of Hygen and Midgaard (*10*). Their curves for decline of the logarithm of the reduced fresh weight of severed branches run straight and are referred to as the cuticular phase.

Stomata of monocotyledonous and dicotyledenous plants behaved differently at the same CO_2 concentrations. At CO_2 concentrations where corn and sorghum stomata closed completely, stomata of cotton and tomato remained open. Soybean stomata were intermediate in response, showing less tendency than cotton and tomatoes to remain open at high CO_2 values; a small percentage remained visibly open. Diurnal effects on stomatal activity probably mingle with the CO_2 effects; such tendencies were considered to be inherent in these experiments and were not compensated for.

The increase in transpiration of the dicotyledonous plants at 4000 ppm CO_2 from that at 2000 ppm is unexplained. It may indicate that CO_2 causes the stomata to begin opening again, or it may indicate an effect only distantly related to stomatal action, such as an increase in cellular permeability to water movement. No deleterious effects were apparent from the CO_2 concentrations used in these studies.

It is easy to see how experiments on plant-water relations may be influenced by the CO_2 content of the plant's environment; little consideration is usually given to CO_2 control in controlled-environment research. On the other hand, the effects of CO_2 on transpiration may be fortunate for those implementing programs of greenhouse fertilization with CO_2 (*12*); they may benefit from increased economy in water used.

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Moth Sounds and the Insect-Catching Behavior of Bats

Abstract. *Captive bats trained to catch mealworms tossed in midair turned away from most of these targets when simultaneously confronted with a recorded train of the ultrasonic pulses generated by an Arctiid moth. When similarly exposed to the recorded echolocation pulses of another bat, presented at the same intensity as the "moth" sounds, they were not so affected.*

Moths of the family Arctiidae have tympanic organs capable of detecting the echolocating cries of bats (*1*). When shaken or otherwise manipulated some members of this family produce trains of clicks with a strong ultrasonic component. These sounds are generated by microtymbal organs on the metathoracic episternites (*2*).

We have confirmed this finding, and in preliminary experiments have found that specimens of *Halysidota tessellaris* and related moths may also be induced to make trains of clicks with a dominant frequency of about 60 kc/sec by being exposed to a series of artificially generated ultrasonic pulses. Freshly captured specimens of *Halysidota tessellaris* and of *Pyrrharctia isabella* were mounted in stationary flight in front of an ultrasonic loudspeaker, and their acoustic and flight behavior was observed. The onset of a train of ultrasonic pulses commonly caused the flying moth to emit a sequence of clicks. At times flight continued with intermittent clicking for many seconds; at others, flying and clicking ceased simultaneously a few seconds after the onset of the stimulus. In one case there was clear evidence of an accelerated frequency of wingbeat accompanied by clicking. In spite of their additional capacity to respond with ultrasonic clicks, Arctiids in fixed flight behave toward ultrasound in a manner similar to Noctuids (*3*).

Because many of these moths are night flyers and are therefore exposed to predation by insectivorous bats, it seems possible that the ultrasonic clicks are normally emitted on the approach of an echolocating bat and somehow protect the moths against attack. The following experiments were designed to determine the reactions of feeding bats to the sounds made by an Arctiid moth.

Five captive *Myotis lucifugus* bats were trained to catch mealworms (*Tenebrio* larvae) tossed into the air from a solenoid-operated "gun" (*4*). A train of ultrasonic pulses recorded on a tape loop running at 1.5 meters per second was turned on upon presentation of some of the mealworms. The loudspeaker from which these sounds came was aimed at the apex of the mealworm trajectory. Tosses with sound were randomly interspersed among those unaccompanied by sounds.

Responses of the bats to the mealworms under these conditions were observed and rated as follows. (i) "Contacts" included those instances in which the bat caught and ate the mealworm, or caught and dropped it, or only hit it, knocking it out of its trajectory. (ii) In a "dodge" maneuver, the bat swerved from its path of flight so as to avoid the

Table 1. The responses of bats to mealworms presented simultaneously with moth sounds. In those instances where the bat's performance was not rated as a contact, dodge, or attempt, the bat continued on its normal path of flight, apparently without paying any attention to the mealworm.

Bat No.	No. of tosses	Number of		
		Contacts (%)	Dodges (%)	Attempts (%)
Targets presented with sound				
1	59	19	73	1
2	49	10	80	4
3	178	5	87	0
4	92	0	100	0
Total	378	8	85	2
Targets presented without sound				
1	71	85	0	8
2	68	80	1	15
3	188	92	0	4
4	94	100	0	0
Total	421	88	1	8

Table 2. The responses of bats to mealworms presented simultaneously with the sounds of a bat or moth. In those instances where the bat's performance was not rated as a contact, dodge, or attempt, the bat continued on its normal path of flight, apparently without paying attention to the mealworm.

Bat No.	No. of tosses	Number of		
		Contacts (%)	Dodges (%)	Attempts (%)
		Bat sounds presented		
3	67	88	7	5
4	150	79	8	12
5	92	65	27	5
Total	309	77	14	8
		Moth sounds presented		
3	95	14	86	3
4	249	14	83	3
5	121	11	87	2
Total	465	13	85	2
		No sounds presented		
3	141	99	0	1
4	373	98	0	1
5	167	97	1	1
Total	681	98	1	1

gun area and the mealworm. (iii) When a bat turned toward a mealworm, apparently in an unsuccessful effort to catch it, the response was scored as an "attempt". (iv) In the remaining instances the bat continued its normal path of flight near the gun without swerving at all; these responses were judged as "no attention."

In the first experiment the sounds made by a hand-held *Halysidota tessellaris* moth were recorded on tape and presented to the bats as already described. This species occurs in the same areas as those in which *Myotis lucifugus* hunt. It is evident from the results of this experiment (Table 1) that the catching performance by the bats was adversely affected by the moth sounds.

Since it is quite possible that the bats would have difficulty in catching when any ultrasonic pulses were emitted from the loudspeaker, their responses were observed when the recorded orientation sounds of another bat of the same species were presented from the same source. For the second experiment a sequence of echolocation pulses made by a *Myotis lucifugus* catching a tossed mealworm was similarly recorded on tape. These sounds were presented together with mealworm targets on alternate days with the moth sounds, again randomly interspersed among tosses with no sounds from the loudspeaker. The intensities of the "bat" and "moth" sounds were matched before each run at the output of a condenser microphone which remained in a constant position relative to the loudspeaker throughout the experiment. The sound intensity measured at the apex of representative mealworm trajectories (that is, within the "catch volume" of the setup) was approximately 100 db (relative to 0.0002 dyne/cm^2) for the least intense pulses in the catching "buzz" (*5*) and 110 db relative to the same reference level for the loudest bat and moth pulses.

The results of this experiment (Table 2) show that the feeding behavior of the bats was somewhat disturbed by the bat pulse sequence, but they veered much more frequently from the target when the moth sounds were presented. The uniformly low contacts in the presence of moth sounds, in spite of ample opportunity for the bats to learn that these sounds did not warn of any noxious target organism, may indicate that the noisy ultrasonic pulses emitted by the moths could protect them against their predators, the bats.

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Crown Gall and Tomatine

May we, by way of comment on the letters from Philip R. White and from B. A. Kovacs and his colleagues on this subject [*Science* **146**, 670 (1964)], draw attention to our paper on "Histamine protection produced by plant tumour extracts. The active principle of tomato plants infected with crown-gall," published in June of this year [*Brit. J. Pharmacol.* **22**, 486 (1964)]. In this we describe our observations that guinea pigs were protected against the lethal effects of a histamine aerosol by intraperitoneal injection of extracts of both normal tomato plants and tomato plants infected with crown gall tumors. No difference was observed between the activities of extracts of normal and of infected plants. An active principle was isolated from the extracts and identified as the steroid alkaloid glycoside tomatine; this accounted sufficiently for the activity in both cases. We undertook this investigation with the object of clearing up the rather anomalous and illogical situation in the field, and we hope that the present reiteration of our conclusions will achieve this.

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