self-administer multiple doses of acetaldehyde and was limited only by the 5-sec delay incorporated into the drug delivery system, this suggestion seems plausible. The report that food deprivation in combination with exposure to ethanol reduced blood-brain barrier functions[15] is interesting in this context. These suggestions do not eliminate the possibiliy that withdrawal of a reinforcing substance, acetaldehyde[1,9,16] for 2 days prior to the start of the ethanol preference sequence, may have led to increased intake of another drug, ethanol.

We believe these results to be important for several reasons. First, they show that the voluntary intake of a metabolite can shift the preference function for its precursor ethanol, one of the most widely used drugs. Secondly, since acetaldehyde changes ethanol preference, the results suggest a strong prima facie case for a) the possible in vivo synthesis of an alkaloid which perpetuates alcohol intake, and/or b) acetaldehyde-induced stimulation of catecholamine release that mediate consummatory functions and reward; the mechanism controlling the release may be linked to the function of aldehyde metabolizing enzymes, particularly ALDH[14]. Thirdly, the results suggest that ethanol preference in the rat may be affected by an association between (a) and/or (b) and possible nutritional variables[10,17–19]. Fourthly, the results suggest the need for an awareness of the possibility that acetaldehyde (which is found to be more abundant in wines than beers and distilled spirits[20]) induced effects may have to be considered separately from that of ethanol when assessing health problems related to high intake of alcohol beverages.

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Antifeedant nature of the quinone primin and its quinol miconidin from *Miconia* spp.

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Summary. The quinone primin (**1**) and its quinol miconidin (**2**) which occur naturally in Miconia spp. (Melastomataceae), were synthesized and then tested as potential antifeedants against 6 insect species. Antifeedant activity was found in all cases, ranging from primin (**1**) being most active against *Pieris brassicae*, to miconidin (**2**) being only slightly effective against *Heliothis armigera*.
Key words. *Miconia* spp.; quinones; primin; miconidin; anti-feedant activity, insect.

The presence in higher plants of quinones and of their reduced forms, quinols, is generally associated either with the process of cellular respiration and photosynthesis[2] or with their defence against insects[3] or with allelopathy[4].

Primin (2-methoxy-6-pentyl-1,4-benzoquinone, **1**), found in the leaves and in the glandular hairs of *Primula obconica*[5], causes severe dermatitis and allergy in some individuals[6]. Primin (**1**) was also isolated, together with its quinol miconidin (**2**), from *Miconia* species[7].

We therefore considered it to be of interest to establish whether compounds **1** and **2**, which are highly active biological substances[6–8], could also be involved in a mechanism for the protection of plants against some insect species.

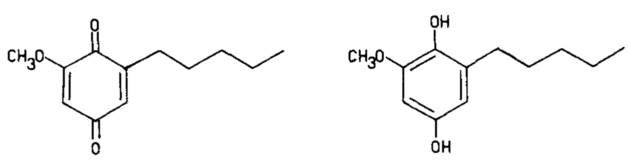
Methods. Owing to the difficulty of obtaining the compounds investigated from natural sources in amounts sufficient for biological tests, large amounts were prepared by simplification of a known route[9].

Thus o-vanillin (**3**) in Et_2O was treated at 0°C with n-BuLi (2 eq.) to give after a standard work-up procedure the alcohol **4**[10] in 95% yield (b.p. 112°C/8 mm Hg; ^{1}H-NMR ($CDCl_3$+TMS): δ 3.85 (s, 3H), δ 6.70 (s, 3H); IR (CCl_4): 3540–3400 cm^{-1}.

The latter compound (5.85 g, 24.8 mmoles) was hydrogenated in EtOH (50 ml) for 2 h at room temperature and atmospheric pressure in the presence of 10% Pd(C) (500 mg) and 2N H_2SO_4 (0.2 ml), affording in 65% yield compound **5**, which had previously been prepared from **3** in 5 steps[9].

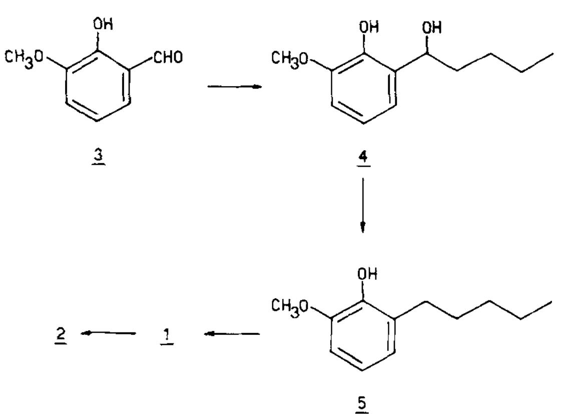
Compound **5** was then converted into primin (**1**)[11] by Fremy's

salt oxidation in the presence of N/6 KH_2PO_4 buffer solution[12], raising the yield of this step from 20–40%[9] to 70%.
The conversion of **1** into **2**[11] was done according to methods described in the literature[7] with $Na_2S_2O_4$ in hot water.
Bioassays were conducted with 6 insect species: the desert locust *Schistocerca gregaria*, the migratory locust *Locusta migratoria*, the army worms *Spodoptera littoralis* and *S. extempta*, the budworm *Heliothis armigera*, and caterpillars of the cabbage white butterfly *Pieris brassicae*. All were tested during the actively feeding phase of the last larval instar.
Individuals were tested in clear plastic boxes and given a choice between 2 glass fiber filter paper discs (Whatman GF/A 4.25 cm diameter). The discs were impregnated with sucrose, the principal phagostimulant, with a final concentration of 5% dry wt. One disc in each pair was treated with the test extract or compound and the other with the solvent only. They were offered to the insects after evaporation of the solvent, and in the case of the caterpillars wet cotton wool was provided.



1 2

Scheme 1.



Scheme 2. Synthetic route to primin (**1**) and miconidin (**2**) from o-vanillin (**3**).

Results of antifeedant tests against 6 insect species

Insect species	Feeding habit	Concentration (% dry wt) which significantly inhibits feeding Primin (**1**)	Miconidin (**2**)
Acridids			
Schistocerca gregaria	Polyphagous	0.01	0.05
Locusta migratoria	Graminivorous	0.1	0.05
Caterpillars			
Spodoptera exempta	Graminivorous	0.01	0.05
Spodoptera littoralis	Polyphagous (herbaceous)	0.01	0.01
Heliothis armigera	Polyphagous (flowers and fruit)	0.1	0.2
Pieris brassicae	Cruciferous	0.005	0.05

There were 10 replicates for every concentration of each compound. When approximately 50% of either disc was gone, the area of each was measured with a Li-Cor electronic area measurer and the amounts eaten compared. For each insect relative ingestion of test disc was calculated thus:

$$\frac{\text{amount of test disc eaten} \times 100}{\text{total amount eaten}}$$

Therefore if 0 is obtained, there is total feeding-inhibition and if 50 is scored there is no effect. In this paper mean values for any test which are below 20 and with a statistically significant difference between test and control (Mann Witney U-test) are considered to show antifeedant characteristics.
Results and discussion. All 6 insect species showed reduced feeding with a concentration of 0.1% dry weight or less (table). *Pieris brassicae* was most sensitive to primin (**1**) with significant feeding-inhibition at 0.005% dry wt, while *Spodoptera littoralis* was most sensitive to miconidin (**2**) (0.01% dry wt). *Heliothis armigera* was least sensitive. There is little obvious pattern in relation to insect feeding habit.
Where these compounds occur naturally in *Primula* and *Miconia*, concentrations are such that a variety of insect species are likely to be deterred from feeding. Thus they are likely to play a role in a non-selection of these plants by insects which have not specialized on them. It is not known whether they are toxic if ingested, but host plant selection by insects is often largely a result of rejection of non-hosts on the basis of antifeedants therein, whether or not they are toxic[13]. The fact that they occur on the leaf surface is also significant since the effective concentration tasted at first contact will be relatively high so that their antifeedant effects will be greatly enhanced.
Such an approach to self defense by plants is now considered to be very important[14]. Clearly, primin (**1**) and miconidin (**2**) are likely to be part of a potential antifeedant complex in *Primula* and *Miconia*.

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