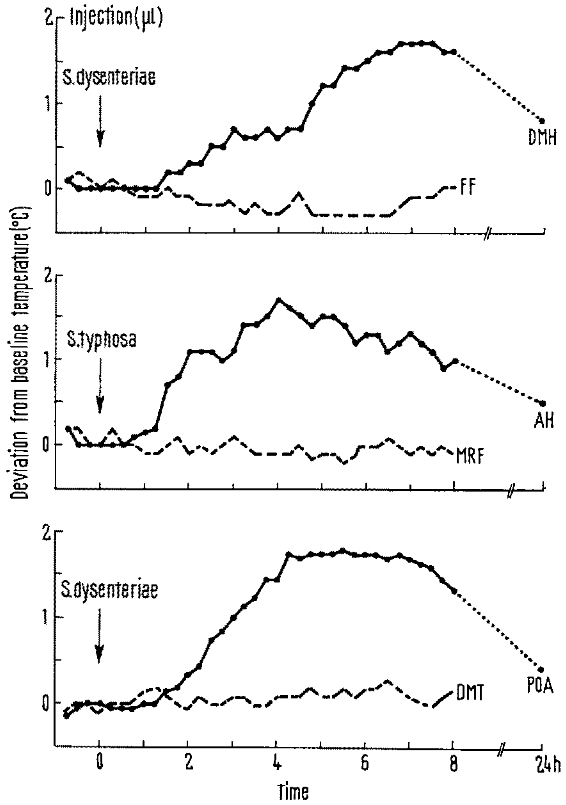
unanesthetized monkeys following micro-injection of *Shigella dysenteriae* or *Salmonella typhosa* into specific sites within the hypothalamus and other brain-stem structures. *Shigella* given in the dorsomedial hypothalamus (DMH) caused a prolonged fever after a latency of a little over an hour. However, when *Salmonella* was micro-injected directly into the anterior hypothalamus (AH), the latency of the febrile response was somewhat shorter and the rate of the rise in temperature appeared to be more rapid. *Shigella dysenteriae* given in the pre-optic area (POA) produced a fever of similar latency and slope.



Changes in colonic temperature of 3 unanesthetized rhesus monkeys in response to injections at zero hour of 1.2 µl of bacterial pyrogen in a 1:2 dilution. Top: *S. dysenteriae* was injected into the dorsomedial nucleus of the hypothalamus (DMH) and the fields of Forel (FF). Middle: *S. typhosa* micro-injected in the anterior hypothalamus (AH) and mesencephalic reticular formation (MRF). Bottom: *S. dysenteriae* micro-injected into the pre-optic area (POA) and dorsomedial nucleus of the thalamus (DMT).

If these endotoxins were micro-injected in anatomical sites other than the rostral portion of the hypothalamus, there were no significant changes in the temperature of the monkeys. These insensitive regions include the fields of Forel (FF), the mesencephalic reticular formation (MRF) and the dorsomedial thalamus (DMT). Moreover, tachyphylaxis to repeated micro-injections of any of the endotoxins was not observed. *Escherichia coli* was micro-injected 16 times into the anterior hypothalamus of 1 monkey at intervals of 48–96 h over a period of 34 days. The features of the pyrexic response on the last day were virtually identical to those of the first.

These results show that cells within the rostral hypothalamus of the monkey are sensitive to at least 3 different types of gram-negative bacteria. In the rhesus monkey, an unknown protective mechanism apparently exists within blood tissue which prevents pyrexia from developing in response to the bacteria present systemically. When 0.8 ml of undiluted *Salmonella typhosa* in a dose of 10^9 organisms per ml was given in our monkeys intravenously, the temperature varied little. Yet a mechanism does exist in the hypothalamus of this species for mediating a fever due to a bacteria, since as little as 1000 organisms injected into the anterior hypothalamus evoked pyrexia. Although the cellular mechanisms which trigger and sustain the fever with all of its *sequelae* are not at present understood, it would appear that a pyrogen may act directly either on the cell membranes of the hypothalamic neurons or indirectly by releasing a neurotransmitter substance[8].

Zusammenfassung. Eine dosisabhängige Steigerung der Körpertemperatur wurde erzielt, wenn Pyrogen-Substanzen aus verschiedenen gram-negativen Bakterienstämmen stereotaktisch in den Hypothalamus nicht narkotisierter Affen injiziert wurden.

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Pheromone and Terpene Attraction in the Bark Beetle *Ips typographus* L.

We report the first evidence that *Ips typographus* L. (Coleoptera: Scolytidae) is strongly attracted to both certain terpenes and a pheromone produced by the male beetle. *Ips typographus* is the most destructive bark beetle in the extensive Norway spruce (*Picea excelsa* Link.) forests in Europe and Asia. The attraction seen in our field studies is similar to the olfactory mechanism which has been intensively studied in several North American scolytids, certain of which are already being experimentally manipulated with terpenes and synthesized pheromones[1,2]. Therefore, further study is indicated of possible control of *I. typographus* by such means.

Earlier, male-produced pheromones were found in destructive *Ips* spp. on pines in North America[3] and in *I. acuminatus* Gyll. on pine in Norway[4]. MERKER[5], CHARARAS[6], ADLUNG[7] et al. have studied effects of host volatiles on *I. typographus* without relation to a pheromone.

The present study was made in 100-year-old spruce forests near Třeboň, Bohemia and Hronec, Slovakia, in May and June 1970. We separated and introduced mature males and females to sections of spruce logs 70 cm long placed in plastic-screened cages, 50 × 50 × 80 cm. As controls we used naturally invaded log sections 2 days after attack, and uninvaded logs. The cages were

Response of *Ips typographus* to spruce logs invaded separately by males, females and pairs, and to 4 monoterpenes near Třeboň, Bohemia in May 1970 at 17–27 °C

	Materials tested	No. of beetles attracted						
		May 15	May 16	May 17	May 18	May 19	May 20	Total
A	Log with males (27 entries)	52	52	16	39	34	17	210
B	Log with females (4 entries)	1	3	0	1	3	1	9
C	Log with pairs (13 entries)	2	7	4	6	16	8	43
D	Naturally invaded log (80 entries)	182	232	181	254	297	76	1222
E	Uninvaded log	2	3	2	1	0	2	10
F	α-pinene[a]	2	1	19	23	38	7	90
	β-pinene[a]	2	2	4	14	7	0	29
	Limonene[a]	0	6	3	11	11	5	36
	Camphene[a]	0	0	1	8	4	1	14

[a] In 1% ethanol solution.

placed 10–15 m apart in a forest opening of about 1 acre, and the attracted beetles alighting on the cages were collected at 10 min intervals. To test for the primary or host attraction known to be operative in other scolytids with secondary or insect-produced attraction[3,8,9], we used both natural log sections and 1% solutions of 4 terpene hydrocarbons in ethanol[10].

As it is practically impossible to separate the sexes of *I. typographus* by external morphological characters, we distinguished living beetles by their different boring behavior and location in the gallery. Males, which are known to initiate boring and construct the nuptial chamber before the females reach them, were collected in naturally infested trees as they started boring in the nuptial chamber. The females were taken in partly constructed egg galleries branching from the nuptial chambers. Following the experiment we debarked the logs and confirmed the sex separation by dissection (with virtually 100% accuracy). The sex of the attracted beetles was determined by dissection.

The response of flying beetles to the variously treated logs is shown in the Table. The attraction to the log with introduced males (Table A) is clear, and may be considered strong because of the disturbance of the test males' normal invasion process inherent to the method of collecting males to be introduced to the test logs. Not surprisingly, the naturally invaded log with undisturbed males (Table D) showed the greatest attractiveness. The ratio of male entry holes to attracted beetles in the naturally invaded log was 1:14, and in the log with disturbed males 1:7. It is evident from the response of flying beetles that the sexually mature male *I. typographus* produces the pheromone after entering the host.

Similar attraction occurred during the second flight of *I. typographus* in experiments performed near Hronec, Slovakia, 9–14 June 1970, with comparable numbers of beetles responding. Others tests, particularly of the sex ratio of attracted beetles, suggest the presence also of a factor regulating the mating behavior of the beetles aggregated on or near a host tree[11].

As expected, the pheromone attraction was numerically much greater than the response to terpenes. Table F shows that 3 terpenes were more attractive than the natural log, especially α-pinene. The sex ratio of attracted beetles (1 male : 1 female in a natural population of 1 male : 2–3 females) reflects the behavior of this species in that the host-selecting or guiding sex responds in greater numbers than the guided sex of this polygamous species.

It is interesting that 3 common predators of *I. typographus, Thanasimus formicarius* L. (Cleridae); *Medetera signaticornis* Lw. (Dolichopodidae); and *Epuraea pygmaea* Gyll. (Nitidulidae), also responded to both the terpenes and the male-invaded logs, suggesting that they may find their prey by this attraction mechanism.

I. typographus is known to prefer wind thrown, damaged or weakened trees but at epizootic population level attacks and easily kills sound trees. In his extensive studies of the severe post war outbreak in Central Europe, SCHWERDTFEGER[12] showed that resinosis is the chief defense of Norway spruce against *I. typographus* and that mass attack by the beetles overcomes this defense. Our data indicate that the mechanism of *I. typographus* effecting such mass attack to overcome the resistance of the host tree is the pheromone attraction produced by the male beetles guided to a suitable host by volatile terpenes[13].

Zusammenfassung. Es wird gezeigt, dass *Ips typographus* L. primär durch Terpene und sekundär durch Pheromon der Männchen zu den Brutstämmen gelockt wird.

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[13] This study was performed while J.A.R. was at the Institute of Entomology, Prague, on the exchange program of the National Academy of Sciences, and the Czechoslovak Academy of Science and was approved for inclusion in the U.S. International Biological Program.