First, it appears that stressful situations must be considered in their full temporal aspects, and that increased concern with observations during a rather long recovery phase may be particularly profitable. It seems likely that, during the stress aftermath, predominance of regulatory changes associated generally with anabolic events promoting restoration and repair would be appropriate. The possibly critical nature of the temporal patterning of stress versus rest periods in the determination of visceral disorders is also suggested by these data, which indicate that rest periods must be of sufficient duration for the full development of this delayed and prolonged gastric aftereffect.

Secondly, although only two visceral systems were studied, the suggestion is raised that the over-all visceral response to stress may include a much greater variety of regulatory changes than is generally suspected. It appears an important goal in stress research, therefore, to evaluate function in many regulatory systems concurrently so as to test the hypothesis that the responses of these systems are integrated into characteristic and purposeful patterns appropriate to the actual or expected adaptive metabolic needs of the organism (*10*).

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Hormonal Control of Sex Attractant Production in the Cuban Cockroach

Abstract. Virgin females of *Byrsotria fumigata* (Guérin) and several other species of Blattidae produce volatile substances which attract males and release in them characteristic precopulatory behavior. The removal of the corpora allata from females shortly after the imaginal molt results in a failure of production of sex attractant, as assayed by male behavior. Implantation of corpora allata can effect recovery.

The occurrence of sex attractants or sex pheromones (ectohormones) (*1*) in a wide variety of insect species of several orders, and their prominent role in assuring successful mating, are well-known phenomena (*1, 2*). Their sites of production have been described in some species of Lepidoptera (*2*), and the isolation and chemical identification of two female sex pheromones—those of the moths *Bombyx mori* and *Porthetria dispar*—have recently been achieved (*3*). The physiology of the pheromone receptor organs in the males of several moth species is under investigation (*4*), but little is known of the control of pheromone production in the female.

A clue to possible physiological control was provided by the report of Engelmann (*5*) that a significant percentage of adult females of the cockroach, *Leucophaea maderae*, failed to mate when deprived of their corpora allata 1 day after emergence as adults. Engelmann noted that mating frequently occurred after the implantation of active corpora allata from young last-instar nymphs. Since virgin females of several cockroach species are known to produce sex pheromones (*6*), one may legitimately conclude that such substances are probably of considerable importance in sex recognition and the release of male precopulatory behavior. The present investigation was undertaken to examine the possibility that the failure of allatectomized females to mate might be mediated by failure of sex pheromone production.

To test this hypothesis, the Cuban roach, *Byrsotria fumigata* (Guérin), was used. All females in these experiments were kept singly in 250-ml beakers, the bottoms of which were lined with disks of Whatman No. 2 filter paper. Males were isolated from females and stored in groups in large containers. The testing procedure for pheromone production was as follows.

The filter paper was removed from the beaker containing the female and placed for 2 minutes in a container of males. If a positive response—indicating the presence of the pheromone—was to appear, it nearly always did so within 1 minute. A positive response is signaled by the "wing-raising display," characteristic of the precopulatory behavior of many roaches (*6, 7*). Actual contact with other males at this time frequently results in the onset of copulatory movements. In the absence of the pheromone, the response is negative; that is, the filter paper is ignored or, at most, casually examined without any evidence of sexual excitement. Tests of this type show that normal virgin females begin to produce the pheromone 10 to 30 days after the imaginal molt and continue to do so for several weeks, sometimes for several months. Females that are permitted to mate show generally a gradual decrease in pheromone production, as indicated by the number of males responding during the tests. Mated or unmated females carrying öothecae rarely produce the pheromone.

To determine whether allatectomized females produce sex pheromone, corpora allata were removed 1 to 3 days after the imaginal molt. These animals, along with the controls, were tested for pheromone production every 5 to 10 days for 30 to 40 days. The results, summarized in Table 1, show that 90 percent of the unoperated controls and 86 percent of the sham-operated controls produced pheromone during the test period, while only 14 percent of the allatectomized individuals did so. Thus, the presence of corpora allata during the test period seems essential for the production of the pheromone.

The correlation between pheromone production and actual mating, as indicated by the presence of a spermatophore in the female's bursa copulatrix, is shown in Table 2. Animals from Table 1 were used in these tests except for an additional group of unoperated controls. After testing each female for pheromone production, a male was added to the female in each beaker, and then each female was examined daily for the presence of a spermatophore in the bursa copulatrix. If mating failed to occur within 3 or 4 days, pheromone production was retested and fresh males

Table 1. Number of *Byrsotria fumigata* females producing sex pheromone. The numbers in parentheses are percentages.

No. tested	Sex pheromone production	
	Presence	Absence
	Unoperated controls	
21	19 (90.4)	2 (9.6)
	Sham-operated controls	
50	43 (86.0)	7 (14.0)
	Allatectomized females	
90	13 (14.4)*	77 (85.6)

*Includes five animals that developed a limited sex pheromone production after the original test period, including the two which subsequently mated (see Table 2).

Table 2. Correlation between sex pheromone production and mating. The numbers in parentheses are percentages.

No. tested	Sex pheromone production			
	Presence		Absence	
	Mating	No mating	Mating	No mating
	Unoperated controls			
30	12	11	0	7
	Sham-operated controls			
23	10	11	0	2
	Allatectomized females			
28	4	6	2	16
	Totals			
81	26 (48.1)	28 (51.9)	2 (7.4)	25 (92.6)

were provided. Nearly all of the 54 females in Table 2 that produced pheromone were "courted" by males immediately after the latter were introduced, whereas this behavior was provoked by only one of the 27 females that failed to produce the pheromone. The high correlation between pheromone production and successful mating is evident in Table 2. In addition, it is noteworthy that the two females that mated in spite of the failure to produce pheromone began to produce small quantities of pheromone some weeks later. Therefore, they may have done so during the test period.

The implantation of corpora allata into previously allatectomized females can result in the recovery of the ability to produce pheromone. In these experiments, each female received by injection into the anterior part of the abdomen four corpora allata taken from adult females 1 to 3 days after the imaginal molt. Two of six animals which received implants 8 to 10 weeks after the imaginal molt showed a strong and sustained recovery of pheromone production beginning 10 and 16 days after implantation. One of these two animals subsequently mated. An older group of 12 animals (implants received 9 to 14 weeks after the imaginal molt) showed no recovery of the ability to produce pheromone. All died 2 to 6 weeks after the operation. Failure to recover may be related to the age of these animals at implantation, for in the absence of corpus allatum stimulation during this prolonged period, the tissue producing the pheromone may have degenerated to such an extent that recovery was no longer possible. Experiments on a series of young adult females (5 to 6 weeks of age) are in progress. Preliminary results show recovery of pheromone production in three of seven animals.

These findings suggest several lines of investigation for future consideration. Of particular interest is the question as to whether pheromone production is directly or indirectly stimulated by the corpus allatum hormone. Preliminary experiments argue against an intermediary role for the ovary, since the removal of the ovaries from last-instar nymphs had no effect on the subsequent production of pheromone. It is also necessary to decide whether pheromone production is the only aspect of the female's mating behavior that is affected by allatectomy. Finally, the results draw attention to the possibility that female sex pheromone production is subject to endocrine control in other species and orders of insects (*8*).

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Nutritional Value of Chemically Modified Corn Starches

Abstract. Male and female weanling rats were fed daily 5 g of a balanced diet supplemented with 1 or 2 g of corn starch, oxidized corn starch, corn starch phosphate, or hydroxyethyl corn starch. Commercially modified corn starches produced the same weight gain as normal corn starch during 21 days of feeding. In contrast to commercial starches, a very highly oxidized laboratory-prepared starch produced a lower weight gain during the same period.

Since increasing amounts of modified starch are being produced to meet requirements for industrial and food uses, it seemed desirable to determine whether slightly modified corn starch might be somewhat more digestible and give higher caloric value than unmodified corn starch.

The nutritional value of starches has been examined by several investigators. Booher *et al.* (*1*) showed that wheat, rice, corn, and waxy maize starches are more digestible in rats than the starches of arrowroot, white potato, and sago palm. Sakurai *et al.* (*2*) found that raw or cooked starches from most cereal grains are effective in producing growth in rats when they are fed as 75 percent of a balanced diet. White potato starch, ball-milled for 250 hours, is equally effective in producing growth, but raw untreated white potato starch is less effective. Jelinek *et al.* (*3*) stated that raw white potato starch is a poor nutritional carbohydrate when fed as 73.6 percent of the diet of weanling rats, but that autoclaved, modified, or ground potato starch is more fully utilized. Booher *et al.* (*1*) showed that modification which produces hydration of, changes the chemical nature of, or disrupts the starch granule makes the carbohydrate a better food substance.

The feeding procedure used was that designed by E. E. Rice *et al.* (*4*) which is based on the theory that food is used for energy to the greatest extent until minimum energy requirements are met. It has been established that the growth of weanling rats varies in proportion to the metabolically available energy of a food when a minimal diet is fed.

Corn starches used as diet supplements were commercial products: corn starch oxidized by 6 percent (wt./wt.) of chlorine, intrinsic viscosity 0.25, carboxyl content 20 meq/100 g of starch; corn starch oxidized by 2.5 percent (wt./wt.) of chlorine, intrinsic viscosity 0.45, carboxyl content 7 meq/100 g of starch; hydroxyethyl corn starch, 0.11 degree of substitution; corn starch phosphate, 0.5 to 0.9 degree of substitution (two samples); and a laboratory sample of corn starch oxidized by 2 equivalents of hypochlorite per D-glucose unit, 43.2 percent (wt./wt.) of chlorine. This very highly oxidized noncommercial starch was prepared only to determine whether

Table 1. Weights gained by rats in 21 days on different types of starch. D.S., degree of substitution.

Type of corn starch	Supplement level	
	1 g	2 g
	Weight gain (g)	
Group 1		
Corn starch	33.7	41.4
a) Corn starch oxidized by 6 percent (wt./wt.) chlorine	33.6	45.0
b) Hydroxyethyl corn starch, 0.11 D.S.	31.6	42.3
c) Corn starch oxidized by 2 eq of hypochlorite, 43.2 percent (wt./wt.) chlorine	18.9	29.7
Group 2		
Corn starch	32.8	43.2
d) Corn starch oxidized by 2.5 percent (wt./wt.) chlorine	35.2	46.8
e) Corn starch phosphate, 0.5 to 0.9 D.S.	36.5	43.5
f) Corn starch phosphate, 0.5 to 0.9 D.S.	33.8	45.2