Comparative effects of five new synthetic juvenile hormone analogues against the red cotton bug *Dysdercus koenigii* F.

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Five synthetic juvenile hormone analogues (nos. I–V: I, 1-(3,4-methylenedioxyphenyl)-4,8-dimethyl nona-1,3,7-triene; II, 1-(3,4-methylenedioxyphenyl)-4,8-dimethyl nona-1,3-dieno-7-oxirane; III, 1-(3-methyl but-2-enyl)-3-(4-methoxy phenyl)-2-propenoate; IV, 1-(3-methyl but-2-enyl)-3-(3,4-methylenedioxyphenyl)-2-propenoate; V, 1-(3,4-methylenedioxyphenyl)-4,8-dimethylnona-1,7-diene) have been evaluated (at 0.1% conc., 2 and 5 µl topical) for their morphogenetic activity against the last instar nymphs of the Pyrrhocorid *Dysdercus koenigii* F. Compound no. V caused 100% 6th instar production at the above-said dosages whereas with compound nos II and I, 35% and 10% 6th instars were formed respectively at 5 µl. The percentage of adultoid production was very high with compounds II and I whereas III and IV possessed no juvenomimetic activity. Compounds V, II, and I also induced a high mortality in the supernumerary instars or in the adultoids. With compounds I and II, the egg hatch was totally inhibited at 5 µl.

One of the widely accepted methods in integrated pest management is the deployment of juvenile hormone analogues (JHAs) on account of their negligible vertebrate toxicity[1] and hence their substitution in place of the toxic insecticides and chemosterilants. Though varied chemical structures can produce a JH response, it was Bowers[2], who on the basis of JH activity in certain synergists possessing the methylenedioxyphenyl (MDP) ring, synthesized a series of compounds having the chemical features of both the terpenoids as well as the MDP group[3]. Subsequently, a number of MDP-containing compounds were reported to act as insect growth regulators against a wide range of species[4–6]. Reported here is a series of five compounds, four with the MDP ring and one without it, whose juvenilizing activity has been evaluated against the last instar nymphs of the red cotton bug *Dysdercus koenigii* F. in view of the highly sensitive response of this exopterygote to the juvenoids[7–10]. The 5 JHAs used in the study are shown in Figure 1.

Freshly moulted 5th instar nymphs of *D. koenigii*, reared under controlled conditions (27 ± 2° C; 60–65% RH; 16 h day light), were starved for 24 h and acetone-solubilized JHAs (5 nos.) applied topically (0.1% conc.; 2 and 5 µl applications; acetone-treated controls; 20 × 6 replicates). The morphogenetic activity of all the compounds was recorded and compared with the controls along with the fecundity and fertility of the moulted individuals.

The most potent of the five evaluated compounds was no. V as 100% supernumerary instars were formed even at the 2 µl application (Figure 2 *a*), at which no such observation was recorded for the other four compounds (Table 1). At the increased dosage of 5 µl, 35% 6th instars were formed with compound no. II and 10% with no. I. The former compound at 2 and 5 µl respectively produced 50 and 55% adultoids (Figure 2 *b*) whereas the latter compound produced 35 and 65% adultoids at 2 and 5 µl respectively. Compounds nos III and IV were totally ineffective and produced perfect adults and except these, in all the treatments the moulting was 1–2 days earlier than the 6 day nymphal period of the controls. On the basis of the formation of 6th instars, the activity of the compounds at both 2 and 5 µl is of the order of V > II > I.

The other observation on the activity of the compounds was the induction of mortality, whether in the individuals stuck in the moulted skin or in those that could cast off the skin. With compound V, at 2 µl and at 5 µl 45% and 25% 6th instars respectively died in their exuviae and rest of the completely moulted 6th instars died within a week of the moult. With compounds II

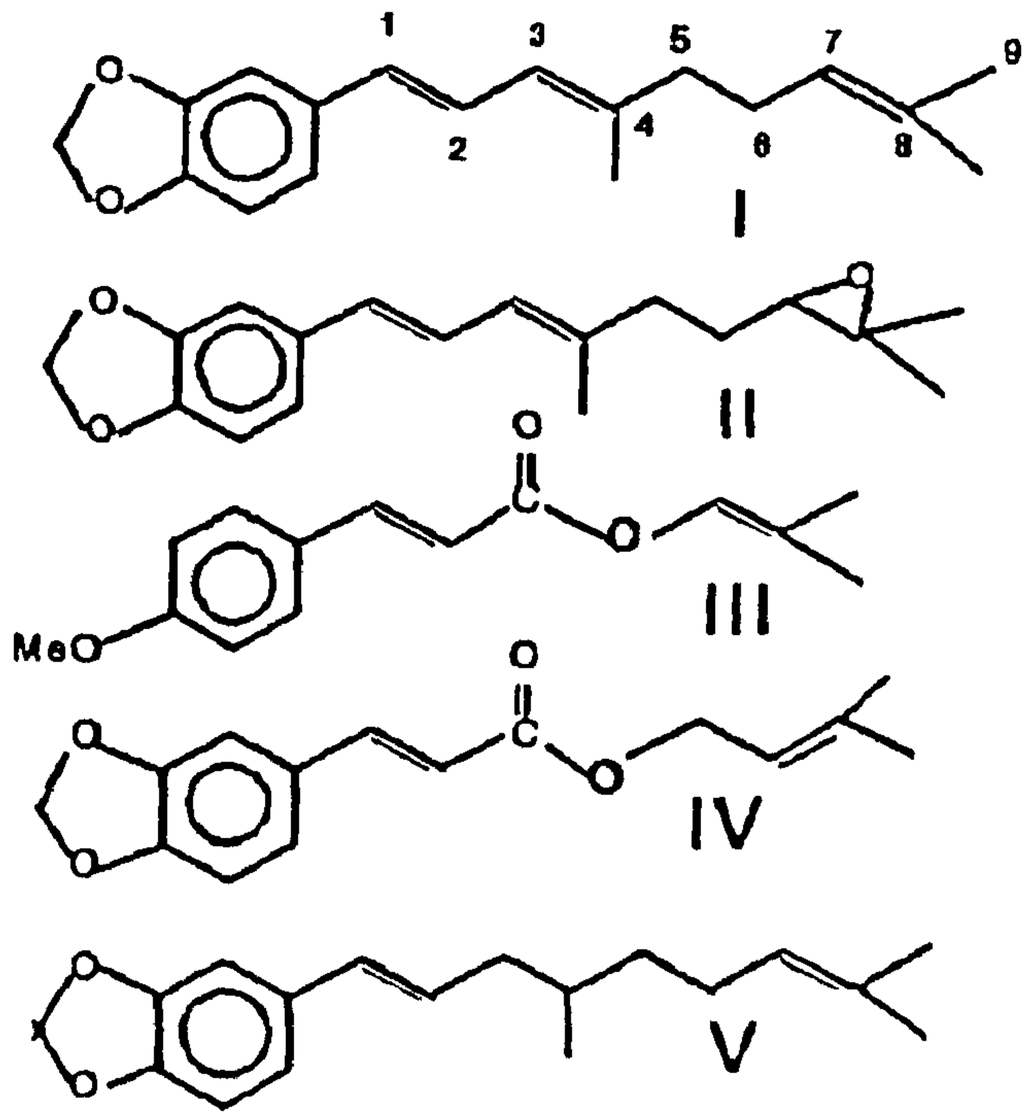

Figure 1. I, 1-(3,4-methylenedioxyphenyl)-4,8-dimethyl nona-1,3,7-triene; II, 1-(3,4-methylenedioxyphenyl)-4,8-dimethyl nona-1,3-dieno-7-oxirane; III, 1-(3-methyl but-2-enyl)-3-(4-methoxy phenyl)-2-propenoate; IV, 1-(3-methyl but-2-enyl)-3-(3,4-methylenedioxyphenyl)-2 propenoate; V, 1-(3,4-methylenedioxyphenyl)-4,8-dimethyl nona-1,7-diene.

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Table 1. Morphogenetic effects of JHAs on the 5th instar nymphs of *D. koenigii*

Compound	Insects/ replicate	Concentration 0.1%					
		2 µl			5 µl		
		6th instars	Adultoids	Adults	6th instars	Adultoids	Adults
Control	20	0.0 ± 0.00	0.0 ± 0.00	19.6 ± 0.73	0.0 ± 0.00	0.0 ± 0.00	19.6 ± 0.73
JHA-I	20	0.0 ± 0.00	7.0 ± 1.29	12.1 ± 1.46	2.0 ± 0.57	13.0 ± 1.52	3.2 ± 0.74
JHA-II	20	0.0 ± 0.00	10.3 ± 1.69	6.0 ± 1.19	6.8 ± 1.06	11.3 ± 0.94	0.0 ± 0.00
JHA-III	20	0.0 ± 0.00	0.0 ± 0.00	19.5 ± 0.76	0.0 ± 0.00	0.0 ± 0.00	19.8 ± 0.37
JHA-IV	20	0.0 ± 0.00	0.0 ± 0.00	19.7 ± 0.45	0.0 ± 0.00	0.0 ± 0.00	19.6 ± 0.47
JHA-V	20	19.6 ± 0.74	0.0 ± 0.00	0.0 ± 0.00	19.8 ± 0.37	0.0 ± 0.00	0.0 ± 0.00

n = 6.

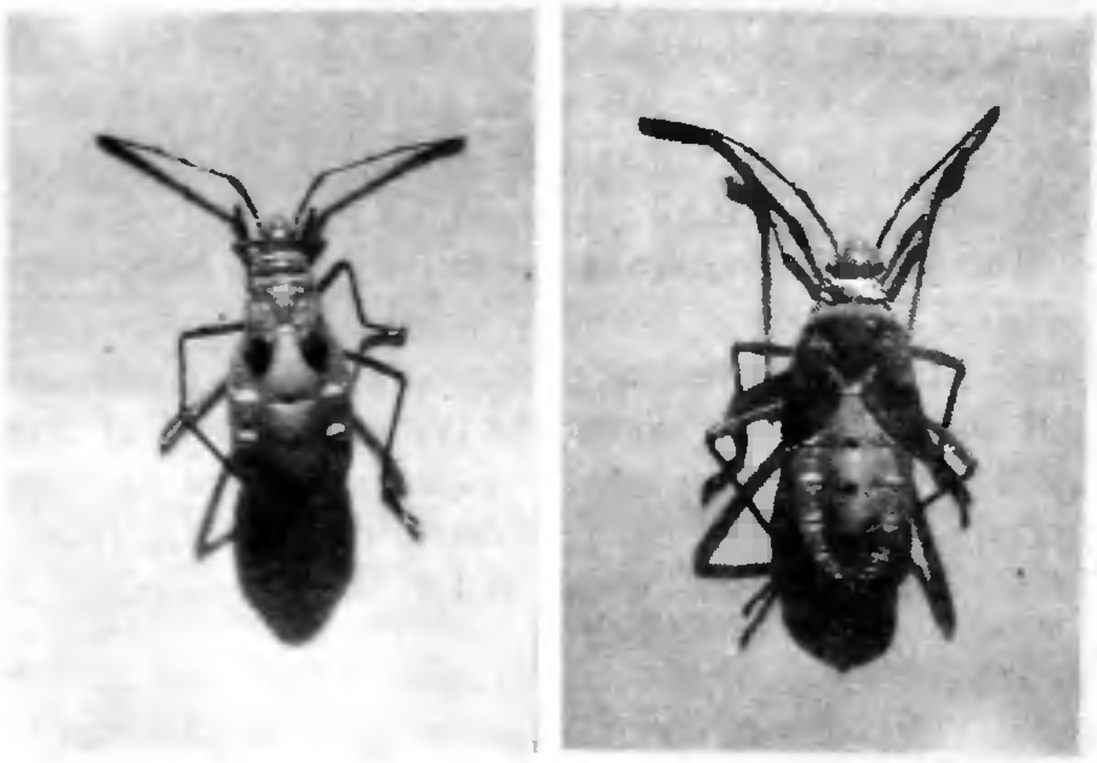

Figure 2. *a*, A 6th instar. *b*, An adultoid.

and I, the percentage of adultoid mortality at the time of moulting ranged between 27 and 40. No adult died during moulting with compounds III and IV but in the former at 5 µl, 15–20% adult mortality took place a few days after the moult.

Some 5th instars remained in an unmoulted state (10–20%) in treatments of compounds II and I. The adults formed with these two compounds had crumpled wings. Copulation was observed with compounds I–IV and the fecundity was comparable with the controls. However, whereas all eggs hatched at the two used dosages with compounds III and IV, with I and II, 100% hatching was observed at 2 µl and no hatch at 5 µl.

The morphogenetic activity of a juvenoid is correlated with the suppression of metamorphosis[6] and in this respect three of the tested compounds (V, II, and I), especially V, possess an excellent potential for use, against at least the Pyrrhocorids, when compared with the toxic insecticides. The increased mortality and production of sterile eggs by compounds I and II, is an additional advantage for their practical exploitation.

The structure–activity relationship of the compounds suggests the absence of double bond at position 3 in compound V to be responsible for its very strong morphogenetic activity since the presence of such a bond in compound I reduces the activity manifold, despite the structural resemblance of the two juvenoids. On the other hand, the epoxide group of compound II appears to make it more effective than compound I. The absence of an epoxide functional group in compounds III and IV along with the shortening of the side chain besides the presence of oxygen functions (as esters) could be the reason for the lack of JH activity in these compounds and the presence (in IV) or absence (in III) of the MDP ring does not play any role in enhancement of the activity.

As the hormonal compounds are specific to the target pest and non-toxic to the beneficial organisms[6], the presently evaluated JHAs and synthetics of similar nature may be utilized in carefully timed applications to derail the development of the pest species.

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