

Archaeozoology of groupers (Epinephelinae) Identification, osteometry and keys to interpretation

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ABSTRACT: A great number of species belonging to different genera of the family Serranidae, sub-family Epinephelinae (for instance, *Cephalopholis*, *Epinephelus* and *Variola*), are classified as «groupers». We find them in temperate and tropical waters, from small- or medium-sized fish to the largest of the Perciformes (*Epinephelus lanceolatus*). They all live under similar environmental conditions, practicing sedentary (and often solitary) carnivorous predation in rocky littorals. Under pre-overfishing conditions, they could be caught with rudimentary fishing gear. Many bones of their robust skeletons are found from the Neolithic onwards in Mediterranean and Indo-Pacific sites, but these remains are difficult to identify to species. The authors, making use of their large reference collection of skeletons from the Atlantic, the Mediterranean and the Indo-Pacific, present and discuss some traditional morphological criteria for specific identifications. They propose a model for the reconstruction of size and weight, calculated from the best preserved bones, which seems to work for the whole sub-family Epinephelinae and appears to be suitable for archaeological purposes.

KEYWORDS: EPINEPHELINAE, GROUPERS, OSTEOLOGY, SIZE/WEIGHT RECONSTRUCTION

RESUMEN: Una gran variedad de especies pertenecientes a diferentes géneros (por ejemplo, *Cephalopholis*, *Epinephelus* y *Variola*) de la subfamilia Epinephelinae, familia Serranidae, se conocen colectivamente como «meros». Se encuentran en aguas templadas y tropicales, desde tallas pequeñas hasta el mayor de los perciformes, *Epinephelus lanceolatus*. Todos viven bajo similares condiciones ambientales, practicando un régimen de vida depredador y, con frecuencia, solitario en litorales rocosos. En condiciones previas a la sobrexplotación pesquera pueden pescarse con artes muy rudimentarias. Muchos huesos de sus robustos esqueletos se recuperan a partir del Neolítico en yacimientos mediterráneos e indopacíficos. No obstante, la identificación a especie es difícil de llevar a cabo debido a la semejanza entre las distintas especies. Los autores, haciendo uso de su extensa colección comparativa de ejemplares procedentes del Atlántico, Mediterráneo e Indo-Pacífico, presentan y valoran algunos criterios morfológicos tradicionales referidos a identificaciones específicas. Asimismo, proponen un modelo de inferencia de talla y peso a partir de los huesos con mayores posibilidades de recuperación en sedimentos arqueológicos que se aplica a toda la subfamilia y que consideran lleno de potencialidades a efectos arqueozoológicos.

PALABRAS CLAVE: EPINEPHELINAE, MEROS, OSTEOLOGÍA, ESTIMACIÓN TALLA/PESO

INTRODUCTION

Groupers have a very wide geographic distribution. They are known as «mérous» in French, «meros» in Spanish, and are universally appreciated by consumers of fish from temperate and tro-

pical seas. Most groupers belong to the genus *Epinephelus*, which is part of the subfamily Epinephelinae, family Serranidae of the order Perciformes, the most numerous group of Osteichthyes (bony fishes).

The sub-family Epinephelinae includes 159 different species of marine fishes grouped in 15 ge-

nera (Heemstra & Randall, 1993)¹ (for Nelson, 1994: 165 species in 14 genera) in which we can find small fishes –some species grow no bigger than 10 cm– and very big taxa, such as one *Epinephelus coioides*² in our collection, from the Arabian Gulf, over 1 m in length, which weights 18 kg. The largest bony fish known is *Epinephelus lanceolatus*, which reaches close to 3 meters and about 400 kg (Smith & Heenstra, 1986).

Epinephelinae (groupers and rock-cods) are generally demersal fishes of temperate, tropical or sub-tropical seas, ranging from shallow coastal waters to moderate depths, rarely exceeding 200 meters; almost all of them live on coral reefs or rocky bottoms. Under natural living conditions, when protected from human predation, large groupers can be seen at the entrance of their rocky shelters in shallow waters. Under those conditions they can easily be captured with rudimentary fishing techniques. Consequently, groupers probably constituted one of the earliest groups of big fish caught by man and have played, at least from the Neolithic onwards, a very important economic role³. Their flesh is usually excellent and can be eaten without any danger, except for the oldest specimens from some tropical waters, where the poisonous disease cigatera is endemic.

The grouper skeleton is usually robust and its bones have a good chance of preservation in archaeological deposits. The big bones we generally use for archaeozoological analyses are easily retrieved during excavation, even without sieving. The wide distribution of groupers, their size, economic interest and strong skeletal elements confer them an extremely important role in the archaeo-ichthyology of warm and temperate coastal sites. But the great number of species seems to have been a handicap to serious attempts at species-level discrimination on the basis of their bones.

As is known by specialists, the keys to discriminate among Serranidae are established from the distinct number of dorsal and anal fin spines and soft rays, from the morphology of the caudal fin

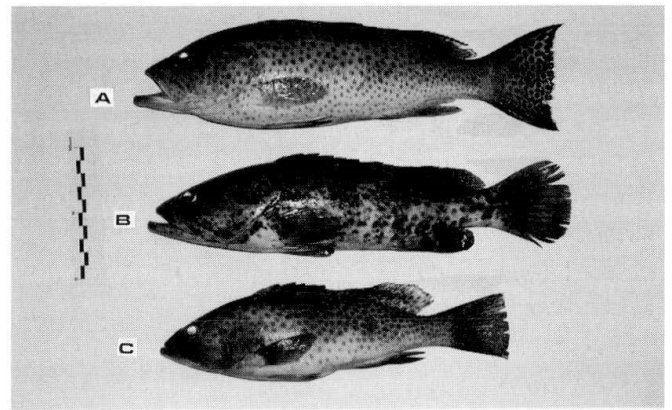


FIGURE 1

These three groupers from the Arabian Gulf are distinguished by the morphology of their caudal fin: A emarginate (*Epinephelus areolatus*); B rounded (*Epinephelus coioides*); C truncate (*Epinephelus bleekeri*).

(Figure 1: emarginate, truncate or rounded), the differences in the cranial profile, the indexes between fish standard length and maximum height, the number of scales along the lateral line, and, obviously, colour differences. All this information is, as we all know, inaccessible to archaeozoologists.

The skeleton of the genus *Epinephelus* has very classical features for a Perciform Teleost. The number of its cranial components is constant, as is its vertebral number (24). One can always find 11 spines in the dorsal fin and 3 spines in the anal fin. But obtaining a species-level identification from archaeological bones, even well preserved ones, presents great difficulties. Only a few distinctive characteristics in bone morphology, such as the presence and number of canine-like teeth, or the number of ranks of the villiform teeth, seem to be of some help.

Interspecific morphological distinctions are not very numerous, are often variable on the archaeological bones, and appear to be useless on the vertebrae.

¹ Genera: *Aethaloperca*, *Alphestes*, *Anypserodon*, *Cephalopholis*, *Cromileptes*, *Dermatolepis*, *Epinephelus*, *Gonioplectrus*, *Gracila*, *Mycteroperca*, *Paranthias*, *Plectropomus*, *Saloptia*, *Triso*, *Variola*.

² The nomenclature of groupers has been reviewed several times. The latest review is that by Heemstra & Randall (1993). The names of frequent species, previously a) *E. guaza* and b) *E. tauvina*, were based on misidentifications of *E. marginatus* (Lowe, 1834) for the first one and *E. coioides* (Hamilton, 1822) for the second one.

³ We have determined it in many Neolithic Mediterranean sites published or under study; in Cyprus, at Khirokitia and Cape Andreas Kastros (Desse & Desse-Berset, 1994 a, b); in Corsica, at Monte Leone and Longone; in Italy, at Arena Candida; in the Arabian Gulf, at Qala'at al Bahrain (Desse-Berset, 1995) and Failaka (Desse & Desse-Berset, 1990); in Tunisia, at Zembra.

Osteometry applied to grouper bones is fortunately of much greater help. It allows us to directly reach the level of archaeological interpretation without a long and uncertain trial of species-level taxonomic diagnoses. The aim of this paper is to furnish a general method allowing grouper total or standard length reconstruction, relevant to any species of the sub-family Epinephelinae, from any place and any date. This results directly from application of the relationship existing between the most important isolated bones for archaeozoological purposes, on the one hand, and fish size and weight on the other.

For many years we have gathered osteometrical data from the numerous groupers caught during our archaeozoological expeditions on a wide geographical scale: the Eastern Atlantic, the Mediterranean, the Arabian Gulf, the Indian Ocean, and, recently, the South Pacific. In the spirit of the «Fiches d'Ostéologie Animale pour l'Archéologie», we have first tried to collect data and apply osteometrical analysis to one of the most common Mediterranean groupers: *Epinephelus marginatus*, wrongly called *guaza*².

MATERIAL, METHODS AND RESULTS

Our research is fundamentally pragmatic, and its sole purpose is an easy inference of fish size and weight, suitable for the numerous bones of groupers discovered at the Neolithic sites of the continental or insular Mediterranean, on the basis of bone measurements. The preliminary results, even when obtained on an infra-statistical number of modern specimens of *Epinephelus marginatus*, are excellent, and indicate a good correlation between the most important bones of the skeleton and the size of the fishes (Figure 2). Working in the Arabian Gulf, we tried to apply this classical osteometrical approach to the most common grouper, *Epinephelus coioides*⁴. This new species, as expected, has provided us with the same kind of good results (Figures 3, 4, 5). We then gathered the data obtained from these two species of groupers and observed good agreement, not only of the relationship between the standard and total lengths of the two

species, but also of the data obtained from the isolated bones of both *Epinephelus* (Figures 6, 7).

Later, we extended the comparison to all fishes belonging to the genus *Epinephelus* in our reference collection, whether from the Eastern Atlantic, the Arabian Gulf or French Polynesia; these re-

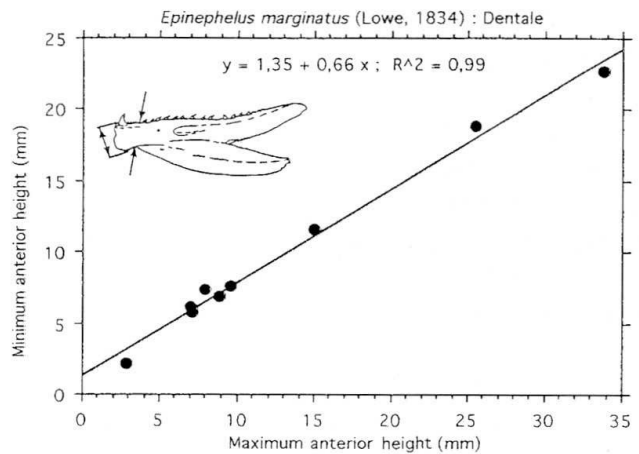


FIGURE 2

Correlation between 2 measurements on the dentale of the most common Mediterranean grouper, *Epinephelus marginatus*.

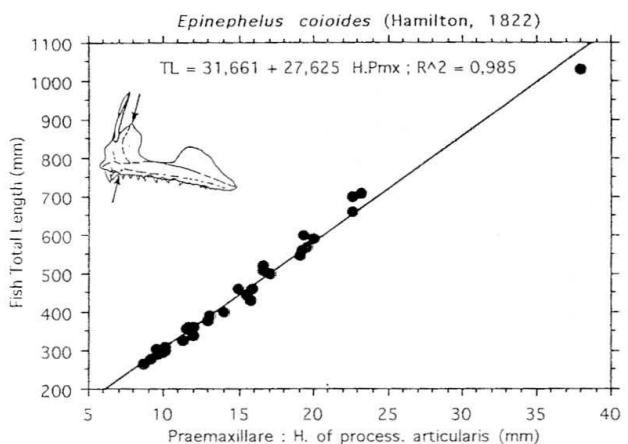


FIGURE 3

Correlation between praemaxillare and fish total length of the most common grouper from the Arabian Gulf, *Epinephelus coioides*.

⁴ Thirty-one specimens have been collected in the Gulf, and this species will be soon published in the «Fiches d'ostéologie animales pour l'archéologie»

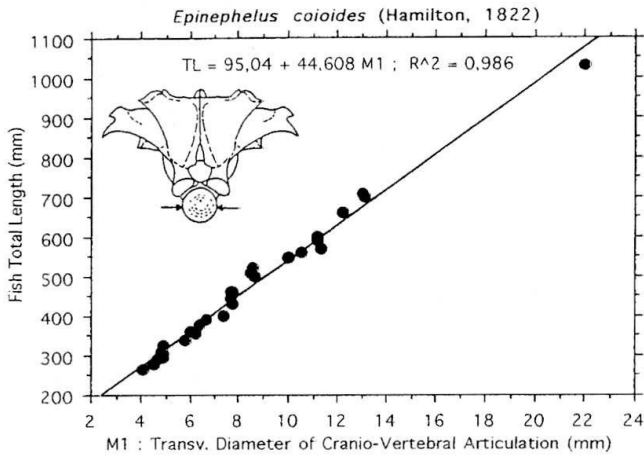


FIGURE 4

Correlation between cranio-vertebral articulation and fish total length of *Epinephelus coioides*.

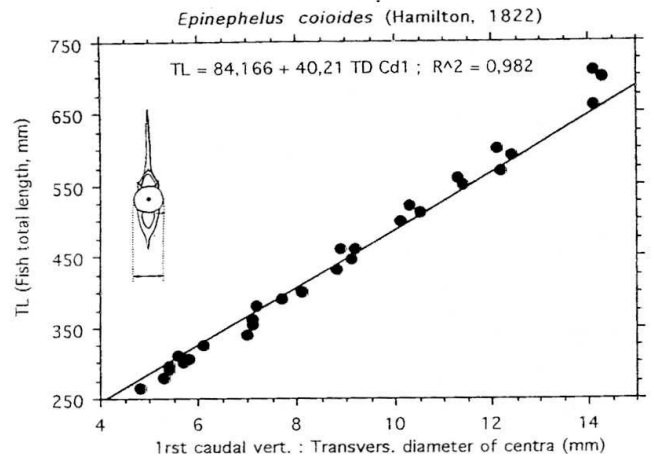


FIGURE 5

Correlation between the first caudal vertebra and fish total length in *Epinephelus*.

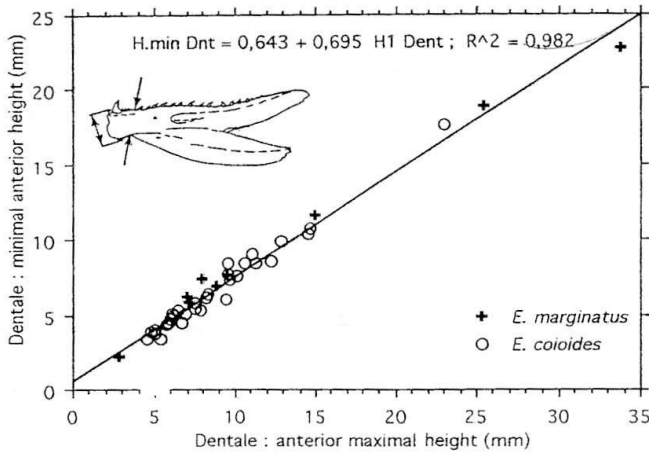


FIGURE 6

Relationship between two measurements on the dentale of two different species of groupers (*Epinephelus marginatus* and *E. coioides*): the regression lines for the two species are superimposed.

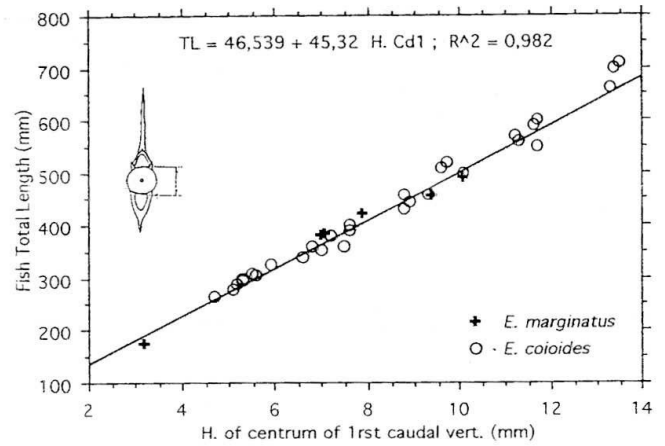


FIGURE 7

Relationship between the height of the first caudal vertebra and fish total length: the regression lines for *Epinephelus marginatus* and *E. coioides* are superimposed.

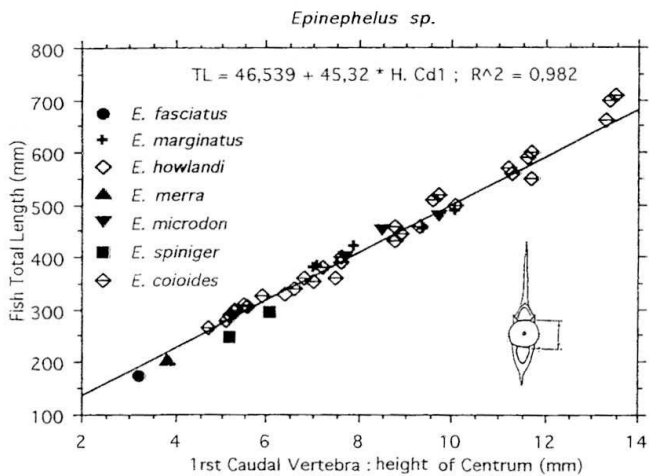


FIGURE 8

Correlation between first caudal vertebra and fish total length for several species of groupers from the Mediterranean Sea, the Arabian Gulf, the Indian Ocean and Polynesia.

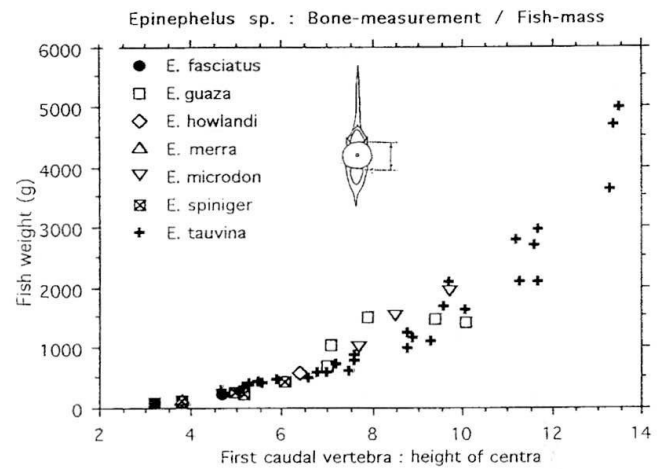


FIGURE 9

Correlation between first caudal vertebra and fish weight for several species of groupers from the Mediterranean Sea, the Arabian Gulf, the Indian Ocean and Polynesia

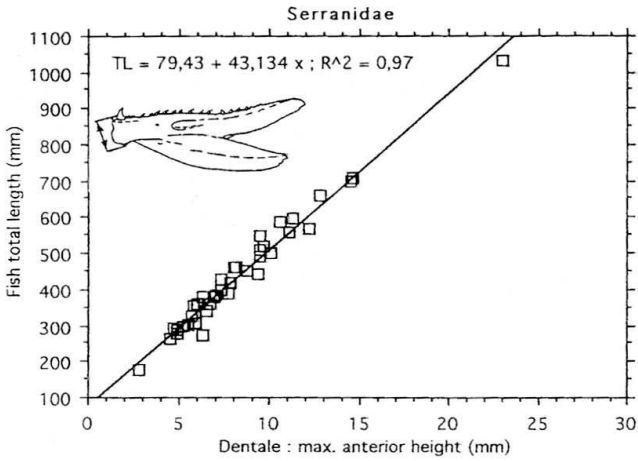


FIGURE 10

All groupers belonging to the genus *Epinephelus* exhibit the same correlation between total length and bone measurements (in this case the dentale).

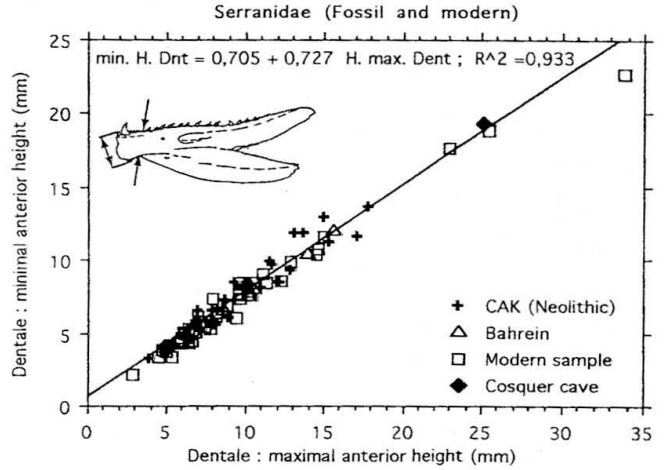


FIGURE 11

Archaeological and modern samples of dentale are positioned on the same curve in the scatter diagrams.

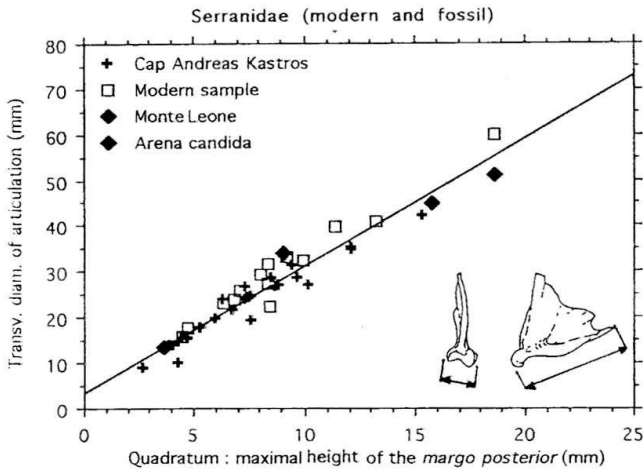


FIGURE 12

Quadratum: relationship between archaeological and modern bone measurement values.

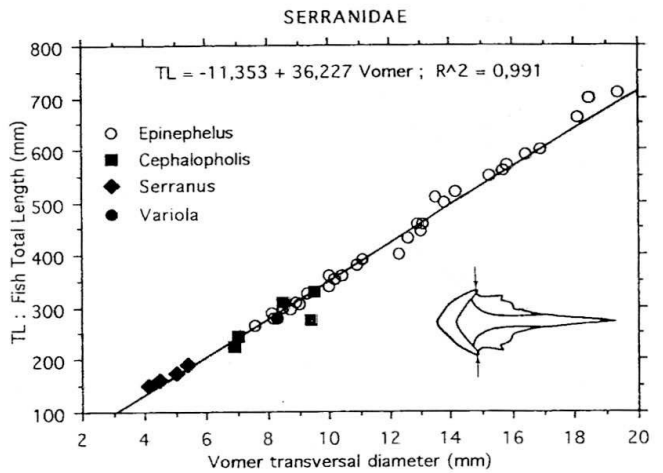


FIGURE 13

Extension to the sub-family level: correlation between vomer measurement and total length for the genera *Cephalopholis*, *Serranus* and *Variola*.

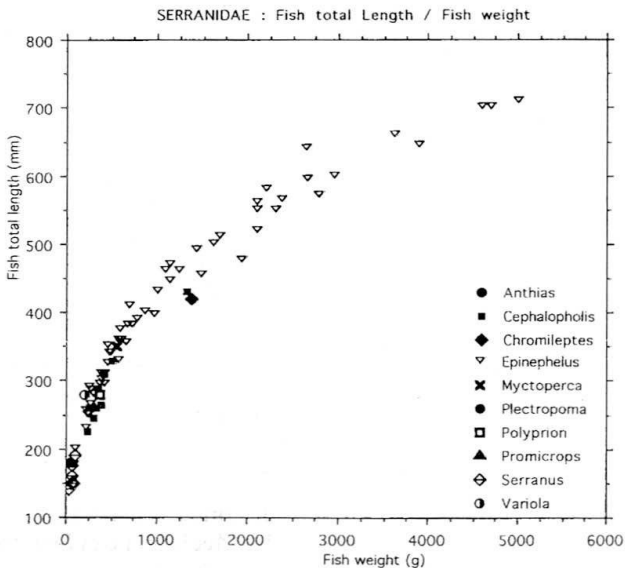


FIGURE 14

Fish weight/fish length relationship extended to all Serranidae in the reference collection of the Laboratoire d'Archéozoologie, Centre de Recherches Archéologiques, C.N.R.S.

present a sample of 128 fishes belonging to 25 species, which is, probably, at this stage, sufficient for statistical purposes.

The results obtained lead to interesting archaeozoological implications (archaeozoology is here used in the full meaning of the word, with some zoological and archaeological connotations). Whatever the specific identity or the geographic origin of each specimen, the relationship between its bone measurements and its body size (Figure 8) or weight (Figure 9) appears on the same curve in the scatter diagrams. For pragmatic purposes, we can consider that all groupers belonging to the genus *Epinephelus* have the same relationship between total length, standard length, weight and bone measurements of their skeletons. Consequently, for archaeological application, this clearly means that any bone belonging to a grouper found in an archaeological site, whatever its geographical origin and its age, is able to provide, through simple calculations, the size and weight of the original fish to which it belonged (Figure 10).

This relationship worked well for all 25 species of the genus *Epinephelus* which we have tested; it probably fits all species of this genus on coastal archaeological sites.

In addition to these results, we must add that the measurements we took on our fossil samples, when added to modern models, conformed to the scatter diagram curves drawn for modern samples (Figure 11, 12).

An extension to the sub-family level was later checked. Two species of the genus *Cephalopholis* (i.e., *Cephalopholis miniatus*, a small grouper of the Arabian Gulf and *Cephalopholis argus*, a Polynesian rock cod), both belonging to the subfamily Epinephelinae, were added to the diagrams. They also exhibited the same osteometric results as those established for *Epinephelus*. Later, we added two small-sized Mediterranean species of the genus *Serranus* (i.e., *Serranus scriba* and *Serranus cabrilla*), as well as specimens of the genus *Variola* (Figure 13). Finally, we extended this analysis to all the genera of the sub-family Epinephelinae in our reference collection. The results, again, appear to be helpful for archaeozoological purposes (Figure 14).

CONCLUSIONS

Our study indicates that all groupers, from the smallest species to the largest one, fit a similar set of regression equations. Furthermore, it also seems evident that all groupers represent a similar way of life. Fishing techniques depend, in fact, more on the animal's weight than on its taxonomic status. Even if they could be fished under the same environmental conditions, a 15 kg *Epinephelus marginatus* could not be captured with the fishing gear used for the small *Cephalopholis miniatus*. Nevertheless, this latter species could actually be caught with the same techniques as a juvenile specimen of some big *Epinephelus coioides*. The opportunities provided by osteometric applications to recalculate groupers' size or weight from isolated bones, even broken ones, seems a good answer to the archaeological problem of groupers' exploitation. And this answer, with all its implications for fishing strategies and palaeo-economy, can be supplied without detailed investigations into the species involved.

Let us end upon the image of a statue of Fatu Hiva, in the Marqueses Islands, kept in Tahiti's Museum of Islands. Ancient Polynesians, who recognised the morphological differences among groupers and gave them different names, nevertheless had a statue, named puna hapu, which means grouper fish. They would take it out of its sanctuary when setting out to fish, so that it might be propitious to them. The anecdote is metaphorically close to the work which has just been presented. Our results open a spectrum of promising applications for many genera of sea fishes, as will be seen in the near future⁵.

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⁵ Desse & Desse-Berset, On the Boundaries of Osteometry applied to Fish, this same volume.

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