model for sympatric speciation through seasonal isolation (*9*).

In our experiments we used the green lacewings, *Chrysopa carnea* Stephens and *Chrysopa downesi* Banks (Neuroptera: Chrysopidae), sibling species that readily hybridize under laboratory conditions (*10*) but that remain reproductively isolated in nature because of differences in their seasonal periods of reproduction. *Chrysopa carnea* is multivoltine and produces three generations each summer in the Ithaca, New York, area before the adults enter diapause in September (*11*). In contrast, *C. downesi* is univoltine, and its reproductive activity occurs only during early spring; summer, as well as autumn and winter, are spent in reproductive diapause (*12*). Underlying the seasonal differences between the two species are their characteristically different patterns of response to photoperiod (*13*).

The quantitative criteria we used for analyzing the genetic basis for the seasonal differences between the two species was based on their differential responses to photoperiod. In *C. carnea* no particular stimulus, other than long day lengths, is needed to avert diapause and allow continuous reproduction (*11*). In contrast, *C. downesi* requires an increase in day length, from short day to long day, during the late larval or pupal stages to avert diapause and promote reproduction by the emerging adults (*13*). Therefore, when individuals with a *C. carnea* genotype are reared under a light dark period of 16 hours and 8 hours, respectively (LD 16:8), reproduction begins without the intervention of diapause; however, when individuals with a *C. downesi* genotype are reared and maintained under LD 16:8, no reproduction occurs and diapause is induced. Consequently we used the numbers of diapausing and nondiapausing adult progeny from each cross (reared and maintained under an LD 16:8 photoperiodic regimen) as a quantitative measure for our analysis.

Under LD 16:8, the F_1 hybrids of reciprocal *C. carnea* × *C. downesi* crosses all showed typical *C. carnea* characteristics; that is, they reproduced without entering diapause (Table 1). Thus, the gene or genes controlling *C. carnea*'s seasonal characteristics are clearly dominant over *C. downesi*'s. Subsequent intercrosses of the F_1 hybrids produced F_2 progeny containing approximately 7 percent of individuals (both males and females) with *C. downesi*'s diapause characteristics, and the progeny (both male and female) of reciprocal backcrosses between F_1 hybrids and pure *C. downesi* stock did not differ significantly from a 1:3 (*downesi*:*carnea*) ratio when tested by chi-square ($P \geq .2$) (Table 2). These results are consistent with the ratios produced by the segregation of a pair of alleles at each of two unlinked autosomal loci; the *C. downesi* phenotype results from homozygous recessive alleles at both loci (*14*).

In summary, our results provide experimental evidence that seasonal isolation between two sympatric insect species is based on small genetic differences. These findings support the proposal that speciation in *C. carnea* and *C. downesi* occurred through seasonal isolation (*9*). We propose that analogous genetic changes may have had a similar function in allochronic speciation in other groups.

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References and Notes

1. E. Mayr, *Animal Species and Evolution* (Belknap, Cambridge, Mass., 1963); J. Maynard Smith, *Am. Nat.* **100**, 637 (1966); B. Wallace, *Topics in Population Genetics* (Norton, New York, 1968).
2. G. L. Bush, *Annu. Rev. Ecol. Syst.* **6**, 339 (1975).
3. M. D. Huettel and G. L. Bush, *Entomol. Exp. Appl.* **15**, 465 (1972).
4. G. L. Bush, *Evolution* **23**, 237 (1969).
5. G. Knerer and C. E. Atwood, *Science* **179**, 1090 (1973); P. A. Phillips and M. M. Barnes, *Ann. Entomol. Soc. Am.* **68**, 1053 (1975).
6. R. D. Alexander, *Syst. Zool.* **12**, 202 (1963); *Q. Rev. Biol.* **43**, 1 (1968); E. Mayr, *Syst. Zool.* **12**, 204 (1963); *Populations, Species, and Evolution* (Belknap, Cambridge, Mass., 1970); S. Masaki, *Kontyu* **35**, 85 (1967).
7. M. J. Tauber and C. A. Tauber, in *Evolution of Escape in Space and Time*, H. Dingle, Ed. (Springer-Verlag, Berlin, in press).
8. S. Masaki, *Bull. Fac. Agric. Hirosaki Univ.* **7**, 66 (1961); *ibid.* **11**, 59 (1965); *Evolution* **26**, 587 (1973); in *Evolution of Escape in Space and Time*, H. Dingle, Ed. (Springer-Verlag, Berlin, in press); A. S. Danilevskii, *Photoperiodism and Seasonal Development of Insects*, Transl. (Oliver & Boyd, London, 1965); P. G. Fontana and T. W. Hogan, *Aust. J. Zool.* **17**, 13 (1969); M. J. Tauber and C. A. Tauber, *J. Insect Physiol.* **18**, 25 (1972); H. Dingle, in *Experimental Analysis of Insect Behaviour*, L. Barton Browne, Ed. (Springer-Verlag, Berlin, 1974), pp. 329–342; J. W. Hong and A. P. Platt, *J. Insect Physiol.* **21**, 1159 (1975); J. Lumme *et al.*, [*Hereditas*, **79**, 143 (1975)] indicate that a major locus, with multiple alleles, or a cluster of linked loci control diapause termination of *Drosophila littoralis*.
9. C. A. Tauber and M. J. Tauber, *Science*, in press; *Nature (London)*, in press.
10. The viability and fertility of F_1 and F_2 hybrids were not significantly different (5 percent level) from those of conspecific progeny.
11. M. J. Tauber and C. A. Tauber, *J. Insect Physiol.* **19**, 1455 (1973).
12. ———, *Nature (London)* **258**, 711 (1975); *Can. J. Zool.* **54**, 260 (1976).
13. ———, *J. Insect Physiol.* **22**, 331 (1976).
14. We propose that each of the two recessive alleles plays a spearate role in controlling the expression of the *C. downesi*'s seasonal cycle. Homozygous *downesi* alleles at one locus probably underlie the short day–long day requirement for diapause prevention and, therefore, control the *induction* of diapause under constant long day conditions. Whereas the *downesi* alleles at the second locus probably act in diapause *maintenance* under long day conditions (*8*).
15. We thank Prof. Bruce Wallace, Cornell University, for reading the manuscript.

18 January 1977; revised 15 March 1977

Coevolution of Foraging in *Bombus* and Nectar Dispensing in *Chilopsis*: A Last Dreg Theory

Abstract. *Flowers of* Chilopsis linearis *dispense nectar into pools and grooves. The bumblebee,* Bombus sonorus, *extracts pool nectar at a rate seven times faster than groove nectar. The result is the coevolution of a plant-pollinator system in which bees, while foraging efficiently, increase the number of flowers visited per calorie of nectar reward provided by the plant.*

The coevolution of plants and their pollinators has received a great deal of attention. Much recent work has focused either on the coevolution of floral morphology and nectar secretion, which restricts visitors and guarantee rewards to a limited number of species (*1*), or on pollinator size, energetics, and behavior, which determine the dispersal of pollen and the nature of the plant breeding system (*2*). However, there has been little attempt to analyze the efficiency of pollinator movements in relation to optimal foraging theory (*3*) and the extent that this behavior is modified by plants. This may be due in part to the scant empirical evidence to support optimal foraging theory, even though its logic cannot be denied (*4*). The aim of this report is to demonstrate how desert willow, *Chilopsis linearis*, has taken advantage of the foraging behavior of bumblebees, *Bombus sonorus*, to increase the visitation rate to its flowers.

Chilopsis linearis is a shrubby tree 3 to 5 m tall, which occurs along dry water courses surrounded by desert scrub. It produces a profuse number of catalpa-like blossoms, which secrete most of their nectar in a single peak of production before dawn (*5*). Plants of the family Bignoniaceae, of which *C. linearis* is a member, are typically pollinated by large to medium-sized bees and are thought to have a long history of morphological and phenological coevolution with their pollinators (*6*). *Bombus sonorus* queens are the most frequent visitors to desert wil-

low and are often observed with pollen on the head and thorax. Because queens generally do not forage after the first workers reach maturity (*7*) the presence of large numbers of foraging queens suggested that they were in the process of establishing colonies. Brown *et al.* (*5*) observed three major visitors in addition to *B. sonorus* queens; two robbed nectar without pollinating the flower and the third was not native to North America. Since none of these four visitors were observed to collect pollen, nectar is considered the only reward offered by the plant.

Most of the data were collected in May 1976 near Portal, Arizona (elevation 1400 m). Desert willow was the most common plant in flower within several kilometers and represented the major source of nectar in the study area. As a result of rapid removal of nectar by bees, sampling was done from dawn to 1030 hours. Micropipets (1 μl) were used to measure both the standing crop of nectar and the nectar remaining immediately after a bumblebee visit. Nectar concentrations were determined on an hourly basis with a pocket refractometer, and all nectar measurements were adjusted for evaporation to the 0600-hour concentration of 14.7 percent. A tape recorder was used in conjunction with an electronic timer to record the foraging activities of more than 2000 bumblebee visits. Ambient temperatures in the shade near flowers were measured to the nearest degree Celsius, and insects were censused every 20 minutes.

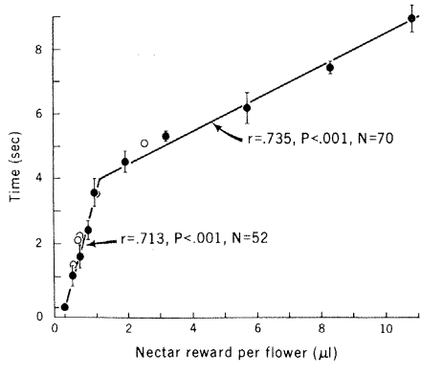

Fig. 1. Time required for foraging bumblebees to remove all nectar from a flower, determined from field (open circles) and laboratory (solid circles) measurements (*8*). In both cases, handling time (mean time spent on empty flowers) has been subtracted from the total time spent on a flower to give feeding time. In the laboratory experiments, five bees were presented with individual flowers containing know quantities of sugar syrup. Each open circle represents the mean of at least ten trials, and vertical bars represent one standard error. The correlation coefficients and sample sizes for two linear regressions fitted to laboratory data on a single queen are given. All bees gave similar results.

Bombus sonorus queens extract nectar from *C. linearis* flowers at two different rates in response to specialized floral morphology. Radiating outward from the base of the corolla are five grooves that collectively hold by capillary action about 1.1 μl of nectar. When grooves are full, as much as 8.0 μl of additional nectar accumulates in a pool at the base of the tube. Pool nectar is rapidly removed at the rate of 2.0 μl/sec, and because each groove must be individually probed, groove nectar is removed at a much slower rate of 0.3 μl/sec (Fig. 1) (*8*). Observations of foraging bees show that they first probe the pool and then probe each groove for nectar.

If, on the basis of extraction rates, we recognize pool nectar as the preferred food type and groove nectar as a less preferred food type, optimal foraging theory (*4*) predicts that when the preferred food type is abundant, bees should specialize on pool nectar and leave the less preferred groove nectar. However, as the abundance of pool nectar declines, groove nectar should be included in the diet with the result that queens remove all nectar. A partial test of this hypothesis is to examine flowers for nectar immediately after a bee visit. Figure 2 shows how much nectar is left in the flower as a function of how much was available. When nectar was abundant, queens left groove nectar, but by 0930 hours they switched their foraging behavior and removed all nectar (*9*).

If queens forage more efficiently by leaving groove nectar when pool nectar is abundant and then by switching to remove all nectar when pool nectar is reduced, they should have higher net caloric intake than constant bees that always remove all nectar. Since the energy expenditure of foraging bees varies with ambient temperature and the proportion of time spent in flight, it is necessary to calculate energy budgets for bees employing each strategy in order to make this comparison. Studies of bumblebee energetics provide estimates of the cost of flight, thermoregulation, and general foraging (*10*). These costs per minute, multiplied by the appropriate time a bee spends in each of these activities (determined from field data), and subtracted from caloric sugar rewards derived from nectar (*11*) yield a net caloric reward per minute of foraging. During the first hour of the morning when flowers contain a mean nectar reward of 2.4 μl, a constant bee requires 5.1 seconds to remove all nectar whereas the switching bee that leaves the last dregs requires an average of 2.0 seconds to remove 1.7 μl. These foraging activities with their associated costs and rewards result in a net caloric gain of 12.3 cal/min for a switching bee and 9.9 cal/min for a constant bee. This 25 percent increase in the efficiency of foraging is a conservative estimate, because the calculated costs are only those incurred while foraging and do not include the cost of flying back to the nest or the cost of establishing a colony and reproduction. For example, heat production for temperature regulation of the nest at night can deplete most of the nectar collected during the day (*12*). These additional costs are equal for both types of foraging, and as they increase, the rel-

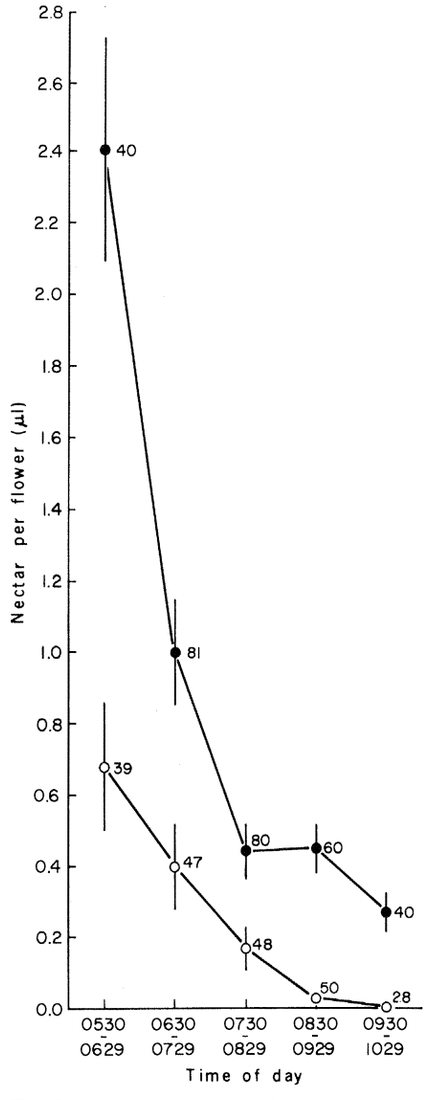

Fig. 2. Amount of nectar in flowers as a function of the time of day. Solid circles represent the mean standing crop of nectar in available flowers, and open circles represent the mean amount of nectar remaining immediately after a bumblebee had visited a flower. Vertical bars indicate one standard error and numbers indicate sample size.

ative advantage of greater foraging efficiency also increases.

If we assume that plant fitness (that is, seed set) is correlated with the number of bee visits its flowers receive, the plant should maximize the number of visits per calorie expended on nectar secretion. The result of switching bees leaving groove nectar when pool nectar is abundant is that they must visit 40 percent more flowers to obtain the same amount of nectar as a bee that removes all nectar. Furthermore, by leaving groove nectar, enough nectar remains in the flower to make a return visit profitable. Comparing the number of visits per calorie expended by the plant shows that switching bees, which leave groove nectar during their first visit and later return, provide 1.6 visits per calorie whereas constant bees make only 0.8 visits per calorie. It should be emphasized that the increased visitation rate achieved by plants containing pool and groove nectar depends on the switching foraging behavior of bumblebees. If all bees were constant in their foraging behavior and always removed all nectar, the existence of groove nectar would serve no function. In fact, if a plant mutation arose which eliminated grooves so all nectar was contained in a single pool, as a result of the different extraction rates of pool and groove nectar, those plants with all pool nectar would become the source of the preferred food type. Thus, the switching behavior of bumblebees and the dispensing of nectar into pools and grooves by desert willow probably are coevolved traits.

Given that there are two nectar extraction rates, the bumblebee must determine either by learning or by evolution of its behavior how much of the total nectar to remove if it is to maximize its net caloric intake. Similarly, if the plant is to maximize the number of visits per calorie of reward, natural selection must determine the total amount of nectar provided and its distribution between pool and grooves. Figure 3 demonstrates in part how this interrelationship has coevolved. The same data (that is, foraging costs and nonfeeding times) were used in conjunction with feeding times derived from the regressions in Fig. 1 to compute time-energy budgets for bees that remove only pool nectar and bees that remove all nectar. If bumblebees are to maintain the highest net caloric gain per minute, they should switch foraging strategies when the total nectar reward per flower is about 2.0 μl. When the nectar reward is below this level, bees should remove both pool and groove

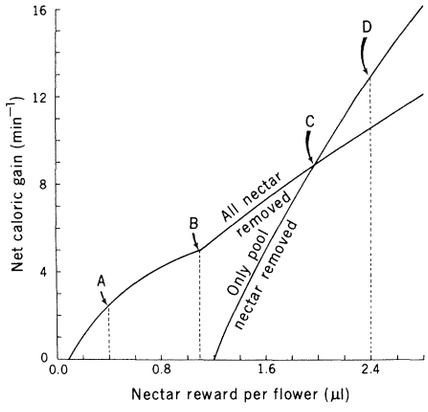

Fig. 3. The net caloric gain per minute as a function of the nectar reward per flower for two cases: a bee that removes only pool nectar and a bee that removes all nectar. Point A represents the minimum reward for a visit; point B, the last dregs or groove nectar; point C, the minimum reward for a bee to leave the groove nectar; and point D, the mean nectar reward per flower. All possible values of groove nectar left by foraging bees (0.0 to 1.1 μl) yield intermediate curves, which also intersect at point C.

nectar; when it is above, they should remove only pool nectar. The empirically derived prediction that bees remove either only pool nectar or all nectar depending on the total nectar reward is precisely the same as predicted by theory (*4, 9*). For the plant to take advantage of the switch in the foraging behavior of bees, it must ensure that groove nectar by itself is sufficient to make a return visit profitable for the pollinator, and it must provide a total nectar reward greater than the predicted 2.0 μl so that bees will leave groove nectar. If these conditions are met, bees can profitably visit the flower twice; if not, no nectar will be left to reward a second visit. The existence of these rather precise requirements suggests that desert willow and bumblebees must be finely tuned to one another for this system to work. Deviations from the desired levels of pool and groove nectar or changes in the foraging of bumblebees could dramatically reduce the number of visits or result in the waste of nectar. If desert willow supplies pool and groove nectar in the amounts required by bumblebees in order for them to exhibit the switching foraging behavior, it should be interpreted as strong evidence that this plant-pollinator system is energetically coevolved.

From Fig. 3 it would appear that desert willow has evolved a pattern of nectar dispensation that meets these conditions with a margin of safety. The mean nectar reward of 2.4 μl produced in early morning is larger than the 2.0 μl required to cause bees to leave groove nectar, and the amount of groove nectar (1.1 μl) is more than sufficient to make a return visit profitable (visits decline markedly at nectar levels below 0.4 μl). Furthermore, the time of day bees switch from leaving groove nectar to removing all nectar depends on the density of bees, since with increased density, nectar is depleted earlier in the morning (*5*). By having pool and groove nectar, the plant's nectar secretion is always synchronized with the pollinator, regardless of the density of pollinators, flowers, or both; therefore, the plant more efficiently utilizes its nectar rewards. By allowing bumblebees to change from a switching to a constant foraging behavior at a nectar level (time of morning) based on bee energetics, the plant has achieved a degree of fine tuning not possible in some other pollinator systems. This feature also allows bumblebees greater flexibility by making it profitable for bees with high costs (distant nests) to visit in early morning when pool nectar is available while still allowing those bees with low costs (nearby nests) to forage when only groove nectar remains. In other systems, such as those in which nectar is secreted continuously, more total nectar must be dispensed to achieve the same result. These characteristics may be important in the desert where fluctuations in rainfall greatly affect the flowering of plants and consequently the density of pollinators. However, the extent that this method of nectar dispensation is limited to deserts is unknown, and once researchers become aware of its existence, it may be found in other habitats. This system should be restricted to those plants utilizing pollinators with relatively small energetic requirements, since grooves probably could not hold enough nectar to make a return visit profitable for pollinators such as bats and hummingbirds.

The major conclusion is that desert willow and bumblebees have coevolved a nectar dispensing–foraging system that takes advantage of the foraging behavior of the bee while satisfying its energetic requirements and at the same time increases the number of visits for the energy expended by the plant on nectar rewards.

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References and Notes

1. V. Grant and K. A. Grant, *Flower Pollination in the Phlox Family* (Columbia Univ. Press, New York, 1965); M. Proctor and P. Yeo, *The Pollination of Flowers* (Toplinger, New York, 1972).
2. B. Heinrich, *Ann. Rev. Ecol. Syst.* **6**, 139 (1975).
3. F. B. Gill and L. L. Wolf, *Am. Nat.* **109**, 491 (1975); G. H. Pyke, in preparation.
4. T. W. Schoener, *Ann. Rev. Ecol. Syst.* **11**, 369

(1971); E. L. Charnov, *Am. Nat.* **110**, 141 (1976).
5. J. H. Brown, A. Kodric-Brown, T. G. Whitham, H. W. Bond, in preparation.
6. A. H. Gentry, *Biotropica* **6**, 64 (19 → *Ann. Mo. Bot. Gard.* **61**, 728 (1974).
7. C. D. Michener, *The Social Behavior of the Bees* (Belknap, Cambridge, Mass., 1974).
8. Since switching bees leave groove nectar when pool nectar is abundant, direct measurement of the time required to remove all nectar is not possible in the field. However, during each of the five 1-hour periods of observation from 0530 to 1030 hours, I know the mean standing crop of nectar per flower (N), the mean nectar removed per flower (R), and (T), the time required to remove that fraction of the total nectar per flower (mean time per flower—mean time per empty flower). By using the formula

$$\sum_{i=1}^{5} T_i(N_i - N_{i+1})/R_i$$

when $N_6 = 0$, I can calculate the time required to remove each fraction of the total nectar. The sum of these fractions is the feeding time required to empty a full flower. This formula assumes linear and time-independent extraction rates of pool and groove nectar. To check the validity of this approach, laboratory experiments were performed in which I measured foraging times of caged bees (starved for 1 hour) with single *C. linearis* flowers that contained measured quantities of 14.7 percent honey syrup. After each trial, flowers were checked for remaining nectar, but bees tested in this manner removed all nectar. Handling time (mean time spent on empty flowers) was subtracted from the total time spent per flower to give feeding time.
9. Theory (*4*) predicts that forager response to a food type will be all or nothing. The data from 0630 to 0930 hours suggest partial preferences, because bees still leave nectar even though the mean standing crop indicates that flowers contain only groove nectar. However, Fig. 2 shows means only. By 0700 hours, 66 percent of all flowers have been visited, but 34 percent are still full. Since the pollinator's only estimate of nectar availability comes from encounter frequency, one is not surprised that the mean response (nectar left) is not a step function of mean nectar available. These data do not allow an empirical test of this foraging problem.
10. The caloric cost of flight is 3.75 cal per 0.6-g queen per minute [B Heinrich, *J. Comp. Physiol.* **96**, 155 (1975); _____ and P. H. Raven, *Science* **176**, 597 (1972)]. If a bee is not producing additional heat for thermoregulation there is still a basic cost to nonflight foraging estimated to be 50 cal g^{-1} $hour^{-1}$. For the ambient temperatures encountered in this study (14° to 31°C) and the amount of cooling that would occur during a nonflight interval (1° to 2°C), the cost of thermoregulation is much less than the 0.5 cal per 0.6-g queen per minute of nonflight foraging. Since both of these costs result in the production of heat, for the purposes of these calculations, I have used that cost which is highest.
11. The caloric reward of nectar per flower is (microliter of nectar per flower) (0.147) (3.7 cal/mg) where 0.147 is the sugar concentration of desert willow nectar and 3.7 cal/mg is the caloric yield of glucose combustion.
→ B. Heinrich, *J. Comp. Physiol.* **88**, 129 (1974).
13. I thank J. H. Brown, T. C. Gibson, A. Kodric-Brown, G. H. Pyke, and K. J. Whitham for their suggestions. Supported in part by NSF grant DEB 76-09499 to J. Brown and the University of Utah research committee.
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Dopamine Receptor Binding Enhancement Accompanies Lesion-Induced Behavioral Supersensitivity

Abstract. *The binding of [^{3}H]haloperidol to rat striatal dopamine receptors increases after lesion (made by injection of 6-hydroxydopamine) of the nigrostriatal dopamine pathway in those rats which are behaviorally supersensitive, as reflected by apomorphine-induced contralateral rotations. The enhanced binding is associated with an increased number of receptor sites with no change in their affinity.*

The behavioral changes that occur in rats in which specific lesions have been made in the nigrostriatal dopamine pathway suggest that postsynaptic dopamine receptors in the corpus striatum become supersensitive to dopamine after removal of their normal innervation. After bilateral lesions (induced by 6-hydroxydopamine) have been made in the dopamine cell bodies of the substantia nigra, rats display increased stereotyped behavioral responses to apomorphine, a dopamine receptor stimulant, and respond to previously subthreshold doses (*1*, *2*). After unilateral lesions (induced by 6-hydroxydopamine) have been made within the nigrostriatal system, behavioral supersensitivity is manifested by the animal rotating after treatment with apomorphine in a direction contralateral to the side of the lesion (*3*). This rotation provides a readily quantified index of behavioral supersensitivity (*4*). The nigrostriatal lesion induced by 6-hydroxydopamine may be a useful model of Parkinson's disease in which the nigrostriatal dopamine pathway is degenerated, and the supersensitivity of the dopamine receptors in the corpus striatum could account for the dramatic therapeutic response to β-(3,4-dihydroxyphenyl)-L-alanine (L-dopa) (*5*).

The enhanced behavioral response to dopamine receptor stimulants after nigrostriatal lesions have been induced might result, however, from changes distal to the dopamine receptor or in other neuronal systems. Alternatively, it could reflect a true alteration in the dopamine receptor itself. Activity of a striatal dopamine-sensitive adenylate cyclase, which appears to be associated with the dopamine receptor, has been reported to be unaffected by nigrostriatal lesions (*6*) or to show some enhanced activity (*7*). The response of striatal cells to iontophoretically applied dopamine and apomorphine is enhanced by nigrostriatal lesion (*8*). Recently, dopamine receptor binding has been demonstrated in brain membranes by labeling the receptor with both the agonist [^{3}H]dopamine and the antagonist [^{3}H]haloperidol (*9*). The binding sites of the two tritiated ligands have a similar regional distribution, their greatest densities occurring in brain regions with high dopamine levels (*10*). Dopamine agonists and phenothiazine antagonists have the same relative potencies in displacing both [^{3}H]dopamine and [^{3}H]haloperidol binding, indicating that both ligands label sites that have the characteristics expected of the dopamine receptor (*10*). However, it is only in displacing [^{3}H]haloperidol binding that the relative drug potencies for all classes of dopamine antagonists (phenothiazine, butyrophenone, thioxanthene, for example) parallel clinical and behavioral effects in man and animals (*11*). We have interpreted this result to indicate that the dopamine receptor may exist in two states, one of which has a high affinity for [^{3}H]dopamine and the other a high affinity for [^{3}H]haloperidol. The [^{3}H]haloperidol binding site [to which dopamine binds with an affinity in the 0.5 to 1.0 μM range paralleling its EC_{50} (effective concentration for 50 percent stimulation) for stimulating adenylate cyclase activity] thus appears to be the physiologically active form of the dopamine receptor while [^{3}H]dopamine may be labeling a high-affinity, desensitized, and perhaps physiologically inactive form of the dopamine receptor (*12*). We now report enhanced dopamine receptor binding of [^{3}H]haloperidol in the corpus striatum of rats in which lesions of the nigrostriatal pathway have been made with 6-hydroxydopamine.

Binding assays were performed as described (*10*). Homogenates (Brinkmann Polytron) of fresh rat corpus striatum in cold tris buffer, *p*H 7.7 at 25°C, were washed twice by centrifugation. The final pellet was resuspended in cold 50 mM tris buffer containing 0.1 percent ascorbic acid, 10 μM pargyline, and ions as follows: 120 mM NaCl, 5 mM KCl, 2 mM $CaCl_2$, 1 mM $MgCl_2$ (giving a final *p*H of 7.1 at 37°C). This mixture was warmed to 37°C for 5 minutes and returned to ice. Each tube received 1.0 ml of tissue suspension (4 to 6.4 mg, wet weight) and contained 0.2 to 4 nM [^{3}H]haloperidol (9.6 c/mmole; Janssen Pharmaceutica). The tubes were incubated at 37°C for 10 minutes and triplicate 0.3-ml portions were rapidly filtered under vacuum through Whatman G F/B filters with three 5-ml rinses of cold buffer. The filters were counted by liquid scintillation spectrometry. Specific binding of [^{3}H]haloperidol, measured as the excess over blanks containing 100 μM dopamine, represented about half of the total binding. Previous experiments have demonstrated that 100 μM dopamine displaces [^{3}H]haloperidol binding to the same extent as the maximum stereo-