

GA is a natural component of plants which does not endanger the environment⁵. In this context it should be noted that these extremely low concentrations are not likely to affect plants in adjacent areas and GA rapidly decomposes in water and soil.

Recent experiments in a greenhouse have shown that a 2,4-D concentration which has little or no effect on water hyacinths, i.e. 100 g/ha, kills the plants within 1 week when it is supplemented with extremely low concentrations of GA.

Water hyacinths were cultured during the summer season 1979 in a greenhouse in concrete reservoirs, 200 cm long, 100 cm wide and 50 cm deep. The reservoirs were filled up to the border with tap water and contained a 20-cm-thick layer of clay on the bottom. Each reservoir contained 10 water hyacinth plants which were sprayed by means of a small hand sprayer from a height of about 40 cm. The volume rate was 200 l/ha. The plants were first sprayed with 100 g/ha of 2,4-D (amine salt). Subsequently 0, 2, 4, 6 and 8 g/ha of GA (ICI product Berelex) was sprayed on plants in different reservoirs. The control plants were sprayed with either water, various concentrations of 2,4-D (50, 100, 200, 500 and 1000 g/ha) or a combination of water and 8 g/ha of GA. A 2nd and 3rd experiment were conducted with respectively 50 g/ha and 200 g/ha of 2,4-D. All experiments were repeated twice.

The results of the experiments are presented in the table. When the water hyacinths were sprayed with various concentrations of 2,4-D alone there was no effect at 50 g/

ha and little or no effect at 100 g/ha. At 200 g/ha and 500 g/ha the plants were clearly affected (limp leaves) but most plants eventually survived the treatment. At 1000 g/ha the plants died within 1 week. A combination of 50 g/ha of 2,4-D with the various GA concentrations had a slight effect on the plants at the higher concentrations of GA. However, at 100 g/ha of 2,4-D the plants died within 1 week when the herbicide was applied in combination with 6 or 8 g/ha of GA. At 2 and 4 g/ha of GA there was a slight effect (limp leaves). In combination with 200 g/ha of 2,4-D the results were more pronounced but at 2 and 4 g/ha of GA most plants were able to survive. Applications of 8 g/ha of GA in the absence of 2,4-D slightly inhibited vegetative growth and float formation which is in accordance with the earlier report⁵. This effect became apparent after a period of 3 weeks. In controls which were sprayed with water only the plants remained healthy and grew profusely.

These greenhouse experiments clearly demonstrate that there is a synergistic effect of 2,4-D and GA with regard to water hyacinth. Consequently the usual field concentrations of 2,4-D could be decreased significantly if sprayed in combination with GA and this would considerably reduce the risk of harming nearby vegetation. Although GA products are relatively costly, smaller amounts of 2,4-D, approximately 10 times less than what is used at the moment, in combination with such extremely low concentrations of GA, might even lower the costs of spray programmes.

It is not clear by which mechanism GA influences the 2,4-D effect on water hyacinth. As in certain cases GA has been shown to enhance the translocation of auxins^{7,8} it could be hypothesized that a similar system is involved.

Field experiments will be conducted in due course.

Effect of 2,4-D/GA spray combinations on water hyacinth

Concentration 2,4-D (g/ha)	Concentration GA (g/ha)				
	0	2	4	6	8
0	—				—*
50	—	—	—	— +	— +
100	— +	+	+	++	++
200	+	+	+	++	++
500	+				
1000	++				

— No effect; —* slight effect on vegetative growth and float formation after a period of 3 weeks; — + little or no effect; + slight effect (limp leaves) but most plants eventually survive; ++ plants die within 1 week, limp leaves after 2 days.

- 1 Acknowledgment. The authors are grateful to Mr G.W. Elson from ICI for sending a sample of Berelex.
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Occurrence of carotid labyrinth in the catfish group of teleost fishes

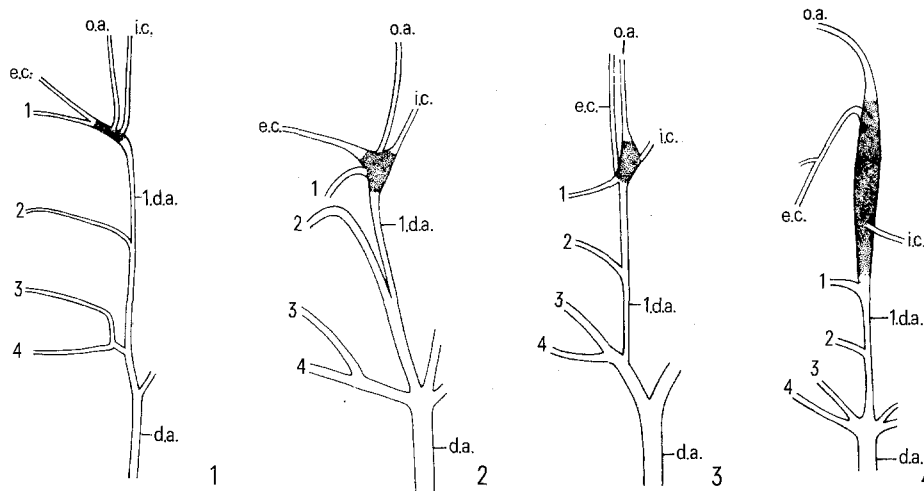
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Summary. A structure similar in topography and morphology to the carotid labyrinth of amphibians has been found in 4 catfishes, namely, *Clarias batrachus*, *Heteropneustes fossilis*, *Rita rita* and *Mystus seenghala*. The present finding of the presence of the carotid labyrinth in fishes is the first report, and the results are discussed in the light of the amphibious habit of these catfishes.

The carotid labyrinth – a spongy enlargement of the common carotid artery where it bifurcates into the external and internal carotid arteries – is confined to Amphibia, and most amphibians possess it². The function of this structure is far from clear. It is generally believed that it is comparable to the carotid body of higher tetrapods, which possesses receptors³ involved in circulatory and respiratory regulation by way of detection of fluid pressure and of

tensions of oxygen and carbon dioxide in the blood. The presence of such receptors has not been confirmed in the carotid labyrinth⁴⁻⁶ though it might be anticipated. However, so far, a piscine precursor or counterpart of the amphibian carotid labyrinth has not been reported. An 'amphibious' habit with bimodal respiration has evolved in a number of fishes, belonging to the Teleostei^{7,8}. Since for fishes the general belief is that cardio-vascular events are



Figs. 1-4. Schematic drawings showing the position of the carotid labyrinth (stippled zone) with respect to the 1st efferent branchial artery (1), the lateral dorsal aorta (1.d.a.), the external carotid artery (e.c.), the internal carotid artery (i.c.), and the ophthalmic artery (o.a.) in *C. batrachus* (figure 1), *H. fossilis* (figure 2), *M. seenghala* (figure 3) and *Rita rita* (figure 4). 2, 3, 4, 2nd, 3rd and 4th efferent branchial arteries.

directly inter-related with respiratory events⁶, the occurrence of a carotid labyrinth is not ruled out at least in the air-breathing species of a certain teleost group, if not in that group as a whole. It was with this view-point that we examined some species of the catfish group of teleosts: a) 2 air-breathing species, *Clarias batrachus* and *Heteropneustes fossilis*, and b) *Rita rita* and *Mystus seenghala*; the former, though not known to possess specific air-breathing organs, is one which is well known to survive for long periods out of water, and the latter is without an air-breathing habit. Also, the disposition of the external and internal carotid arteries in catfishes is found to be closer to the amphibian pattern than to the teleost pattern⁹. Histological preparations in the form of serial sections were made of the various regions of the aortic arches, particularly the region from where the external and internal carotid arteries arise, from material fixed in Bouin's fluid. The stains used were iron haematoxyline, and eosin-haematoxyline.

Result and discussion. In *C. batrachus* (figure 1) the region of the 1st efferent branchial artery where it meets the lateral dorsal aorta, and from which arise the external

carotid artery, the internal carotid artery and the ophthalmic artery, is a swollen, thick spongy structure discernible in freshly dissected fish. An examination of serial sections reveals a very heavy plexus of blood capillaries surrounding its lumen (figure 5), recalling the conditions of the carotid labyrinth in amphibians². The capillary network does not show any regular array, but it appears as a system of branching and anastomosing capillaries. It is found that there are 2 sets of capillaries, one which connects the lumen of the 1st efferent branchial artery with that of the external carotid artery, and the other with that of the internal carotid artery. Unlike the case in Amphibia, here the external and internal carotid arteries have no direct opening into the principal vessel, i.e. the 1st efferent branchial artery, and all blood flowing into these arteries must first pass through the capillaries of the carotid labyrinth. The ophthalmic artery is found to open directly into the 1st efferent branchial artery without mediation of the capillaries. This swollen region, we suggest, should henceforth be called the carotid labyrinth.

In *H. fossilis* (figure 2) and *M. seenghala* (figure 3) the

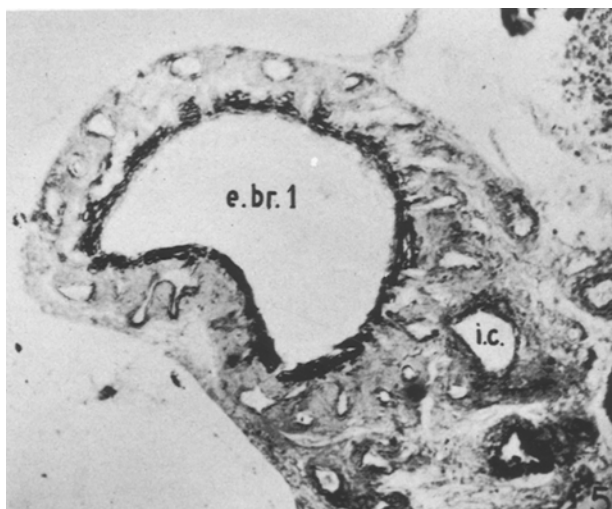


Fig. 5. Transverse section of the carotid labyrinth of *C. batrachus* showing the set of capillaries that connect the lumen of the 1st efferent branchial artery (e.br.1) with that of the internal carotid (i.c.). ×280.

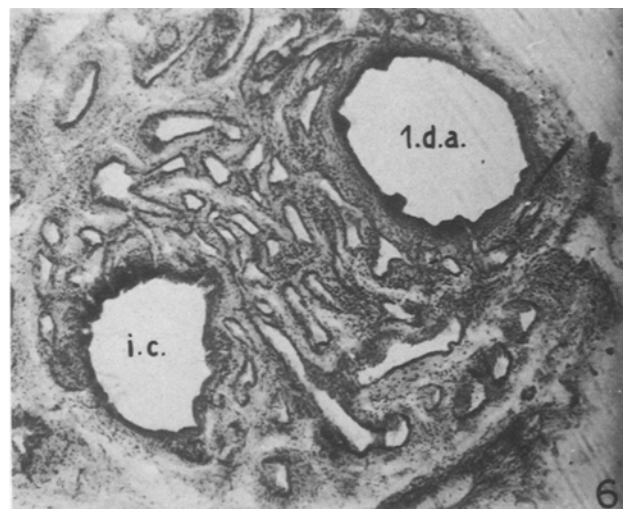


Fig. 6. Transverse section of the carotid labyrinth of *Rita rita* showing the enormous capillaries that join the lumen of the lateral dorsal aorta (1.d.a.) with that of the internal carotid (i.c.). ×84.

carotid labyrinth is similar to that described for *C. batrachus*. *R. rita* (figure 4) presents a case of morphological variation, with the carotid labyrinth showing an enormous capillary plexus surrounding a large anterior section of a prolongation of the lateral dorsal aorta beyond the point where the 1st efferent branchial artery meets it.

From the above findings it is clear that the amphibian type of carotid labyrinth is present in all the catfish teleosts examined, irrespective of their air-breathing habit. Similarities in histology and topographical relationship with the external carotid artery and with the internal carotid artery point to a homology between the carotid labyrinths of the two. It remains to be determined whether a carotid labyrinth has evolved in other groups of teleosts.

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The C-banding pattern of 6 Japanese species of vespertilionine bats (Mammalia: Chiroptera)

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Summary. The C-banding patterns of 6 species of Japanese vespertilionine bats are presented. The variation in amount and distribution of heterochromatin indicates that deletions and additions of heterochromatin have contributed to the karyotypic diversity in Vespertilioninae.

It has been assumed, from conventional data, that various derived karyotypes found in many species within Vespertilioninae are mainly differentiated from that of *Myotis* ($2n=44$, FN=50) by centric fusion²⁻⁴. Further, this hypothesis has been supported by the comparison of C- and G-banding patterns of American vespertilionid bats⁵. In this paper, we report C-band patterns of 6 Japanese species belonging to 4 genera (*Myotis*, *Pipistrellus*, *Nyctalus* and *Vespertilio*) of the Vespertilioninae, and the karyotypic evolution within this subfamily is reviewed in connection with the characteristics of their C-bands.

The air dry method described by Uchida and Andō⁶ was used for karyotypic analysis. Chromosomal classification followed the method of Patton⁷. The C-banding procedure was essentially identical with that of Sumner⁸.

As shown in the figure, a and b, most of the autosomal elements and the (sub-)metacentric X chromosomes in 2 *Myotis* species, *M. frater* and *M. macrodactylus*, have distinct centromeric C-bands, except 1 pair of large biarmed autosomes (very obscure centromeric C-band), 1 pair of small ones (centromeric C-band and heterochromatic short arm) and the small (sub-)metacentric Y chromosomes which are totally heterochromatic. These results are in good agreement with those for the same species described by Harada and Yosida⁹, and are strikingly similar to those for 2 other Japanese⁹, 2 European and 11 American species¹¹ of this genus.

Only the second smallest pair of the biarmed autosomal complement in *P. endoi* (figure, c) has a distinct centromeric C-band, the remaining pairs have little or no C-band material. The largest and the second smallest pairs of its unarmed autosomal series are completely C-band negative, while the smallest pair appears totally heterochromatic. The remaining pairs of unarmed autosomes have distinct centromeric C-bands. The acrocentric X chromosome has a centromeric C-band.

The C-banding pattern of *P. abramus* (figure, d) has been reported previously¹², but the banding pattern of its Y chromosome has remained unknown. 5 pairs of large-to medium-sized biarmed autosomes and a pair of small

acrocentrics have large centromeric C-bands. 2 pairs of medium-sized biarmed ones have tiny centromeric C-bands. The remaining autosomal elements have no detectable bands in this material. The acrocentric X chromosome, possessing a visible secondary arm, is deeply stained from the centromeric region to the short arm, but the small acrocentric Y chromosome is completely C-band negative. The amount of constituent heterochromatin in individual autosomal sets in *N. furvus* (figure, e) is very high. Autosomal pairs are characterized by large centromeric C-band regions or they are entirely heterochromatic. The (sub-)metacentric X chromosome has a distinct centromeric C-band, and the small acrocentric Y chromosome is totally heterochromatic.

The C-banding pattern observed in *V. superans* (figure, f) is similar to that of *V. orientalis*¹³, except for minor differences. 2 pairs of large biarmed autosomes and a pair of the smallest ones have obscure centromeric C-bands. The remaining pairs of this series do not possess distinct C-bands. The smallest and the second smallest pairs of its unarmed autosomal complement are completely C-band positive, and most of the remaining pairs have centromeric C-bands. The (sub-)metacentric X chromosome possesses an obscure centromeric C-band, and the small acrocentric Y is totally heterochromatic.

The C-band variation found in the 6 species, in connection with their taxonomic allocation within their subfamily and the direction of karyotypic evolution, would be explained in terms of the interpretations outlined below. It has been assumed that *Pipistrellus* is phylogenetically a specialized form which derived from a *Myotis*-like ancestor, and that *Vespertilio* is a specialized offshoot of a *Pipistrellus*-like form, both being placed in the tribe Pipistrellini. Indeed, *P. endoi* and *V. superans* have rather differentiated karyotypes, and the increase in their large biarmed autosomal elements is due to the centric fusion of the unarmed elements, such as those found in *Myotis*. Most of the biarmed elements in *P. endoi* and *V. superans*, however, do not show distinct heterochromatin. The above facts and the existence of distinct C-bands on large unarmed autosomes