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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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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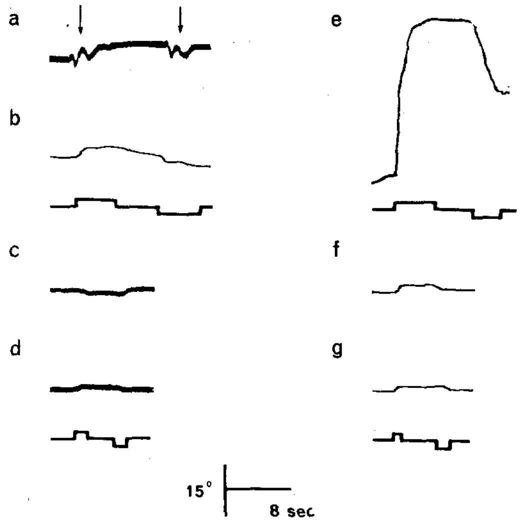
back to its original position as either a black or white stripe passed across the eye.

A further difference in response was seen when a single black-white edge was passed across the left eye. Figure c) and d) show the response of a female *Pieris* to small movements of a white-black edge (white anterior) and the black-white edge (black anterior). Although the female's head followed the movement of the black-white edge in both directions, the head turned in the opposite direction when the white-black edge was moved. The males followed the motion of both edges (Figure f and g).



The head movement responses of male and female *Pieris* to movement of 90° stripes and single edges. Upward deflection in both head movement and drum marker traces indicates movement to the right. Vertical calibration shows degrees of head turning. Speeds for large movements of broad stripes were approximately 90°/sec and for small movements of single edges 8°/sec. a–d) responses of female; a, b) to movement of 90° stripes. Arrows point to oscillations induced by the broad stripes. c) Response to white-black edge and d) black-white edge. e–g) Responses of male *Pieris*; e) to movement of 90° stripe, f) to movement of white-black edge and g) black-white edge.

Black-white edge (both directions)		White-black edge (both directions)	
Males (%)	Females (%)	Males (%)	Females (%)
72.5	100.0	70.5	2.3
97.5	64.0	66.6	0.0
91.0	83.5	93.5	0.0
84.0	86.4	88.5	12.8
	98.8		56.7

For each animal data from approximately 40 tests with each edge were expressed as the percentage of movements where the head moved in the direction of drum rotation (Table).

Tests where the head did not move at all were excluded (up to 1 in 6 trials). Therefore 0% indicates a 100% reversal. A χ^2 test on the pooled data shows a significant difference at the 0.1% level between responses of the male and female to the white-black edge and between responses of the female to black-white and white-black edges. No difference was found between male and female responses to black-white edge or male responses to black-white edge. In the female it is presumably the reversal of responses to one edge that causes the head to oscillate when very broad stripes are passed before one eye.

To demonstrate that the reversal response of the female to the black-white edge was indeed an optomotor response either edge was placed in front of the eye in the dark. The head movement was noted when the light was switched on. In the 3 females tested (10 trials with each edge) there was usually no movement (only 1 trial in 5). No preference could be seen for either black or white areas. Therefore there was no phototactic preference.

In the courtship behaviour of *Pieris* the male may pursue either flying males or females. The female exhibits no such behaviour, only alighting immediately after accepting a pursuing male[2]. The male, for accuracy of pursuit, may have different visual requirements from the female, particularly with respect to motion analysis. The difference between the sexes in optomotor responses also reflects a difference in the visual system. This may be either a structural or functional difference in the optic lobes where motion perception is thought to take place[4].

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Zusammenfassung. Männliche und weibliche Kohlweisslinge, *Pieris rapae L.*, zeigen unterschiedliche optomotorische Reaktionen zu einer bewegten Schwarz-weiss-Kante. Es wird angenommen, dass dies auf unterschiedlicher neuraler Integration im Zentralnervensystem der beiden Geschlechter beruht und dass die spezifische optomotorische Reaktion des Männchens bei seinem visuell orientierten Geschlechtsverhalten von Bedeutung ist.

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Ultrastructure of Epihyphal Rhizoids in *Allomyces arbusculus*

Fungal rhizoids can be defined as non-nucleated thin tubes formed in the basal extension of the main trunk-like hyphae. In aquatic fungi, such basal rhizoids are usually polarly emitted either from zoospores of zygotes[1]. In extensively grown mycelia of *Allomyces*, other rhizoids also appear laterally from the main hyphae and can thus be designated as epihyphal. Their extrusion through the hyphal walls can be highly increased under certain evironmental conditions, like the presence of sublethal concentrations of copper ions in the medium[2] or, as recently found and applied in the present study, under the semi-anaerobic conditions of submerged liquid cultivation.

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