Table II. Effect of ethylene during the forcing period (day temp. 18 °C, night temp. 16 °C)

Ethylene concentration (ppm)	No. of bulbs formed [a]
0	3
1	3
2	5
5	7
10	7

Tulip (cv. Paul Richter) plants treated during forcing after the flowers bloomed gave different number of daughter bulbs depending on the ethylene concentration. The plants were exposed to ethylene concentrations of 0, 1, 2, 5 and 10 ppm for a period of 1 week. The ethylene was then removed and the plants allowed to mature. After the foliage leaves had died down, the bulbs were lifted and the number of bulbs formed noted.

[a] Counting was done on a population of 5 bulbs for each concentration.

[11] S. P. BURG and E. A. BURG, Science *152*, 1269 (1966).
[12] N. RETIG and J. RUDICH, Physiologia plant. *27*, 156 (1967).

tulips are very sensitive to the gas. The variety, growth phase and environmental conditions under which the bulbs are treated, however, determine to a large extent the concentration threshold for ethylene effectiveness. The bulbs appear to be most sensitive to the gas during periods of active morphogenesis – flower initiation and formation, and initial phase of the forcing period. In this study, we found most of the disturbances described by other authors[3,4]. Ethylene did not increase the 'femaleness' in tulips as it did in pineapples[11] and cucumber[12], instead it induced an abnormal elongation of the stamens resulting in the formation of 'open' buds.

The data obtained in the studies on the nucleic acids and protein are too scattered to lead to definite conclusions. However, three points may be stressed. Firstly, ethylene appears to act first on the somatic and phenotypical apparatus of the cell, and only subsequently on the DNA. Secondly, ethylene proved to be able to alter the nuclear genetic information. Thirdly, the altered genetic information appears to be irreversible. A study on the species of DNA and RNA of the treated plants would give a more definite answer to the question of the effect of ethylene on morphogenesis.

Growth and Development of the American Bollworm *Heliothis armigera* Hubn. under Laboratory Mass Rearing Conditions

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Summary. A kidney bean meal diet was the most satisfactory laboratory diet for the larvae of the American bollworm *Heliothis armigera* Hubn. Optimum rates of survival (63.5%) occurred and the larval growth was better than that of larvae reared on castor oil plant leaves. The pupal weight and the fecundity of the resulting adults were also much better than those on the control host plant.

Artificial diets have been devised for rearing a variety of insect species in the laboratory but many of these diets were developed with an eye to nutritional adequency and little consideration to cost. However, the present emphasis on methods of insect control which can supplement or replace control with insecticides has created a demand for large quantities of laboratory reared insects. The success of methods of control based on plant resistance pheromones and insect pathogens, and the eventual success of control by release of parasites or sterile male insects, depends on economical production of great numbers of the pest species. Development of rearing technique has been reported by authors[1–3] that would reduce the cost of rearing larvae of the tobacco budworm *Heliothis virescens* (F.) and the bollworm *H. zea* Boddie. Since these species consume large quantities of the diet, the cost of the medium is an important factor in production. Therefore manipulation of the ingredients in the diet was an obvious method of further reducing costs.

Table I. Constitution of an artificial diet for the American bollworm *Heliothis armigera* Hubn.

Ingredient	Quantities (g)	Total weight (%)
Dried kidney beans	236	26.4
Dried brewers yeast	37	4.1
Ascorbic acid	3	0.33
Methyl *p*-hydroxybenzoate	2	0.22
Agar	14	1.5
Water	600 ml	67.2

The purpose of this research was to produce a simple, highly reproducible artificial rearing medium for the American bollworm.

Material and methods. The soy bean protein diet developed by [4] and [5] as modified by the present author was selected for this study (Table I). The American bollworm larvae reared on this diet were compared with those reared on castor oil plant leaves. Adults were confined in one gallon wide-mouthed glass jars in the ratio of 3 males to 2 females. The moths were provided with 10% honey solution. Jars were covered with a black cloth on which the moths deposited their eggs. This method made egg collection easy as the cloth could be removed daily. Upon hatching of the eggs, the larvae were transferred to glass vials (7.5 × 10 cm) partially filled with the media, and were kept at 27 ± 1 °C. 1000 larvae were fed on an artificial diet and the same number were reared on castor oil plant leaves. 10 larvae were put in each glass vial from 1st to 3rd instar followed by a single larva per vial till pupation.

[1] J. R. RAULSTON and P. D. LINGREN, J. econ. Ent. *62*, 959 (1969).
[2] J. R. RAULSTON and T. N. SHAVER, J. econ. Ent. *63*, 1743 (1970).
[3] T. N. SHAVER and J. R. RAULSTON, Ann. ent. Soc. Am. *64*, 1077 (1971).
[4] H. H. SHOREY, J. econ. Ent. *56*, 536 (1963).
[5] H. H. SHOREY and R. L. HALE, J. econ. Ent. *58*, 522 (1965).

Table II. Effect of the diet on some biological aspects of *H. armigera* at 27 °C

Type of food	Average larval duration (days)	Pupating (%)	Average weight of pupae (mg)		Adults emerging (%)	Average fecundity
			Males	Females		
Diet	10.3 ± 0.2	64.1 ± 8.2	317.6 ± 13.3	316.7 ± 6.8	63.5 ± 7.9	568.0 ± 28.5
Castor oil plant leaves (control)	15.2 ± 0.6	34.0 ± 5.6	292.0 ± 10.8	295.0 ± 12.5	33.5 ± 5.2	472.0 ± 25.9

Larvae reared on the artificial diet were transferred to fresh diet on the 5th day of the larval development. Larvae on fresh castor oil leaves were transferred to fresh food daily. Pupae were removed from the vials and placed in an emergence chamber operating at 27 °C and 70% R.H. As the moths emerged, they were collected in glass jars and the oviposition sites (deccan hemp flowers, *Hibiscus cannabinus* L.) were provided during the period of egg laying. The larval duration percentage of survival, as well as the pupal weight and the fecundity of the resulting adults, were taken into consideration.

Results and discussion. Several artificial diets for mass rearing of insects were evaluated for *Heliothis* species[2,3,6], but the diet shown in Table I provided the fastest and most uniform larval growth and development. This species was reared for 5 generations with no apparent change in morphology or fecundity, with the exception of the larval colour. The colour of the larvae was distinctly black in comparison to those larvae fed on the control plant. The survival rate (1st instar larvae to adults) was high and a high percentage of adults with perfect wings were produced. The rates of pupation as well as adult emergence were significantly high in comparison to fresh castor oil plant leaves. The incidence of deformed adults was low. Also the number of instars reared on an artificial diet was identical with the number obtained when castor oil plant leaves were used. Newly hatched larvae can be reared to the final stage without transfer but larval uniformity and adult recoveries were not as good. The transfer also reduced the incidence of microbial contamination. Pupae from the kidney bean protein diet were slightly heavier and weighed an average of 317 mg compared with 293.5 mg for the control pupae. Also the larval duration was enhanced in comparison to the control and the total number of eggs laid per female was significantly high (Table II).

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Electric Organ Discharges of the Weakly Electric Fish *Gymnarchus niloticus* (Mormyriformes) in its Natural Habitat

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Summary. Electric organ discharges (EODs) of *Gymnarchus niloticus* in its natural habitat (Chari River, Chad Basin) and accompanying ecological data (pH, conductivity, temperature, turbidity, O_2 dissolved) were recorded. The EOD frequencies ranged from 204 to 313 Hz (day) and 196–326 Hz (night). In social swimming the range of interfish EOD frequency differences was from 4 to 82 Hz. The EOD frequency seems to decrease with the age of the fish.

The monospecific electric fish, *Gymnarchus niloticus*, inhabits freshwater systems from East to West Africa north of the equator. In 1951 Lissmann[3] monitored the electric organ discharges (EODs) of these fish in the Black Volta and later suggested that the electric signals emitted by mormyriform fishes serve as an electrolocating and/or electrosignaling device[4,5]. During our stay in the Chad Basin (January 1975) we tape recorded the EOD activity of *G. niloticus* and monitored associated ecological data such as water temperature, conductivity, turbidity, pH, and dissolved O_2 in the fishes' natural habitat in 2 study areas: A) a lateral channel of the Chari River in the Kalamaloue Reservation in Cameroon, located about 12 km downstream from N'Djamena(Chad) and B) a swampy marsh type area on the island of Irounda, about 4 km off N'Djamena. The lateral channel is permanently connected with the main river, whereas the marshy area was drying up, leaving several permanent pools, no longer in connection with the Chari.

Method. The EODs were detected with submerged pairs of electrodes (detection range: approximately 1.50 m ⌀) and recorded on a portable cassette recorder for analysis with a sonograph spectrum analyzer. Figure 1 shows an example of a sonogram illustrating the presence of 5 different fish with individual EOD frequencies. The ecological measurements were taken with portable, battery powered equipment.

Results. A) The noon measurements in 195–215 cm depth in the center of the 40 m wide Kalamaloue channel were: temperature 20.2 ± 0.2 °C and conductivity 105.7 ± 5.3 $\mu mho \cdot cm^{-1}$. The corresponding data taken at

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