

Electronic Supplementary Material (ESM)

Histology of the endothermic opah (*Lampris guttatus*) suggests a new structure-function relationship in teleost fish bone

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Comment on the renewed taxonomy of *Lampris* species

The individual of *Lampris* sp. studied here (MNHN-ZA-AC-A-7506) is a historical specimen previously referred to the species *Lampris guttatus*. The original publications in which endothermy was initially reported were also based on individuals referred to *L. guttatus* [1,2]. Shortly after completion of our histological work, the once circumglobal *L. guttatus* was divided in five species, each having a more limited geographical range [3]. As a consequence, the specimens in which whole-body endothermy has been detected [1] would belong to the North Pacific species *L. incognitus* (N. Wegner, pers. comm.), and our specimen might not pertain to the same species. There is no available information on where MNHN-ZA-AC-A-7506 was collected, and since the specimen consists only in a portion of vertebral column and associated ribs, it is impossible to confirm its identity based on comparative anatomy. On the other hand, the six extant species of *Lampris* are all very similar in terms of ecology, external morphology and behaviour [3], and all seem to share similar pectoral muscle anatomy (N. Wegner, pers. comm., D.D. and F.J.M. pers. obs.). It is then reasonably likely that they are all capable of endothermy, which would not change the conclusions of the present paper.

ESM table S1. List of specimens used for the histological observations.

Only one bone was sampled for each extant taxon, due to their rarity in osteological collections. Only non-pathological and non-hyperostotic bones were used. When possible, only ribs were sampled, with one exception (*Velifer hypselopterus*) that we do not expect to affect the results since cellular or acellular bone has been shown to be consistent over the whole skeleton in virtually all teleosts [4,5].

In addition to the two extant lampridiforms, six fossil acanthomorphs and close neoteleost relatives from the Cenomanian (Late Cretaceous) of Lebanon were sampled as well.

For *Lampris* sp. (MNHN-ZA-AC-A-7506) the 7th abdominal rib was sectioned transversally and longitudinally ~5 mm from the articular head. For fossil taxa, we took samples where ribs were already fragmented or broken. The thin section photographs of Fig. 1 were modified to edit out background noise and remaining soft tissues in bone cavities.

All thin sections are kept in the palaeohistological collections of the Muséum national d'Histoire naturelle (MNHN, Paris, France).

Taxon	Dry skeleton specimen number	Bone sampled
<i>Lampris</i> sp.	MNHN-ZA-AC-A-7506	7 th abdominal rib
<i>Velifer hypselopterus</i>	MNHN-ICOS-01117	scapula
† <i>Aipichthys</i> <i>velifer</i>	MNHN.F.HAK1991	1 st and 6 th abdominal rib
† <i>Omosoma</i> sp.	MNHN.F.SHA2563d	7 th abdominal rib
† <i>Acrogaster heckeli</i>	MNHN.F.SHA38g	posteriormost abdominal rib
† <i>Eurypholis</i> sp.	MNHN.F.HAK1550	3 rd abdominal rib
† <i>Ctenothrissa vexillifer</i>	MNHN.F.HAK246d	6 th abdominal rib
† <i>Pycnosteroides levispinosus</i>	MNHN.F.HDJ55	posteriormost abdominal rib

ESM table S2. Selected list of acanthomorph and neoteleost taxa for which the type of bone (cellular or acellular) is known.

Systematic position	Taxon	Bone type	References
Other Neoteleostei			
Neoteleostei <i>incertae sedis</i>	† <i>Ctenothrissa vexillifer</i>	acellular	this study
Aulopiformes	† <i>Eurypholis</i> sp.	acellular	this study
Acanthomorpha			
Acanthomorpha <i>incertae sedis</i>	† <i>Pycnosteroides levispinosus</i>	acellular	this study
stem-Lampridiformes	†' <i>Aipichthys</i> ' <i>velifer</i>	acellular	this study
Lampridiformes, Veliferidae	<i>Velifer hypselopterus</i>	acellular	this study
Lampridiformes, Lampridae	<i>Lampris</i> sp.	cellular	this study
Lampridiformes, Trachipteridae	<i>Trachipterus trachipterus</i>	acellular	[6]
	<i>Zu cristatus</i>	acellular	[6]
Lampridiformes, Regalecidae	<i>Regalecus russelii</i>	acellular (except in hyperostotic pterygiophores)	[7]
Polymixiiformes	† <i>Omosoma</i> sp.	acellular	this study
Trachichthyiformes	† <i>Acrogaster heckeli</i>	acellular	this study
Xiphioidae, Xiphiidae	<i>Xiphias gladius</i>	acellular	[6,8]
Xiphioidae, Istiophoridae	<i>Istiophorus albicans</i>	acellular	[4,8]
	<i>Kajikia albida</i>	acellular	[8]
	<i>Makaira nigricans</i>	acellular	[4,8]
	<i>Tetrapturus angustirostris</i>	acellular	[8]
	<i>Tetrapturus belone</i>	acellular	[6]
Scombridae, Scombrini	<i>Scomber scombrus</i>	acellular	[6]
Scombridae, Scomberomorini	<i>Scomberomorus cavalla</i>	acellular	[4]
	<i>Scomberomorus maculatus</i>	acellular	[4,9]
Scombridae, Thunnini	<i>Auxis rochei</i>	cellular	[6]
	<i>Euthynnus affinis</i>	cellular	[10]
	<i>Euthynnus alletteratus</i>	cellular	[11]
	<i>Euthynnus lineatus</i>	cellular	[12]
	<i>Katsuwonus pelamis</i>	cellular	[4,5,10,13]
	<i>Thunnus alalunga</i>	cellular	[6,10,13–15]
	<i>Thunnus albacares</i>	cellular	[10]
	<i>Thunnus obesus</i>	cellular (scales)	[16]
<i>Thunnus thynnus</i>	cellular	[6,11,17]	

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