velopment, maintenance, and recovery from conditioned suppression could provide additional clues to possible neurotransmitter-behavior interactions in both normal and abnormal states.

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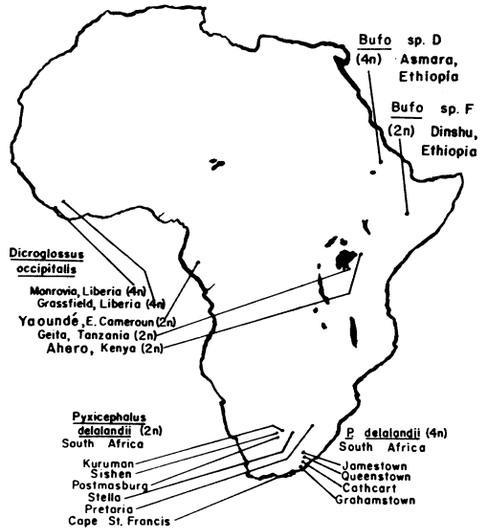
Polyploid Amphibians: Three More Diploid-Tetraploid Cryptic Species of Frogs

Abstract. *The nominal African species* Pyxicephalus delalandii *and* Dicroglossus occipitalis *have diploid and tetraploid populations. There are also cryptic tetraploid and diploid species similar to* Bufo kerinyagae. *These represent the first bisexual polyploid "species" so far encountered in the major frog families Ranidae and Bufonidae. The contention that polyploidy is a widespread and important evolutionary phenomenon in anuran amphibians is supported.*

The prior assumption that bisexual polyploid animal species would not be able to overcome sexual imbalances in gametogenesis as proposed by Muller (*1*) is no longer tenable because of the recent recognition of several bisexual, naturally occurring, populations of polyploid animals. Unlike fishes, where polyploidy has been involved in past evolutionary dichotomies (*2*), frogs appear to be the only unique group of vertebrates that have diploid and polyploid populations included in the same bisexual species or in closely related "cryptic species" (*3–6*). It is expected that future investigations will reveal these diploid and polyploid populations to be distinct and separable. This tenet has been discussed (*3, 6*).

During an extensive survey of the chromosomes of African anurans, two "species" demonstrated diploid and tetraploid populations. Two cryptic species, one diploid and one tetraploid, were also found. Chromosomes were obtained from epithelial squashes of adult cornea or tadpole tail tips by means of standard techniques (*7*). *Bufo* sp. D from Asmara, Ethiopia, are tetraploid ($2n \rightarrow 4n = 40$), but *Bufo* sp. F from Dinshu, Ethiopia, are diploid. South African *Pyxicephalus delalandii* populations from Kuruman, Sishen, Postmasburg, Stella, Pretoria, and Cape Saint Francis are diploid ($2n = 26$) but this species is tetraploid ($2n \rightarrow 4n = 52$) at Jamestown, Queenstown, Cathcart, and Grahamstown. At Ahero in Kenya, Geita in Tanzania, and Yaoundé in East Cameroun *Dicroglossus occipitalis* are diploid ($2n = 26$) but populations from Monrovia and Grassfield, Liberia, are tetraploid ($2n \rightarrow 4n = 52$). The distribution of the sampled populations is provided in Fig. 1, and representative karyotypes are presented in Fig. 2.

Polyploid frogs are known to occur in the families Leptodactylidae (*3, 5, 9*), Hylidae (*3, 4, 6, 10*), and even the "primitive" family Pipidae (*11*). The present recognition of polyploids in the Ranidae (*Dicroglossus occipitalis*, *Pyxicephalus delalandii*) and the Bufonidae (*Bufo* sp. D) helps to establish the fact that polyploidy is a general phenomenon in frogs and may appear in any genus. The rela-



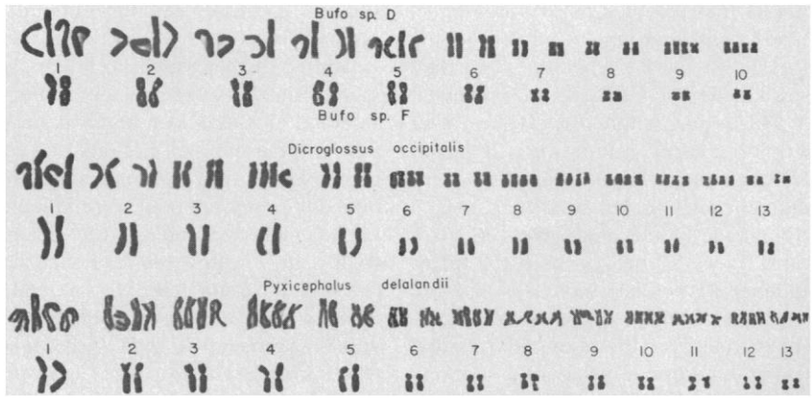


Fig. 1 (left). Map of Africa showing the localities of the diploid ($2n$) and tetraploid ($4n$) populations. Fig. 2 (right). Representative karyotypes of the diploid and tetraploid "cryptic" species. The chromosome sets are numbered from longest to shortest for each respective population.

tive rarity of anuran polyploid species is, therefore, unexpected rather than the reverse. The majority of the currently recognized polyploid frogs have diploid counterparts and, considering the dearth of chromosomal investigations at the population level, additional polyploid populations or "cryptic species" will undoubtedly be uncovered.

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Functional Development of Prefrontal Cortex in Rats Continues into Adolescence

Abstract. *Bilateral removal of the sulcal prefrontal cortex in rats at 60 days of age and older results in aphagia and adipsia, but removal of this area before 60 days of age does not affect food or water regulation. Apparently the development of the role of this neocortical region in feeding and drinking continues well beyond the time of weaning in the rat.*

Studies of food and water regulation have shown that lesions in the lateral hypothalamus, zona compacta, trigeminal system, globus pallidus, dorsomedial amygdala, or sulcal (ventral or orbital) prefrontal cortex in rats (*1*, *2*) produce aphagia and adipsia such that animals will die unless given special care (*3–5*). The involvement of the lateral hypothalamus in feeding and drinking behavior apparently develops quite early in rats since destruction of this area during the first week of life produces aphagia and adipsia even more severe than that produced by comparable lesions in adults (*6*). In contrast, the results of the present study indicate that the sulcal prefrontal cortex of the rat is not critically involved in food and water regulation until nearly 60 days of age despite the fact that rats are normally weaned between the third and fourth week of life and must thereafter forage for food on their own.

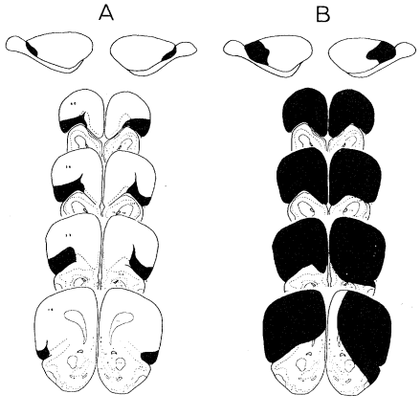

Fig. 1. (A) Coronal sections showing a typical orbital frontal lesion. Most of the lesions in the adults, juveniles, and infants were similar to this one. (B) Coronal sections illustrating the largest lesion. This rat was operated at 6 days of age and failed to exhibit aphagia. It continued to eat and to gain weight normally after surgery.

The subjects were 80 rats, 40 with bilateral lesions of the sulcal prefrontal cortex induced between 2 and 60 days after birth and 40 age-equivalent sham-operated controls. There were eight control rats and eight with lesions (four male and four female) operated at 2 to 6 days and 8 to 10 days after birth, as well as six controls and six with lesions (three male and three female) operated at 25, 35, 40, and 60 days after birth, respectively. Bilateral lesions were made under ether anesthesia in all rats operated at 10 days of age or less while animals operated in the older groups were given intraperitoneal injections of sodium pentobarbital (50 mg per kilogram of body weight). Lesions were made by removal of the sulcal prefrontal cortex by subpial aspiration by procedures outlined elsewhere (*7*) (Fig. 1A). All rats were separated from their mothers at 23 days of age and were then housed in groups of three or four for the duration of the experiment. The animals were weighed daily for the first 21 postoperative days and then at 1- or 2-week intervals until 110 days after surgery. Purina Rat Chow and water were freely available for all subjects throughout the experiment.

Lesions made before 60 days of age failed to alter food and water intake or growth rate (Fig. 2) or to produce the motor dysfunctions observed after similar lesions in older rats (*8*). Indeed, not a single rat operated before 60 days showed aphagia or adipsia, whereas every subject operated at 60 days required gastric intubation for up to 14 days to prevent death from starvation and dehydration. The age effect did not result from smaller lesions in the younger rats since many of those operated 2 to 10 days after birth had large lesions that included up to three times as much tissue as the average adult lesion (Fig. 1). Even those operated early with very large lesions showed only a mild and transient weight loss (Fig. 2).

These results suggest that although rats are normally weaned at about 21 days and must thereafter forage for their own food, the neural mechanisms underlying behavior related to food intake are not fully developed until late adolescence. This suggestion is supported by recent studies of development of ingestive behavior in weanling rats. For example, Epstein (*9*) concludes that although some of the physiological mechanisms controlling feeding and drinking are present at birth, the "developmental process for ingestive behavior continues beyond the time of weaning well into the juvenile period."

Since most known indices of neo-

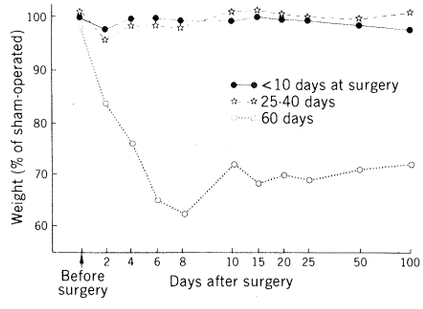

Fig. 2. The effects of orbital frontal lesions on body weight in the first 100 days after surgery. Each point represents the ratio (as a percentage) of the weight of rats with lesions to the weight of sham-operated rats in the respective groups.