Effects of exogenous juvenile hormone I on the numbers and distribution of antennal and maxillary and labial palp sensilla of male *Blattella germanica* (L.) (Dictyoptera: Blattellidae)

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Summary. Unlike in the female, application of exogenous juvenile hormone I to 6th-instar male nymphs does not result in the retention of nymphal characteristics on the antennae and maxillary and labial palps. JH-treatment differentially affects the numbers of sensilla on the 3 appendages of adult male *B. germanica.*
Key words. Juvenile hormone I; *Blattella germanica,* male; sensilla; antenna; maxillary and labial palps; courtship behavior.

Conflicting reports in the literature exist concerning the endocrine control of mating behavior of male cockroaches. For example, it is known that the courtship behavior of allatectomized males of *B. fumigata* is normal and therefore their sexual behavior is not under corpus allatum control[2]. And *Periplaneta americana* males, as a result of JH treatment, retained the 'larval' complement of antennal sensilla and therefore did not respond to the volatile female pheromone[3]. JH treatment of male *B. germanica* nymphs resulted in adults that exhibited normal courtship behavior[1].

It was reported that JH treatment of the last-instar (6th) female nymph of the German cockroach resulted in the retention of the nymphal complement of sensilla on the antennae and maxillary and labial palps in the adult, and consequently no mating occurred[1]. No one has reported on the JH effect on these sensilla in males of this species.

The aim of this study is to report on the effects of exogenous JH I on the number and distribution of the sensilla on the antennae and maxillary and labial palps of the male *B. germanica,* which play a role in courtship behavior.

Materials and methods. We selected groups of 6th-instar German cockroach nymphs from a laboratory colony, maintained at 25°C and reared on Purina laboratory chow and water, and treated them by injecting 0.3 µl of 0.5% juvenile hormone I (JHI) (Sigma) solution in acetone. After adult emergence, the antennae and maxillary and lavial palps were excised from these groups. We excised also antennae and labial and maxillary palps from normal adult males and 6th-instar male nymphs after injection with 0.3 µl of acetone (controls). Tanned antennae and palps were processed and examined under light microscopy[4]. We recorded the numbers of each sensillum type for 30 individual antennae and maxillary and labial palps and determined the means and standard deviations. We compared the different numbers of sensilla between normal and JH-treated male adults (t-test) and compared these results with those of 6th-instar male nymphs.

Results. The same 5 types of sensilla (s. chaetica A, s. chaetica B, s. trichoidea, s. campaniformia and s. basiconica) are present on the antennae and maxillary and labial palps of the male, as previously reported[4], except that s. basiconica were absent from the maxillary and labial palps and s. campaniformia were absent from the labial palps. The mean numbers of s. chaetica A, s. chaetica B, s. campaniformia, s. trichoidea, and s. basiconica on the antennae, maxillary, and labial palps of normal and JH-treated adult males and 6th-instar male nymphs are presented in tables 1, 2 and 3.

The number of s. chaetica B and s. campaniformia on the antennae of treated individuals was insignificantly increased and the number of s. chaetica A and s. trichoidea was insignificantly decreased. No s. basiconica were found in the treated individuals. However, of the three appendages, the maxillary palps of the treated male had a larger number of all 4 types of sensilla than the normal adult with the difference in the numbers of s. chaetica B and s. trichoidea being significant. On the labial palps, the number of s. chaetica A was insignificantly larger and the numbers of s. chaetica B and s. trichoidea were insignificantly smaller in the treated adult. Contact chemoreceptors (s. chaetica B) are the most common sensilla types of all 4 groups on all appendages. S. trichoidea (olfactory) are also common on the antennae. For most sensilla types on the appendages, the male nymph had a smaller complement of sensilla than the adult. The distribution of sensilla types on the antennae and palps of JH-treated males was similar to the distribution for the normal male[4].

Discussion. Our JH experiments indicate a differential effect on the numbers of olfactory sensilla (s. trichoidea, s. basiconica, s. chaetica B) present on the male antennae. There is a significant

Table 1. Mean number of sensilla on the antennae of normal and JH-treated *B. germanica*

	Antennae A ± SD	B ± SD	T ± SD	C ± SD	S ± SD
Adult male	60.6 ± 12.5	2211.5 ± 264.3	727.7 ± 126.8	9.9 ± 6.7	0.1 ± 0.3
JH-treated male	56.0 ± 10.5	2347.1 ± 368.8	671.1 ± 139.3	14.4 ± 6.2	–
6th-instar male nymph	49.8* ± 15.7	1545.9* ± 163.7	421.4* ± 159.4	17.4* ± 4.6	0.1 ± 0.1

Mean numbers of sensilla are based on counts from 15 pairs of appendages. Numbers with an * are significant at the 0.05 level when compared with normal adult male; t-test analysis. A = s. chaetica A; B = s. chaetica B; C = s. campaniformia; S = s. basiconica; T = s. trichoidea.

Table 2. Mean number of sensilla on the maxillary palps of normal and JH-treated *B. germanica*

	Maxillary palps A ± SD	B ± SD	T ± SD	C ± SD
Adult male	47.6 ± 15.5	270.8 ± 21.1	29.0 ± 10.1	12.4 ± 6.3
JH-treated male	54.0 ± 14.5	306.4* ± 60.3	42.6* ± 17.9	13.6 ± 6.6
6th-instar male	34.0* ± 12.1	296.5 ± 89.2	37.8* ± 11.9	5.5* ± 2.1

Mean numbers of sensilla are based on counts from 15 pairs of appendages. Numbers with an * are significant at the 0.05 level when compared with normal adult male; t-test analysis. A = s. chaetica A; B = s. chaetica B; C = s. campanformia; S = s. basiconica; T = s. trichoidea.

Table 3. Mean number of sensilla on the labial palps of normal and JH-treated *B. germanica*

	Labial palps A ± SD	B ± SD	T ± SD
Adult male	60.6 ± 13.4	144.3 ± 23.3	51.4 ± 10.0
JH-treated male	63.5 ± 12.1	141.7 ± 21.1	48.0 ± 9.7
6th-instar male	41.5 ± 8.9*	139.2 ± 26.3	39.9* ± 6.7

Mean numbers of sensilla are based on counts from 15 pairs of appendages. Numbers with an * are significant at the 0.05 level when compared with normal adult male; t-test analysis. A = s. chaetica A; B = s. chaetica B; T = s. trichoidea.

decrease in the number of olfactory sensilla on the antennae of JH-treated male *P. americana*[5,3]. In contrast, we found not only slight decrease (7.8%) in the number of s. trichoidea and s. basiconica but also a small increase (6%) in s. chaetica B on the antennae in JH-treated male *B. germanica*. Discrepancies in sensilla number for normal adult males between those reported previously[4] and this study can be attributed to insufficient sample sizes in their work (counts were based on only 5 pairs of appendages in their study)[4]. In addition, our laboratory has reported that JH-treated males do not show anomalous mating behavior and that JH treatment to female *B. germanica* results in the reduction of sensilla numbers on the antennae and maxillary and labial palps[1]. It seems that JH treatment has different effects on the numbers of sensilla in different species and sexes, and may or may not suppress the animal's behavioral repertoire in courtship. An increase in the s. chaetica B and trichoidea on the maxillary palp of treated males is of little consequence, since the maxillary and labial palps play no major role in his courtship behavior. It is reported that sensory receptors on the antennae of male *B. germanica* play a major role in the induction of courtship behavior by perceiving the female pheromone[6]. Isolated female antennae brought in contact with the male antennae only is sufficient to induce male wing-raising. Other sense organs, such as the maxillary and labial palps, did not affect the courtship response. Roth and Willis found that antennectomy alone reduced the number of males responding to females and that maxillary and labial palpectomy alone did not affect courtship. Their observations suggest that none of these organs, except the antennae, are important in the mating behavior of the male German cockroach. However, our laboratory has reported that all these organs are important in the mating behavior of the female[1].

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Ethanol influence on insulin secretion from isolated rat islets[1]

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Summary. This study was done to delineate the role of α- and β-adrenergic receptors and cyclic AMP in the mechanism of ethanol effects on insulin release from isolated islets. Rats were given an α-adrenergic blocker, phentolamine, or a β-adrenergic blocker, propranolol. In addition, ethanol 1 g/kg was given intragastrically 1 h prior to sacrifice. Glucose mediated insulin release from isolated islets was enhanced by phentolamine and decreased by propranolol. Ethanol treatment inhibited glucose-induced insulin release from isolated islets of control rats as well as those given phentolamine and/or propranolol. Insulin release from isolated islets in response to dibutyryl-cyclic AMP was attenuated by ethanol. Theophylline enhanced glucose mediated insulin release from control islets but ethanol treatment produced a significant inhibition of insulin response. The data suggest that the site of action of the deleterious effects of ethanol on insulin release from isolated islets in rat does not involve adrenergic system and cyclic AMP.
Key words. Insulin; islets; ethanol; adrenergic receptors; cyclic AMP; theophylline.

Ethanol ingestion can produce hyperglycemia and it may, in part, be due to catecholamine release[3]. The catecholamine-induced changes in glucose homeostasis are the product of several factors, including an enhancement of hepatic glycogenolysis, gluconeogenesis, inhibition of peripheral glucose utilization, and indirectly via pancreatic hormone secretions[4,5]. The relative contribution of each of these factors for the total hyperglycemic response to ethanol-induced catecholamine release is unknown. Previously, studies from our laboratory and of others have shown that ethanol inhibits insulin secretory response to glucose and tolbutamide in intact rat and in isolated rat islets[6–8]. The underlying mechanism for these observations is not clear, although Malaisse et al.[9] have suggested that ethanol can interfere with microtubular functions of β-cells. Since ethanol stimulates catecholamine secretion[10] and insulin release is inhibited by the α-adrenergic system but enhanced by the β-adrenergic system[5], it is possible that ethanol alters insulin secretion, via the α-and/or β-adrenergic system. Intracellular regulatory mechanisms in insulin secretion involve cyclic AMP; and inhibition of insulin secretion by ethanol may be mediated by the catecholamines effect on cyclic AMP. Secondly, Kuo et al.[11] reported that ethanol exerts an inverse dose-dependent influence on adenyl cyclase activity in the homogenate of rat islets. It is likely, therefore, that the underlying mechanism of ethanol-induced inhibition of insulin response to glucose involves catecholamines and islet cyclic AMP.

The present study was therefore done to determine the role of α- and β-adrenergic receptors as well as of cyclic-AMP in ethanol effect on glucose-induced insulin release. The data show that inhibitory effect of ethanol on insulin secretion from isolated rat islets is not mediated by perturbations in adrenergic receptors activity or cyclic AMP.

Materials and methods. Male Sprague-Dawley rats, weighing 400 ± 25 g, were housed individually in conditions of controlled temperature, humidity and light cycle, and were given Purina chow and water ad libitum. One rat of each pair was given ethanol (1 g/kg) intragastrically 1 h prior to sacrifice, whereas the other animal received saline. The dose and time of ethanol administration prior to sacrifice were selected in view of our previous studies to determine ethanol effects on insulin secretion in isolated rat islets[8]. Based essentially upon experiments in rats by Luyckx and Lefebvre[12], both rats were given either propranolol (2 mg/kg) or phentolamine (20 mg/kg) or both i.p. twice, 3 and 1 h prior to the sacrifice, to block α- and/or β-adrenergic receptors.

Isolated islet studies. The method of isolation of rat islets has previously been described[13]. Briefly, animals were anesthetized with sodium nembutal i.p. (50 mg/kg b.wt), blood was taken by cardiac puncture for ethanol estimation, and the islets isolated from the pancreas using collagenase digestion. Approximately 100 well preserved islets were harvested from the individual pancreas. Islets were divided into batches of 10 each and prein-