

MDH and esterase, 2 bands for PGM. This result was not to be expected considering the frequent electrophoretic variants of enzymes found in other organisms.

If compared to other species, there seem to be fewer polymorphic loci in the honeybee. What may be the explanation for this reduction? It is known that parthenogenetic reproduction should generally lead to a reduction of genetic variability. However, the enzymes of the parthenogenetically reproducing *Daphnia magna* have been shown to be as polymorphic as those of other species⁷. Honeybees, on the other hand, have a special parthenogenetic system with heterozygous workers and hemizygous drones (in *Daphnia* males are diploid). The fact that all genes are under selection in the males has to lead to a reduction in variability. Also, one of the advantages of polymorphism, namely the heterotic effect, is lost for part of the population.

Another reason for the reduction could be constancy of the environment, for bees regulate the temperature extremely well within the hive and also the feeding of the larvae. But it has been shown that animals living in presumably constant environments, like deep-sea animals and coralreef clams, have the same amount of polymorphic loci as other species^{8,9}. Therefore it seems likely that the heterozygous-hemizygous system of hon-

eybees, enforced by constant, well regulated conditions during development, and adult life is necessary to produce the observed absence in isozyme polymorphisms.

Zusammenfassung. Elektrophoretische Untersuchungen zum Enzympolymorphismus der Honigbiene (*Apis mellifica*) ergaben, dass alle untersuchten Individuen, Tiere aus 4 Rassen, monomorph für Malatdehydrogenase, Esterase und Phosphoglucumutase waren.

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Chromosomes and DNA of the Ambystomatoid Salamanders

The Salamanders (Amphibia, Caudata) of the families Ambystomatidae and Plethodontidae are often associated in the suborder Ambystomatoidea^{1,2}; the small paedogenetic family Amphiumidae (formerly included in the Salamandroidea³) appears to show various affinities with one of the preceding families^{4,5}. Indeed, the members

studied of the 3 families – unique within the order – have the same diploid number of 28 chromosomes with the exception of the ambystomatid *Rhyacotriton* and some bolitoglossine Plethodontids (with 2n = 26)⁶⁻⁹. We present here new comparative data on the chromosomes and the nuclear DNA amounts in 7 species of

Taxonomic position	Diploid number	Nuclear DNA amount (pg/N)	Reference in the Figure
Family Ambystomatidae			
Subfamily: Ambystomatinae			
Subgenus: <i>Linguaelapsus</i>			
<i>Ambystoma texanum</i>	28	48	A
<i>Ambystoma annulatum</i>	28	50	B
Subgenus: <i>Ambystoma</i> :			
The <i>maculatum</i> group: <i>Ambystoma maculatum</i>	28	52	C
<i>Ambystoma macrodactylum</i>	28	52	D
The <i>opacum</i> group: <i>Ambystoma opacum</i>	28	48	E
<i>Ambystoma talpoideum</i>	28	62	F
The <i>tigrinum</i> group: <i>Ambystoma tigrinum</i>	28	55	G
Family: Amphiumidae <i>Amphiuma means</i>	28	150	H
Family: Plethodontidae			
Subfamily: Desmognathinae <i>Desmognathus fuscus</i>	28	30	I
Subfamily: Plethodontinae			
Tribe: Hemidactyliini: <i>Gyrinophilus danielsi</i>	28	44	J
<i>Pseudotriton ruber</i>	28	49	K
<i>Eurycea lucifuga</i>	28	41	L
Tribe: Plethodontini: <i>Plethodon cinereus</i>	28	46	M
<i>Ensatina eschscholtzii</i>	28	84	N
<i>Aneides aeneus</i>	28	86	O
Tribe: Bolitoglossini: <i>Batrachoseps attenuatus</i>	26	84	P

Ambystoma, in *Amphiuma means* and in 8 species of Plethodontids belonging to the main taxonomic subdivisions of this family. The chromosomes have been obtained from intestinal and spermatogonial metaphase plates, while the quantitative reports on the nuclear DNA in picograms per nucleus (pg/N) have been measured by histophotometrical methods on Feulgen-stained blood smears¹⁰. We have followed the systematics proposed for the Ambystomatids by TIHEN¹¹ and for the Plethodontids by WAKE²; the species studied, their chromosome numbers and nuclear DNA amounts are listed in the Table, while the karyotypes of each species are represented in the Figure.

With the exception of the bolitoglossine *Batrachoseps* all the species have $2n = 28$ and bi-armed chromosomes (save the 3 smallest pairs of *Aneides* which are acrocentric). Interspecific differences in chromosome morphology at both intra- and inter-familial levels are generally small and not always in agreement with the proposed system-

atics; however, karyological data support the recent hypotheses of close phyletic relationships between the Ambystomatids and the Plethodontids^{1,2} and are in favour of the inclusion of the Amphiumids in the same suborder Ambystomatoidea: actually, *Amphiuma means* is karyologically almost indistinguishable from some Ambystomatids and Plethodontids (Figure).

As regards the nuclear DNA, *Amphiuma*, with about 150 pg/N, has larger amounts than the other species studied here, thus being similar, in this quantitative character, to other paedogenetic Salamanders (families Cryptobranchids, Proteids and Sirenids)^{9,10,12}. The intrafamilial variability in the DNA amounts seems generally higher in the Plethodontids than in the Ambystomatids; however, we have measured about 99 pg/N of DNA in some triploid *Ambystoma* of the *jeffersonianum* complex¹³. Among Plethodontids, besides *Batrachoseps* which, like other Bolitoglossini, seems largely influenced by paedomorphic effects², also some non-paedomorphic diploid Plethodontini (*Ensatina*, *Aneides*) have much more DNA than the related (but more generalized) *Plethodon*, the Desmognathinae and the Hemidactyliini (Table); the quantitative differentiation in the nuclear DNA of this family seems therefore to have been correlated with other factors besides paedomorphosis (and its higher expression, paedogenesis) and the degree of ploidy¹⁴⁻¹⁶.

Riassunto. La notevole somiglianza cariologica fra sette specie di Ambystomatidi, una di Amphiumidi e otto di Plethodontidi è in favore dell'ipotesi di una inclusione delle tre famiglie nello stesso sottordine (Ambystomatoidei). Fra i Plethodontidi, ci sono variazioni nel contenuto di DNA nucleare che non sembrano correlate, come avviene in altri Urodeli, con fenomeni di pedomorfosi o col grado di ploidia.

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The karyotypes of the 7 species of *Ambystoma* (A-G), of *Amphiuma means* (H) and of the 8 Plethodontids (I-P) here studied; for more precise references, cf. Table. The scale (bottom right) is 20 μ m.

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