It has been shown that cell surface carbohydrates are involved in both intercellular and substrate adhesion on the part of procaryotic and eucaryotic cells[14,15], though no clear relation between adhesion and ConA-binding sites has yet been demonstrated[3,16].

Our findings, however, suggest that the carbohydrate-containing surface protein that binds ConA is primarily responsible for the adhesion of *T. vaginalis* to glass surfaces. The influence of other factors, however, such as the active protrusion of filopodia, or movements of the cell periphery mediated by cytochalasin B-sensitive microfilaments, must not be overlooked[17].

These results are in line with the hypothesis that sugar-containing proteins are involved in cellular interactions and particularly in cell-to-substrate adhesion phenomena[3,15,18,19].

Summary. Treatment of *Trichomonas vaginalis* with EDTA removes their ability to adhere to glass surfaces and changes their affinity to Concanavalin A (ConA) by a different distribution of their surface structures. Filtrates of the EDTA-treated *Trichomonas* passed through affinity chromatography columns (ConA bound to Sepharose 4B) separate into 2 fractions, one fraction was bound to the ConA-Sepharose beads, the other was not. The Con A - bound fraction appears to be a glycoprotein which restores in a specific way the ability of the EDTA-treated protozoa to adhere to glass.

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Environmental Factors Control the Periodical Reproduction of Tropical Electric Fish

Weakly electric fish (Gymnotoidei, Mormyriformes) have since the time of their discovery[1] been more and more the object of intensive studies[2]. Two important topics, however, sexual behaviour and embryology, could not as yet be studied systematically.

Little is known about the reproduction of these fishes. Apart from an isolated chance success with *Petrocephalus bovei*[3], weakly electric fish have never been bred in captivity. The Gymnotoidei, which live in tropical Central and South America, breed during the rainy season[4] as do most of the African mormyrid fishes[5,6]. The factors which control the periodical reproduction of fishes in the tropics in relation to dry and rainy season were, however, not known[7]. It has not therefore been possible up to now to induce gonad growth in these fishes in the laboratory.

Eigenmannia virescens was chosen for most of the experiments because they are transparent and the growth of the gonads could be continuously observed. A prolonged series of experiments has proved that a combination of environmental factors induce the growth of gonads in *Eigenmannia:* pH and conductivity of the water were continuously decreased. At the same time, the water level was increased. Simulated rain (8 h/day) and a constant photoperiod (L D 13:11) completed the system. After about 2 months under these conditions, the animals showed mature gonads (Figure 1). These fish are similar in appearance to mature fish caught in South America during the rainy season[4]. If the above conditions are changed in the opposite direction, then mature *E. virescens* reduce their gonads in 4 to 6 weeks.

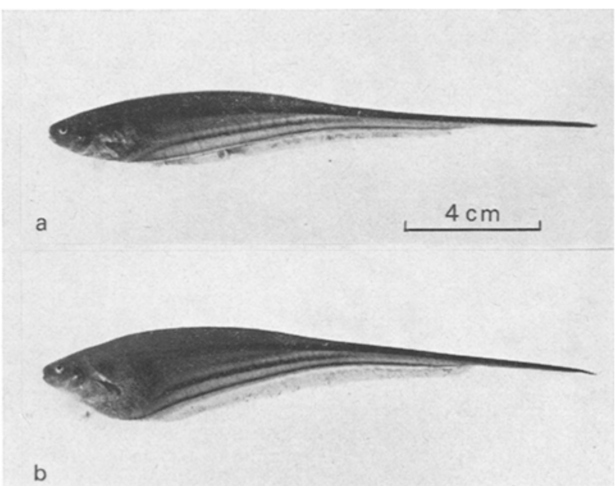

Fig. 1. Female of *E. virescens* with entirely reduced ovary (a), and the same fish 87 days later after induction of ovarian growth (b) by simulating the rainy season (Figure 2).

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In a special breeding experiment, it was shown that the described environmental factors also regulate the reproduction of these fish by inducing gonad growth: mature fish first spawned about 2 months after the beginning of the experiment (Figure 2). The 3 spawnings which have taken place, showed that the fish laid only 30–80 eggs each time. Mature females, however, hold 200–400 eggs, which might indicate that *E. virescens* spawns at regular intervals during the rainy season.

Subsequent experiments have shown that, after gonad reduction, *Eigenmannia* can immediately reach maturity again when a further rainy season is imitated. This indicates that this fish does not have a 'postbreeding refractoriness'. Gonad growth could furthermore be induced with the same technique in the gymnotid species *Apteronotus* (*Sternarchus*) *albifrons*, *Sternopygus macrurus*, *Gymnotus carapo*, and *Eigenmannia troscheli*. By varying the same environmental factors, gonad growth and spawning could be induced 9 weeks after the beginning of the experiment in the African mormyrid species *Marcusenius spec.* Preliminary results indicate that, like *Eigenmannia virescens*, all these species have no 'postbreeding refractoriness'.

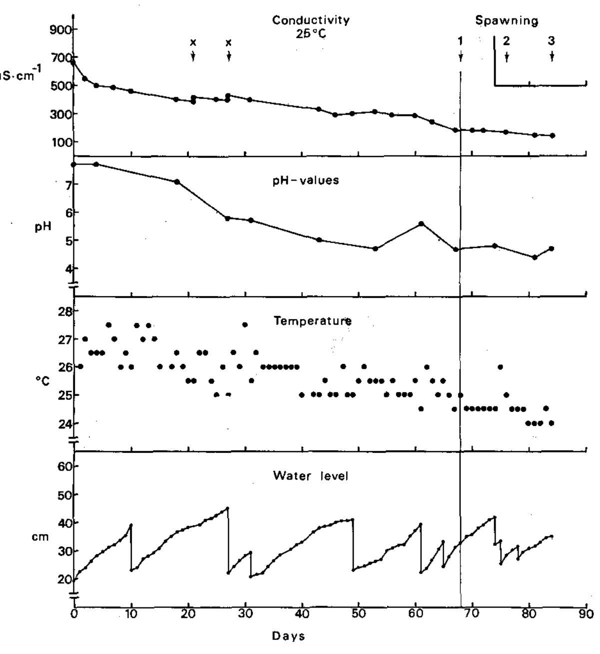

Fig. 2. Environmental factors which induce the growth of the gonads in *E. virescens*. At the beginning of the experiment, conductivity and pH-values were purposely chosen much higher than those found in the natural environment of the fish. The higher values made it easier continuously to lower pH and conductivity. The fish do not react to the absolute values of these variables but only to their change. The decrease of pH and conductivity was achieved by continuously adding water of lower values than those finally required. The water level reflects the amount of water added. x shows a sudden increase in conductivity after treating ill fish. Spawnings 2 and 3 took place in a group of 3 fish, 1 male and 2 females, which were transferred at the 74th day of the experiment into another breeding tank in which they bred under different conditions. (Spawning 2 at 25.5 °C, 175 μS, 7.3 pH, 34.2 cm water level; spawning 3 at 26.0 °C, 170 μS, 7.2 pH, and 34.9 cm water level.) In this experiment a slight temperature decrease occured. The fish react, however, even if the temperature is held constant.

The modifications of the water conditions in the experiment are very similar to those found in the South American tropics during the rainy season: the heavy rain falls cause an enormous increase in water level which leads to substantial dilution of the water and a pH-decrease[8]. Similar changes occur in the African tropics during the rainy season. In those habitats where changes between dry and rainy season are only very slight, fish migration may not only lead the fish to the breeding sites, but might also be responsible for greater environmental changes during the migratory phase, thus facilitating gonad growth. It is known, for example, that African fishes commence migrating at decreasing water conductivity[9], and several mormyrid species show similar reactions[6]. The experiments described show for the first time so far as is known, how the periodical reproduction of tropical fishes in relation to dry and rainy season is controlled by environmental factors which regulate gonad growth. But further experiments must show which factor or combination of the factors used in the present study are essential to induce the reaction of the fish. At any rate, these factors are quite different from the classical variables of temperature and photoperiod which control the periodical reproduction of fishes of the temperate zones[7].

The present experiments indicate that both gymnotid and mormyrid fish can reach maturity about 2 months after the beginning of the rainy season. At this time the fry will find optimal conditions in the flooded areas. Furthermore, the lack of a 'postbreeding refractoriness' makes the fish much more adaptable to irregularities during the rainy season and explains why tropical fishes can breed twice a year[6] in regions which have 2 dry and rainy seasons. The described or a modified technique might permit the continuous breeding of tropical fish which spawn only during the rainy season, and thus represent a vital protein source for many of the African and South American countries.

Summary. By varying environmental factors, gonad growth and spawning could be induced in *Eigenmannia virescens* and *Marcusenius spec.* The same factors can lead to gonad reduction. These fish have no "postbreeding refractoriness".

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