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

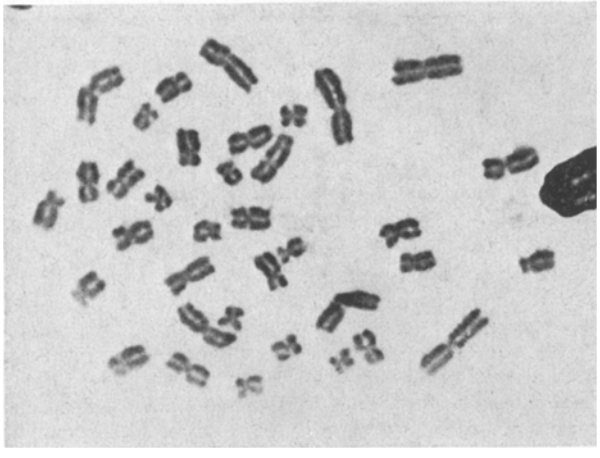

Fig. 1. Metaphase of *Calamoichthys calabaricus:* carbol-fuxin stained, phase-contrast. ×1,500×.

[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).

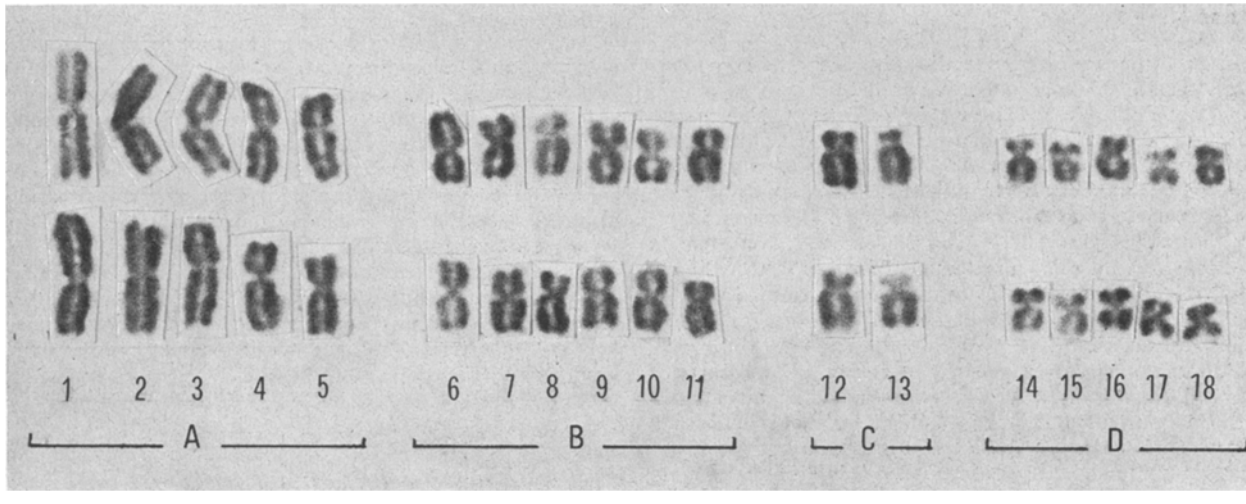

Fig. 2. Karyotype of *Calamoichthys calabaricus*. ×2,500.

this species was also studied through 16 well-spread metaphases having no underlapping chromosomes, and showing chromosomes which had not been shortened by the action of the antiblastic drug, or only a little. The karyotype of *Calamoichthys calabaricus* is composed of 18 pairs of two-armed chromosomes which have been divided into 4 groups (Figure 2): A) 5 pairs of large metacentric chromosomes the sizes of which vary between 7 and 4 μm. B) 6 pairs of medium-size metacentric chromosomes (3.5–3 μm). C) 2 pairs of subtelocentric chromosomes (2.5 μm). D) 5 pairs of small metacentric chromosomes having sizes about 2.5 μm.

What is very surprizing is the enormous size of the *Calamoichthys* chromosomes compared with those present in the Actinopterygian karyotypes, considering not only what is observed in the numerous orders of Teleosts, but even in Chondrosteans and Holosteans that are held to be primitive Actinopterygians and related to the paleoniscoid trend. Infact, in a recent paper OHNO et al[6] describe the karyotypes of a Chondrostean (*Scaphirhyncus platorhyncus*, Acipenseriformes) and 2 Holosteans (*Lepidosteus productus*, Lepidosteiformes, and *Amia calva*, Amiiformes). The morphological features of the karyotypes of all these 3 species are clearly quite different from those of the *Calamoichthys* karyotype, showing numerous very small chromosomes (more than 100 in *Scaphirhyncus*). In fact the larger chromosome in the karyogram of the Holostean and Chondrostean species studied by OHNO et al[6] is smaller than the shorter chromosomes of the karyogram of *Calamoichthys calabaricus*.

This karyological evidence clearly supports the taxonomic separation of Polypteriformes from the Acipenseriformes which some authors[7], on the basis of paleozoological arguments, consider to be related to the Polypteriformes and include in the same super-order (infraclass) Chondrostei.

The phyletic relationship between Polypteriformes and Dipnoans is also fully confirmed by the karyological observations that have been made. In fact, papers by AGAR[8], WICKBOM[9], and OHNO and ATKIN[10] have clearly shown that the diploid numbers of the lungfishes vary between $2n = 38$, in *Lepidosiren*, and $2n = 34$, in *Protopterus*. Even the morphology of the karyotype and the size of the chromosomes in Dipnoans are very like those found in *Calamoichthys*. The similarity between the karyotype now proposed for *Calamoichthys* and the one by OHNO and ATKIN[10] described for *Lepidosiren paradoxa* is most surprizing and convincing in this respect.

Thus, although tempting similarities with higher Anura and Urodela (MORESCALCHI[11]) are evident, it is felt that a comparison with Amphibian karyotypes could only lead to dangerous speculation. Indeed, present knowledge on the karyology and cytotaxonomy of primitive bony fishes, and of the Amphibians alike, is inadequate to make an objectively credible comparison between different classes of Vertebrates. However it is felt sufficiently interesting to have emphasized a number of interesting points merely by underlining certain comparisons between taxa that are certainly related, viz.: Dipnoans, Polypteriformes and other Chondrostei.

Riassunto. È stato descritto il cariotipo di un Polypteriforme, *Calamoichthys calabaricus*, Smith. Il numero diploide, $2n = 26$, le dimensioni dei cromosomi e la stessa morfologia del cariotipo mettono in evidenza le affinità filetiche intercorrenti tra Polypteriformi e Dipnoi e la linea evolutiva tetrapoda, diversificandoli, al contrario, dagli altri primitivi Attinopterigi, Holostei e Chondrostei.

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30 August 1972.

[6] S. OHNO, J. MURAMOTO, C. STENIUS, L. CHRISTIAN and W. A. KITTRELL, Chromosoma *26*, 35 (1969).
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A Difference Between the Sexes in an Optomotor Response in the Cabbage White Butterfly, *Pieris rapae* L.

In many species of butterflies the different courtship behaviours of the sexes are released by visual stimuli[1]. However, no differences between the sexes in other visual behaviours have been reported. In the cabbage white butterfly, *Pieris rapae crucivora* mating behaviour is released only by visual stimuli, these being the colour of the female wing and motion of the wings[2]. The preliminary experiments reported here show a difference in optomotor reactions of wild male and female *Pieris rapae L.* when a single black-white edge is moved across one eye. It is possible that both cases of sexual variance in visual behaviour are related.

Butterflies were placed in the centre of a rotatable drum (diam. 27 cm), after the right eye had been occluded with opaque paint. The drum held the visual stimuli and was rotated by hand. The level of illumination was 1,600 Lux. Head movements were recorded using the movement of the antenna over an illuminated photocell. 5 females and 4 males were used.

Each animal was first tested with an optomotor stimulus of alternating black and white stripes[3], each subtending 12.5° at the eye. All butterflies responded by turning their heads in the direction of motion each time the drum was turned. When stripes subtending 90° at the eye were rotated both sexes turned their heads in the direction opposite to the stripe movement, at least once in 8 trials. However, as shown in the Figure e) the males responded with a smooth head movement similar to that elicited by narrow stripes while the females' response was much smaller and contained superimposed oscillations (Figure b). In 1 of 4 trials the head tended only to make large oscillations (Figure a). The head made a full oscillation

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