Effect of Juvenile Hormone Mimics on the Coconut Rhinoceros Beetle[1,2,3]

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ABSTRACT

Methoprene, hydroprene, and 1-(*p*-chlorophenoxy)-7,8-epoxy-4,8-dimethyl-3-decene were effective juvenile hormone mimics in tests against pupae of *Oryctes rhinoceros* (L.).

The coconut rhinoceros beetle, *Oryctes rhinoceros* (L.), is a serious pest of the coconut palm. Although the virus *Rhabdionvirus oryctes* Huger gives good control of the insect (Marschall 1970, Zelazny 1973a, b, Young 1974), it may still be necessary to avoid the accumulation of potential breeding sites (mostly rotting wood). When the palms of old plantations are felled, stems can be used for posts or charcoal (Little 1973), but the stumps are difficult to destroy. Insecticides can be used to protect the stumps from insect attack (Dhondt 1973) but since this could cause an environmental hazard, it was thought worthwhile to investigate the use of synthetic juvenile hormones (JH) or mimics as an alternative to persistent insecticides. Reported here are the results of trials with 53 such chemicals; of these, twenty-five were active.

Materials and Methods.—Pupae that were less than 24 h old were used. All pupae were reared in kapok-cowdung mixture in the project's mass-rearing facility. Their average weight was 8.7 g.

The chemicals that showed activity[6] were: **1,** AI3-35477 ("JH-25"; 2-Octene, 7-ethoxy-1-(*p*-ethylphenoxy)-3,7-dimethyl-, (*E*)-); **2,** AI3-70459 (Hydroprene; 2,4-Dodecadienoic acid, 3,7,11-trimethyl-, ethyl ester, (*E,E*)-; Altozar®, ZR-512); **3,** AI3-70460 (Methoprene; 2,4-Dodecadienoic acid, 11-methoxy-3,7,11-trimethyl-, isopropyl ester, (*E,E*)-; Altosid®, ZR-515); **4,** AI3-20871 (Sesamex; Acetaldehyde, 2-(2-ethoxyethoxy) ethyl 3,4-(methylenedioxy) phenyl acetal); **5,** AI3-33970 (Acetaldehyde, 2-(2-propoxyethoxy) ethyl 3,4-(methylenedioxy) phenyl acetal); **6,** AI3-34137 (Acetaldehyde, 2-(2-ethoxyethoxy) ethyl *p*-(methylthio)-phenyl acetal); **7,** AI3-34315 (2-Octene 1-(*p*-chlorophenoxy)-6,7-epoxy-3,7-dimethyl-); **8,** AI3-34601 (Benzene, 4-[(6,7-epoxy-3,7-dimethyl-2-nonenyl) oxy]-1,2-(methylenedioxy)-); **9,** AI3-34616 (2-Nonene, 1-(*p*-cumenyloxy)-6,7-epoxy-3,7-dimethyl-); **10,** AI3-34853 (2-Nonene, 6,7-epoxy-1-(*p*-ethylphenoxy)-3,7-dimethyl-); **11,** AI3-34854 (2-Nonene, 6,7-epoxy-1-(*m*-ethylphenoxy)-3,7-dimethyl-); **12,** AI3-35137 (2-Decene, 1-(*p*-chlorophenoxy)-6,7-epoxy-3,7,9-trimethyl-); **13,** AI3-35138 (2-Decene, 6,7-epoxy-1-(*p*-ethylphenoxy)-3,7,9-trimethyl-); **14,** AI3-35487 (2-Nonene, 6,7-epoxy-3,7-dimethyl-1-(*p*-propylphenoxy)-); **15,** AI3-35491 (2-Nonene, 6,7-epoxy-1-(*p*-ethoxyphenoxy)-3,7-dimethyl-); **16,** AI3-35540 (2-Octene, 7-ethoxy-1-(*p*-ethoxyphenoxy)-3,7-dimethyl-, (*E*)-); **17,** AI3-35810 (Ether, 4,8-dimethyl-3,7-decadienyl *p*-ethylphenyl); **18,** AI3-35811 (Ether, 4,8-dimethyl-3,7-nonadienyl *p*-ethylphenyl); **19,** AI3-35812 (Ether, 5,9-dimethyl-3,8-decadienyl *p*-ethylphenyl); **20,** AI3-35854 (3-Decene, 8-ethoxy-1-(*p*-ethylphenoxy)-4,8-dimethyl-); **21,** AI3-35856 (3-Decene 9-ethoxy-1-(*p*-ethylphenoxy)-5,9-dimethyl-); **22,** AI3-35863 (3-Decene, 1-(*p*-chlorophenoxy)-7,8-epoxy-4,8-dimethyl-); **23,** AI3-35864 (3-Nonene, 1-(*p*-chlorophenoxy)-7,8-epoxy-4,8-dimethyl-); **24,** AI3-70033 (Benzene, 4-[(6,7-epoxy-3,7-dimethyl-2-octenyl) oxy]-1,3-(methylenedioxy)-, (*E*)-); **25,** AI3-70369 (2-Nonene, 1-(*p*-chlorophenoxy)-6,7-epoxy-3,7-dimethyl-, (*E*)-).

All the chemicals except no. 2 and 3 were synthesized at the Beltsville laboratory and were at least 95% pure when analyzed by gas chromatography Compounds 2 and 3 are products of Zoecon Corporation, Palto Alto, CA.

The following scale was used to rate the activity of the chemicals. 0=no effect (the beetle emerges from the pupa alive with only slight or no deformation of the elytra); 1=the beetle emerges completely from the pupal skin, but the wings are badly deformed and at least remains of one or a pair of treated stridulation organs (gin traps) are visible; 2=the beetle does not completely emerge from the pupal skin, which covers the abdomen; head and thorax are free; 3=the pupal skin is only detached between the legs on the ventral side of the thorax; 4=pupa died with newly formed beetle inside; and 5=second pupa (never observed).

Experiments.—1.—1000-, and 200-μg amounts of each chemical (equivalent to ca. 125 and 25 ppm AI) were applied to the venter of the abdomen of individual pupae.

2.—The 25 chemicals that had shown an effect in the 1st experiment were retested. If the rating was greater than 1, 200 μg were injected into the stridulation organ. If the effect was slight (rating of 1), 400 μg were injected into the stridulation organ. Usually the stridulation organ used was the one closest to the thorax.

3.—Further dilutions of the chemicals were made in acetone. In accordance with the results obtained in the previous experiments, applications were made at lower doses.

Though the number of coconut palm beetles in infested areas is small, their potential for damage is

[1] Coleoptera: Scarabaeidae.

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[3] Mention of proprietary products is for identification only and does not constitute endorsement by the USDA.

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[6] A list of the inactive chemicals is available from T. P. McGovern upon request.

Table 1.—JH-activity rating of compounds on young pupae of *Oryctes rhinoceros*.

Compound no.	Applied topically to venter of abdomen, μg/pupa		Injected into stridulation organs, μg/pupa			
	1000[a]	200[a]	200[b]	40[c]	4[b]	0.4[b]
1	4	—	2	0.2	0	0
2	3	4	4	1.2	1.0	0
3	4	4	4	4	—	—
4	4	3	3.5	0.4	0	0
8	4	3	2.5	2.0	0	0
10	4	0	2.0	0	0	0
12	4	3	3.5	0.4	0	0
14	3	3	3.5	0	0	0
19	—	4	1.5	0.6	0	0
22	4	4	4.0	1.4	0.5	0
23	3	1	1.5	0.6	0	0
	1000[a]	200[a]	200[b]		20[b]	
5	2	0	4.0		0	
9	2	0	1.5		0	
13	2	0	1.5		0	
15	2	0	2.5		0	
16	3	0	2.5		0	
17	4	1	1.0		0	
20	4	0	2.5		0	
25	3	2	1.5		0	
	1000[a]	200[a]	400[b]	200[b]	40[b]	
18	1	1	3.5	1.0	—	
24	1	0	3.0	—	0.0	

[a] Result on one pupa.
[b] Average of 2 treated pupae.
[c] Average of 5 treated pupae.

great. These low populations, even in infested areas, greatly limited the number of beetles available for our work and limited the number per test we could use.

RESULTS.—No activity could be discerned in the pupae treated with 28 of the chemicals; further work with them was therefore abandoned.[6]

Nineteen compounds that gave a response greater than 1 with the 1000 μg dose were tested at lower dosages (Table 1). Compound 3 (methoprene) gave very good results. Unfortunately, the solution was lost before it could be tested at dosages lower than 40 μg AI/pupa. Compounds 2 and 22 still showed a slight effect at 4 μg AI/pupa (equivalent to a rating of ca. 0.5).

Six chemicals gave a slight response (rating 1) with the 1000 μg dose. These chemicals were retested in experiment 2, 400 μg being injected into the stridulation organs of 2 pupae for each compound. Compounds 6, 7, and 21 did not show any effect at this dosage, compound 11 had a slight effect (rating 0.5). Compounds 18 and 24 gave a good response, and pupae were treated with them at lower dosages (3rd set of data in Table 1).

Thus, a number of JH-mimics have an effect when applied topically or injected into young pupae of the rhinoceros beetle. The most effective compound was methoprene.

REFERENCES CITED

Dhondt, A. A. 1973. Report of the project manager 1972–1973, UNDP/FAO project for research on the control of the coconut palm rhinoceros beetle. Pages 77–87. Internal Report.

Little, E. C. S. 1973. Report of the project manager 1972–1973, UNDP/FAO project for research on the control of the coconut palm rhinoceros beetle. Pages 25–9. Internal Report.

Marschall, K. J. 1970. Introduction of a new virus disease of the coconut rhinoceros beetle in Western Samoa. Nature (London) 225: 288–9.

Young, E. C. 1974. The epizootiology of two pathogens of the coconut palm rhinoceros beetle. J. Invertebr. Pathol. 24: 82–92.

Zelazny, B. 1973a. Studies on *Rhabdionvirus oryctes*. II. Effect on adults of *Oryctes rhinoceros*. Ibid. 22: 122–6.

1973b. Studies on *Rhabdionvirus oryctes*. III Incidence in the *Oryctes rhinoceros* population of Western Samoa. Ibid. 22: 359–63.