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

[1] Supported by CUNY/RF No. 10748; Hunter College; American Philosophical Society, Penrose Fund No. 7135.
[2] Supported by C.N.R.S./R.C.P.
[3] H. W. Lissmann, Nature, Lond. *167*, 201 (1951).
[4] H. W. Lissmann, J. exp. Biol. *35*, 156 (1958).
[5] H.W. Lissmann and K.E. Machin, J.exp.Biol. *35*, 451 (1958).

midnight were: 20.2 ± 0.3 °C and 106.5 ± 7.6 μmho · cm^{-1}. The turbidity was 136 ± 19 FTU (Formazin turbidity units), the pH ranged from 7.0 to 7.5, and dissolved O_2 was 5.3 ± 0.6 ppm. EOD recordings were obtained from single fish and groups of 2 to 5 individuals passing through the electrodes' detection field. Figure 2 shows the EOD frequency distribution of all detected *G. niloticus* during day and nighttime. The daytime average EOD frequencies and their ranges were not significantly different from the nighttime data: day, 253.4 ± 27.9 Hz, range 204–313 Hz; night, 251.5 ± 34.8 Hz, range 196–326 Hz. While fish were passing in groups of 2 to 5 individuals the initial EOD frequency differences (Δf) among individuals were maintained for as long as the fish stayed in the detection range of the electrodes. These differences were not significantly different with regard to the number of fish passing: groups of 2 (25 observations): Δf = 28.6 ± 17.6 Hz, range 5–82 Hz; groups of 3 (14): Δf = 26.9 ± 15 Hz, range 6–53 Hz; groups of 4 (9): Δf = 14.7 ± 9 Hz, range 4–33 Hz; and groups of 5 (12): Δf = 16.8 ± 9.1 Hz, range 8–33 Hz.

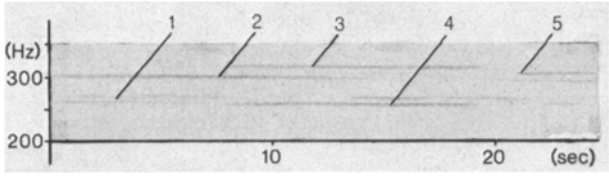

Fig. 1. Sonogram illustrating the electric organ discharge frequencies of 5 *G. niloticus* passing through the detection field of the recording electrodes.

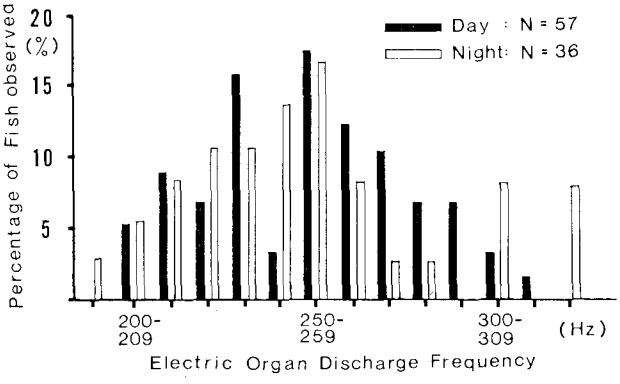

Fig. 2. Range and distribution of electric organ discharge frequencies of *G. niloticus* during day and nighttime.

B) In one of the permanent pools on the island of Irounda EOD recordings and ecological data were taken between 12:00 and 5:00 P.M. at different observation sites ranging in depth from 30 to 100 cm. The water temperature was 19.5 ± 1.0 °C, conductivity 82.9 ± 4.5 μmho · cm^{-1}, turbidity 64.2 ± 8.3 FTU, pH range 7.0 to 7.5, and dissolved O_2 was 7.7 ± 1.2 ppm. Over a period of 2 weeks, 5 specimens of *G. niloticus* were observed to maintain the same hiding places in partly submerged bushes of *Mimosa aspirata* (during daytime) which they left during the night to prey. The 5 individuals were identified by their characteristic EOD frequencies of 193, 212, 223, 235 and 250 Hz.

Discussion. Our field data confirm the wide range of frequencies obtained from *G. niloticus* kept under laboratory conditions. Contrary to nighttime EOD increases in other mormyriform fishes[6] we did not find significant daily EOD variations in *G. niloticus*. LISSMANN[4] reported a decrease in EOD frequencies in 2 captive specimens over a 5 year period when these fish grew in size from 28 and 38 cm to 52 and 54 cm. We caught 2 of the Irounda fish and also related a higher frequency of 250 Hz to the smaller fish (22.5 cm) and a lower frequency of 212 Hz to the larger fish (37 cm). Laboratory recordings from young 6.7 to 9.5 cm *G. niloticus* show an average frequency of 300 Hz at 21 °C under comparable conductivity conditions[7]. Since we recorded the Kalamaloue fish under relatively constant physico-chemical conditions we attribute the observed range of EOD frequencies in part to the fishs' age. Sex differences and possible frequency variations and/or frequency phase shifts during specific behavioral interactions remain to be investigated. Recent laboratory studies on (EOD frequency-) jamming-avoidance[8] showed that *G. niloticus* when stimulated with frequencies close to its own will shift its EOD frequency by at least 4 Hz, a value which is in accordance with our natural observations.

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[7] P. MOLLER, unpublished data.
[8] W. HEILIGENBERG, J. comp. Physiol. *103*, 55 (1975).

Primary Nucleolus and Amphinucleoli in the Oocytes of *Patella coerulea* L. (Moll. Gast.)

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Summary. Electron microscope observations show in the primary nucleolus some granulations with dimensions less (70 Å) than those of the amphinucleoli (90 Å). Even though the primary nucleolus has a high RNA content, this has not a very active turnover except at the periphery, probably in relation to the emission of 'daughter-nucleoli'. The amphinucleoli, even though they do not have RNA which is cytochemically discloseable, possess, however, RNA at a very high rate of turnover.

From the research done especially by JÖRGENSEN[1] and by the researchers of the Institute of Zoology[2] of the University of Messina, it appears that the oocytes of *Patella coerulea* present a complex nucleolar apparatus during their growth. This is constituted by a 'primary nucleolus' more or less distant from the nuclear membrane, colourable in red with Mallory's method and in blue with Dominici's method, with clear evidence of RNA and without nucleolini, and by a variable number of 'amphinucleoli' which generally adhere to the nuclear membrane until they gradually wear themselves out. The amphinucleoli are colourable in blue with Mallory's method and in red with Dominici's method; they show no evidence of RNA and have nucleolini which are more