Insecticide resistance of adult housefly in Hokkaido¹⁾

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Though the development of resistance to insecticides has become one of the most important problems in relation to insect control in Japan, only a little reliable datum on resistance of medical insects in Hokkaido is available. In the case of the housefly, only a report was published by Yasutomi (1961a) on the resistance levels of colonies collected at several spots in Hokkaido.

In 1970, houseflies were collected from various places in Hokkaido, and their resistance levels to insecticides were evaluated and compared with those of housefly colonies collected in Honshu.

TEST INSECTS and METHODS

Insects: Two or three couples of the housefly, *Musca domestica vicina*, were collected from garbage cans, garbage dumping places or pigpens at 44 places in Hokkaido, and brought to the tests after breeding for three or four generations in the laboratory.

Larvae were reared with the Oriental's Animal Food (Powder for the rearing of experimental animals, Oriental Yeast Manufacturing Co.).

Adults were fed with a 2% sucrose solution. Only female flies were brought to the tests on 3 to 4 days after the emergence.

Insecticides used: Eight kinds of insecticides; lindane (γ -BHC), malathion, dichlorvos (DDVP), diazinon, fenitrothion (Sumithion), bromophos, pyrethrins and allethrin, were used as test chemicals. These chemicals

were dissolved in acetone and applied to the test insects.

Test method (Topical application): Half μ l of serial dilution of the insecticides was applied topically onto dorsum of each fly using a microsyringe. Each dilution was tested on 20 flies and the experiment was repeated three times. After the treatment flies were transferred to containers in a constant temperature chamber held at 24 to 27°C, and fed with 2% sucrose solution. The mortality was counted at 24 hours after the treatment.

Evaluation of the level of resistance: The dosage required to produce 50% mortality (LD50) was used as the basis for comparison of resistance level. The LD50 of Takatsuki strain, which has never exposed to any insecticides, was used as the reference value.

RESULTS and DISCUSSION

Results of the tests in flies collected from Hokkaido and Honshu are summarized in Table 1 and 2.

Comparison of the resistance to lindane: Though the considerable variation in LD50 value of Takatsuki strain to γ -BHC was reported by Nagasawa (1962), the LD50 value of 4.547 μ g per female fly was obtained in the present study. Many samples of flies in Hokkaido were less susceptible to γ -BHC than the Takatsuki strain. The highest resistance level for γ -BHC was observed in Otaru colony, with the LD50 value of 84.19 μ g.

Comparison of the resistance to malathion: All samples of flies collected in Hokkaido were higher resistant to malathion than the Takatsuki strain. LD50 values of Japanese houseflies for malathion reported by several

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Table 1. LD₅₀ values for 8 insecticides of the adult female house flies in Hokkaido ($\mu\text{g}/\text{fly}$)

County	Colony	Malathion	Dichlorvos	Fenitrothion	Diazinon	Bromophos	Lindane	Allethrin	Pyrethrins
Kamikawa	Asahikawa	161.112	0.056	0.176	0.365	0.459	4.439	0.939	0.314
	Fürén	3.748	0.111	0.178	0.207	0.400	52.950	1.614	0.591
	Nayoro	1.887	0.077	0.379	0.340	0.656	2.425	1.186	0.878
Oshima	Yakumo	0.655	0.017	0.137	0.352	0.241	1.467	0.409	0.181
	Kikonai	10.537	0.049	0.096	0.226	0.179	2.308	0.767	0.247
	Hakodate	1.151	0.097	0.651	0.505	1.111	8.419	0.783	0.366
	Onuma	34.450	0.070	0.167	0.080	0.350	28.522	1.308	0.135
Shiribetsu	Rusutsu	93.873	0.156	0.236	0.483	0.511	40.189	0.799	0.480
	Iwanai	205.197	0.101	0.434	0.527	0.696	3.181	1.524	0.939
	Yoichi	197.453	0.098	0.244	0.449	0.492	8.967	0.459	0.265
	Otaru	87.897	0.083	0.218	0.560	0.377	84.190	1.323	0.243
Ishikari	Nakayama-toge	50.888	1.060	0.270	0.828	0.734	9.496	0.859	0.606
	Ishikari-tōbetsu	92.129	0.082	0.092	0.188	0.293	2.940	0.544	0.232
	Sapporo	213.388	0.058	0.145	0.134	0.318	0.741	0.730	0.379
	Shikotsuko	144.024	0.047	0.320	0.714	0.401	12.972	1.011	0.211
Abashiri	Hama-saroma	0.818	0.048	0.151	0.447	0.183	4.571	0.915	0.178
	Kitami	112.437	0.053	0.236	0.483	0.343	16.308	0.847	0.291
	Memambetsu (I)	75.384	0.045	0.226	0.669	0.395	1.942	1.104	0.277
	(II)	137.163	0.052	0.207	0.703	0.307	1.504	1.195	0.493
	Rubeshibe	0.778	0.040	0.142	0.425	0.159	4.375	0.561	0.640
	Saroma	1.244	0.081	0.221	0.623	0.307	8.249	0.865	0.269
	Naka-yūbetsu	1.869	0.024	0.192	0.533	0.320	3.120	0.696	0.670
	Monbetsu	1.039	0.038	0.128	0.225	0.241	3.113	1.204	0.744
Rumoi	Rumoi	47.551	0.040	0.083	0.233	0.210	2.326	0.322	0.381

County	Colony	Malathion	Dichlorvos	Fenitrothion	Diazinon	Bromophos	Lindane	Allethrin	Pyrethrins
Sorachi	Shyumarinai Takikawa	15.712	0.051	0.174	0.230	0.388	6.779	1.450	0.235
		1.732	0.059	0.275	0.382	0.479	6.671	0.770	0.431
Kushiro	Kushiro	73.014	0.064	0.183	0.586	0.453	3.118	0.792	0.176
	Akkeshi	16.086	0.041	0.168	0.479	0.270	4.194	0.365	0.124
	Shibechya	25.251	0.048	0.229	0.501	0.273	2.795	0.659	0.277
	Kawayu	1.266	0.032	0.143	0.318	0.215	2.706	0.376	0.341
Hiyama	Esashi	0.694	0.069	0.187	0.608	0.409	0.799	0.730	0.211
	Kamino-kuni	16.757	0.108	0.224	0.751	0.277	4.744	0.256	0.101
	Okushiri	1.498	0.054	0.256	0.719	0.399	1.186	0.783	0.335
Hidaka	Shizunai	1.414	0.083	0.165	0.326	0.213	2.433	0.746	0.225
Iburi	Tomakomai	132.106	0.156	0.137	0.365	0.315	2.274	0.552	0.485
	Muroran	57.991	0.108	0.377	0.474	0.373	41.800	0.958	0.192
Tokachi	Obihiro	2.640	0.132	0.217	0.545	0.266	11.149	0.736	0.672
	Honbetsu	0.783	0.036	0.179	0.572	0.291	2.133	0.868	0.164
Nemuro	Nemuro	36.002	0.043	0.143	0.659	0.612	5.493	0.585	0.165
	Attoko	0.730	0.059	0.107	0.463	0.245	0.695	0.232	0.165
	Naka-shibetsu	0.856	0.070	0.178	0.442	0.325	5.772	0.253	0.075
	Rausu	26.137	0.046	0.180	0.527	0.266	1.325	0.627	0.643
	Nemuro-shibetsu	70.238	0.034	0.210	0.575	0.322	5.675	0.484	0.598
Soya	Wakkanai	1.896	0.056	0.176	0.286	0.321	14.942	0.516	0.432

Table 2. LD₅₀ values for 8 insecticides of the adult female house flies in Honshu ($\mu\text{g}/\text{fly}$)

Colony	Malathion	Dichlorvos	Fenitrothion	Diazinon	Bromophos	Lindane	Allethrin	Pyrethrins
Takatsuki	0.454	0.076	0.088	0.293	0.161	4.547	0.481	0.387
Kochi (Toichi)	1.167	0.052	0.241	0.575	0.325	7.279	0.859	0.728
Hachimantai	51.589	0.068	0.243	0.359	0.123	3.432	0.839	0.297
Aomori	4.926	0.085	0.299	0.502	0.238	3.292	1.126	0.767
Morioka	58.025	0.083	0.189	0.233	0.124	3.627	0.751	0.321

workers were nearly locationg around $0.5 \mu\text{g}$ per female fly, for example, $0.5016 \mu\text{g}$ in the RP strain (Yasutomi, 1960, 61 b), $0.59 \mu\text{g}$ and $0.589 \mu\text{g}$ in the Denken and Hokota strains (Suzuki et al. 1961; Yasutomi, 1961 b). Recently, Yasutomi (1968) reported that the high resistance in houseflies to malathion was found at Yumenoshima Island, the 15th dumping island in Tokyo Bay and Matsudo dumping site in Chiba Prefecture, the LD₅₀ values being 18.51, 25.26 and $10.35 \mu\text{g}$ respectively. The high resistance recognized on the flies in Hokkaido is quite notable because this insecticide has been used seldom in Hokkaido. In the flies collected Sapporo, Kitami, Rusutsu, Ishikari-tobetsu, Memanbetsu and Onuma, the LD₅₀ values for malathion ranged between 0.818 and $213.388 \mu\text{g}$, being 1.8-470 times of that of Takatsuki strain.

Comparison of the resistance to allethrin: The LD₅₀ values of the flies from Memanbetsu ($1.104 \mu\text{g}$), Nayoro ($1.186 \mu\text{g}$) and Onuma ($1.308 \mu\text{g}$) were higher than that of the Takatsuki strain ($0.481 \mu\text{g}$). These values were not so higher than $1.180 \mu\text{g}$ reported by Ogami (1970), and $0.712 \mu\text{g}$ by Nakanishi (1970).

Comparison of the resistance to pyrethrins: The LD₅₀ values of the flies from Rausu ($0.643 \mu\text{g}$), Obihiro ($0.672 \mu\text{g}$), Monbetsu ($0.774 \mu\text{g}$), Naka-yubetsu ($0.670 \mu\text{g}$), Rubeshibe ($0.640 \mu\text{g}$), Tomakomai ($0.485 \mu\text{g}$), Iwanai ($0.939 \mu\text{g}$), Nayoro ($0.878 \mu\text{g}$) and Furen ($0.591 \mu\text{g}$) were higher than the Takatsuki strain ($0.387 \mu\text{g}$).

Comparison of the resistance to dichlorvos: The Takatsuki strain ($0.076 \mu\text{g}$) seemed to be more tolerant to dichlorvos if it was compared with the Hokota strain ($0.042 \mu\text{g}$) and Matsudo strain ($0.023 \mu\text{g}$) reported by

Yasutomi (1968) and the Denken strain ($0.031 \mu\text{g}$) tested by Suzuki (1968). The flies collected by the authors from Obihiro ($0.132 \mu\text{g}$), Rusutsu ($0.156 \mu\text{g}$) and Tomakomai ($0.156 \mu\text{g}$) were much resistant to dichlorvos than the Takatsuki strain.

Comparison of the resistance to diazinon: The LD₅₀ values of the flies from Nemuro ($0.659 \mu\text{g}$), Okushiri ($0.719 \mu\text{g}$), Kamino-kuni ($0.751 \mu\text{g}$), Saroma ($0.623 \mu\text{g}$), Memanbetsu (I) ($0.669 \mu\text{g}$), Memanbetsu (II) ($0.703 \mu\text{g}$), Shikotsuko ($0.714 \mu\text{g}$) and Nakayama-toge ($0.828 \mu\text{g}$) were higher than the value of the Takatsuki strain ($0.293 \mu\text{g}$).

Comparison of the resistance to fenitrothion: Every colony of housefly collected in Hokkaido except for Ishikari-tobetsu colony, tended to be slightly resistant to fenitrothion as compared with the Takatsuki strain ($0.088 \mu\text{g}$).

Bromophos: The susceptibilities of flies in Hokkaido to this insecticide were similar to those observed in the test with fenitrothion. Bromophos seems to be a hopeful insecticide, because it has very low toxicity in mice, the LD₅₀ value being 5.0 g/kg .

CONCLUSION

Houseflies were collected from 44 places in Hokkaido and 5 places in Honshu, and their resistance levels to lindane, malathion, diazinon, dichlorvos, bromophos, fenitrothion, allethrin and pyrethrins were evaluated. It was found that many housefly colonies in Hokkaido were much resistant to these insecticides than the Takatsuki strain. All samples of flies from Hokkaido were resistant to malathion, especially notably high LD₅₀ values were obtained in the flies from Sapporo ($213.388 \mu\text{g}$), Tomakomai ($132.106 \mu\text{g}$) and

Kitami (112.437 μg). These LD values were far much higher than the LD50 value of 25.26 μg obtained in the flies from the 15th dumping island (Tokyo). The flies in Hokkaido, however, were found to be still susceptible to both of the pyrethroid insecticides and dichlorvos.

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摘 要

北海道におけるイエバエ成虫の殺虫剤感受性について

北海道内 44 箇所と本州の 5 箇所で採集したイエバエ成虫の殺虫剤感受性をしらべた。実験に用いた殺虫剤は malathion, dichlorvos, diazinon, fenitrothion, bromophos, lindane, allethrin および pyrethrins の 8 種類である。実験は局所施用法により LD₅₀ 値を求め、相互の比較を行なった。とくに興味ぶかい点は北海道ではほとんど malathion が使用されていないにもかかわらず、非常に強い抵抗性をしめしたことである。また、lindane に対してもかなり強い抵抗性をしめすものがあつた。しかし、交差抵抗性はとくに認められなかつた。また、pyrethroid に対しての抵抗性は発達していなかつた。なお、malathion に強い抵抗性をしめすものでも、他の有機燐殺虫剤で駆除し得るものと考えられる。ことに、bromophos は今後、興味ぶかい殺虫剤と思われる。