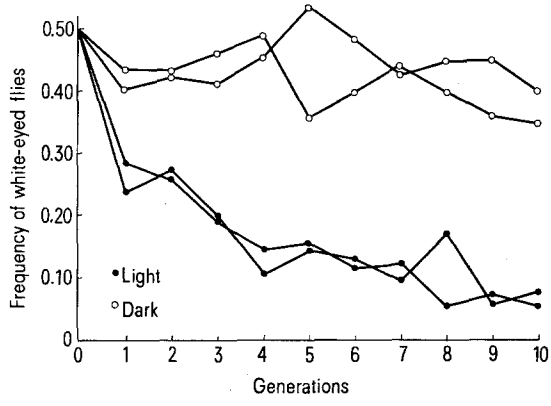
*lion*; *brown* strain were crossed to a single mutant *vermilion* strain. Heterozygous $F_1$ females were then backcrossed to males of the parental inbred *v*; *bw* strain and the process repeated for a further 6 generations. The progeny of the final backcross were transferred before eclosion from the pupa to each of 4 replicate population cages in which they hatched to form the founder population (generation 0) which was allowed to mate at random. Two population cages were maintained in continuous light, and two cages in continuous darkness, in the same constant temperature room at 25 °C. Under a system of random mating each population contained two phenotype groups: a) white eyed *v*; *bw* and b) red eyed *v*; + and *v*;+/*bw*. In continuous darkness the frequency of white eyed flies fluctuated around a mean of 43% over 10 generations. The absence of a significant change in gene frequency over this period shows that the white eyed double mutant flies are not at any marked physiological disadvantage under these conditions. In constant light the situation is quite different. The frequency of white eyed flies declined steadily and substantially over 10 generations indicating that they are at a competitive disadvantage relative to red eyed flies in the random mating population.

The disadvantage to the white eyed flies in the light is confirmed by the data summarized in the Table. Four replicate trials on flies drawn from the cage populations were set up in which 50 pairs of virgin flies of each of the two phenotype groups were placed in a 10 × 10 × 0.5 cm perspex box. The phenotype of the partners making up the first 25 matings was recorded for each trial. There were no significant differences between trials, for which the pooled result is shown. There is no significant difference between phenotype groups with respect to females, but white eyed males are clearly at a marked competitive disadvantage relative to red eyed males in the multiple choice situation ($p<0.001$). These results confirm our previous findings[7] using 1 ♀ + 2 ♂ and 2 ♀ + 1 ♂ competition experiments in small mating cells. The origin of the competitive disadvantage of white eyed males is, as previously shown, their reduced efficiency in establishing and maintaining contact with the female. Males of both phenotype groups compete equally in darkness, since neither are able to use visual cues during orientation. Wild type flies will mate in darkness but they take substantially longer to achieve copulation than in the light. Visual information, whilst not essential for courtship nor for attainment of copulation in this species is important to the extent that flies which are unable to use visual cues during courtship have a lower fitness than those which are able to do so. GROSSFIELD's classification scheme is thus too simple in that it does not take account of relative mating success in relation to light. Within that scheme however *D. melanogaster* are more appropriately placed in class II of facultative dark mating species. This class we believe could be usefully subdivided to take account of the nature of the mating 'inhibition' caused by absence of light.




Change in frequency of phenotypically white eyed mutant *v*; *bw* flies in random mating populations maintained in continuous light or in continuous darkness. The initial frequency is 50% in each cage. Since the mutant *v* is fixed in the population the frequency of white eyed flies depends only on the frequency of the *bw* allele.

*Zusammenfassung.* Untersuchungen an Mutanten von Drosophila melanogaster mit fehlendem Schutzpigment im Komplexauge und mit verminderter Sehkraft deuten darauf hin, dass es sich bei Drosophila um eine vom Licht abhängige, im Dunkeln paarende Art handelt.

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[8] Thanks are due to Mrs. J. M. RELTON for technical assistance with the population cage experiment, and to Dr. R. COOK for his suggestions during preparation of the manuscript.

## Chromosome Complements of Three Species of Mugilidae (Pisces, Perciformes)

Of the Teleosts, the Mugilidae have always interested ichthyologists, not solely from the practical point of view, but also because of the evolutionary, and consequently systematic, problems they pose. In fact, although the Mugilidae family is per se a homogeneous taxonomic entity, its arrangement at the level of the order is a much-debated question.

To mention only some of the most recent revisions, BERG[1] and BERTIN and ARAMBOURG[2] ascribe the Mugilidae, together with the Atherinidae and Sphirenidae families, to a separate order, Mugiliformes, while NORMAN[3], GOSLINE[4], BINI[5] and, very recently, TORTONESE[6] disagree with this systematic arrangement into such a high-order taxon ascribing the families to the suborder Mugiloidaea in the large Perciformes order.

Moreover, Atherinidae were removed from this taxon by ROSEN[7] in order to constitute, along with Beloniformes, Esocoetidae and Cyprinodontiformes, the new order Atheriniformes.

There are also some authors[6,8] who recommend revision of the old genus *Mugil*, Linnaeus 1758, contending that this taxon is so heterogeneous as to warrant its dismemberment into several genera as *Mugil, Liza, Chelon* and *Oedalechilus*, to mention only the Mediterranean genera.

These taxonomic rearrangements are based essentially on morphological arguments (MCALLISTER[9]) and cytotaxonomic evaluation has never been attempted for the interpretation of this systematic and evolutionary problem. In fact no karyological data exist for Mugilidae.

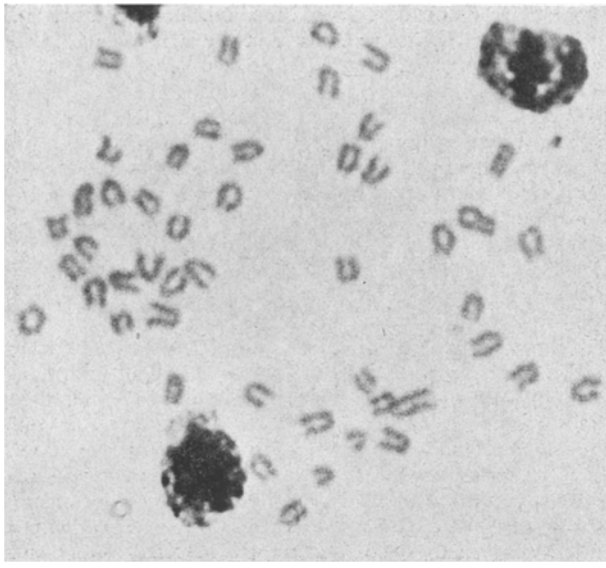

Fig. 1. Metaphasic plate of *Mugil cephalus*; × 2,500.

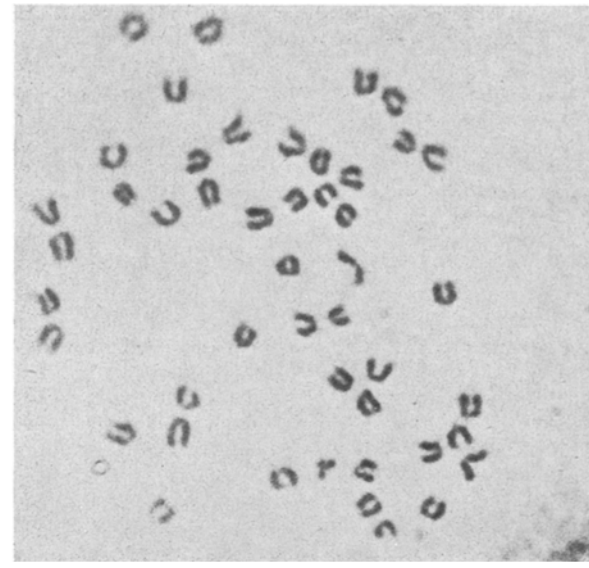

Fig. 2. Metaphasic plate of *Chelon labrosus*; × 2,500.

Consequently it was considered that, within the ambit of a research program on Osteoichthyes cytotaxonomy, it would be interesting to take a look at this taxon, in the conviction that karyological data can be successfully inserted in a systematic problem such as that outlined above.

The species studied were: *Mugil cephalus* L., *Liza ramada* (Risso), and *Chelon labrosus* (Risso). The technique employed involved an air-drying process which is an improved version[10] of the one proposed by HITOTSUMACHI et al.[11].

In all the species examined the diploid number is $2n = 48$; the chromosomes in all species are very small (varying between 2.5 and 1 μm) and acrocentric in shape. None-the-less, although *Mugil cephalus* shows a karyotype with 24 pairs of acrocentric chromosomes, on the other hand the karyotypes of *Liza ramada* and *Chelon labrosus* are characterized by 1 pair of subtelocentric chromosomes (indicated by arrows in Figure 3).

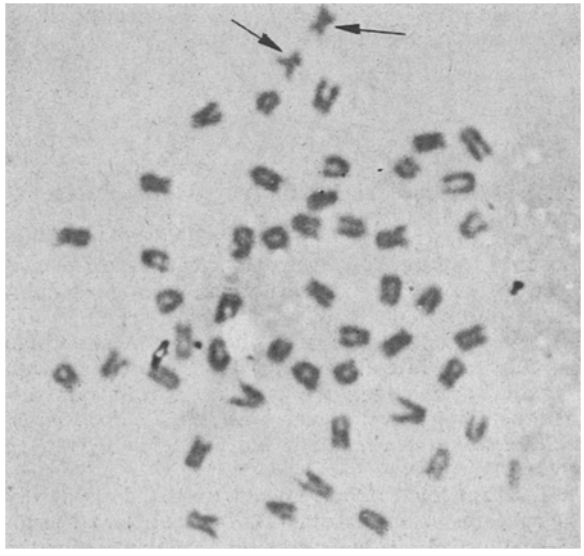

Fig. 3. Metaphasic plate of *Liza ramada*, arrows indicate the pair of submetacentric chromosomes; × 2,500.

It is held that if the presence of such subtelocentric pairs is found in other species of the genus *Liza*, e.g. *L. aurata* and *L. saliens*, the rearrangement of the genus *Mugil* would be fully confirmed as far as *Liza* and *Chelon* is concerned.

Regarding the problem of ascribing Mugilidae to a separate order or else to Perciformes, karyological data support the opinion of those authors[3-6] who ascribe Mugilidae to the Perciformes, since other Perciforms' families show a very similar karyotype made up by 48 acrocentric chromosomes, e.g. Centrarchidae (ROBERTS[12]), Serranidae (NOGUSA[13]), Percidae, Cichlidae (POST[14]), etc.

None-the-less this data has to be cautiously discussed because, among Teleosts, a karyotype characterized by 48 acrocentric chromosomes is common and widespread throughout all orders of bony fishes. In fact 48 can be considered the *modal number* (WHITE[15]) of Teleosts.

Research is therefore presently being undertaken involving karyotype study of other Mugilid species, as


[1] L. S. BERG, Trudy zool. Inst., Leningr. *2*, 87 (1940).
[2] L. BERTIN and C. ARAMBOURG, in *Traité de Zoologie* (Ed. P. P. GRASSÉ; Masson, Paris 1958), vol. 13, p. 2205.
[3] J. R. NORMAN, *A Draft Synopsis of the Orders, Families, Genera of Recent Fishes and Fish-like Vertebrates* (British Museum, London 1966).
[4] W. A. GOSLINE, Pacific Sci. *16*, 207 (1962); Proc. U.S. natn. Mus. *124*, 1 (1968).
[5] G. BINI, *Atlante dei pesci del Mediterraneo* (Mondo sommerso, Roma 1968), vol. 4.
[6] E. TORTONESE, Natura, Milano *63*, 21 (1972).
[7] D. E. ROSEN, Bull. Am. Mus. nat. Hist. *127*, 219 (1964).
[8] L. P. SCHULTZ, Proc. U.S. natn. Mus. *96*, 377 (1946).
[9] D. E. MCALLISTER, Natn. Mus. Canada Bull. *221*, 1 (1968).
[10] E. CAPANNA, S. CATAUDELLA and R. VOLPE, Boll. Pesca Piscic. Idrobiol. *26*, 245 (1971).
[11] S. HITOTSUMACHI, M. SASAKI and Y. OJIMA, Jap. J. Genet. *44*, 157 (1969).
[12] F. L. ROBERTS, J. Morph. *115*, 401 (1964).
[13] S. NOGUSA, Mem. Hyogo Univ. Agric. *3*, 160 (1960).
[14] A. POST, Z. Zool. system. Evol. Forsch. *3*, 47 (1964).
[15] M. J. D. WHITE, *Animal Cytology and Evolution* (University Press, Cambridge 1945).

well as through the karyological characterization of several Teleost families related to Mugilidae.

*Riassunto.* Sono stati determinati i numeri diploidi di tre specie di Mugilidi: *Mugil cephalus*, *Liza ramada* e *Chelon labrosus*. La morfologia del cariotipo di *Mugil cephalus* mostra 24 coppie di piccoli cromosomi acrocentrici; nel cariotipo di *Liza ramada* e di *Chelon labrosus* fa invece spicco, tra gli acrocentri, una coppia di subtelocentrici. Il dato cariologico è discusso in rapporto al problema della collocazione sistematica dei Mugilidae ed alla revisione del genere *Mugil*, Linneo.

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## The Chromosomes of *Calamoichthys calabaricus* (Pisces, Polypteriformes)

Most authors[1–4] agree in assigning the Polypteriformes a very peculiar place in the evolutionary history of bony fishes (Osteichthyes). Infact they are considered as a branch which became detached at a very early stage from the evolutionary trend of the paleozoic Paleoniscoid Actinopterygians that has preserved unaltered, throughout this long period of time, the archaic morphological features of its members.

Moreover, some developmental peculiarities and the presence of 2 air bladders, which arise bilaterally from the underside of the oesophagus, mean that the Polypteriformes can be related to the lungfishes and Crossopterygians; hence indicating them as being on the evolutionary trend towards Tetrapods. For these reasons some authors[3,4] place the Polypteriformes far from the Actinopterygians, putting them in a separate subclass, Branchiopterygians, including only one family (Polypteridae) based on just 2 living genera: *Polypterus* and *Calamoichthys*.

Notwithstanding this very interesting evolutionary (i.e. systematic) position, no karyological data exist concerning Polypteriformes. Therefore, although having available only 1 living male of *Calamoichthys calabaricus* Smith, it was nevertheless considered of interest to perform the caryological analysis of this specimen.

The cytological method used is a personal[5] improvement of an air-drying process of somatic tissues colcemid-treated in vivo. Metaphasic plates were stained by the carbol-fuxine method and phase-contrast photographed. 40 metaphases were photographed, 33 of which showed a $2n = 36$ chromosome complement, the rest showing 1 or 2 chromosomes missing through technical faults.

Consequently it is possible to fix the diploid number of *Calamoichthys calabaricus* at $2n = 36$. The karyogram of

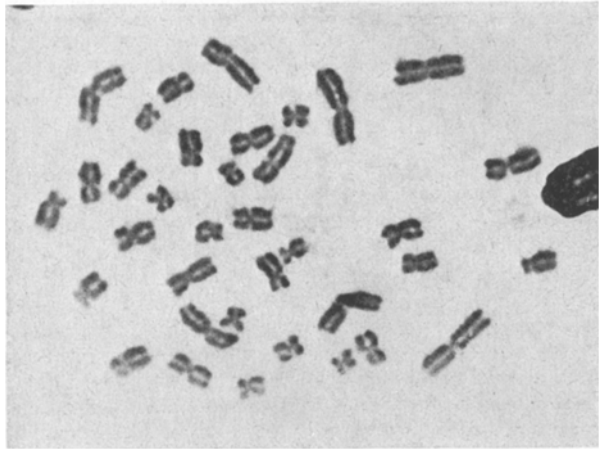

Fig. 1. Metaphase of *Calamoichthys calabaricus:* carbol-fuxin stained, phase-contrast. ×1,500×.

[1] L. P. Berg, in *Osnovy Paleontologii* (Ed. D. V. Obruchev; Izd. Nauka, Moskwa 1964).
[2] B. Gardiner, Bull. Br. Mus. nat. Hist., Geol. *14*, 145 (1967).
[3] J. Daget, Mém. Inst. fr. Afr. noire *11*, 1 (1950).
[4] C. Arambourg, *Traité de Zoologie* (Ed. P. P. Grassé; Masson, Paris 1958), vol. 13, p. 2068.
[5] E. Capanna, S. Cataudella and R. Volpe, Boll. Pesca Piscic. Idrobiol. *26*, 245 (1971).

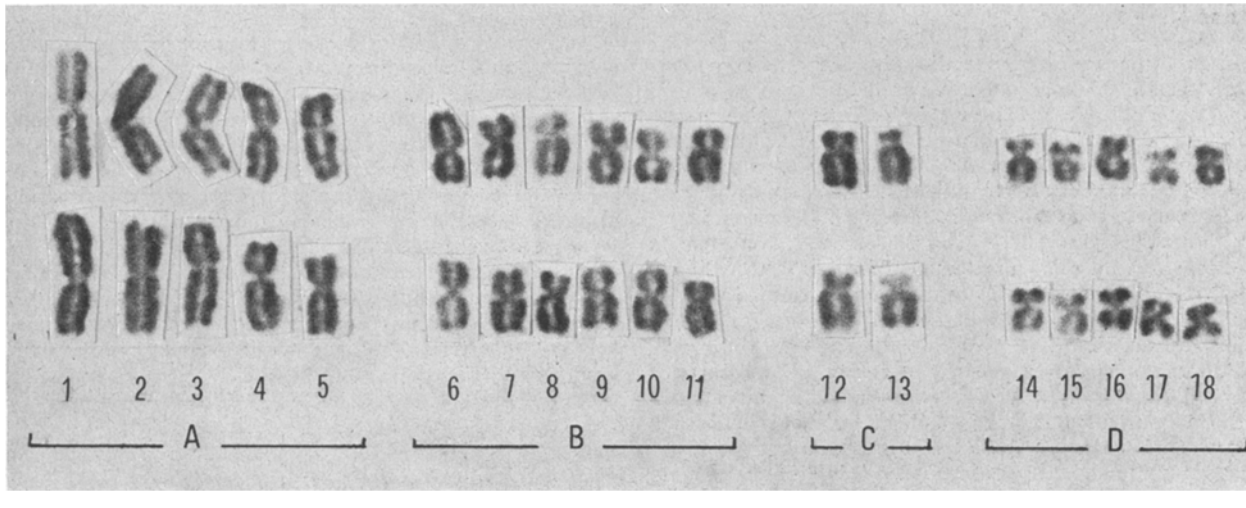


Fig. 2. Karyotype of *Calamoichthys calabaricus*. ×2,500.