de Sunidad Agropecuaria) located in the suburbs of San José. The larvae were fed with an artificial diet of a mixture of the materials described in Table 1 at the room temperature of about 25°C. The newly emerged flies were reared for a 10-day period on an artificial diet as described in Table 2. After confirming the egg-laying capacity, the adult flies were used for the experiments.

Fields: The following three test plots were selected in the fields. The location of these fields are shown in Figure 1.

(1) Field-CA 1 (Cachi valley, 600 m above the sea, Cartago) — Commercial plantation with bananas (Valey and Platain) and coffees growing.

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Table 1. ARTIFICIAL MEDIUM FOR LARVAE

Ingradient	Quantity
Water	5,500.00 m*l*
Sodium benzoate	11.25 gr
Methyl *p*-hydroxybenzoate	11.25 gr
HCl	56.00 m*l*
Sugar	1,125.00 gr
Wheat germ	630.00 gr
Torula yeast	675.00 gr
Sugar cane	742.50 gr

Table 2. ARTIFICIAL MEDIUM FOR ADULTS

Ingredient	Quantity	
Yeast type "M"	1 part	(1 : 5)
Sugar	5 〃	
Agar	0.75%	

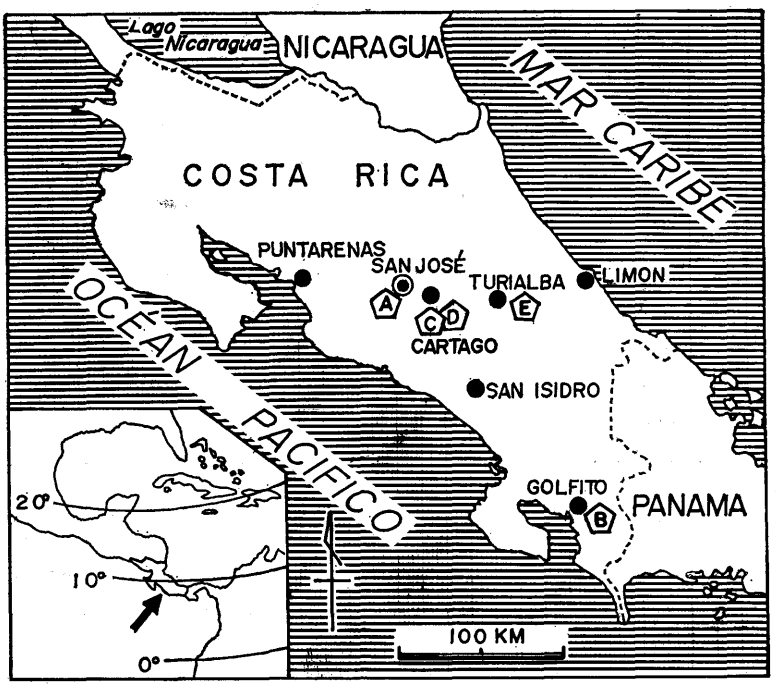

Fig. 1. MAP OF COSTA RICA

(2) Field-CA 2 (The same as above, nearly 4 km west of Field-CA 1) — Commercial plantation with bananas (Valery) and coffees.

(3) Field-TU (Turrialba, 300 m above the sea) — Property of the "Instituto Interamericano De Ciencias Agricolas", with only bananas (Valery) growing.

Bananas: The cultivar of bananas used for the experiments was all Valery which is a selection for export industry and known as immune to Panama disease. The size of banana

fingers in the bunches on the trees were measured with a banana caliper (a gauge for measuring the size of banana fingers), (see plate), and the bunches with the fingers of the largest export grade of size 9—15, were marked out for the experiments. Export grade of Costa Rican bananas are: to U.S.A.—9 (or 1 inch and 9/32) to 17 (or 1 inch and 17/32); to Europe—8 to 17; to Japan—7 (1 inch and 7/32) to 12 (1 inch and 12/32). A total of 10 bunches in the Field-CA-1 and CA-2, respectively, and 12 bunches in the Field-TU were used for the experiments.

Methods: At the end of pre-oviposition period of adult flies, the cage containing innumerable adult flies was taken into a darkroom and the adult flies were attracted to one side with a black-light. Then, by using a calibrated aspirator, approximately 2,000 adults (1,000 pairs) each were removed separately into small kraft paper bags (20 cm×30 cm).

In dispensing the adult flies, they were collected into the aspirator and temporarily anesthetized with carbonic-acid gas. Excelsior was inserted in the bags as buffers, and then, the bags were sealed tightly. These bags were taken to the field and put into seran-screen bags (1 m×1.5 m) which had been previously placed over every bunch. The upper openings of the screen bags were fastened tight with vinyl string at the stem base of the bunches. The paper bags were torn off to release the flies from them. After allowing 48 hours for mating and oviposition, the adult flies were anesthetized again with carbonic-acid gas or ether and all the adults were removed. The bunches were covered with screens for further nine days to prevent natural oviposition by wild fruit flies and then reaped and collected.

Every hand was severed from the stem after making its order of junction and put into carton boxes respectively tree by tree and carried into the laboratory. These packed bananas were ripened with ethylene gas in a room at about 30°C for 48 hr to make it easy to peel the bananas at the time of examinations. The examinations were carried out as follows. The number of fingers was counted for every hand and bunch, and the number of oviposition punctures on the bananas randomly selected at the rate of 20 fingers per bunch was also counted. Of three bunches of the Field-CA 1, the number of the punctures was counted for all fingers to assess whether there were uneven patterns of oviposition in relation to the location of each particular hand on a stem. The survival and growth of hatched larvae were examined by peeling. The data of every experimental work is shown in Table 3. In every case, the examination by peeling was carried out around the 13th day after oviposition. This 13-day period means the duration within which the larvae, if any, are assumed to be premature for the pupation but to develop well enough for the naked-eye examination.

Table 3. DATE OF FIELD EXPERIMENTS IN THE THREE FIELDS

	Fields		
	CA 1	CA 2	TU
Placement of screens, Adults released	Jan. 6	Jan. 11	Jan. 16
Adults removed	8	13	18
Bananas collected	17	22	27
Ripening of bananas with ethylene	18	23	28
Examination by dissection	20	25	30

Results

The results of the experiments are given in Table 4. It was found that, under these experimental conditions, the adult flies oviposited actively even on green bananas. However, no larvae at all were able to grow in the green bananas which remained on the trees for 12 days after oviposition. When eggs were laid in the green bananas, the tannin-containing sap bleeded out of the oviposition punctures and the punctures were sometimes closed. However, the number of laid eggs was not affected by this phenomenon. A total of 4,336 fingers (216 hands on 31 bunches) were examined by peeling only to find that neither the larval survivors nor their traces of feeding were present. This fact evidently leads to the conclusion that, as far as the green bananas on the growing tree are concerned, the hatched larvae cannot attain the stage when they can bore into the flesh. In other words it can be said that they all cease to grow at the stage of eggs or the first instar larva inside of the peel.

Table 4. RESULTS OF FIELD EXPERIMENTS

Field	Bunch	Total No. of hands	Total No. of fingers	Oviposition punctures per finger on average	Presence of larva (13th day after oviposition)
CA 1	A	7	129	5.4	No survivors no trace of feeding in the flesh
	B	9	157	1.9	
	C	9	148	12.0	
	D[1]	—	—	—	
	E	10	173	2.4	
	F	10	174	5.2	
	G	9	178	8.4	
	H	9	154	5.6	
	I	8	146	6.4	
	J	9	163	2.8	
CA 2	A	9	153	2.2	〃
	B	9	149	2.8	
	C	8	134	6.3	
	D	8	131	2.8	
	E	9	142	4.4	
	F	9	156	8.6	
	G	9	130	8.0	
	H	8	118	6.5	
	I	8	136	1.9	
	J	8	125	1.0	
TU	A	9	142	1.1	〃
	B	9	147	0.9	
	C	7	111	3.9	
	D	9	128	2.1	
	E	8	120	3.8	
	F	8	127	3.8	
	G	7	105	4.5	
	H	7	105	13.0	
	I	8	132	3.6	
	J	10	188	3.6	
	K	5	71	6.5	
	L	9	164	2.1	

[1] Failure due to an accident

Although we used the adult flies which had been reared under the identical conditions, the total number of the punctures presented a striking difference among the bunches; that is, the maximum in number totaled 1,776 punctures (1.8 eggs per female on the average) on the tree C in the Field-CA 1, and the minimum was 125 (0.1 egg per female). There was the difference of 18 times between the two extremes. It may be appropriate to assume that the

ovipositing behaviour was more significantly affected by the micro-climatic factors due to the difference of the position of the bananas used, rather than the difference of the data and field of the experiments.

Further, as shown in Table 5, the distribution of the oviposition punctures on the same bunch showed a tendency that the average punctures per finger was more in number at the hand on the stem base than those on the stem end. However, as there is no significant difference between them as a result of the *T*-test, the fruit flies do not seem to have any preference for their oviposition as to the site of the same bunch.

Table 5. DISTRIBUTION OF OVIPOSITION PUNCTURES ON THE BUNCH
(Examples from the experiments in Field CA-1)

Bunch	Hand from stem base	No. of fingers of each hand	No. of punctures	Punctures per finger (on the average)
				punc.
B	No. 1	27	102	3.8
	2	20	46	2.3
	3	18	37	2.0
	4	16	13	0.8
	5	16	10	0.6
	6	16	23	1.4
	7	16	16	1.0
	8	14	39	2.8
	9	14	26	1.9
E	No. 1	24	94	3.9
	2	20	66	3.3
	3	18	54	3.0
	4	18	26	1.4
	5	16	16	1.0
	6	16	42	2.6
	7	16	20	1.3
	8	16	22	1.4
	9	16	43	2.7
	10	13	30	2.3
H	No. 1	26	191	7.3
	2	18	179	9.9
	3	17	46	2.7
	4	16	52	3.3
	5	16	114	7.1
	6	16	18	1.1
	7	16	144	9.0
	8	16	95	5.9
	9	13	20	1.5

III. Laboratory Experiments

In the previous experiments, it was confirmed that the hatched larvae were unable to survive when the eggs were laid in the green bananas and the infested bananas were held for a certain period in the field. However, it was not known whether the larvae could develop when the eggs were laid in the bananas after harvest and in the bananas harvested immediately after oviposition. These experiments were conducted to know the effect of the change of the physiological conditions of the bananas after harvest on the larval development.

Materials and Methods

The experimental works were carried out at the laboratory of OIRSA. Five large-sized cages (120 cm×35 cm×60 cm) (see plate) were piled up. Each 12,000 pupae of Medflies reared under the same conditions as stated in the foregoing chapter were put in the five

cages, respectively. Emerged flies were reared on the food described in Table 2 during the pre-oviposition period. After their ovipositing capacity was confirmed, the bananas were put in those cages to make the flies oviposit freely for 24 hours. The experiments on oviposition were repeated three times on the different days without supplying additional flies. Due to the natural death, the number of the adult individuals in each cage at each time of the experiment turned out as follows: the first time (December 27)—approximately 10,000 individuals (5,000 pairs); the second time (January 4)—7,000 individuals (3,500 pairs); and the third time (January 9)—4,000 individuals (2,000 pairs).

All the bananas used for the experiments were Golfito-grown, and the cultivars and the number of the bananas were given in Table 6. The green bananas were collected on the day before the experiments. The ripe bananas were gathered a few days before, and ripened artificially with ethylene gas. Each of them was air shipped and carried into the laboratory in San José for each experiment. The bananas used were the same largest-grade in size for export as the ones in the field experiments stated in the foregoing chapter. At the time of the experiments, the green bananas contained 0.1—0.2% sugar and 21.5—19.5% starch, while the ripe bananas, so-called "green tip" (almost yellow in color but the tip remains green), contained 10.0—18.0% sugar and 10.5—2.5% starch.

Table 6. CULTIVAR, DEGREE OF RIPENING AND NUMBER OF FINGERS USED FOR EACH EXPERIMENT

Section	Cultivar	Degree of ripening	No. of fingers (for one time)	Adult rearing-cage[1]		
				First time	Second	Third
			fingers			
Single	Gros Michel	Green	40	A	D	C
	〃	Ripe	40	B	C	A
	Valery	Green	40	C	B	D
	〃	Ripe	40	D	A	B
Compound	(10 each of two cultivars and two degrees of ripening)		40	E	E	E

1) From the lowest to the top of the stacked cages, A-E in order. The top-most cage (E) is lighter than others.

The bananas were so reaped as to produce a pair consisting of the outer and inner fingers of one hand and inserted at regular intervals in each cage containing the adult flies. Only in the compound section, however, the bananas were arranged at random by using a table of random numbers, because the cultivar and the degree of ripenning of the bananas were different. A 13-day period was needed for a round of the experiments, which consisted of: the first day — bananas air shipped and selected; the second~third day — bananas to be put into rearing cages, oviposition for 24 hours, and removed into wooden boxes according to every cultivar and the degree of ripening, respectively; the fourth day (the next day after oviposition) — punctures to be examined for each banana; the eighth day (the fifth day after oviposition) — intermediate examination (record the number of the hatched larvae and "alive" or "dead" individuals after random sampling of each 10 fingers in the single section and each five in the compound section); the 13th day (the 10th day after oviposition) — final examination (dissection of all the used bananas and examination for the presence of any survivors of

the larvae and the number of the larvae of each instar).

To supplement the above, an additional experiment was carried out on January 30—31, with 7,000 adult flies (3,500 pairs) each, and the number of eggs per puncture was counted immediately after oviposition. All the experiments were carried out under the natural day length and at the indoor temperatures. During this season, the temperatures at San José were stable. The indoor temperatures and the humidity averaged 21.0±3.27°C and 66.5±7.49% respectively through the course of the experiments.

Results

Number of punctures and eggs

The average number of punctures on each banana, as shown in Table 7, decreased conspicuously in propotion to the number of the adult flies from the first experiment through the third one. Only at the first trial, under the highest density of the adult flies, the average number of punctures on the ripe bananas was significantly larger than that on the green ones. As a whole, both in single and compound sections, no significant difference was recognized between the ripe bananas and the green ones. Further, no difference was recognized in the preference of oviposition between the two cultivars. These results indicate that the Medfly oviposits in the green bananas just as in the ripe bananas under the experimental conditions. Especially, the fact that eggs were equally laid regardless of the difference of the cultivars and the degree of ripening in the compound section, suggests the possibility of oviposition in the green bananas even in the field conditions. While the fruit flies have a nature to oviposit one after another into the same puncture made by other flies, the average number of eggs per puncture was investigated as given in Table 8. The difference between the maximum and the minimum in number of eggs per puncture was not so wide between the green bananas and the ripe ones. However, the green banana on the average contained only about a half of those in the ripe banana. The result of the *T*-test was also significant at 1% level. Many punctures on the green bananas were plugged with the tannin-containing sap bleeding from the peel. The above factor may possibly render the successful oviposition difficult and rare (see plate). On the other hand, no difference was also found in the average number of eggs per puncture between Gros Michel and Valery.

Table 7. NUMBER OF OVIPOSITION PUNCTURES ON BANANA IN THE LABORATORY EXPERIMENTS
(Average number of the punctures per finger)

Section	Replication	Gros Michel		Valery	
		Green	Ripe	Green	Ripe
Single	I	91±68.8	222±51.7	107±67.2	183±55.9
	II	70±31.8	69±24.2	75±24.8	89±34.7
	III	17± 9.3	17± 6.1	40±22.6	25±13.7
Compound	I	259±74.9	354±84.3	311±52.7	360±78.6
	II	144±25.2	190±56.9	132±52.3	182±50.3
	III	30±14.9	49±22.0	65±43.0	62±15.4

1) The results of oviposition for 24 hr. (10,000 adults in the first time, 7,000 in the second, and 4,000 in the third).

Table 8. NUMBER OF EGGS PER PUNCTURE

Number of eggs per puncture	Gros Michel		Valery	
	Green	Ripe	Green	Ripe
Maximum number	42	41	32	56
Minimum number	0	0	0	1
Mean	4.9	11.6	7.8	14.0
Variance	(39)	(83)	(61)	(135)
T-Test	$t=4.24$	$p<0.01$	$t=9.78$	$p<0.01$

Remark: Result of an additional replication of the single section in Table 7. Five punctures were randomly sampled out of 10 fingers and a total of 50 punctures per one subsection.

Result of intermediate examination

An intermediate examination was carried out in each experiment for the survival of the hatched larvae in relation to each cultivar and the degree of ripening. A total of 10 bananas were sampled out of the single and five out of the compound one.

The result are given in Table 9. In the ripe bananas, the average number of the hatched larvae per finger totaled over 1,000 in the first experiment in which the cages contained a dense population of the adults. In a part of the banana sections in the second experiment, the average number of the hatched larvae per finger exceeded 1,000 as well. Although the larvae thrive when they live gregariously to some extent, the above number means undoubtedly an overpopulation. The very low survival rate in the high-density sections was probably due to suffocation of the larvae caused by the overpopulation.

Meanwhile, in each ripe-banana section in which the number of the hatched larvae averaged less than 400 individuals per finger, the survival rate accounted for more than 80%.

Table 9. AVERAGE NUMBER AND SURVIVAL RATE OF THE NEWLY HATCHED LARVAE (1st instar) PER FINGER ON THE 5TH DAY AFTER OVIPOSITION (The random-sampling of five fingers each in the compound section and 10 fingers each in the single section.)

Sections	Replication	Gros Michel		Valery	
		Green	Ripe	Green	Ripe
		Hatched larvae (Survival rate)	Hatched larvae (Survival rate)	Hatched larvae (Survival rate)	Hatched larvae (Survival rate)
Single	I	25.0 (34.8%)	2,107.2 (32.1%)	56.4 (16.5%)	1,621.0 (22.8%)
	II	139.6 (45.8%)[1]	363.3 (82.4%)	18.5 (9.2%)	112.8 (91.2%)
	III	31.1 (21.9%)	68.6 (98.8%)	50.0 (22.4%)	100.6 (89.8%)
	Average	65.2	846.4	41.6	6,111.5
Compound	I	4.0 (20.0%)	1,049.8 (0.4%)	5.6 (0.0%)	1,550.2 (0.3%)
	II	62.4 (73.4%)[2]	1,646.6 (68.9%)	59.8 (8.0%)	950.0 (25.8%)
	III	98.2 (32.8%)	271.4 (94.8%)	145.8 (44.2%)	338.8 (97.9%)
	Average	54.9	1,022.6	70.4	946.3

1) Five of the 10 examined fingers ripened on the 2nd~5th day after oviposition.
2) Six " "

Although the number of laid eggs in the green bananas was assumed to be a half of that in the ripe bananas, the percentage of hatched larvae in the former was extremely low except in the third trial in which a low density of adults were employed. In view of the low hatching rate in the green bananas, the effect of over-crowding on the survival of larvae can be excluded. However, the survival rate was usually lower than 50%.

Result of final examination

The final examination for the presence of the larvae was made on the 10th day after oviposition. The reason for a 10-day period is that it is enough for the development of larvae on ordinary host fruits, and even on an unfavourable diet such as green bananas, the larvae attain such a size that one can determine their survival with naked eyes.

The result of the examination of the whole remaining bananas is given in Table 10. In the case of the ripe bananas, many larval survivors were found, except the first trial of the compound sections in which the bananas were totally destroyed due to the overpopulation. As to the age structures, the second instar larvae were predominant in number followed by the first instar larvae, and the third instar ones were the fewest. In case of the bananas which had been kept green[1] for 10 days after oviposition, no larval survivors were found, nor was a trace of feeding present in the flesh. The above fact proves that the larva of the Medfly is unable to grow and dies in the banana which remains green for 10 days after oviposition. In other words, it means that the larvae can not grow up to the second instar inside of the green banana. Among the test bananas, however, there were some bananas which ripened naturally within 10 days after oviposition. In this case, the survival of the larvae becomes obscure depending upon how many days after oviposition they start ripening. In fact, some survivors were found in some such bananas.

Table 10. THE FINAL READING OF THE LABORATORY EXPERIMENTS (on the 10th day after oviposition)

The average number of the larval survivors per finger from the total examination of 30 fingers each in the single section and 5 fingers each in the compound section.

The figures in the brackets refer to the age structures. (First instar: second: third).

Sections	Replication	Gros Michel		Valery	
		Green banana	Ripe banana	Green banana	Ripe banana
		Larvae (Age)	Larvae (Age)	Larvae (Age)	Larvae (Age)
Single	I	0 (—:—:—)	0 (—:—:—)	0 (—:—:—)	68.7 (29:56:15)
	II	8.4 (23:66:11)	107.7 (36:45:19)	0 (—:—:—)	40.1 (37:49:14)
	III	0 (—:—:—)	11.1 (0 :29:71)	0 (—:—:—)	56.6 (77:17: 6)
Compound	I	1.8 (100:0:0)[1]	0 (—:—:—)	0 (—:—:—)	0 (—:—:—)
	II	0 (—:—:—)	73.4 (39:58: 3)	0 (—:—:—)	69.6 (40:60: 0)
	III	0 (—:—:—)	44.0 (24:66:10)	0 (—:—:—)	45.2 (27:68: 5)

1) The survivors were all found in the naturally ripened bananas (see Table 11).

1) The green banana stated here is unripe one naturally of which peel is inseparable from the fruit flesh, and not one so-called "aobuku" in Japanese nor one matured enough but green in color.

In Table 11, among the green bananas used, the bananas which had naturally ripened by the time of the final examination are all enumerated, and the onset of yellowing, the presence of the larvae and their age structures are shown, respectively. It is to be noted from this table that the larvae were all found in the bananas which have already ripened naturally within six days after oviposition, and the earlier the natural ripening was, the more the larval survivors increased in number, and the better the larvae grew. Consequently, the age structures came closer to the case of ripe bananas. Furthermore, some of the naturally ripened bananas in which no survivor was found did contain a few traces of feeding. This fact shows that, at least, the hatched larvae developed up to the beginning of the second instar.

Table 11. THE PRESENCE OF THE LARVAL SURVIVORS IN THE NATURALLY RIPENED BANANAS (The 10th day after oviposition)

Time of natural ripening (Number of days after oviposition)	Cultivar	(Section · Replication)	No. of fingers	No. of larvae	Individuals of each instar (First:Second:Third)
2～3rd day	Gros Michel	(Single II)	2	98	(0 : 87 : 11)
				62	(0 : 57 : 5)
	〃	(Compound II)	2	41	(0 : 32 : 9)
				0	(1 dead larva of 2nd instar)
4～5th day	〃	(Single II)	6	4	(4 : 0 : 0)
				4	(4 : 0 : 0)
				25	(6 : 8 : 11)
				18	(5 : 13 : 0)
				11	(9 : 2 : 0)
				31	(31 : 0 : 0)
	〃	(Compound II)	3	0	(— : — : —)
				0	(— : — : —)
				0	(— : — : —)
5～6th day	〃	(Compound I)	5	5	(5 : 0 : 0)
				2	(2 : 0 : 0)
				2	(2 : 0 : 0)
				0	(— : — : —)
				0	(— : — : —)
7～10th day	〃	(Single II)	22	No larval survivors or traces of feeding in the flesh	
	〃	(Single III)	3	〃	
	Valery	(Single II)	1	〃	
	〃	(Single III)	2	〃	
	〃	(Compound III)	3	〃	
	〃	(Compound I)	1	〃	

On the contrary, in the bananas which had ripened since the seventh day after oviposition, neither survivor nor traces of feeding in the flesh were found. Accordingly, it can be said that the essential condition for the Medfly to complete its growth in the green bananas is that the host fruit ripens within six days after oviposition.

In addition to the experiments mentioned above, the authors carried out an "inoculation test" in which the collected eggs were set under the peel and the subsequent development was examined. The result was that, in case of the ripe bananas, the emergence of adults accounted for about 10% of 750 eggs in 15 fingers of Gros Michel and about 2% of the corresponding number of eggs in Valery, but in case of the green bananas of both cultivars, none of them was found.

IV. Discussion

The present studies have indicated that the Medfly can not live in the green bananas at all. However, there may be a short period for the hatched larvae to survive in the immature tissue (this period is considered to be six days at 20°C). If the bananas ripen within this period, the larvae may continue to develop. From the fact that only the first instar larvae were found on the 10th day in the bananas which ripened in the proximity of six days after oviposition, the larval development is considered to be scarecely possible in the green bananas and it may only commence at the time of natural ripening. Further, the fact that the larvae developed considerably slower even in the ripe bananas as compared with their growth in other fruits and many first instar larvae were found even on the 10th day after oviposition proves that the banana is not a proper host of this fruit fly. However, the result of these experiments cannot be directly applied to the natural conditions because an abnormally high population of adult flies was confined to oviposit in the screen bags or in the rearing cages. At present, therefore, it cannot be discussed whether oviposition actually occurs in the green bananas under natural conditions.

Like the Medfly, the oriental fruit fly is an injurious insect pest and Japan keeps stringent watch over its invasion. However, the latter does not attack green bananas even in a caged condition (UMEYA, unpublished). For that reason, unripe banana is not prohibited from the areas where the oriental fruit fly is known to occur.

As clarified by the authors, there is still a possibility that the female of the Medfly oviposits in green banana under the natural conditions. However, it has been proved that the Medfly cannot develop in the green banana by keeping it unripe only for six days after oviposition.

As far as the two cultivars, Gros Michel and Valery are concerned, the authors are inclined to believe that there is no longer any fear of the introduction of this fly into Japan in association with the green bananas.

V. Summary

1. Medflies that were set free on the green bananas of the two principal cultivars (Gros Michel and Valery) oviposited well both on the bananas on the trees ("field banana" hereafter) and the harvested ones ("indoor banana" hereafter).

2. There was no difference in number of the oviposition punctures between the green bananas and the ripe ones. However, the eggs per puncture in the green bananas accounted for only about 50% of those in the ripe ones.

3. From the field bananas held on the tree for 10 days after oviposition, neither the larval survivors nor traces of feeding in the fresh were detected. Consequently, the hatched larvae, if any, were presumed to have died at the stage of the first instar under the peel.

4. In the indoor experiments, the hatched larvae, though smaller in number than in the ripe bananas, were found in the green bananas at the intermediate examination on the fifth day after oviposition, and a few of them were found alive. When the green bananas did not ripe within six days after oviposition, it was impossible for the larvae to grow up to the second instar and over beyond. Besides, the later the ripening was, the more slowly larvae

developed.

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Reference

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摘　　要

チチユウカイミバエの未熟バナナに対する寄生性に関する試験

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各種生果実の大害虫として有名なチチュウカイミバエ *Ceratitis capitata* WIEDEMANN の分布地域から，わが国はその寄主植物の輸入を禁止している。しかし，この禁止対象生果実の中に未熟バナナを含めてあることについて，かねてより該当各国から異論がとなえられていた。

本種の未熟バナナ寄生に関する報告はオーストラリアから JENKINS (1948) によってなされているが，以後，この事実を裏付ける追加データも，否定的な報告もなされないまま今日に至っていた。このため，チチュウカイミバエの未熟バナナ寄生を否定する論拠の多くは，経験的な域を出ることなく，決着のためには独自の試験にもとづく確認が必要であった。

本報告は，上記の目的のため，中央アメリカ，コスタ・リカ政府の協力によって1968年12月から1969月２月まで同国において行なった一連の試験の結果をとりまとめたものである。

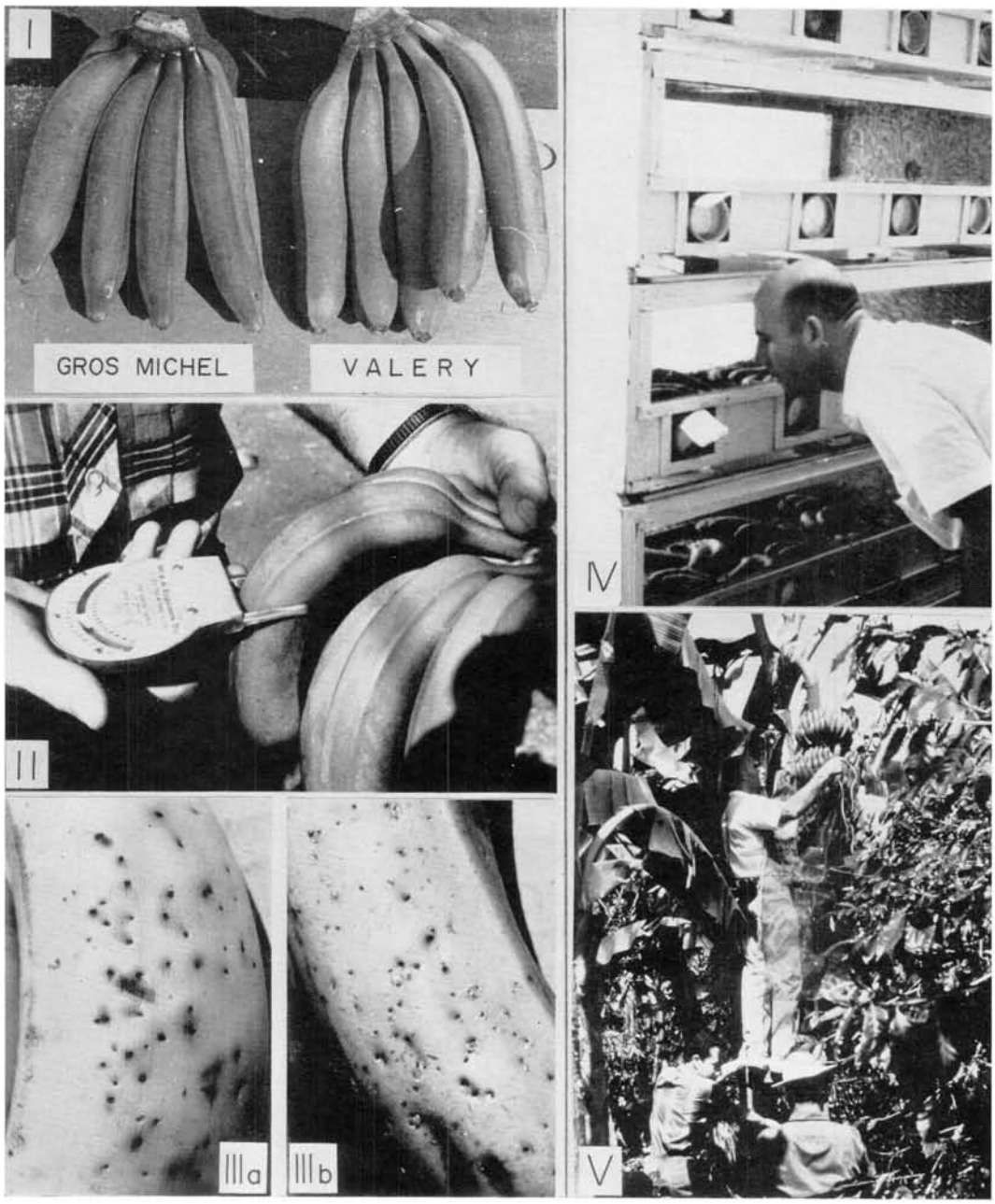
コスタ・リカのサン・ホセ市において大量飼育したチチュウカイミバエの成虫を用いて，室内および野外において未熟バナナに対する寄生性の可否を調査した結果，次のことが判明した。

1　野外のバナナ園において，生長した青バナナをバンチごとサランネットでおおい，多数の成虫に24時間自由に交尾産卵させたのち，９日目にバナナを収穫し，後熟させて内部の幼虫の有無を調査した。この結果，バナナ表面には多数の産卵痕が認められたが，生存幼虫は発見されず，また果肉表面の食痕も発見されなかった。なお，本試験は３地域合計31株のバナナについて行なったものである。

2　多数の成虫を密度を変えて大形ケージに分入し，人工的に後熟させた黄熟バナナおよび収穫後24時間以内の青バナナに24時間自由に産卵させ，室温(21.0±3.3℃)下で保存した。このバナナについて産卵後５日目に孵化率と幼虫の生存率の中間調査を行ない，さらに５日目に残存全量について解体調査を行なった。この結果，チチュウカイミバエは青バナナにもよく産卵するが，孵化率

と幼虫生存率は，黄熟バナナでは80%を越えたのに対して青バナナの場合ははるかに低い値を示し，孵化幼虫の生存率も50%以下にとどまった。また，産卵後10日目の最終調査においては，黄熟バナナで多数の成長した幼虫が認められたのに対し，青バナナにおいては，その後自然黄熟した一部のものを除いて生存幼虫および果肉に達する食痕は認められなかった。また，自然黄熟したバナナの場合も，熟化が産卵後7日目以降に始まったものからは生存幼虫は発見されなかった。なお，本調査は主要バナナの2品種（Gros Michel および Valery）について，約600本のバナナを対象に行なったものである。

3　上記の調査結果から，チチュウカイミバエは閉鎖環境下において産卵の場合は青バナナにもよく産卵するが，孵化率は低く幼虫は生育不能であることがわかった。また，青バナナにおける孵化幼虫の一部は未熟バナナ内部で成長しないまま最大6日間にわたって生存が可能で，この期間内に寄主が熟化しない限り，すべて死亡することが確認された。



PLATE

I Two cultivars of bananas tested
II A banana calliper
III Punctures caused by oviposition
a. on ripe bananas
b. on unripe bananas (with sap bleeding)
IV Adult rearing cages used for oviposition test
V Covering a bunch of bananas with a screen bag in the field experiment