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Reply to the note of Jason A. KAUFMAN "On the Expensive Tissue Hypothesis: Independent Support from Highly Encephalized Fish"

By Claude Marcel HLADIK and Patrick PASQUET

It is of great interest that the debate on brain size and energy expenses is reopen by a zoologist, since most considerations on this topic have been based on zoological considerations. Moreover, including fishes, among which were our most remote vertebrate ancestors, can widen and make the issue clearer than in discussions limited to a closed circle of anthropologists, paleontologists, or primatologists.

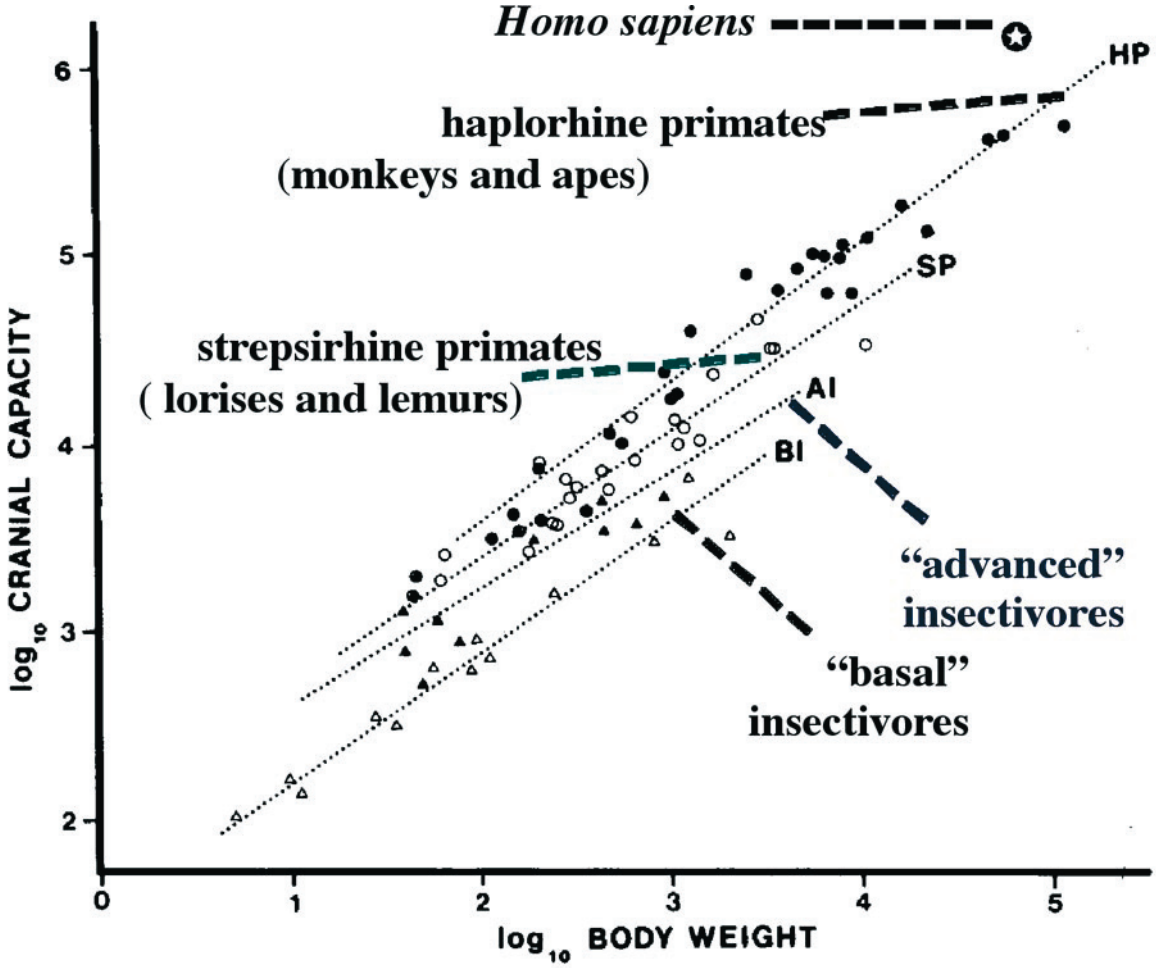
However, in this widen issue, considerations on the relationship between gut size and brain size do not appear as a possible solution to explain the conditions of evolution towards large brained Homo. If we consider the data computed by R.D. Martin (1983), that we introduced in a discussion on the evolution of human dietary adaptations (Hladik and Pasquet, 2003), the four groups shown by four independent regression lines (Fig. 1), respectively for 'basal' insectivores, 'advanced insectivores, and especially among strpsirhine primates and haplorhine primates, include species adapted to a wide range of diets, (insect-eaters, fruit-eaters and leaf-eaters). Thus, taking into account the allometric relationships, dietary adaptations appear to be totally independent of brain size, in each of the four groups.

Of course, there are significant relationships between diet and gut size and the proportions of the different parts of the alimentary tract in various species (Chivers and Hladik, 1980). To account for the increase of energy expenditure by species with a large brain, we suggested in this journal (Hladik et al., 1999) that the energy cost is compensated by a reduction of proportions of most body parts, rather than by a mere reduction of gut size, that does not fit with our data.

The observations of J.A. Kaufman do complete the data with examples of fishes that have not been previously included in the discussion. Several independent regression lines could be probably added below the other four lines of Figure 1, to include fishes and reptiles, if we obtain enough data for statistics (is there enough data in the mentioned data base of Crile and Quiring?). Among fishes, the observation of a large brain in species that 'hunts' and thus require efficient coordination of movements, and eventually a 'hunting strategy', is not surprising. And the relative small size of their digestive tract reflects an adaptation to energy-rich foods also reflected by the divergence from the allometric prediction computed from a teleost sample that probably includes species with various diets. Conversely, grazing on common plants does not require to be clever (except to escape the predators), and the large gut of Hypostomus plecostomus, is a necessary adaptation to a vegetarian diet, with no direct relationship to brain size.

Anyway, many thanks are due to J.A. Kaufman for not hesitating to bring the fishes into the field of anthropology. Although not providing an adequate model for encephalization, fish studies may allow to understand other aspects of primate (and human) adaptations. This is especially true for sensory perception (Hladik et al., 2003), considering the fish species able to perceive tastes through their whole skin (a kind of tongue covering the whole body!) and the necessity to take into account our fish origins to understand why we can presently detect a salty taste. The large mormyrid brain is presumably adapted to a world of sensory perceptions unknown of humans, in relation to electric signals that would necessitate encoding a large amount of information.

Figure 1 Allometric relationships between cranial capacity and body weight in different categories of primates and insectivorous mammals (after R.D. Martin, 1983).



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