

sur *T. pallidum*. Après inoculation, l'apparition des anticorps est également rapide: dès le deuxième jour chez l'un des animaux. Elle est très nette au 4<sup>e</sup> jour, mais les titres n'ont pas dépassé 1350 au 10<sup>e</sup> jour et semblent se stabiliser à 450. Parallèlement, le marquage sur *T. pallidum* s'élève à 150 sans jamais dépasser ce chiffre (tableau 6).

### Conclusion

La haute sensibilité de la réaction indirecte d'IF a permis de mettre en évidence l'apparition remar-

quablement précoce d'anticorps sériques chez les lapins inoculés massivement par la souche Nichols de *T. pallidum*. Le même fait est noté avec des inoculums tués par la chaleur et le formol, ainsi qu'avec le tréponème de Reiter.

Cette ascension est déjà nette pour la plupart des animaux au 4<sup>e</sup> jour après l'inoculation. La sécrétion des anticorps par les cellules immunologiquement compétentes n'est pas liée à l'évolution des lésions cliniques, et des taux élevés sont déjà atteints à la phase d'orchite floride.

## A Case of Developed Irritability to Insecticides

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Whether anopheline mosquitos can develop changes in their irritability to DDT as a result of selection by the insecticide is an important point still lacking clear evidence.<sup>a</sup> This note deals with an instance of such a change, although it concerns behaviouristic resistance to organophosphorus compounds rather than to DDT. Moreover, since our observations concern a fly (the spotted root maggot *Euxesta notata* Wied.) of agricultural and not medical importance, only a brief summary of them is presented here, a fuller paper being published elsewhere.<sup>b</sup>

Three strains of this fly had been selected for 7-12 generations by malathion, parathion and methyl parathion respectively, by exposing the adults in each generation in the plastic tubes used in the mosquito resistance tests recommended by the WHO Expert Committee on Insecticides<sup>c</sup> to papers impregnated with 4% of the organophosphorus compound concerned until 80% mortality had been achieved. When their susceptibility levels were assessed by continuous exposure to treated papers in the treated tubes, an increase in their time to 50% knockdown (LT<sub>50</sub>) seemed to indicate they were

becoming more resistant; but when the levels were assessed by topical application of the insecticide in a 9:1 mixture of acetone and olive oil, a reduction in the LD<sub>50</sub> indicated that they had really become more susceptible to the selecting and test insecticide (see the table). It therefore appeared that the flies

CHANGES IN SUSCEPTIBILITY AND IRRITABILITY OF *EUXESTA NOTATA* TO INSECTICIDES AS A RESULT OF SELECTION

Insecticide	Generation	LT <sub>50</sub> (hours)	LD <sub>50</sub> (μg/fly)	End-resters (%)
Malathion	P	1.80	0.210	26.5
	F <sub>12</sub>	6.10	0.080	41.7
Parathion	P	1.80	0.062	12.7
	F <sub>11</sub>	1.90	0.039	31.3
Methyl parathion	P	1.02	0.017	28.4
	F <sub>7</sub>	2.44	0.006	48.1
DDT	P	2.0	0.75	35.6
	F <sub>17</sub>	17.0	3.05	17.6
Dieldrin	P	41.0	7.50	31.8
	F <sub>16</sub>	29.8	19.40	35.9

<sup>a</sup> Muirhead-Thomson, R. C. (1960) *Bull. Wld Hlth Org.*, 22, 721.

<sup>b</sup> Hooper, G. H. S. & Brown, A. W. A. (1965) *Ent. exp. appl.*, 8, No. 4 (in press).

<sup>c</sup> WHO Expert Committee on Insecticides (1963) *Wld Hlth Org. techn. Rep. Ser.*, 265, 41.

had come to survive for a longer period in the plastic-tube test because they were now spending less time on the treated paper and more on the untreated ends of the tubes.

To check this point, the numbers of flies resting on the screen top and the untreated base of the tubes were counted at 5-minute intervals when they were exposed to the selecting and test insecticide concerned. It was found that the proportions of end-resting flies in the selected strains had increased to about double those in the original material. The end-resters were collected for comparison with the paper-resters and 24 hours later each fly in these two categories was tested by a single topical dose of 0.1  $\mu\text{g}$  of the organophosphorus compound concerned. In all three selected strains the end-resting were slightly more susceptible than the paper-resting flies (showing 99% as against 91% test mortalities).

This effect was general among the three organophosphorus insecticides, inasmuch as the parathion-selected strain showed a higher  $\text{LT}_{50}$  and lower  $\text{LD}_{50}$  to malathion as compared with the parental strain. These two strains were then tested for their ability to absorb and detoxify malathion, and it was found that the parathion-selected strain absorbed slightly more insecticide than the parental strain (14.4% as against 12.3% of the dose applied). More important, the selected strain detoxified less than half as much malathion as the parental strain did to carboxy-esterase and phosphatase products (17.3% as compared with 41.8% in three hours).

A parallel selection of strains of *Euxesta* with DDT or with dieldrin by this plastic-tube method, on the other hand, resulted in a truly increased resistance, with higher  $\text{LD}_{50}$  as well as  $\text{LT}_{50}$  values. In the DDT-selected strain, it was found that the proportion of end-resters had been halved instead

of doubled (see the table); although the end-resters were again found to be slightly more susceptible than the paper-resters ( $\text{LD}_{50}$  0.62  $\mu\text{g}/\text{fly}$  as against 0.70  $\mu\text{g}/\text{fly}$  in the selected strain, and 2.8  $\mu\text{g}/\text{fly}$  as against 3.3  $\mu\text{g}/\text{fly}$  in the parental strain). In the dieldrin-selected strain, the end-resters were no more susceptible than the paper-resters, and the proportion of end-resters had been scarcely increased.

These results, in our opinion, provide a coherent rationale for the understanding of insecticide irritability in Diptera, among which *Euxesta* happens to occupy a central and ancestral taxonomic position. Strains with increased irritability have greater physiological susceptibility, as the organophosphorus-selected strains demonstrate, as well as the individuals within the organophosphorus-selected and the DDT-selected strains. The greater susceptibility derives in turn from a reduction in the detoxication rate, as shown, for example, in the parathion-selected strain; this would result in the insecticide reaching the nervous system more readily to irritate the fly. On the other hand, strains with decreased irritability have greater physiological tolerance, as the DDT-selected strain demonstrates. The corollary that DDT-resistant strains or populations should be less DDT-irritable has been found in *Anopheles sacharovi*,<sup>d</sup> *A. stephensi*, *A. albimanus*, *Culex fatigans*<sup>e</sup> and *Aedes aegypti*.<sup>f</sup> Strains selected with dieldrin show no increase in irritability because the end-resters are not constitutionally different from the paper-resters in their response to this non-excitorepellent insecticide.

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<sup>d</sup> Zulueta, J. de (1959) *Bull. Wild Hlth Org.*, **20**, 797.

<sup>e</sup> J. R. Busvine, unpublished data, 1962.

<sup>f</sup> Brown, A. W. A. (1964) *Bull. Wild Hlth Org.*, **30**, 97.