

groups showed a partial superlattice problem:

EEE	EE0	EOE	E00
1.41	1.60	0.56	0.61
0EE	0E0	00E	000
1.65	1.51	0.52	0.50

Thus, about 75% of atomic positions (x, y, z) should be found after translation by $\pm b/2$ in $(x, 1/2+y, z)$, while 25% should have any other position.

The structure was solved by direct methods with MULTAN 78 [4]. Centrosymmetric trials gave no solution. After some acentric cycles of trial-and-error calculations, one model with four distinct molecules gave an R_1 value of 37%. Further cycles of refinements and calculations of difference maps with the SHEL-X program [5] showed subsequently the correct positions of four times 21 atoms. The centre of symmetry was found and the atomic positions and isotropic temperature parameters of the superlattice were refined to an R_1 value of 25%.

Chemical aspects (bonding distances and angles) led to the structure of a p-quinone with one methoxy group, another one was situated at the third ring system, which contained a hydroxy group too. The use of the correct scattering factors [6] as well as further cycles of isotropic refinement led to an R_1 value of 13.2%. The consecutive calculations of the difference maps [5] now showed all of the 24 expected H atoms. After introduction of anisotropic temperature factors and refinement of all positional parameters the calculation was stopped at an R_1 value of 6.02% (Fig. 1). The obtained sensitizing quinone was named cyprapedin. Further crystallographic descriptions of the structure, e.g., hydrogen bonding, packing of molecules and the superlattice problem will be reported later in *Acta Crystallographica*. Cyprapedin belongs to the group of rare non-terpenoid phenanthraquinones chemically termed as 2,8-dimethoxy-7-hydroxy-1,4-phenanthraquinone. As far as we could exhaust from the literature this quinone has not been reported from natural sources previously.

Phenolic phenanthrenes, which might be considered as precursors of cyprapedin and the other still unknown *Cyprapedium* quinones and which commonly are called phy-

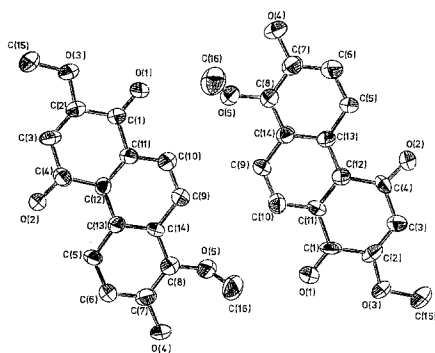


Fig. 1. ORTEP drawing [9] of the two independent molecules of cyprapedin with atom numbering and vibrational ellipsoids at the 50% probability level without H atoms

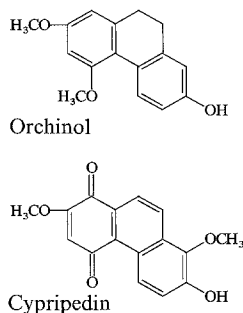


Fig. 2. Structure of orchinol as an example for a phytoalexin hypothetically considered as a precursor of a *Cyprapedium* quinone, e.g., cyprapedin

toalexins have already been found in different orchid species, as for example in *Orchis militaris* L. (orchinol) and *Himanto-*

glossum hircinum (L.) Koch (loroglossol, hircinol) [7, 8]. They are produced as defensive substances against fungal attacks in the corms of the orchids.

It might be imagined hypothetically that these phytoalexins are enzymically or by other influences oxidized to the corresponding phenanthraquinones like cyprapedin (Fig. 2). Further investigations on the structures of the other quinones are in progress.

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Synergism between Chemical and Physical Stimuli in Host Colonization by an Ambrosia Beetle

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We propose a hypothesis in which chemical and physical stimuli synergize host recognition and colonization by the ambrosia beetle *Trypodendron* (= *Xyloterus*) *lineatum* Ol. (Coleoptera: Scolytidae). In a sequence of behavioral events ("Reizkette"), α -pinene, a monoterpene common to the coniferous host trees of the ambrosia beetle, appears responsible for host re-

cognition. Ethanol synergizes the response [1], as it develops under anaerobic metabolism in tree trunks suitable for breeding [2]; together with the α -pinene, the ethanol achieves host acceptance and induces attack. Invasion of the host's bark and saw-wood triggers release of the aggregating pheromone 3,3,7-trimethyl-2,9-dioxatricyclo[3.3.1.0^{4,7}]nonane called "lineatin" [3]

Table 1. Field response of *T. lineatum* to perforated cylinder traps baited with lineatin. (A) at Buchenbach (Black Forest, Germany), (B) at Lardal, Norway; May 1979. Each test was repeated three times

Stimulus description	Trap	Average (and extreme) numbers of beetles responding per trap	Sex ratio ♂:♀	total response [%]
A Lineatin, ethanol, α -pinene	Cone ^a	244.7 (219–295)	1:0.7	93
Lineatin		18.3 (11–26)	1:0.2	7
B Lineatin, ethanol, α -pinene	Pipe ^b	184.3 (103–288)		91
Lineatin		17.3 (12–24)		9
Ethanol, α -pinene		0.3 (9–1)		–
Control		0		–

^a “Konusfalle” (Röchling, Haren/Ems, Germany) 20/35 × 100 cm

^b “Kammrør” trap (Borregaard, Sarpsborg, Norway) 12 × 120 cm

Table 2. Estimated average efficiency in catches of *T. lineatum* in (A) flight barriers (“window trap”) and (B) perforated cylinders (“cone trap”) baited with behavioral chemicals in ascending order of complementarity

Description of stimuli compared	Source of data	Rate of increase	Efficiency
α -Pinene: α -pinene + ethanol	[1,9]	1:7	7 ×
α -Pinene + ethanol: lineatin	[5]	1:7	50 ×
Lineatin: lineatin + ethanol	[5]	1:1.5	75 ×
Lineatin + ethanol: lineatin + ethanol + α -pinene			
without optical stimulus (window trap)	[8]	1:1.3	100 ×
with optical stimulus (cone trap)	[8]	1:2	150 ×

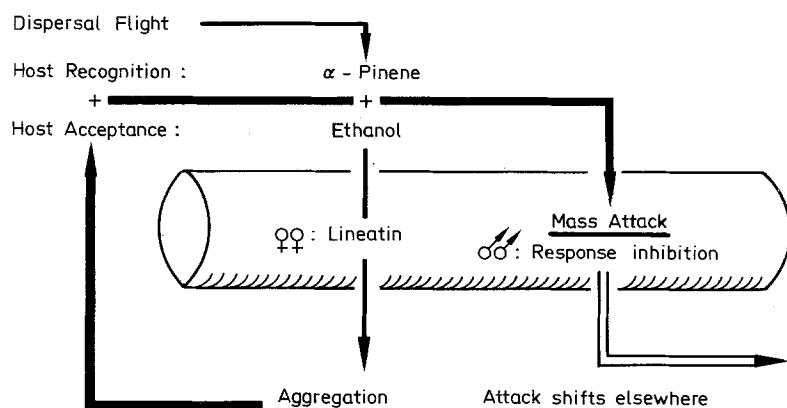


Fig. 1. Hypothetical sequence of behavioral events in the colonization of a coniferous log by *T. lineatum*

by the attacking female beetle which leads to aggregation *en masse* [4,5], and timely utilization of the tree trunk as a “temporary habitat”.

Trypodendron species are known to discriminately select individual tree trunks or logs while ignoring others in the same log

pile. We hypothesized that lineatin – though considered a single-component pheromone [3,4] – may not constitute the signal for host acceptance and/or host invasion. To test this theory, we baited perforated cylinder traps which simulated tree trunks with synthetic lineatin [6]. *T. lineatum*

is readily caught on flight barriers [5] and sticky traps [4] baited with lineatin only. In contrast, the tree trunk simulating cylinder traps required the addition of the two host volatiles α -pinene and ethanol to become effective in trapping flying *T. lineatum* in stands of Norway spruce (*Picea abies* Karst.) in Norway, and fir (*Abies alba* Mill.) in Germany. The traps baited with lineatin *per se* were entered by a few beetles only, most of them males (Table 1).

In agreement with observations by Kerck [7] on the host-selection behavior of *T. domesticum* L., we conclude that lineatin induces aggregation in flight, and together with visual stimuli, it induces landing on tree trunks. However, the actual attack and invasion occurs in response to ethanol and the presence of odors specific to the host. Such sequence of behavioral events would explain the discriminate colonization of host trees containing ethanol as well as the acceptance of perforated cylinder traps in the presence of ethanol. Apparently, trapping devices providing an optical cue along with the tripartite mixture of the key behavioral chemicals accommodate the beetle’s response behavior better than flight barriers of similar trapping surface (Table 2). The naturally occurring response inhibition by the males [10] does not seem to affect the trap catches (Fig. 1).

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