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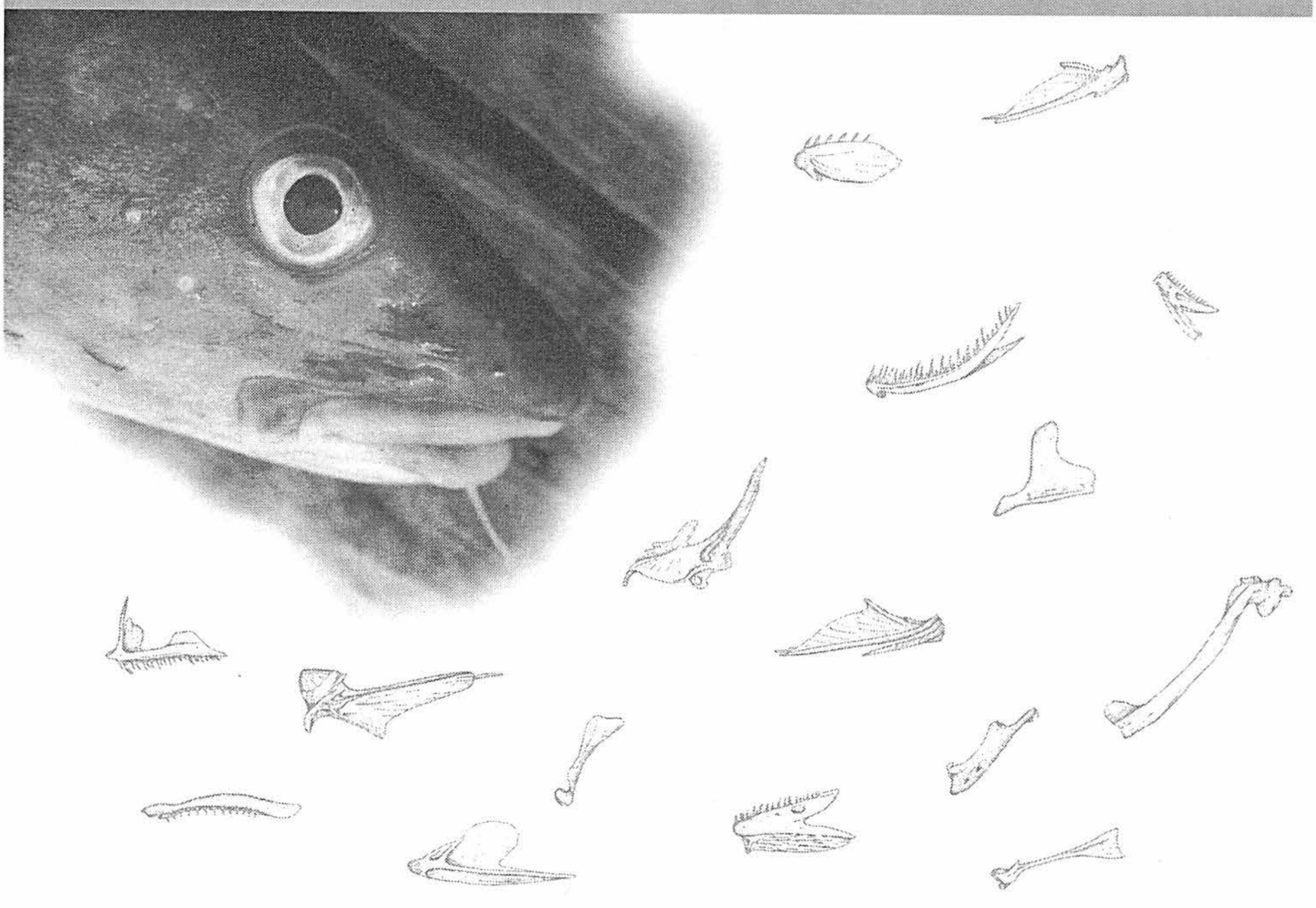
Morphological and Biometric Study of the Bones of the Buccal Apparatus of Some Nova Scotia Fishes of Archaeological Interest

By Alfonso L. Rojo



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MORPHOLOGICAL AND BIOMETRIC STUDY OF THE BONES OF THE BUCCAL APPARATUS OF SOME NOVA SCOTIA FISHES OF ARCHAEOLOGICAL INTEREST

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Alfonso L. Rojo

I. INTRODUCTION

The present report describes the results of the work carried out thanks to a N. S. Museum Grant (1998-1999). This pilot work, although incomplete, will fill a gap in Nova Scotia faunal studies since, to my knowledge, there is not yet an organized reference collection of fish bones available to zooarchaeologists in the area nor a systematic description of the osteology of Nova Scotia fishes.

The first difficulty that arose was to determine which fishes were of archaeological interest, since there are few local research works done on fish remains in the province (Cumbaa, 1976; McDonald, 1968; Rojo, 1986, 1990, 1991; Scott, 1977; Smith, 1973; Stewart, 1986; Turnbull, 1980; Wintemberg, 1973). As a general rule, we can say that any edible fish available in the area, both from freshwater and marine environments, was a candidate for our study. Table 1 lists the species most likely to be found in archaeological sites. It is obvious that there are more candidates, but we were unable to obtain specimens of them for this report.

Some fishes (*Coregonus huntsmani*, *Coregonus clupeaformis*, *Salvelinus namaycush*, *Ictalurus nebulosus*, bass and minnows) which could be found in archaeological sites are not included here because of the lack of representation in our samples.

Some species were collected (Table 2), but were excluded because of the absence of important data or for lack of archaeological value.

Although only fishes from Nova Scotia were studied, the conclusions from this work can be applied, with some reservations, to fishes of other Maritime Provinces, Newfoundland and the state of Maine (U. S.).

All fishes studied for this report have been deposited in the collection of the Nova Scotia Museum of Natural History, in Halifax. N. S. A personal collection from previous years, already donated to the Museum, has been partially incorporated into the present study.

Table 1. List of the Nova Scotia fish species studied in this report. They represent 231 specimens and 21 species. The numbers refer to the N. S. Museum collection.

Order	Family	Collection number	N
CLUPEIFORMES			
Clupeidae			
1.	*Clupea harengus*	12775-12788	14
2.	*Alosa aestivalis*	11291; 12714-12738	26
3.	*Alosa pseudoharengus*	12477-12488; 12766-12768; 12800-12804	20
4.	*Alosa sapidissima*	11294-11296; 11524-11525; 12751; 12754	7
ANGUILLIFORMES			
Anguillidae			
5.	*Anguilla rostrata*	12497; 12498; 12829-12837	11
SALMONIFORMES			
Salmonidae			
6.	*Salmo salar*	12406; 12499; 12713;127	4
7.	*Salvelinus fontinalis*	12490-12494; 12701-12706; 12752-12753; 12769-12770; 12794	16
Osmeridae			
8.	*Osmerus mordax*	12847-12851	5
CYPRINIFORMES			
Catostomidae			
9.	*Catostomus commersoni*	11271-11273; 11279-11289; 12495; 12710-12711	17
GADIFORMES			
Gadidae			
10.	*Gadus morhua*	12406; 12499; 12713; AR127	4
12.	*Melanogrammus aeglefinus*	1556; 12845-12846	3
12.	*Pollachius virens*	11237-11243; 11259; 11262-11265; 11268; 12772-11774; 12789	17
13.	*Brosme brosme*	11544; 12838	2
14.	*Microgadus tomcod*	12839-12842	4
Merlucciidae			
15.	*Merluccius bilinearis*	11545-11553; 11557-11559; 11568-11571; 11574	17
LOPHIIFORMES			
Lophiidae			
16.	*Lophius americanus*	11256-11258; 11555	4

SCORPAENIFORMES
Cottidae

17.	*Myoxocephalus octodecimspinosus*	11292; 11536-11537; 11541; 11593; 12760-12765	11
18.	*Hemitripterus americanus*	11266; 11269; 11538; 11573; 12411	5

PERCIFORMES
Scombridae

19.	*Scomber scombrus*	12476; 12489; 12712; 12750; 12755-12759; 12805 -12825; 12856	31

PLEURONECTIFORMES
Pleuronectidae

20.	*Hippoglossoides platessoides*	12792-12793; 12828; 12843-12844; 12852-12853	7
21.	*Pseudopleuronectes americanus*	12790-12791	2

Table 2. List of the species collected but not included in this study. They represent 19 species with a total of 32 specimens.

1.	*Acipenser brevirostris*	11526; 11528; 11579	3
2.	*Anarhichas lupus*	11543	1
3.	*Coregonus huntsmani*	11862	1
4.	*Coryphaena hippurus*	AR2081	1
5.	*Fundulus diaphanus*	11595	1
6.	*Glyptocephalus cynoglossus*	12826; 12827	2
7.	*Hippoglossus hippoglossus*	11297; 11529	2
8.	*Ictalurus nebulosus*	11270	1
9.	*Macrozoarces americanus*	11293	1
10.	*Merluccius albidus*	11575	1
11.	*Myoxocephalus scorpius*	12408	1
12.	*Notemigonus crysoleucas*	11274-78;12857-12858	7
13.	*Notropis cornutus*	12860	1
14.	*Perca flavescens*	11596	1
15.	*Salmo gairdneri*	12496; 12771	2
16.	*Sebastes marinus*	11290	1
17.	*Sebastes mentella*	12475	1
18.	*Semotilus atromaculatus*	11594; 12859	2
19.	*Tautogolabrus adspersus*	11527; 12407	2

II. OBJECTIVES

The general purpose specified in the title can be divided in this report into the three following objectives:

1. Preparation of a reference collection of disarticulated fish skeletons of commercial size for the use of zooarchaeologists interested in fish remains. During the preparation of the material, it was considered advisable to add small size specimens for the benefit of biologists working on the diets of fish predators, such as larger fish, birds and mammals.

2. Calculation of regression equations, to estimate the size (length or weight) of the live fish with selected bone dimensions.

3. Preparation of drawings and plates to identify the bones and dichotomic tables for the rapid identification of the species to which the bones belong.

III. IMPORTANCE OF THE STUDY OF FISH REMAINS

A survey of North American archaeological literature of more than 200 references before and including 1990 dealing with fish remains shows that fish bones have been somewhat neglected by archaeologists in North America. Some papers simply state the presence of fish bones (Kidd, 1969; Savage, 1969), while others identify the larger bones without any further study (Rowe, 1940). Some quotations will illustrate this point. Olsen (1968) states that "examination of archaeological collections in many of our larger museums and universities have revealed a scarcity of fish . . . in the assemblages of stored habitation residue." Mori (1970) points out that "the inability to identify faunal remains is one reason why archaeologists continue to devote minimal attention to their study." Alex (1973) says that "in the case of fish bone, some mention of its recovery is usually given in the list of faunal remains from a particular site. Often no more than a very general identification has been made (e.g. catfish, garpike)." Recently, Greenspan (1985) complained in her work on the Great Basin, that "traditionally, fish have not been given much consideration by Great Basin archaeologists." With few exceptions, her complaint can be applied to many archaeological reports. A further proof of this negligence or lack of interest is the absence of small bones, scales, and otoliths in many of the samples, due to the lack of proper retrieval methods.

It is also appropriate here to quote archaeologist David A. Phillips, Jr, who revised the entire report "Hohokam Archaeology along the Salt-Gila Aqueduct Central Arizona Project". In reference to volume 7 (Fish *et alii*, 1987), he states: "in the case of Salt-Gila Aqueduct, biology specialists were given an active role in designing their research contribution, were allowed large sample sizes, and were given the opportunity to synthesize the results. The overall success of the project has been enhanced in direct proportion to this generosity of support."

These observations are not intended as criticisms, but only to reflect the fact that, for whatever reason (negligence and lack of knowledge, interest or time), there is a need to intensify the study of fish remains. This gap in archaeological research can easily be filled by biologists interested in archaeology.

I must acknowledge that we have recently seen strong interest in fish remains thanks to the work of the international group ICAZ (International Council for Zooarchaeology).

Animal skeletal structures from archaeological sites, and in our case, fish remains (bones, teeth, scales, spines, and otoliths), can provide a great deal of information, from biological, environmental, and cultural points of view.

From the biological point of view, fish remains are necessary for

a) the correct identification of a fish species,
b) the estimation of the size of the live fish, both in length and weight,
c) the estimation of its food value, both in quantity and quality,
d) the determination of the age of the fish,
e) the determination and distribution of sexes,
f) the determination of the spawning areas,
g) the dynamics of fish populations by the study of the distribution of fish sizes and ages in a time series, and
h) from the latter, conclusions can be drawn about the fishing activity itself, whether it was sporadic or regular, rational or even an abusive use of the natural resources available in the area.

From the environmental point of view, fish remains are useful to draw conclusions about

a) the geographical distribution of the water bodies,
b) their nature, whether freshwater or salt water,
c) the temperature and other water variables,
d) the extension and depth of the water bodies, and
e) the taphonomic circumstances, human, animal, or environmental, responsible for their present state.

From the cultural point of view, fish remains can provide information on

a) the seasonality of the campsite based on the behaviour of the fish represented, especially in the case of migratory fishes,
b) the time of the year when the fishing activity took place by studying the growth marks on certain bones, scales, and otoliths,
c) the feeding habits of human societies,
e) their commercial transactions through the study of the presence of certain bones in inland middens far away from water bodies, and
f) their fishing activities and techniques.

Since the material used in this report does not come from any archaeological site, its study is restricted here only to some of the most basic biological aspects.

IV. PROBLEMS ASSOCIATED WITH FISH REMAINS

There are several problems associated with fish bones in contrast with the less complex skeletons of birds and mammals. This situation is probably one of the reasons for the delayed interest of archaeologists in fish remains.

We can group these problems into two main categories.

IV.1 Intrinsic Problems

In this category are included those problems directly related to the nature of fishes.

IV.1.1 Taxonomic complexity

Bony fishes are the most successful aquatic organisms of all time. Three main factors have contributed to their extraordinary diversification. Firstly, fishes are the most primitive and, as such, the structure of their organs is the simplest and the most labile of the remaining vertebrates. This fact has made them more sensitive to anatomical and physiological innovations and consequently more susceptible to the changes in the environmental forces to which they are exposed.

Secondly, fishes are the oldest vertebrates. Their evolutionary time, which extends for more than 450 million years, has provided them with more opportunities to diversify and evolve.

In the third place, fishes appeared and evolved in the aquatic environment which occupies an area equivalent to 71% of the earth's surface, but with its three-dimensional character offers a habitable space 300 times larger than land. If to this advantage, we add the wide range of gradients in salinity, temperature, pressure, oxygen, light, food, etc., the water environment offers fishes a greater number of evolutionary possibilities.

Fishes, from Ostracoderms to modern Teleosts, show not only more variety of forms, but also their anatomical and structural characteristics are more striking (presence and absence of mandibles, fins, and scales, cartilaginous or bony skeletons, variable number of vertebrae, gills, and fin rays, gas bladder or lungs, pediculate or apediculate fins, etc.) than the anatomical differences that can be found between amphibians and reptiles.

The result of such an enormous variety of structures makes the class Fishes the most complex and, as a consequence, the most heterogeneous taxonomic group. Extant fish alone are organized into some 46 orders divided into 450 families and 4,032 genera (Nelson, 1976). For comparison purposes, present day mammals are distributed only into 19 orders and 122 families and 1,017 genera (Morris, 1965). These latter figures represent a conservative estimate. Other systematists have offered higher numbers, but always far below their equivalent in fishes.

IV.1.2 Number of species of modern fish

Fish species alone are as numerous as the remaining vertebrates combined. Nelson (1976) lists 18,818 modern fish species, while Cohen (1970) calculates a total of 20,065. These numbers give an idea of the almost infinite variety of fish bone forms compared to the estimated 4,237 species of modern mammals (Morris, 1965). Yet, there is a general pattern common to most of the bones from the most primitive to the most advanced species. Obviously, in some cases it is difficult to recognize a bone only by its shape.

According to the Zoological Record, new species of fishes are still discovered at the rate of 75 to 100 every year.

IV.1.3 Numerical diversity of fish bones

The number of bones in any species of teleost fishes is greater than in any other species of the remaining vertebrate classes. The human skeleton has 222 bones compared with some 340 in an adult cod. The American eel (*Anguilla rostrata*) has an average of 107 vertebrae with a similar number of fin rays in the dorsal and anal fins.

It is impossible to give the exact number of bones for a species, because certain groups of bones (vertebrae, fin rays, etc.) vary in number depending on the ecological agents (temperature, salinity, etc.) in the water where the eggs developed. Thus, two fish from the same population can have a different number of bones. The number of vertebrae found in a sample of 82 cod off Nova Scotia waters ranged from 51 to 55.

IV.1.4 Poor mineralization of the bones

A third problem in studying fishes arises from the poor mineralization of laminar bones and also the membraneous expansions in other bones, making them more vulnerable to deterioration and breakage by natural forces. In some groups of fishes (Clupeidae, Salmonidae, Lophiidae, Cyclopteridae, etc.) this situation affects the whole skeleton.

IV.1.5 Weak structure of the bones

Although many bones (dentary, maxillary, cleithrum, etc.) have thick and stout structures, they also have expansions in the form of spines, prongs, and wings, which break easily when exposed to external forces. In spite of these difficulties, many bones can still be recognized, but they are useless for an accurate estimation of the live size of the fish. In this work, I tried to partially solve this problem by taking several measurements of each bone hoping that, at least, some dimensions would be preserved intact in the excavated bone.

IV.1.6 Size of the bones

While mammalian bones are mostly of large size, fish bones are mostly small. Some bones require the use of the microscope not only to see their exact shape and structures but to obtain accurate measurements as well.

IV.2 Extrinsic Problems

To the problems listed above, we have to add other problems, considered extrinsic to the bones themselves. This second group arises from a number of factors, among them the following.

IV. 2.1 Low priority

Low priority on the part of archaeologists, more traditionally attracted to other more interesting aspects of the human past such as religion, history, warfare and weaponry, habitation, numismatics, monuments, art, burials, etc.

IV 2.2 Lack of expertise

Early archaeologists lacked the necessary familiarity with fish species and skeletons to appreciate their value as testimonials of past human endeavours and environmental conditions. Fortunately, there is presently an awareness of the importance of fish remains. This has prompted many to seek closer collaboration with biologists interested in fish remains.

IV.2.3 Inconsistencies of the osteological nomenclature

The lack of a fixed nomenclature for fish bones, as opposed to the well-defined terminology for the skeletal remains of birds and mammals, is significant. Fish osteological nomenclature has been lagging due to a lack of knowledge of the homologies between the vertebrate classes. Names for the skeletal elements were given in antiquity first to human, mammalian and bird bones. Later on, when fish skeletons caught the attention of scholars, the names already in use for other vertebrate groups were applied to fishes. The lack of embryological studies at that time, added to the new concepts of homology and evolution, has made the interpretation of the fish skeleton very difficult. This situation created a plethora of synonymous names (Rojo, 1991) which confused and frustrated many archaeologists interested in fish remains. (Personal communications).

IV.2.4 Late recognition of the taphonomic factors

Another very important reason for the reluctance to study fish bones was the poor understanding of the action of taphonomic agents affecting the bones after their deposition in the ground. Animals and humans by their trampling, chewing, or partially digesting of the bones, along with environmental factors (water, wind, and fire) can reduce the bones to pieces that are unrecognizable, much less identifiable.

IV.2.5 Methodology

A final problem arises from the methodology used in obtaining the material. Several fishing techniques and various collecting methods should be used in order to get representative samples of the natural populations of fish and of the archeological material under study. The samples presented in this report bear witness to the difficulties mentioned in the section MATERIAL AND METHODS for the preparation of suitable material and data.

V. MATERIAL AND METHODS

Fishes from the province of Nova Scotia were collected between May 1st, 1998 and the end of the same year. Some 230 fish were procured from different sources. Many were bought from fishermen. Unfortunately, due to the Swissair Flight 101 disaster on Sept. 2nd/1998 about 10 km Southwest of Peggy's Cove, fishing operations were suspended in the area for almost a month, which unfortunately corresponds to one of the most profitable periods for fishing operations. To overcome this unforeseen problem, some specimens were bought from local markets. Some specimens were graciously donated by friends.

Before the preparation of the skeletons, the following biological information was recorded, when possible, from each specimen: total, fork and standard lengths, total and dressed weights, and sex. Scales and otoliths were removed for age studies.

All lengths were taken to the nearest millimeter. The total length was taken from the snout to the tip of the caudal lobes when squeezed to join each other in the middle line. If the lobes were of different length, the longest lobe was used for the measurement after being brought toward the middle line. The standard length was taken from the snout to the end of the scaly area in the caudal peduncle. For fishes possessing forked tails, the fork length runs from the snout to the end of the shortest central rays of the caudal fin. These techniques are the most commonly used in biological research in fishery and taxonomic studies.

The total and dressed weights were taken with scales accurate to the nearest tenth of a gram. For fishes bought at local markets, the weight in grams was that provided by the merchant. For large fish the weight provided was acceptable for our work. Small specimens were weighed later in the lab to obtain a more accurate value. Dressed weight is that of a fish once the viscera had been removed.

The skeletons were prepared by the simple, fast and effective method of maceration of the whole specimen in warm water. Every important bone was cleaned and in many cases bleached with hydrogen peroxide. Larger specimens were cut into smaller pieces to facilitate the work.

Two types of skeletal preparations were made: one for each species, shows the bones displayed and glued to a piece of acid-free cardboard in their natural position and place. This presentation allows for an easy and rapid comparison of individual bones. The secon type consists of loose bones of skeletons of different sizes and sexes stored in plastic boxes, vials or bags. Every container has been labeled and an individual record form completed for the Museum files.

I must add, that it was very difficult to make a large collection of skeletons of all species found in the province, of either sex and of different sizes from all diverse geographic and ecological areas. The main reasons for this near-impossibility were the pressure of time, the scarcity of money and manpower, the vagaries of the weather, and the availability of fish at a particular time and place. Consequently, the samples corresponding to the different species of fish collected here vary in number from one to 31 specimens.

Due to the impossibility of studying all the bones of so many species, only the bones of the buccal apparatus were studied for the present report. These bones are the premaxillary, the maxillary, the dentary, and the angular.

The graphic representation of each bone has been made by scanning the bones with the program Scan Wizard 2.42 and processing the images with Adobe Photoshop 4.0.1.

For the morphometric study, linear regressions and correlation coefficients were calculated between the total length and other dimensions of the live fish, and also between this same length and some selected dimensions of the four bones studied. Future acquisitions of specimens will be added to complement the present results.

Since our purpose was to determine the size of the live fish from fish remains, we have considered the total length as the dependent variable (Y). This variable is treated as a function of each bone dimension, which are the independent variables (X).

The correlation coefficients between two variables were calculated with the understanding that no variable is biologically dependent on another. No further statistical analyses were done because of the small size of the samples. The data offered here have only a provisional value which has to be confirmed or refined with new material.

The graphs and photos provided facilitate the identification of the bones and the use of the dichotomic keys prepared for each bone will help in the identification of the species concerned. When in doubt, the keys can be checked against the plates of the bones presented at the end of this report.

VI. THE SKELETON OF OSTEICHTHYES (BONY FISHES)

As has already been mentioned in the section PROBLEMS ASSOCIATED WITH FISH BONES, fishes have a number of bones far exceeding that of the other vertebrate groups. (Table 3).

Some bones, called paired bones, are arranged by twos, one bone on each side of the body of the fish, while others (median bones) have developed in the middle line of the body. In each category, there are bones which appear in variable number in different species. For example, in Cyprinidae there are 3 pairs of branchiostegals bones while in Gadidae there are 7 pairs. Moreover, sometimes two bones (frontals) that form a pair during embryonic or juvenile stages fuse into one during adulthood, as is the case in cod.

Nova Scotia fishes whose bones can be found in archaeological sites belong mostly to the Class Osteichthyes (Bony fishes). The sharks and rays, which belong to the Class Chondrichthyes (Cartilaginous fishes), are represented by teeth, dermal denticles, spines and spiny rays. Sturgeons, included in the Chondrostean series, are represented by bones and dermal scutes. All the species of fish studied in this report belong to the Class Osteichthyes.

Although, under ideal conditions, any of the bones listed in Table 3 can be found, the following are the most important bones from an archaeological point of view due to their shape, size, and strength:

Premaxillary	Hyomandibular
Maxillary	Opercular
Dentary	Preopercular
Angular	Cleithrum
Palatine	Postcleithrum
Quadrate	Vertebrae

Other bones, such as the fifth ceratobranchials of Cypriniformes, spines, and Weberian ossicles, can also be of interest for certain groups of fishes. Scales and otoliths, although not included in the skeleton proper, are often more important than bones in providing valuable biological information. Fortunately, there is a rich fish literature regarding both.

Table 3. List of the bones present in osteichthyans.

Paired bones		**Median bones**	
One pair	*Several pairs*	*Single bone*	*Several bones*
Angular	Branchiostegals	Basioccipital	Anal rays
Antorbital	Ceratobranchials	Basisphenoid	Basibranchials
Capsular ethmoid	Epibranchials	Ethmoid	Basihyals
Ceratohyal	Gulars	Glossohyal	Caudal rays
Clavicle	Hypobranchials	Kinethmoid	Dorsal rays
Cleithrum	Hypohyals	Myodome	Epurals
Coracoid	Infraorbitals	Parasphenoid	Hypurals
Dentary	Intermusculars	Parhypural	Dorsal fin rays
Dermosphenotic	Jugostegals	Preethmoid	Anal fin rays
Ectopterygoid	Pectoral fin rays	Supraethmoid	Pterygiophores
Endopterygoid	Pelvic fin rays	Supraoccipital	Urodermals
Epihyal	Pharyngobranchials	Stegural	Uroneurals
Epiotic	Radials	Urohyal	Vertebrae
Exoccipital	Ribs	Vomer	Caudal fin rays
Frontal	Sclerotics	Intercalar	Supraorbitals
Hyomandibular	Supramaxilla		
Interhyal	Tabular bones		
Interopercle	Weberian ossicles		
Jugal			
Lacrymal			
Maxillary			
Mesocoracoid			
Metapterygoid			
Nasal			
Quadrate			
Opercle			
Orbitosphenoid			
Palatin			
Parietal			
Parietooccipital			
Pelvic bone			
Posttemporal			
Preethmoid			

Premaxillary
Preopercle
Proethmoid
Prootic
Pterosphenoid
Pterotic
Retroarticular
Rostral
Scapula
Sphenotic
Subopercle
Supracleithrum
Symplectic

VII. THE BUCCAL APPARATUS OF BONY FISHES

VII.1 Introduction

The buccal apparatus of fishes is one of the most important and interesting units of the fish skeleton from the anatomical and functional view points. For the present report, I have selected the four main bones that together constitute both the upper and the lower jaws.

Jaws first appeared in the evolution of fishes with the Placoderms some 450 millions years ago. Intimately related to the jaw bones are the teeth, no less important in the successful evolution of fishes.

Since the feeding function is one of the most important, if not the most important, in the life of fishes, it is obvious that the buccal bones are more exposed to new adaptations and environmental pressures than other bones, such as the vertebrae. The bones respond to these pressures by changing their shape and relative size. A long and dramatic evolution has determined the relationship of these bones among themselves and with the rest of the skull skeleton. They also are important for the archaeologist since they are often sturdy, which account for their frequent presence in the middens. Their characteristic shapes make them easily recognizable even when they have been broken.

VII.2 The jaw bones

The feeding apparatus of modern bony fishes consists of four large bones: the premaxilla and the maxilla which together make up the upper mandible, and the dentary and the angular which form the lower mandible (Fig.1). The first three are of dermal origin. Only the angular bone has a mixed origin having been formed by the fusion of endochondral and membraneous elements. These bones are not only responsible for the opening and protrusion of the mouth, but because of the presence of teeth in three of them, they participate in the capturing and securing of prey. All these bones are present in pairs and are symmetrical, except in fishes of the Order Pleuronectiformes.

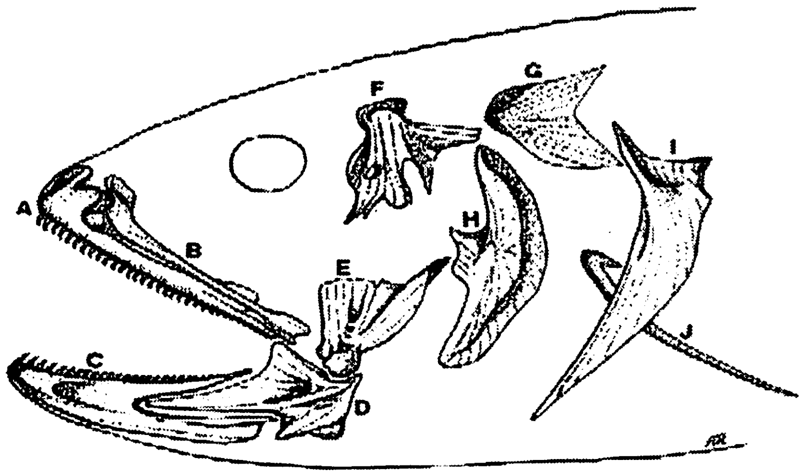


Fig. 1. The buccal bones in relation to themselves and other important bones in the skull of the teleost fish. A. Premaxillary. B. Maxillary. C. Dentary. D. Angular. E. Quadrate. F. Hyomandibular. G. Opercular. H. Preopercular. I. Cleithrum. J. Postcleitrum

During the evolutionary process, the bones of the buccal apparatus of modern bony fishes or parts thereof originated from the dermal plates of the cephalothorax of Placoderms and Acanthodians. These mandibles are considered in evolutionary terms "secondary," in contrast to the original or "primary" mandibles of ancient fishes. The latter formed at the expense of the endochondral tissues of the palato-quadrate bar in the upper mandible and Meckel's cartilage in the lower. These initial ossifications were first covered and finally replaced by dermal plates.

In the upper mandible, there are also present in the more primitive teleosts (Clupeidae and Salmonidae), one or two supramaxillaries (=surmaxillaries) and sometimes a hypomaxilla (Berry, 1964). Meckel's cartilage is still present in modern bony fishes as a vestigial rod of cartilage in the mesial side of the angular, extending forward deeply into the Meckelian fossa of the dentary (See Plates 1 and 8).

Several bones of little importance in archaeology because of their small size form from Meckel's cartilage in some fish species. They are from front to rear, the mentomeckelian, the mediomeckelian, the coronomeckelian. More widespread is the presence in the lower mandible of one retroarticular (= angular) and less frequently, one or two coronoids.

VII.3 The teeth

Although teeth do not belong to the skeleton proper, they are of great interest for archaeologists. They preserve well after a long period of time and have specific shapes and sizes facilitating the recognition of their owners. They also provide valuable information on the feeding habits of their possessors.

Teeth are very useful to identify sharks and rays; their value is nevertheless restricted in the case of modern fishes. Except for a few species, such as *Lophius* (goosefish) and *Anarhichas* (wolffish), most fishes have inconspicuous teeth. Individual teeth are difficult to identify, but they are very useful for identification purposes when considered as a whole, and more so when they are still implanted in the bones.

The teeth of fishes originated at the expense of modified dermal plates. During the embryonic development of the fish, they attach themselves to a dental plate of fibrous tissue that in turn often fuses with the bones. Of the four main bones comprising the jaws of bony fishes, only the angular always lacks teeth.

Teeth are anchored on the dental plate in three different ways. Depending on the type of attachment, teeth are classified as acrodont, (when implanted on top of a circular and hollow prominence, the alveolus); pleurodont (if attached to the side of the bone); and, in the rare cases when they are rooted inside the alveolus, thecodont. Acrodont and pleurodont teeth lack roots. When the teeth are not too numerous, their number has a specific value. Even in their absence the number of teeth can be obtained by counting the hollow alveoli.

Teeth are set in one or several rows. This arrangement is a useful feature for identifying certain species in conjunction with other features. When several rows of teeth are present, usually the anterior part of the plate has more rows than its narrow, posterior end.

According to their shape, teeth can be classified as cardiform, villiform, conical, incisiform, caniniform or molariform. Cardiform teeth are thin, pointed, but not too sharp, tightly grouped in dental pads (Ictaluridae); villiform, similar but thinner (Carp); incisiform, similar in shape to the incisive teeth of mammals, are spatulate or compressed sideways and have cutting edges (Canadian plaice); caniniform teeth are conical and long, strong, very often curved and sharp (goosefish); molariform teeth, like mammalian molars, are strong and flat at the top, able to crush and grind the shells of mollusks and crustaceans (wolffish). (Fig. 2).

There is a strong correlation between the shape of the teeth and the feeding habits and diet of fishes.

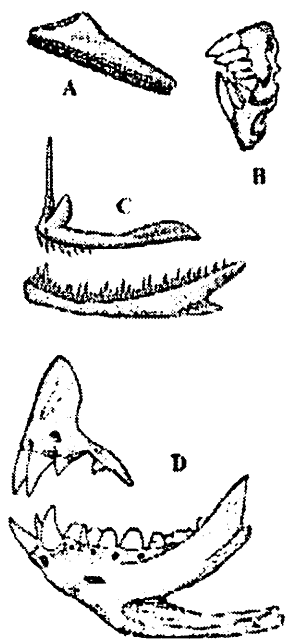


Fig. 2. Different types of teeth in fishes: A. Cardiform teeth in *Prototrocles.* B. Incisiform teeth of *Balistes capriscus.* C. Caniniform teeth of *Lophius americanus.* D. Caniniform and molariform teeth of *Anarhichas lupus.*

VIII. MORPHOLOGICAL STUDY OF THE JAW BONES

The descriptions presented here are only valid for the species listed and for the range of sizes specified in the tables in the Section BIOMETRIC STUDY OF THE JAW BONES.

These descriptions should be read with the understanding that there are slight variations in the shape of the same bone in individual fishes of the same species.

For the terminology of the anatomical landmarks of each of the bones, I mainly followed Lepiksaar (manuscript 1981-83).

VIII.1 The Premaxillary (PMA)

VIII.1.1 Definition and synonymy

The premaxilla or premaxillary of teleosts is a paired, dermal bone found at the anterior part of the upper jaw where it meets its counterpart. The joint of both premaxillaries, called the symphysis, is composed of fibro-cartilaginous tissues of different strengths giving them some flexibility. In Diodontidae, or parrot fishes, both premaxillae ankylose into a single bone.

There was no premaxilla in primitive fishes; it appeared later in the evolution of the Actinopterygians. During the evolution of these fishes, the principal role in the feeding mechanism assumed by the upper jaw, shifted from the maxilla to the premaxilla. In a large proportion of modern teleosts, the premaxilla thus forms the whole of the tooth-bearing border of the upper jaw excluding the maxilla which remains above it as a toothless bone. In some fish families, such as Cyprinidae and Catostomidae, and in some Clupeidae, the premaxillaries are toothless.

In older fish literature, this bone has also been called *intermaxillary* (Weber and de Beaufort, 1922), *surmaxillary* or *bimaxillary,* among other less known names.

VIII.1.2 General morphology of the premaxillary

There is a wide variation in size and form of the premaxillary in modern fishes. This bone (fig. 3) consists of several elements: one long, the body, enlarged at the anterior, end is overlain on its dorsal margin by as many as three processes named from front to back: the ascending (=nasal), the articular and the maxillary. The ascending process has been considered as an independent bone attached to the premaxillary. In fact, in *Lophius americanus* (goosefish) this bone separates easily in many specimens.

The body extends, in some cases, into a more or less horizontal expansion called the caudal process. The main connections of the premaxillary are with the ethmoid above and the maxillary behind.

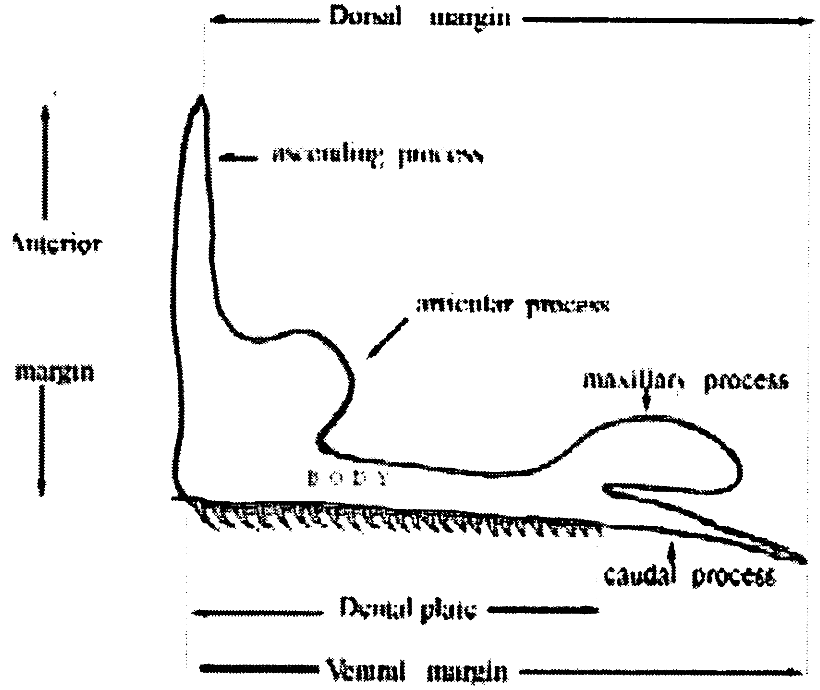


Fig. 3. Morphological features of the premaxillary bone.

VIII.1.3 Specific descriptions of the premaxillary

Clupea harengus — Atlantic herring

The general shape of the premaxillary is subtriangular (Plate 1). The body of the bone is cylindrical, tapering to the posterior end. An alar membrane of subtriangular shape extends dorsally, tapering to the end of the bone. The anterior margin of the membrane is short, while the posterior, much longer, extends to the end of the bone. Ventral to the body of the bone another narrow membrane expands anteriorly into a knob and runs backward along three quarters of the length of the bone. This bone lacks teeth.

The ratio ML/MH (Maximum length/maximum height) varies from 2.33 to 2.83 (mean = 2.54) based on 4 specimens. Fig. 7 shows how to measure these two dimensions.

Alosa aestivalis — Blueback herring

General shape, subtriangular (Plate 2). The body or thickest part of the bone, cylindrical, tapering towards the back; anteriorly, it expands into a globular thickening, clearly visible in the mesial face. The anterior margin has a knob-like expansion pointing upward that divides the border into two halves: the upper, concave and the lower, either straight or slightly concave. Dorsally, the bone expands into a wing-like membrane with a convex border that tapers towards the back. The ventral border shows anteriorly a rounded protuberance directed downwards. This bone lacks teeth.

The ratio ML/MH varies from 2.17 to 3.05 (mean = 2.52) based on 15 specimens.

Alosa pseudoharengus Gaspereau

Similar in shape to the premaxillary of *A. aestivalis* (Plate 3). The body of the bone is prominent. A knob directed forward divides the anterior border into two sections. Dorsal wing-like membrane with sinuous border tapering backward. Knob in the body of the bone more prominent and expanding a little ventrally. The anterior lower protuberance grows ventrally. This bone lacks teeth.

The ratio ML/MH varies from 2.33 to 3.04 (mean = 2.73) based on 16 specimens.

Alosa sapidissima American shad

General shape as in the last two previous species (Plate 4). Spines and projections longer and more pronounced. The knob in the middle of the bone's body more prominent and visible. This bone lacks teeth.

The ratio ML/MH varies from 1.92 to 2.55 (mean = 2.20) based on 4 specimens.

The premaxillae of the three species of *Alosa* are very small when compared to the maxillae. This bone is easily lost in the preparations and most likely almost impossible to find in archaeological sites. The shapes of the premaxillaries of the three species of genus *Alosa* are so similar that it is difficult to set them apart. Their sizes could be a criterion, albeit not infallible, to separate them.

The following sizes of adult fish of the genus *Alosa* in their anadromous migrations, the time when they are caught, are quoted from Scott and Scott (1988).

The maximum fork length of *A. aestivalis* for New Brunswick is given as 28.4 cm. No type of length was specified.

For New Brunswick, the maximum fork length of *A. pseudoharengus* has been recorded as 31.6 cm. For Atlantic Canada, places not specified, the usual fork length of fish caught is between 25.4 and 30.5 cm.

The maximum fork length of *A. sapidissima* recorded is 61.7 cm. In Annapolis River (Melvin *et al.* 1985) the usual size caught is around 50 cm.

Anguilla rostrata Eel

Both premaxillaries of *Anguilla* are fused with the ethmoid and, very often, with the vomer into a compound bone called appropriately, ethmo-premaxillary-vomer.

Salmo salar Atlantic salmon

Bone of subtriangular shape (Plate 6). The ascending process short and clearly defined; separated from the bone's body. The teeth, from 3 to 6, based on 7 specimens.

The ratio ML/MH varies from 1.53 to 2.23 (mean = 1.97) based on 4 specimens.

Salvelinus fontinalis Brook trout

General shape roughly that of an equilateral triangle (Plate 7). Dorsal process unciform pointing backward. Upper part of process separated from the bone's body by a narrow groove. The teeth, from 4 to 7 based on 14 specimens, are set wide apart in a single row.

The ratio ML/MH varies from 0.99 to 3.60 (mean = 1.50) based on 15 specimens.

Osmerus mordax Smelt

Thin, transparent bone (Plate 8). Dorsal alar membrane thin with sinuous margin. One spiny process in the posterior section of the membrane. Dental plate thin, one row of sharp, long and loosely spaced teeth.

The ratio ML/MH varies from 3.66 to 4.95 (mean = 3.85) based on 2 specimens.

Catostomus commersoni White sucker

Thin bone, subtriangular in shape (Plate 9). The only dorsal process (ascending process) ends in a knob-like expansion. The anterior border is longer than the ventral margin; both set at a 90° angle. Lower margin of the bone, straight. Posterior border, concave in outline. Teeth absent.

The ratio ML/MH varies from 0.63 to 0.78 (mean = 0.70) based on 12 specimens.

Gadus morhua Cod

Strong and thick bone (Plate 10). The four processes, ascending, articular, maxillary and posteroventral well differentiated. Ascending process slightly bifid; wider than the articular; both separated by a wide groove. Articular process round, with pointed ventral margin. Maxillary process subquadrangular. Posteroventral process extending farther than the maxillary process. Dental plate wide, with numerous rows of well packed teeth near the symphysis and few at the aboral end. Teeth sharp, thin, and acrodont.

Cod has not been included in the calculations in this report. For the relationships between the total length of cod and the four bones studied in this report refer to Rojo (1986), or the conclustions on page 178 of this report.

Melanogrammus aeglefinus Haddock

Strong and thick bone (Plate 11). The four processes, ascending, articular, maxillary, and posteroventral, well differentiated. Ascending process, slender and taller than the articular; both separated by a deep groove. Articular process pointed above and below. Maxillary, subquadrangular, ending short of the posteroventral process.

Dental plate wide, with numerous rows of well packed teeth near the symphysis and few at the aboral end. Teeth sharp, thin, and acrodont.

The ratio ML/MH varies from 8.5 to 12.0 (mean = 10.33) based on 3 specimens.

Pollachius virens Pollock

Strong and thick bone (Plate 12). The four processes, ascending, articular, maxillary, and posteroventral, well differentiated. Ascending process, higher than the articular; both separated by a wide groove. Maxillary process, round. Posteroventral process extending farther than the maxillary.

Dental plate wide, with numerous rows of well packed teeth near the symphysis and few at the aboral end. Teeth sharp, thin, and acrodont.

The ratio ML/MH varies from 3.0 to 4.0 (mean = 3.45) based on 16 specimens.

Brosme brosme Cusk

Strong and thick bone (Plate 13). The four processes, ascending, articular, maxillary, and posteroventral, well differentiated. Ascending and articular processes of almost same length;

separated by a deep and wide groove. Maxillary, subquadrangular, ending at the same level with the posteroventral.

Dental plate wide, with numerous rows of well packed teeth near the symphysis and few at the aboral end. Teeth acrodont, sharp, and thin.

The ratio ML/MH varies from 3.74 to 4.15 (mean = 3.94) based on 2 specimens.

Microgadus tomcod Tomcod

Delicate and membranous bone (Plate 14). Ascending process wide with round upper border; longer than the articular process and separated from it by a groove extending half of the length of the articular. Maxillary process, longer than tall; its posterior section free; upper border, convex. Posteroventral process prolonged farther than the maxillary process.

Dental plate extending the whole length of the bone. Three or four rows of acrodont, small, pointed teeth; those on the lateral margin much longer.

The ratio ML/MH varies from 3.03 to 3.77 (mean =3.37) based on 16 specimens.

Merluccius bilinearis Silver hake

Slender and long (Plate 15). The four processes, ascending, articular, maxillary and posteroventral, well differentiated. Ascending and articular processes almost of the same length, separated by a wide but shallow groove. Maxillary, taller than wide. Posteroventral process, long and pointed, extending more than one fourth of the total length of the bone.

Dental plate narrow. One or two rows of teeth near the symphysis; only one on the rest of the bone. Teeth acrodont, thin, sharp, and spaced apart

The ratio ML/MH varies from 6.89 to 9.57 (mean = 8.32) based on 15 specimens.

Lophius americanus Angler fish

Ascending process, long, more than twice the size of the articular process; slender and pointed in lateral view; its anterior facet, triangular. Articular process, small with curved margins; separated from the ascending process by a deep groove (Plate 16).

Dental plate extending the whole length of the bone; two rows of cylindrical, long, pointed teeth on the anterior section of the bone and one row with small, pointed and spaced teeth on the posterior.

In some specimens the ascending process disconnects itself from the rest of the bone.

The ratio ML/MH varies from 1.65 to 1.79 (mean = 1.72) based on 2 specimens.

Myoxocephalus octodecimspinosus Longhorn sculpin

The three dorsal processes, ascending, articular and maxillary, well developed (Plate 17). The ascending process is long, slanting backward in relation to the base of the bone, pointed, and separated from the articular by a deep groove. The articular process, wide and shorter than the ascending process; its upper margin round or slightly bilobed. Maxillary process, clearly subtriangular, with a wide base and its posterior slope ending at the level of the tip of the bone.

Dental plate overhanging the symphysial border and extending the whole length of the bone. Several rows of tightly-packed and curved teeth.

The ratio ML/MH varies from 1.23 to 1.79 (mean = 1.37) based on 9 specimens.

Hemitripterus americanus Sea raven

Three dorsal processes: ascending, articular and maxillary (Plate 18). Ascending process, long and pointed; in frontal view its face is triangular; it is separated from the articular by a deep groove. Articular process wide, much shorter than the ascending process; round upper border. Maxillary process set anteriorly, is laminar with its upper border convex. It extends as far as the posterior tip of the bone.

Dental plate advances in front of the symphysial border up to the posterior tip of the bone. As many as 5 rows of teeth on the anterior part of the dental plate. Teeth tightly packed

The ratio ML/MH varies from 1.90 to 1.98 (mean = 1.94) based on 4 specimens.

Scomber scombrus Mackerel

Slender and thin bone (Plate 19). One dorsal process only, in anterior position. The bone ends in a small ovoid enlargement. Dental plate running from the symphysial border to the beginning of the ovoid enlargement. Teeth acrodont, small, pointed, curved, and spaced in a single row.

The ratio ML/MH varies from 3.19 to 4.94 (mean = 4.48) based on 27 specimens.

Hippoglossoides platessoides Canadian plaice

Both premaxillaries differ only in size and shape (Plate 20), the left being longer. The premaxillary has three dorsal processes: the ascending, long; its symphysial face, wide and triangular tapering dorsally. The articular process is oval in shape and it is separated from the ascending process by a groove.

Dental plate ending before the end of the bone. Teeth acrodont, straight, compressed laterally, set in a continuous single row.

The right premaxilla has three dorsal processes. The ascending and articular similar to their counterparts on the left side. Maxillary process set on the middle of the bone is well defined; its upper border convex, ending before the bone. The remaining part of the bone forms a posteroventral process tapering posteriorly. Teeth similar to those on the left side.

The ratio ML/MH is different for both premaxillae. The left premaxilla varies from 2.59 to 3.57 (mean = 3.01) and the right, from 2.05 to 3.89 (mean = 2.51) both set of values based on 7 specimens.

Pseudopleuronectes americanus Winter flounder

Strong and short bone (Plate 21). Three dorsal processes. The ascending and articular processes joined anteriorly for the whole length of the articular. On the mesial side there is a groove between them. Dorsal margin of the maxillary process, convex. Posteroventral process bent downward.

Teeth on the left premaxillary, acrodont, compressed laterally, touching each other and set in a single row. Right dentary edentulous.

VIII.2 The Maxillary (MA)

VIII.2.1 Definition and synonymy

The maxillary of modern teleosts, also known as maxilla, is a paired bone of dermal origin that forms the posterior part of the upper mandible. In primitive teleosts the maxilla is toothed and forms most of the gape of the upper jaw, but during the evolution of fishes, the premaxillary replaced in importance the maxillary which migrated backward and lost its teeth. It articulates anteriorly with the premaxillary.

VIII.2.2 General morphology

The premaxilla (Fig. 4) is a long, slender bone with an elaborate enlargement in front, named, the "head". It is shaped as a bridge with two processes: one internal; the other, external. This arrangement makes the articulation of the maxilla with the articular process of the premaxillary one of great mobility, making possible the protrusion of the mouth. Behind the head there is usually a constriction, named the "neck." The maxillary process of the premaxilla constrains the maxilla from sliding outward. The dorsal margin often presents a thin crest ---the maxillary crest and the posterior part of the maxillary expands usually on a ventral flange of bone.

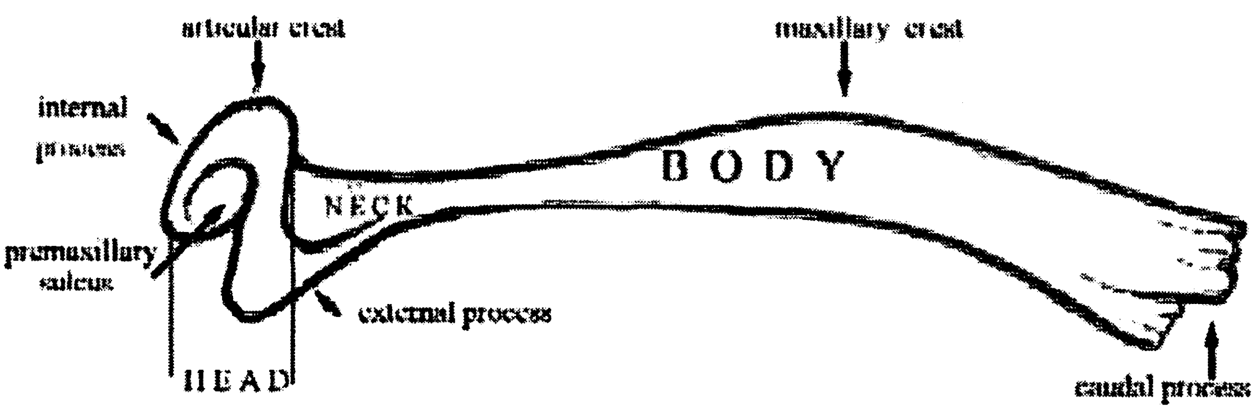


Fig. 4. Morphological features of the maxillary bone.

VIII.2.3 Specific descriptions of the maxillary

Clupea harengus Atlantic herring

Laminar and transparent bone, except for the neck and head (Plate 1). External process with a thickening at its base. Neck short. Articular crest joined to the external process.

The ratio ML/BH varies from 4.06 to 5.38 (mean = 4.69) based on 12 specimens. See Figure 8.

Alosa aestivalis Blueback herring

Laminar and transparent bone, except in the neck and head (Plate 2). Very similar to those of *Alosa pseudoharengus* and *A. sapidissima* although of smaller size.

The ratio ML/BH (Maximum length/body height) varies from 4.31 to 7.33 (mean = 5.14) based on 26 specimens. See Fig. 8.

Alosa pseudoharengus Gaspereau

Laminar and transparent bone, except for the head and neck (Plate 3). Head strong, bent inward, forming a wide arc with the body of the bone. Internal process absent; external, round and pointed downward. Articular crest with a strong condyle. Neck long and narrow with a condyle on its inner facet. A small and thin crest on the anterior part of the body. A long groove on the lateral facet of the bone. Upper margin concave; ventral margin, convex. The body tilting upward and pointed.

The ratio ML/BH varies from 4.12 to 7.30 (mean = 4.73) based on 20 specimens.

Alosa sapidissima American shad

Head robust, bent inward. Internal process, strong; external process, small (Plate 4). A groove separates both. Articular crest elongate with a prominent condyle. Narrow neck. Bone's body flat, laminar, transparent; bent upward. Maxillary crest on the anterior part of the bone's body. A ventral crest runs the whole length of the bone. Caudal region round. Several long narrow grooves on the outer facet.

The ratio ML/BH varies from 2.55 to 6.78 (mean = 4.54) based on 7 specimens.

Anguilla rostrata Eel

Strong bone, well-ossified with several rows of small, tightly-packed, cylindrical teeth (Plate 5). Head formed mainly by the articular crest. Thick neck. Maxillary crest long with its upper margin curved. Caudal process long and pointed directed downward. On the lateral side there is a strong rib running the whole length of the bone.

The ratio ML/BH varies from 4.81 to 11.11 (mean = 7.91) based on 11 specimens.

Salmo salar Atlantic salmon

Slender toothed bone (Plate 6). Head bent toward the middle line of the fish, at an angle of some 130° with the body of the bone. Articular crest, triangular, pointed, directed slightly upward. Internal and external processes absent. Maxillary crest, long. The bone's lower margin almost straight. Caudal section, a little expanded. Posterior margin round.

The ratio ML/BH varies from 7.20 to 8.96 (mean = 8.19) based on 4 specimens.

Salvelinus fontinalis Brook trout

Similar in shape and features to salmon's maxilla. (Plate 7). Articular crest, round and pointing downward.

The ratio ML/BH varies from 10.46 to 15.91 (mean = 12.22) based on 13 specimens.

Osmerus mordax Smelt

Thin and long bone with a row of teeth. Head at an angle of more than 90° with the rest of the bone (Plate 8). Internal and external processes, absent. Maxillary crest, narrow. There is a prominence at the beginning of the neck. Long and narrow maxillary crest. Lower margin of the bone, straight. Posterior margin, round and pointed upward.

The ratio ML/BH varies from 7.66 to 10.95 (mean = 9.59) based on 5 specimens.

Catostomus commersoni White sucker

Strong bone with a very elaborate shape (Plate 9). Head, large; internal process, pointed and directed downward; the external, just initiated. Articular process, tall, cylindrical. Narrow neck. Right after the neck, the body expands above and below into two crests: the maxillary, with a hook directed forward, and the lower, triangular in shape. The caudal process prominent, round and bent downward.

The ratio ML/BH varies from 2.10 to 2.70 (mean = 2.42) based on 17 specimens.

Gadus morhua Cod

Strong and well-ossified bone (Plate 10). Internal process, higher than the articular crest and larger than the external. At its base, there is a protuberance with a concavity. External process, pointed. Articular crest, with a shallow depression. Body thick, with straight ventral margin. It expands into a large caudal process, concave on its lateral face. Maxillar crest, well developed; its lateral face convex. Posterior margin, bilobular.

See observation on *Gadus morhua* in the conclusion on page 178 of this report.

Melanogrammus aeglefinus Haddock

Strong and well-ossified bone (Plate11). Massive head. Internal process, larger than the external. Both set at an angle of approximately 60°. Articular crest with a prominent condyle. Body, bent upward after the neck; wide maxillary crest. Posterior margin, bilobular.

The ratio ML/BH varies from 4.41 to 6.14 (mean = 5.14) based on 3 specimens.

Pollachius virens Pollock

Strong and well-ossified bone (Plate 12). Interior process, larger than the external, with a protuberance at its base. External process smaller. Both form an angle of 90°. Articular crest, prominent. Ventral margin, straight with a caudal process. Dorsal margin expanding into an anterior maxillary crest. Posterior margin bilobular; the upper lobe longer.

The ratio ML/BH varies from 3.82 to 7.81 (mean = 4.55) based on 16 specimens.

Brosme brosme Cusk

Long, smooth, strong and well-ossified bone (Plate 13). Head prominent. Internal process large and round with a strong protuberance on its lateral facet. External process pointed and smaller than the internal. Articular crest with a flattened condyle. The neck shows a deep groove ventrally. In lateral view, the body is straight. In dorsal view, it curves towards the middle line of the fish. Strong caudal process directed downward; its surface slightly convex.

The ratio ML/BH varies from 3.98 to 4.73 (mean = 4.35) based on 2 specimens.

Microgadus tomcod Atlantic tomcod

Massive head. Internal process larger than the external (Plate 14). Articular process with prominent condyle. Ventral margin straight, but bent downward at the caudal end. The bone expands dorsally into a maxillary crest. Posterior margin bilobed.

The ratio ML/BH varies from 4.54 to 6.09 (mean = 5.30) based on 4 specimens.

Merluccius bilinearis Hake

Thin and elongated bone (Plate 15). Internal process strong with a depression in its middle part; longer than the external. External process, triangular in shape. Articular crest, small. Body of the bone straight, with a clear maxillary crest not reaching the end of the bone. Posterior margin somewhat pointed.

The ratio ML/BH varies from 5.12 to 7.47 (mean = 5.98) based on 15 specimens.

Lophius americanus Angler

Light and long bone; spongy in places (Plate 16). Head prominent, bent upwards in the same plane as the rest of the bone. Internal crest large and long with a protuberance on its lateral facet. External process absent or represented by a narrow crest on the ventral margin of the neck. Articular crest well developed. Body strong, curved upward with two crests: one small on the anterior part and a second, the maxillary crest, long and prominent. The bone tapers but ends abruptly at the caudal end. A strong rib runs the whole length of the bone. The mesial face is concave on its entire length.

The ratio ML/BH varies from 10.00 to 10.96 (mean = 10.37) based on 4 specimens.

Myoxocephalus octodecimspinosus Longhorn sculpin

Head vertical (Plate 17). Body curved towards the middle line of the fish. External process round. Narrow neck, flattened horizontally. Dorsal margin straight. Crest prominent. Caudal region enlarged ventrally. Posterior margin slightly convex.

The ratio ML/BH varies from 4.16 to 5.36 (mean = 4.64) based on 11 specimens.

Hemitripterus americanus Sea raven

Head inclined backward with well-developed internal and external processes (Plate 18). The internal, stronger with a knob on its lateral face. Articular crest strong, with a deep depression on its posterior side. Upper margin of bone arched into a clear maxillary crest. lower margin straight, but enlarged at the caudal end. Posterior margin convex.

The ratio ML/BH varies from 7.17 to 8.14 (mean = 7.60) based on 5 specimens.

Scomber scombrus Mackerel

Slender bone with smooth surfaces (Plate 19). On lateral view, it curves downward. Head inclined backward. Internal process larger than the external. Narrow and short neck. Body with equal height all along but its caudal end expands downward. Articular crest with a small condyle. Posterior margin round.

The ratio ML/BH varies from 4.83 to 8.04 (mean = 6.61) based on 29 specimens.

Hippoglossoides platessoides Canadian plaice

Head massive (Plate 20). Internal and external processes bilobed; the upper lobe of the internal process, separated from the articular crest by a depression. Articular crest with a well-developed condyle. Body arched downward; on lateral view almost straight. On the dorsal margin there is a small barb. Caudal region expanded, both above and below. Posterior margin blunt.

The ratio ML/MH for the left maxilla varies from 5.30 to 6.64 (mean = 5.95) and for the right, from 4.96 to 8.88 (mean = 5.96) based on 7 specimens.

Pseudopleuronectes americanus Winter flounder

Bone straight in lateral view, but seen from above it curves toward the center line of the fish body (Plate 21). Head massive. Internal and external processes bilobular. Articular crest well developed into a condyle. The bone upper margin shows a small barb. Posterior region enlarged, mostly downward. Posterior margin convex.

The ratio ML/BH for the left maxilla varies from 5.07 to 5.38 (mean = 5.23) based on 2 specimens. The ratio ML/BH for the right maxilla varies from 3.82 to 4.57 (mean = 4.19) based on 2 specimens.

VIII.3 The Dentary (DE)

VIII.3.1 Definition and synonymy

The dentary is a paired bone present in the anteriormost part of the lower mandible. Both dentaries, right and left, meet anteriorly in the mandibular symphysis. In Tetraodontiformes both dentaries fuse together in the shape of a parrot's beak.

The dentary has also in most cases a dental plate fused to its upper margin. Cyprinidae and Catostomidae have edentulous dentaries, In these two families, the securing and cutting functions of the teeth are taken over by the pharyngeal teeth implanted on the fifth ceratobranchials, known also as pharyngeal bones. The dentary, the main bone of the lower jaw has remained fairly constant in the evolution of fishes.

The dentary has also been called dentosplenial (Holmgren and Stensiø, 1936; Jollie, 1986); dentalo-splenial-mentomandibular (Holmgren and Stensiø,1936); Pehrson,1944) and Lekander, 1949), and splenial-dentosplenial.

VIII.3.2 General morphology of the dentary

The shape of the dentary is in most cases that of a lying "Y" with its stem in an anterior position (Fig. 5). The stem forms the body of the bone and the two arms make the posterior processes: the dorsal, known also as coronoid process, and the ventral process.

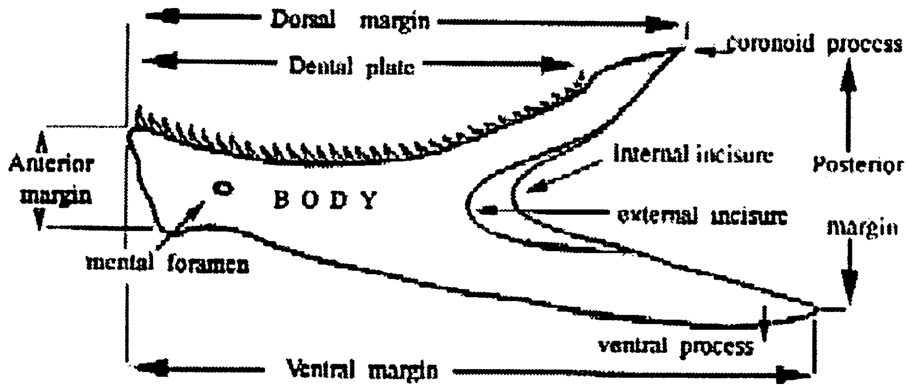


Fig. 5. Morphological features of the dentary bone.

This peculiar shape determines four borders or margins: the anterior or symphysial margin, that joins both dentaries; the dorsal margin, that extends from the uppermost point of the mandibular symphysis to the end of the coronoid process; the posterior margin, that usually forms an angle more or less acute, and runs from the tip or the higher point of the coronoid process down to the tip or the lowest point of the ventral process; and, finally, the ventral margin running from the inferior point of the symphysial margin to the tip of the ventral process or the most posterior point of the bone. These landmarks are not so well defined in some families of fishes, for example in Cyprinidae.

The body of the dentary is compact in its anterior part, but, as it grows posteriorly, it separates into two laminae, leaving a cavity between them --the Meckelian fossa. This fossa encloses Meckel's cartilage and lodges the anterior part of the angular. Both laminae end, in most cases, short of the tips of the posterior processes forming in their middle part a notch of variable amplitude, called more appropriately the mesial and the lateral incisures. The two laminae do not often end at the same level, a characteristic that can be used to differentiate species in combination with other features.

On the lateral face of the dentary there are several anatomical landmarks. Close to the anterior margin opens the mental foramen for the passage of a ramification of the mandibular branch of the trigeminal nerve. This foramen can run directly through the bone forming a canal perpendicular to the surface of the bone. In other cases the canal joining both openings is at a slant. This results in an outer opening more or less prolonged, with its anterior border well defined and the posterior extended posteriorly, as in an elongated "c."

On the lower part of the body of the dentary is sometimes present a flare of bone -the body crest -that lodges or simply protrudes above the mandibular section of the sensory lateral line. In the former case, the sensory pores can still be seen along the length of the canal, but in the latter case, the pores have disappeared with the soft tissues of the lateral line.

The dentary bone as its name implies is, in most cases, associated with teeth.

VIII.3.3 Specific descriptions of the dentary

In the ratio ML/MH (maximum length/maximum height) for the dentary, ML is replaced by SVP or SCP, depending on which of the two dimensions represents the maximum length of the bone. See Fig. 9.

Clupea harengus Atlantic herring

Symphysial margin convex (Plate 1). Dorsal margin divided into three sections: the first one, convex; the second, concave, and the third, almost horizontal. From the anterior part of the bone grows a narrow band of solid bone that reaches the highest point of the upper border; two more bands of the same type of tissue run backward forming the sensory canal and shelf. Coronoid process in form of an alar membrane extending back 4/5 of the length of the bone. The ventral process extends farther than the coronoid process. Teeth absent.

The ratio SVP/MH varies from 1.83 to 2.19 (mean = 2.06) based on 13 specimens.

Alosa aestivalis Blueback herring

Symphysial border inclined downward and backward (Plate 2). Upper margin straight and tilted upward in its first half and horizontal in its second half. The coronoid process forms a large transparent membrane pointed at the back. It ends close to the middle section of the ventral process. Ventral process long, strong and tapering at the end. The lateral wall extends farther than the mesial. Sensory canal and shelf prominent, with some pores. Teeth absent.

The ratio SVP/MH varies from 1.39 to 2.20 (mean = 2.01) based on 25 specimens.

Alosa pseudoharengus Gaspereau

Symphysial border inclined downward and backward (Plate 3). Upper margin straight and tilted upward in its first part and almost horizontal on top. The body of the bone is well ossified. Ventral process, pointed and long. The lateral wall expands into a large transparent alar membrane (=coronoid process) with its posterior margin convex. It reaches farther than the mesial wall, which can be considered absent, although a notch formed by strong bony tissue implies the end of the inner wall. Teeth absent. The long sensory canal and the shelf extend the whole length of the ventral process. Several pores, some elongated, can be detected.

The ratio SVP/MH varies from 1.80 to 1.97 (mean = 1.90) based on 20 specimens.

Alosa sapidissima Shad

Symphysial border inclined downward and backward (Plate 4). Upper margin straight and tilted upward. The body of the bone is well ossified. Ventral process long and pointed. Lateral wall (=coronoid process) expands into a large transparent alar membrane with its posterior margin convex. It extends farther than the mesial wall, which can be considered absent, although there is a notch formed by strong bony tissue which implies the end of the inner wall. Teeth absent.

The long sensory canal and the shelf extends the whole length of the ventral process. Several pores, some elongated, can be detected.

The ratio SVP/MH varies from 1.89 to 2.78 (mean = 2.37) based on 8 specimens.

Anguilla rostrata Eel

Anterior margin, convex (Plate 5). Dorsal margin, straight, tilting upwards at 4/5 of its length. Posterior margin with two deep indentations, delimiting three round lobes: the upper, small; the middle large, and the lower small and pointed. The mesial wall is shorter than the lateral wall. Ventral margin, slightly concave. Coronoid process, small and round. Ventral process, extending farther than the coronoid. Sensory canal with some pores prominent, extending from the mental foramen to the lower posterior incisure. Dental plate extends to the coronoid process.

The ratio SVP/MH varies from 3.56 to 5.20 (mean = 4.35) based on 11 specimens.

Salmo salar Salmon

Symphysial margin slightly bilobate; the inferior lobe forms a pointed mental process (Plate 6). Dorsal margin straight as far as the beginning of the coronoid process. The mesial wall much shorter than the lateral. Ventral margin more or less straight. No mental foramen visible. Coronoid process, narrow ending in a round expansion. The ventral process, longer than the coronoid, is wider; with truncated extremity. A sensory canal runs the whole length of the bone's body. Ventral process with some pores visible.

Dental plate ending short of the dorsal margin. Six to eight scattered teeth in a single row.

The ratio SVP/MH varies from 2.69 to 3.74 (mean = 3.07) based on 4 specimens.

Salvelinus fontinalis Brook trout

Symphysial margin, bilobated (Plate 7). Ventral lobe forming a clear mental process. Upper margin, concave. Coronoid process, enlarged. Ventral process, slender and longer than the coronoid. Mesial wall much shorter than the lateral. The angles formed in the mesial and lateral walls of the Meckelian fossa are curved. A sensory canal runs the whole length of the bone's body. The ventral process shows some pores. No mental foramen visible.

The dental plate ends at the expansion of the upper margin. Teeth acrodont, curved, pointed, spaced and set in a single row.

The ratio SVP/MH varies from 3.31 to 4.94 (mean = 3.58) based on 16 specimens.

Osmerus mordax Smelt

Symphysial border bilobed; the lower lobe forms a pointed apophysis (Plate 8). Upper margin straight; the ventral margin slightly convex. Coronoid process enlarged into an ellipsoid lamina at the aboral end. Lateral wall extending farther than the mesial. The ventral process extends farther than the coronoid. A sensory canal runs its whole length. No mental foramen detected.

The dental plate ends at the expansion of the coronoid process. Teeth acrodont, sharp, curved, spaced and in a single row.

The ratio SVP/MH varies from 1.36 to 3.30 (mean = 2.72) based on 5 specimens.

Catostomus commersoni White sucker

Symphysial margin, horizontal; mental apophysis directed backwards (Plate 9). Dorsal margin, straight on its first half and separated by a notch from the coronoid process. The coronoid process has arched outline. Two foramina on the lateral side run through the bone and open on the mesial side.

The ventral margin forms an ample curve downward. Posterior margin bilobed. The ventral process is formed by a large membrane with its posterior margin convex.

No teeth, even in young specimens.

The ratio SVP/MH varies from 1.11 to 1.51 (mean = 1.32) based on 17 specimens.

Gadus morhua Cod

Anterior margin vertical, bilobate; lower lobe forming a prominent mental apophysis (Plate 10). Dorsal margin, slightly concave, tilted upwards. The lateral wall shorter than the mesial. Ventral margin almost in a straight line. Mental foramen large and ovoid in outline. Coronoid process, long and narrow with pointed tip. Ventral process wider, truncated at its end, but forming a narrow apophysis in its upper third section.

The sensory canal and its shelf run the whole length of the bone's body and the ventral process. Four or five sensory pores visible.

Dental plate running for two thirds of the upper margin. Teeth acrodont, long, pointed, sharp, set in several rows depending on the age of the fish.

See observation on *Gadus morhua* included in the conclusions on page 178 of this report.

Melanogrammus aeglefinus Haddock

Symphysial margin tilted backward, bilobed; the inferior, forms a small mental apophysis (Plate 11). Dorsal margin concave. The lateral wall, shorter than the mesial. Ventral margin, clearly convex. Mental foramen, oblong. Coronoid process, narrow and pointed; the ventral process extends downward in a large wing; posterior border, bilobed. Sensory canal and shelf extending the whole length of the body and the ventral process. Four enlarged pores visible.

The dental plate extends two thirds of the upper margin.

The ratio SVP/MH varies from 2.29 to 2.38 (mean = 2.33) based on 2 specimens.

Pollachius virens Pollock

Symphysial margin bilobed; mental apophysis present (Plate 12). Dorsal margin, slightly convex and tilted upwards. Posterior margin, deeply indented in an acute angle. Mesial wall, longer than the lateral. Ventral margin straight, bent upward at the end. Mental foramen circular. Coronoid process, long and pointed; ventral process, longer and slightly bilobate. Sensory canal and shelf extending from the mental symphysis to the tip of the ventral margin with some (4) pores visible.

Dental plate extending along two thirds of dorsal margin, up to three rows of teeth at the anterior end of the bone.

The ratio SVP/MH varies from 2.60 to 3.44 (mean = 3.06) based on 17 specimens.

Brosme brosme Cusk

Symphysial margin bilobular (Plate 13). Mental apophysis strong. Upper margin, slightly concave. Mental foramen, close to the upper border. Lateral wall extending farther than the mesial. Coronoid process strong, ending a little shorter than the ventral process. Sensory canal and shelf, prominent, with several (4) pores visible. Ventral process wide and strong with its posterior end jagged.

Dental plate extending almost to the tip of the coronoid process. Teeth acrodont small, pointed, well-packed in several rows.

The ratio SVP/MH varies from 2.78 to 2.96 (mean = 2.87) based on 8 specimens.

Microgadus tomcod Tomcod

Symphysial margin bilobular (Plate 14). Upper margin slightly concave. Mesial wall longer than the lateral. The angles of the mesial and lateral walls of the Meckelian fossa, curved. Mental foramen elongated. Coronoid process slender and pointed. Ventral margin straight, tilted upward towards the end. End truncated. Sensory canal and shelf extending from the mental symphysis up to the tip of the ventral margin. Four pores clearly visible.

Dental plate extending three quarters of the length of the upper border.

The ratio SVP/MH varies from 2.10 to 2.65 (mean = 2.29) based on 4 specimens.

Merluccius bilinearis Silver hake

Symphysial margin, straight and tilted downward (Plate 15). Upper margin concave, except for the last fifth of its length, where it is straight. Coronoid process pointed. Lateral wall extending a little farther than the mesial. A deep sensory canal and its shelf run the whole length of the ventral process. Several pores visible. Ventral process, strong, ending at the same level than the coronoid process.

Dental plate extending almost the whole length of the upper margin. Teeth acrodont, long, conical, curved, spaced, and set in two rows.

The ratio SVP/MH varies from 3.56 to 4.50 (mean = 4.01) based on 15 specimens.

Lophius americanus Goosefish

Large bone with the symphysial margin wide and inclined outward and downward (Plate 16). Coronoid process, long and pointed. Ventral process pointed and shorter than the coronoid. Mental foramen, narrow and elongated, located at one third the length of the bone. Lateral wall shorter than the mesial. Bone spongy, not well ossified.

Dental plate extending almost the whole length of the upper margin. Teeth acrodont, long, pointed in and backward set into two or three rows.

The ratio SCP/MH varies from 6.64 to 7.04 (mean = 6.88) based on 3 specimens.

Myoxocephalus octodecimspinosus Longhorn sculpin

Symphysial border straight, slightly tilted backwards (Plate 17). Upper border straight. Coronoid process pointed. Mesial wall ending shorter than the lateral. A long groove separates the coronoid and ventral processes. Ventral process wide extending a little farther than the coronoid process. The sensory canal and its shelf extend from the mental symphysis down to the tip of the ventral margin. Several (3-4) large pores clearly visible. Mental foramen circular, close to the dental plate.

Dental plate extending almost to the end of the dorsal margin. Teeth acrodont, small, curved, sharp and well-packed in several rows.

The ratio SVP/MH varies from 2.55 to 3.23 (mean = 2.82) based on 9 specimens.

Hemitripterus americanus Sea raven

Symphysial margin straight, sloping down and backwards (Plate 18). Mental apohysis prominent. Upper margin straight. Coronoid process, wide and tapering but with an expansion at its end; it extends farther than the ventral process. Mental foramen, high with oblong opening. Lateral wall of the Meckelian fossa extending farther than the mesial wall. Ventral border concave, tilted upwards at the end of the bone. Ventral process wide. Sensory canal and shelf extending from the mental symphysis up to the tip of the ventral margin. Two large pores visible.

Dental plate extending almost the whole length of the upper border. Teeth acrodont, small, curved, pointed, and well-packed in several rows.

The ratio SCP/MH varies from 2.96 to 4.86 (mean = 3.82) based on 4 specimens.

Scomber scombrus Mackerel

Symphysial margin inclined backwards (Plate 19). Dorsal margin, straight and tilted upwards with a single row of small teeth. Mental foramen, small and high on the side. Posterior margin, deeply indented, with coronoid process shorter than the ventral process. Mesial wall shorter than the lateral. Ventral margin, slightly convex.

Dental plate narrow with small teeth implanted in a single row.

The ratio SVP/MH varies from 2.06 to 2.70 (mean = 2.35) based on 27 specimens.

Hippoglossoides platessoides Canadian plaice

Symphysial border, straight inclined backwards with a prominent mental process (Plate 20). Upper margin straight. Coronoid process wide, tapering at the end. Ventral process very wide, rounded at the end. Both processes of same length. A sensory canal and shelf present with several pores. Mental foramen high on the lateral wall and half way of its length. Lateral wall extending a little farther than the mesial.

Dental plate extending almost 4/5ths of the length of the upper border. Teeth acrodont, straight, spaced in single row.

The ratio SVP/MH is different for both dentaries. The left dentary varies from 2.43 to 2.90 (mean = 2.59) and the right, from 1.76 to 4.06 (mean = 3.42), both based on 7 specimens.

Pseudopleuronectes americanus Winter flounder

Symphysial border, straight and strongly inclined downward and backwards (Plate 21). Upper margin, slightly concave. Ventral border concave. Ventral process wide. Coronoid and ventral processes of same length. Mesial incisure round. Lateral wall extending a little farther than the mesial. Sensory canal and shelf with 6 pores. Mental foramen high on the lateral side and midway of its length.

Dental plate extending almost till the end of the coronoid process. Teeth acrodont, spatulate, and packed in a single row.

The ratio ML/MH on the left side varies from 1.35 to 1.40 (mean = 1.37) based on 2 specimens.

VIII.4 The Angular (ANG)

VIII.4.1 Definition and synonymy

The angular is a paired bone of mixed origin, partially endochondral, but predominantly membraneous, that forms the posterior part of the mandible. Although many authors call it articular, Haines (1937) and Lekander (1949) showed that it should be called angular, since the membraneous part that constitutes the larger part of this bone corresponds to the true angular.

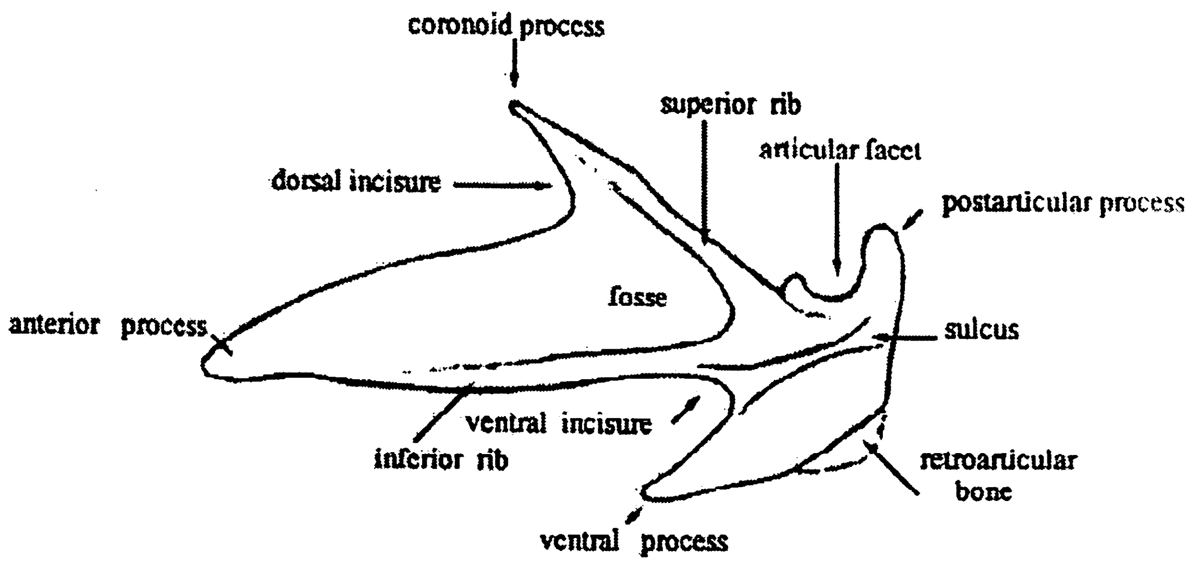
The angular has also been called articular (Gregory, 1933; Berg, 1940) and dermoarticular (Goodrich, 1930)

VIII.4.2 General morphology of the angular

The shape of the angular (Fig. 6) is reminiscent of an arrow with a pointed shaft. The three points of the arrowhead correspond to the coronoid process, which occupies a dorsal position; the postarticular, located aborally; and the ventral, below the body of the bone. The pointed shaft of the arrow is represented by the anterior process, which extends forward.

The coronoid process abuts the coronoid process of the dentary while the anterior process of the angular fits firmly into the angle formed by the coronoid and the ventral processes of the dentary restricting somewhat the movement between the two bones.

Fig. 6. Morphological features of the angular bone.



On the back of the angular there is a concavity where the quadrate articulates through a condyle. In this way, the lower mandible connects to the skull via the suspensorium. The postarticular process, very often unciform in shape, extends upward, backward or, in a few cases, horizontally.

On the lateral face of the body of the angular there is sometimes a large depression called the prearticular fossa. A superior crest reinforces the margin of the coronoid process and a ventral crest runs parallel to the anterior process. In the posterior part of the angular there is often present an uncinate expansion with two apophyses or processes: the postarticular, directed upward or backward, or in a few cases, horizontally; and the ventral process. On the mesial side of the bone there is sometimes a depression, called the internal fossa, which in some fishes splits into two.

On the posterior angle of the angular there is a small bone, the retroarticular or angular of *authors*. This last bone has very little value for our purpose in archaeological studies, except possibly in very large specimens.

VIII.4.3 Specific descriptions of the angular

Clupea harengus Atlantic herring

Subtriangular in shape and laminar in texture (Plate 1). Anterior process, pointed. Coronoid, round. Postarticular, wide and blunt, directed back and upwards. Superior and inferior "ribs" prominent; fossae, shallow. Subarticular sulcus, prominent. The margin between the ends of the anterior and coronoid processes has a sigmoid outline. The ratio ML/MH varies from 1.82 to 3.43 (mean = 2.05) based on 13 specimens.

Alosa aestivalis Blueback herring

Bone of subtriangular shape and laminar texture (Plate 2). Anterior process pointed; coronoid, pointed, ending well ahead of the ventral; postarticular, short, round, with a posterior knob; ventral short with no ventral incisure.

Superior and inferior ribs prominent. Fossae shallow. The margin between the points of the anterior and coronoid processes, sinuous; its convex section longer than the concave.

The ratio ML/MH varies from 1.75 to 2.23 (mean = 1.95) based on 26 specimens.

Alosa pseudoharengus Gaspereau

Bone of subtriangular shape and laminar texture (Plate 3). Anterior process pointed; coronoid, pointed, ending well ahead of the ventral; postarticular process, short, round, with a posterior knob; ventral process, short with no ventral incisure. Superior and inferior "ribs" prominent. Fossae shallow. The margin between the points of the anterior and coronoid processes, sinuous; its convex and concave sections of equal length.

The ratio ML/MH varies from 1.50 to 2.11 (mean = 1.74) based on 20 specimens.

Alosa sapidissima Shad

Subtriangular and laminar bone (Plate 4). Anterior process long and pointed. Coronoid, long and pointed, ending slightly ahead of the ventral process. Postarticular, strong and round. Ventral process, narrow and pointed; barely insinuated. Superior and inferior "ribs" prominent. Prearticular and internal fossae, shallow. Margin between the points of the anterior and coronoid processes, sinuous: its convex section long and flattened; its convex, deep. Apophysis for Meckel's cartilage, strong and long.

The ratio ML/MH varies from 1.58 to 2.34 (mean = 1.94) based on 7 specimens.

Anguilla rostrata Eel

General shape, subtriangular (Plate 5). Anterior process pointed; coronoid process, short and blunt; postarticular process, absent; ventral process very thin, pointed and running parallel to the ventral margin, ending well ahead of the coronoid. Deep ventral incisure.

Strong superior "rib". Prearticular fossa, very shallow; internal fossa, long, deep and narrow, formed by the lateral wall and an internal shelf of bone.

The ratio ML/MH varies from 2.95 to 4.60 (mean = 3.30) based on 11 specimens.

Salmo salar Salmon

Well-ossified bone (Plate 6). Four processes: anterior, long and blunt; the coronoid process pointed and insinuated, with its posterior margin convex; the posterior process, long, vertical, unciform and pointed; the ventral process, thin, with a shallow ventral incisure, its ventral border inclined in relation to the axis of the bone.

The coronoid process ends farther ahead than the ventral process. In front of the articular facet there is a small spine. Superior "rib" almost absent; inferior "rib" extending till the end of the anterior process. Prearticular fossa, shallow; internal fossa, deep. Coronomeckelian bone present. Apophysis for Meckel's cartilage prominent,

The ratio ML/MH varies from 2.37 to 2.96 (mean = 2.70) based on 4 specimens.

Salvelinus fontinalis Brook trout

Well-ossified bone (Plate 7). Four processes: anterior process, long; coronoid process, short and pointed, ending ahead of the ventral; coronoid incisure noticeable; postarticular process, round; ventral process, horizontal and blunt. Superior crest, strong, running the full length of the coronoid process. In the anterior border of the articular facet there is a clear knob of bone. Apophysis for Meckel's cartilage prominent.

The ratio ML/MH varies from 2.44 to 3.10 (mean = 2.78) based on 15 specimens.

Osmerus mordax Smelt

Thin, fragile, and transparent bone (Plate 8). Anterior process pointed; coronoid process, blended with the dorsal margin of the bone. Postarticular process, prominent, unciform. The ventral process, subquadrangular in shape, short and blunt. Superior and inferior ribs strong for their lower half length. Prearticular and internal fossa present.

The ratio ML/MH varies from 2.75 to 3.86 (mean = 3.12) based on 5 specimens.

Catostomus commersoni White sucker

The angular of the white sucker doesn't show the characteristic shape of most angulars (Plate 9). The general outline is oval. No processes. The articular notch is at a slant. The postarticular process very small and horizontally oriented. External facet smooth; the internal process has a shallow fossa.

The ratio ML/MH varies from 1.96 to 2.84 (mean = 2.40) based on 16 specimens.

Gadus morhua Cod

Strong and well-ossified bone (Plate 10). Four processes: anterior process, long and round, slightly jagged; coronoid process short and round ending farther forward than the ventral; postarticular long, unciform; ventral subquadrangular, expanded, pointed forward and downward. Superior "rib", short, strong from its base up to a third of its length; the inferior "rib" strong, running the whole length of the anterior process. Under the ventral "rib" there is a long furrow. Prearticular fossa visible; long and deep subarticular sulcus. Mesial wall with a fossa. Apophysis for the Meckel's cartilage, prominent.

See observation on *Gadus morhua* in the conclusions on page 178 of this report.

Melanogrammus aeglefinus Haddock

Strong, well-ossified bone (Plate 11). Four processes present: the anterior, blunt and slightly jagged at its end; the coronoid, wide, short, jagged, ending a little ahead of the ventral; the postarticular process, unciform, short and strong; the ventral, long, pointed showing two tuberosities. Deep subarticular sulcus. Superior "rib", robust at its base; ventral rib, running the whole length of the anterior process. Deep internal fossa. The process for the attachment of Meckel's cartilage, prominent.

The ratio ML/MH varies from 2.03 to 2.29 (mean = 2.12) based on 3 specimens.

Pollachius virens Pollock

Strong and well-ossified bone (Plate 12). Four processes present: the anterior ends abruptly; the coronoid, short and blunt, ends farther ahead than the ventral; the ventral, strong, pointed and expanded; the postarticular strong, pointed, and unciform. The superior "rib" visible only at its base, while the inferior runs the whole length of the anterior process. Prearticular fossa present. Strong subarticular sulcus. Shallow inferior fossa.

The ratio ML/MH varies from 2.11 to 3.28 (mean = 2.34) based on 16 specimens.

Brosme brosme Cusk

Strong and well ossified bone (Plate 13). Four processes present. Anterior process, triangular in shape with abrupt ending. Coronoid, short, wide, with its anterior margin jagged. It ends at the same level as the ventral. Coronoid incisure short. Postarticular process, strong, unciform, perpendicular to the long axis of the bone. The ventral process long and wide, with a convex margin. Subarticular sulcus present, with its central part covered by a bony bridge. Inner facet with two fossae: the dorsal, deep; the ventral, shallow.

The ratio ML/MH varies from 3.00 to 3.08 (mean = 3.04) based on 2 specimens.

Microgadus tomcod Tomcod

Small, well-ossified bone (Plate 14). Four processes: the anterior, long and blunt at its end; the coronoid, forming an angle of 45° with the anterior process; the postarticular, leaning backward. Ventral process pointed downward and forward. A deep furrow present between the ventral and the anterior processes. On the lateral facet, the prearticular fossa extends under a bony shelf.

The ratio ML/MH varies from 1.60 to 2.03 (mean = 1.88) based on 4 specimens.

Merluccius bilinearis Silver hake

Four processes present: the anterior, with jagged outline; the coronoid, thin and blunt; the postarticular round; ventral process long, thin, well defined, with convex border. The ventral incisure, deep and narrow (Plate 15). On the lateral facet, prominent superior and the inferior ribs. The prearticular fossa is shallow. There is a deep internal fossa on the mesial side.

The ratio ML/MH varies from 1.79 to 3.31 (mean = 2.61) based on 15 specimens.

Lophius americanus Goosefish

Light ossified bone (Plate 16). It lacks the typical shape of most angulars. Anterior process pointed, with the upper margin straight. Coronoid process absent, although it can be considered to be fused with the anterior. Postarticular process elongated posteriorly, pyramidal. Articulation facet horizontal, with two extra processes: a lateral ending in a spine and a mesial, round. Ventral process absent. Superior "rib" absent, but the inferior is prominent and runs the whole length of the anterior process. Very shallow subarticular fossa. Internal fossa, deep and long.

The ratio ML/MH varies from 5.58 to 6.44 (mean = 6.15) based on 4 specimens.

Myoxocephalus octodecimspinosus Longhorn sculpin

Well-ossified bone (Plate 17). Four processes: the anterior, strong, long and pointed; the coronoid, slender, at a 45° angle with the anterior, deep coronoid incisure; the postarticular process, clearly visible, and the ventral, wide, more advanced than the coronoid. On the lateral face there are two fossae: the dorsal, large, extending under a shelf of bone; the ventral, shorter but deeper forms a cavity. There are several prominent "ribs". On the mesial side there are two shallow fossae.

The ratio ML/MH varies from 1.67 to 1.90 (mean = 1.77) based on 11 specimens.

Hemitripterus americanus Sea raven

Four processes (Plate 18). The anterior is long, pointed, wide and it is reinforced with a ventral "rib." The coronoid is narrow, blunt and runs forward and upward. Between both, there is a fossa -the prearticular fossa. The postarticular process, stout and short; ventral process, wide, strong, with jagged convex margin. On the inner wall there are two fossae: dorsal and ventral. The dorsal, deep, located between the coronoid and the anterior process; apophysis for Meckle's cartilage, visible. The ventral fossa is formed by the ventral process and a bony expansion of the articular facet. Between both fossae there is an elongated foramen.

The ratio ML/MH varies from 1.70 to 1.93 (mean = 1.85) based on 4 specimens.

Scomber scombrus Mackerel

Four processes (coronoid, anterior, ventral and postarticular) well defined (Plate 19). Anterior process, long and strong, ending in a translucent, pointed lamina; coronoid process short, ending in a point directed orally; ventral process, sharp, pointed and long, ending ahead of the coronoid. The unciform postarticular curves upward. Internal fossa shallow.

The ratio ML/MH varies from 1.62 to 2.76 (mean = 2.48) based on 30 specimens.

Hippoglossoides platessoides Canadian plaice

Four processes (Plate 20). The anterior, pointed and with a prominent rib. The coronoid, thin, slants forward at a 45° angle; its posterior margin is reinforced and advances forward ahead of the ventral process. Between both processes there is a shallow fossa. The postarticular process is strong and runs perpendicularly to the longitudinal axis of the bone. The ventral process long, wide, ending in a jagged margin. In the internal facet of the bone there are two fossae: the dorsal, triangular, deep, between the coronoid process and the anterior process. The ventral fossa, shallow and long. Two deep, parallel grooves below the articular facet: the dorsal, longer than the ventral. The apophysis for Meckle's cartilage clearly visible.

The ratio ML/MH is different for both angulars. The left angular varies from 2.40 to 2.87 (mean = 2.67) and for the right, from 1.91 to 2.87 (mean = 2.31), both based on 7 specimens.

Pseudopleuronectes americanus Winter flounder

Small and strong bone (Plate 21). Four processes. The anterior strong, short and blunt. Both, the coronoid and the ventral short and slightly pointed. The coronoid a little more advanced than the ventral. The postarticular, short and blunt. Lateral face bulging; the inner fossa deep. The apophysis for the attachment of Meckel's cartilage prominent.

The ratio ML/MH for the left angular varies from 1.81 to 1.85 (mean = 1.83) and for the right angular between 2.00 to 2.14 (mean = 2.07), both based on 2 specimens.

IX. BIOMETRIC STUDY OF THE JAW BONES

IX.1 Introduction

The second objective of this work was to provide information about the possibility of estimating the size of the live fish using the size of bones, whole or fractionated. To accomplish this goal, skeletons of the 21 most likely species to be found in archaeological middens were prepared. The number of individuals used for each species is variable since it depended on their availability in the field and in the local markets.

The three linear parameters most often used in biological research (total, fork, and standard length) were recorded to represent the fish length. All lengths were taken as the straight distance between the perpendiculars drawn at two selected points of the fish, and not following the curve of the fish body. Although there are several ways to take the total and the standard lengths, only one in each case was used as defined below.

The total length was taken between the anteriormost point of the snout to the end of the longest caudal fin ray, after squeezing the caudal lobes towards the middle line. The fork length was taken from this same anteriormost point to the end of the median rays of the tail. The standard length was taken, as in most biological works, from the snout to the end of the vertebral column, i.e. to the base or beginning of the caudal fins. All three measurements were taken to the nearest millimeter.

The total weight was taken with an approximation of 0.1 of a gram. This weight is the most commonly used, but its value in dietary studies is reduced since several body parts (scales, bones, gills, stomach and intestine), which are not eaten, are included in the value.

The dressed weight was taken after the fish was eviscerated. Its value was recorded with an approximation of 0.1 of a gram. For fish of commercial size, this weight doesn't represent either a good value, since there are highly-nutritional organs, the most important being the gonads and the liver, which are not included here.

For each bone, I have selected certain dimensions that I consider to be easily recognized and measured. These measurements vary from bone to bone. For the same bone, it is not always possible to take the measurements selected, because the shape and certain anatomical landmarks vary from family to family. The premaxillary and the maxillary have shown more morphological and functional variability through evolution than their counterparts of the lower mandible, the dentary and the angular. The shape of these latter bones is much more consistent.

Since the data presented here, is for several reasons scanty, those interested in finding the relationships between length and weights should refer to other studies. Here, these relationships have been calculated only for some species, when the number of individuals warranted it.

The following tables show the original data for each specimen, both for the live fish and for each of the four bones of the buccal apparatus. Linear regression equations have been calculated between the total length (dependent variable) and the fork and the standard lengths, as independent variables. The calculated equations will help when, in fishery research, one only length (total, fork or standard) has been related to the fish weight. In this study, all these equations show a strong correlation between the total length and the other two lengths, as is reflected in the high values of their coefficients.

Equations for the relationship between total length and both weights, total and dressed, have been calculated and presented here in their exponential form. Total weight shows more variability than length for fish of the same age, because it depends on several very variable factors, such as stomach content, gonad maturation, health condition, degree of parasitism, etc.

One of the more valuable objectives for archaeologists and biologists is the determination of the live fish size from the bone dimensions. For each bone, I have presented a series of equations relating the total length to each dimension. Some of these pairs of values are highly correlated; others are less so. Some values were not included in the tables, because they indicated a poor correlation. Only a few in this category were given, to illustrate that we have to first test every dimension to see whether it is useful or not for archaeological work.

The reasons for the variable value of each dimension selected are many. Some are inherent to the bone features. An example of this type is the value for the body height of the maxillary, because of the difficulty in finding the two points most widely apart in a structure which is not uniformly regular. Other reasons arise from the methodology, as in the case of the naturally bent bones or those warped during the preparation process. Other reasons are due to taphonomic factors, as when the spiny or laminar expansions of the bones are eroded or altogether missing. The most important biological reason, however, could be the allometric growth of certain bone parameters in relation to the growth of the fish. This and many other problems could not be studied in detail here, because of the exploratory nature of this work.

Similarly no effort has been made in this paper to find the homologies between anatomical features in the different species selected. Until these homologies are ascertained, no uniform methodology can be used in most cases. There have been attempts to standardize the methods for taking biometric measurements (Morales and Roselund, 1979; Roselló 1990), but for the moment, I suspect, the only standardization possible is at the family level.

IX.2 Maximum or usual size of Nova Scotia fishes

To give some idea of the size of the bones to be expected in the middens, I am indicating here the size which has been recorded for Nova Scotia or adjacent regions fish. These values can be compared with the values of the fish and bones presented in the tables that follow. In some cases, the fish length, whether total, fork or standard, has not been specified in the original sources, but it is assumed that they meant total length.

Deep sea commercial marine fishes, such as cod, haddock, halibut, flatfishes, etc. can reach different sizes at the same age in different stocks. Since only littoral specimens from those species are expected to be found in the middens no data are offered for them. A similar observation applies to diadromous fishes (salmon and eel).

Clupea harengus. Atlantic herring

Jean (1956) has given the following data for the Gulf of St. Lawrence: spring spawners have a total length value of 35.7 cm, while fall spawners reach up to 37.3 cm.

Salvelinus fontinalis Brook trout

Wilder (1952) gives the standard length for the sea-run as 39.6 cm and 27.4 cm for the freshwater run in the Moser River, N. S.

Osmerus mordax Smelt

McKenzie (1964) gives the length (not specified whether total, fork or standard) in Miramichi River, N. B. as 18 cm for males and 20.6 for females.

Lophius americanus Goosefish

Connolly (1920) estimated the length from the otoliths as 76.2 cm at 9 years and 101.6 cm for the 12 years-old.

Merluccius bilinearis Silver hake

Hunt (1978) gives the maximum size for males as 37 cm and 65 for females in the Scotian Shelf.

Microgadus tomcod Tomcod

No maximum values for length available, but Scott and Scott (1988) suggest 38 cm.

Pollachius virens Pollock

For the Bay of Fundy, Steele (1963) gives from 50 to 67 cm for fish between 4 and 7 years-old.

Brosme brosme Cusk

Oldham (1972) estimated the maximum length size for the Scotian Shelf as 72 for males and 68.9 cm for females.

Myoxocephalus octodecimspinosus Longhorn sculpin

The usual length of specimens caught is up to 35.6 cm in length (Scott and Scott, 1988)

Hemitripterus americanus Sea raven

Usually around 30 cm. in length (Scott and Scott, 1988)

Scomber scombrus Mackerel

Average size from 32 to 36 cm. At 11 years-old this fish can reach 39.6 cm (Scott and Scott, 1988)

Hippoglossoides platessoides Canadian Plaice

In the northern region of the Scotia Shelf this fish can reach a length of 22-23 cm at 4-5 years of age. Females reach 30 cm when 8 years-old.
(Scott and Scott, 1988)

Pseudopleuronectes americanus Winter flounder

In St. Mary's Bay, N. S. 8 year-old fish can attain a length of 42.4 cm. (Scott and Scott, 1988).

IX.3 Abbreviations

The following abbreviations have been used throughout this report:

NSM#	Nova Scotia Museum of Natural History (file number)
AR	Specimens from my personal collection
TFL	Total fish length
FFL	Fork fish length
SFL	Standard fish length
TFW	Total fish weight
DFW	Dressed fish weight
#T	Number of teeth
#R	Number of teeth rows
Y	Dependent variable
X	Independent variable
N	Number of individuals
r^2	Correlation coefficient
PMA	Premaxilla
MA	Maxilla
DE	Dentary
ANG	Angular

For the abbreviations of bone dimensions see the figures 7, 8, 9, and 10 in the following subdivisions.

IX.4. Data and Statistical Analysis

In the following tables are given the original data of length and weight of the live fish and the linear dimensions of their corresponding four buccal bones for each species; the regression equations between the most important parameters of the fish, which can be used to predict the size of the live fish using the bone parameters selected, and the correlation coefficient of each relationship.

Scatter diagrams are offered only for the premaxillary to give a visual representation of the degree of correlation between the paired values selected. These are omitted for the remaining bones (maxillary, dentary, and angular), since the regression equations and correlation coefficients provided are sufficient to show the type and the degree of the relationship between any two parameters.

At the end of the tables and to avoid repetition, information regarding the time of capture, fishing gear, location of the catches and some sample statistics of the live fish is presented only in the section for the premaxillary bone.

IX.4.1 Premaxillary

Figure 7 shows the different measurements taken on the premaxilla. All measurements were taken between the perpendiculars traced over the two points considered.

SAP = Distance between the anteriormost point of the premaxillary symphysis and the most posterior point of the articular process, when present.

SMP = Distance between the anteriormost point of the premaxillary symphysis and the most posterior of the maxillary process, when present.

ML (Maximum length) = Distance between the anteriormost point of the premaxillary symphysis and the posteriormost of the bone.

MH (Maximum height) = Distance between the dental plate (excluding the teeth) and the tip of the ascending process or the uppermost point of the bone when there is no ascending process.

HAP = Distance between the dental plate (excluding the teeth) and the most dorsal point of the articular process, when present.

HMP = Distance between the dental plate (excluding the teeth) and the most dorsal point of the maxillary process, when present.

DP = Dental plate length.

#T = Number of teeth.

#R = Number of teeth rows.

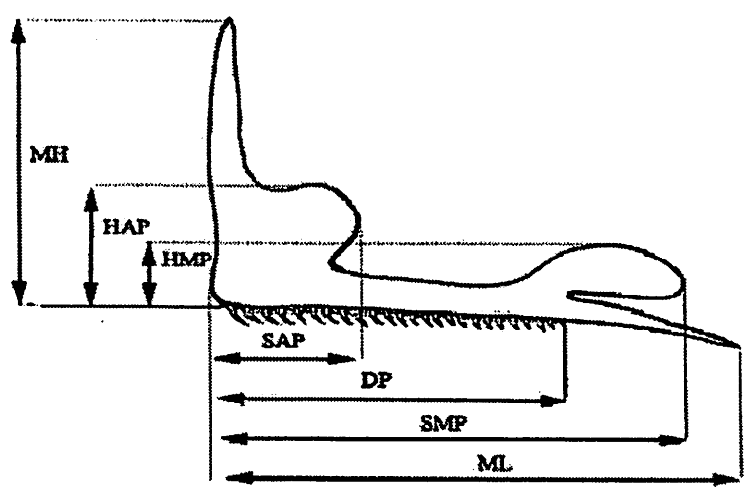


Fig. 7. Measurements aken on the premaxillary bone

Table 4. Original data of the live fish and the premaxillary bone, with the regression equations and the correlation coefficients (r^2) between them in Atlantic herring (*Clupea harengus*)

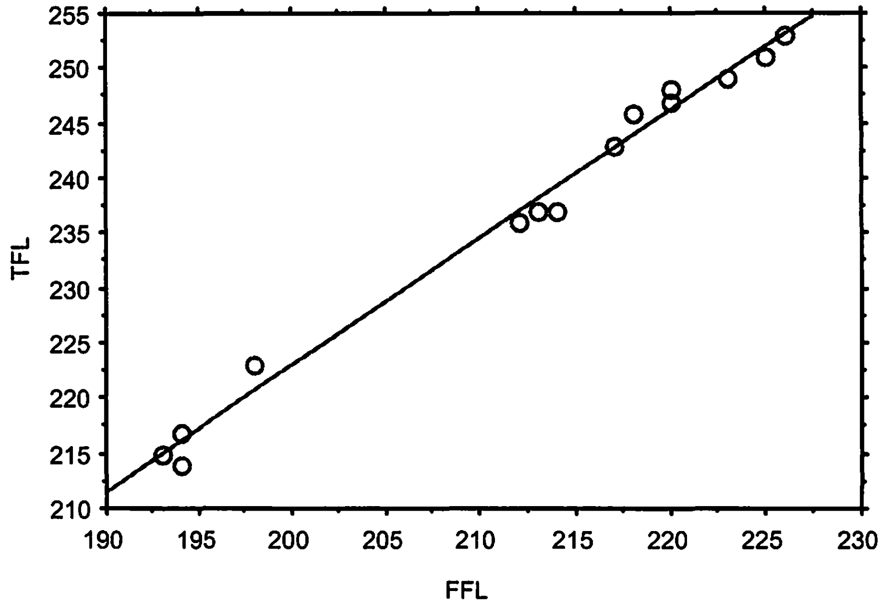
	FISH					PMA	
NSM#	TFL	FFL	SFL	TFW	DFW	ML	MH
12775	253	226	216	115.7	102.4	•	•
12776	237	213	203	93.5	83.0	•	•
12777	215	193	180	75.7	69.7	•	•
12778	237	214	198	94.0	85.8	•	•
12779	249	223	210	120.7	105.0	•	•
12780	223	198	188	86.8	78.5	•	•
12781	243	217	206	130.8	107.8	6.4	2.5
12782	217	194	184	80.6	72.7	6.8	2.4
12783	251	225	216	130.5	105.3	•	•
12784	248	220	209	115.5	96.5	•	•
12785	247	220	210	125.1	104.0	•	•
12786	246	218	207	98.7	91.5	6.8	2.8
12787	214	194	183	72.0	64.3	5.6	2.4
12788	236	212	203	91.2	84.5	•	•

VARIABLES Y	X	REGRESSION EQUATION	CORRELATION COEFF. r^2	N
1. TFL	FFL	Y = 1.155 X - 8.006	0.989	14
2. TFL	SFL	Y = 1.121 X + 11.645	0.976	14
3. TFL	TFW	log. Y = 0.269 log. X + 1.836	0.826	14
4. TFL	DFW	log. Y = 0.336 log. X + 1.721	0.892	14

Since the premaxillary bone in this species is very small, only a few measurements were taken to give some idea of its size. No regressions were calculated between the live fish data and the PMA dimensions.

SCATTER DIAGRAMS

1. Total length versus fork length



2. Total length versus standard length

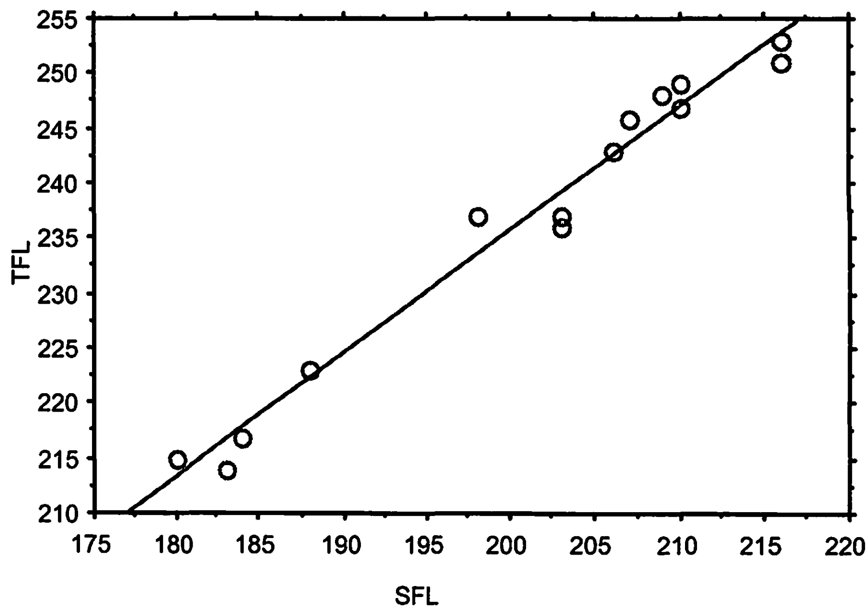
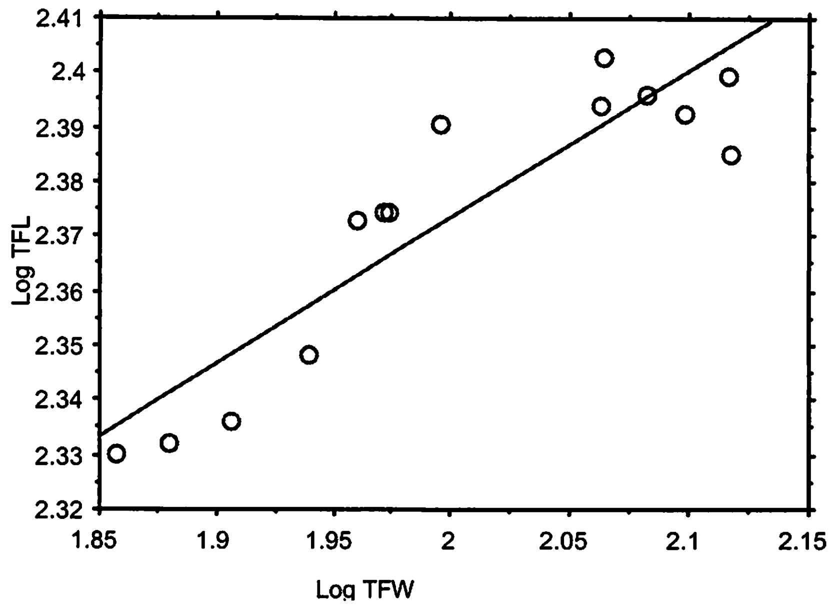
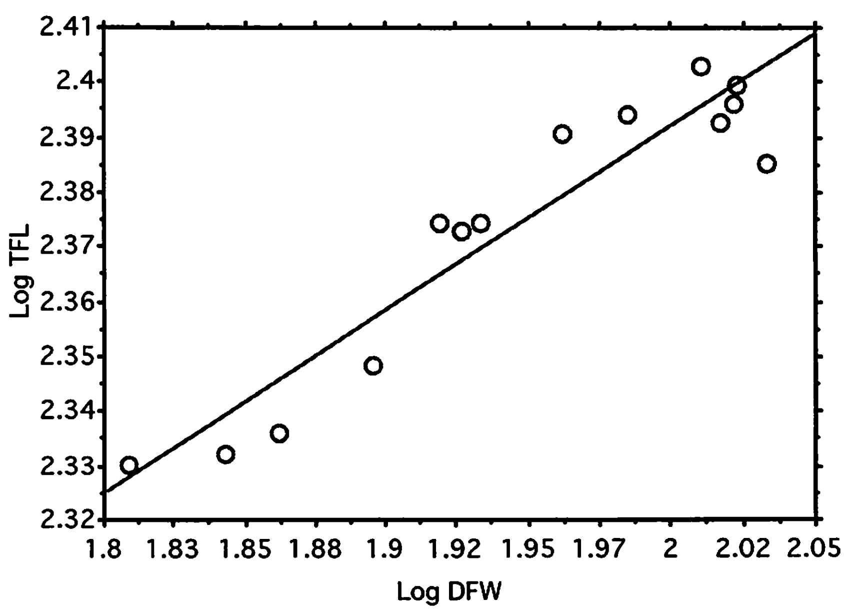


Table 4. (cont.)

3. Log. of total length versus log. of total weight



4. Log. of total length versus log. of dressed weight



The sample of Atlantic herring was taken in St. Margaret's Bay. N. S. in a mackerel trap on August 6, 1998.

Some statistics of the total fish length for this sample are the following: Range 214-253 mm; Mean 236.86 mm; St. dev. 5.74; Coeff. Var. 5.906

The premaxillary of the Clupeidae is very small and fragile. It is not likely to be found in the middens and consequently it is of no practical value for the archaeologist. This observation is valid for Atlantic herring, blueback herring, gaspereau, and shad.

Table 5. Original data of the live fish and the premaxillary bone, with the regression equations and the correlation coefficients (r^2) between them in blueback herring (*Alosa aestivalis*)

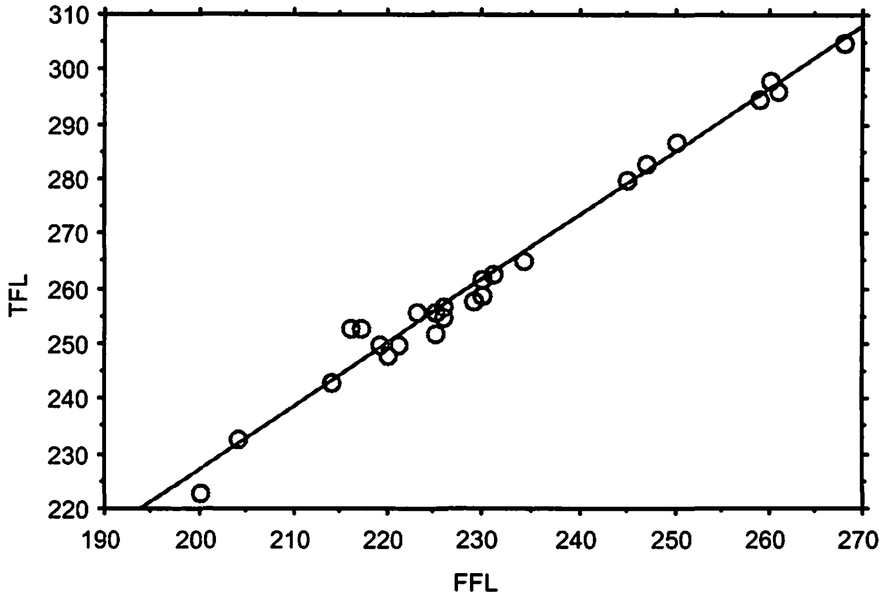
		FISH				PMA	
NSM#	TFL	FFL	SFL	TFW	DFW	ML	MH
11291	320	•	268	376.8	319.0	•	•
12714	263	231	222	128.8	111.6	6.1	2.0
12715	248	220	210	103.3	•	6.8	2.5
12716	283	247	231	146.3	134.0	6.5	3.0
12717	305	268	256	193.7	171.5	•	•
12718	298	260	247	221.3	178.0	•	•
12719	256	223	214	132.7	121.2	•	•
12720	252	225	201	129.8	116.8	•	•
12721	295	259	247	164.3	155.7	7.8	3.0
12722	296	261	250	171.8	161.5	7.3	3.3
12723	250	219	210	130.5	111.0	•	•
12724	262	230	221	118.8	107.0	•	•
12725	257	226	215	114.5	104.9	6.3	2.5
12726	233	204	•	88.5	81.3	6.0	2.6
12727	287	250	242	171.5	160.8	6.8	2.8
12728	265	234	222	123.8	114.0	6.7	2.8
12729	223	200	187	99.0	87.8	5.3	2.0
12730	250	221	210	110.6	102.5	•	•
12731	258	229	218	115.6	102.7	6.2	2.2
12732	253	217	210	107.5	•	5.8	2.6
12733	256	225	216	130.0	118.0	6.2	2.2
12734	259	230	218	135.5	127.2	•	•
12735	255	226	215	113.0	106.0	6.0	2.5
12736	280	245	236	158.0	146.6	•	•
12737	243	214	205	112.8	103.3	6.0	2.4
12738	253	216	209	107.0	98.7	•	•

VARIABLES Y	X	REGRESSION EQUATIONS	CORRELATION COEFF. R2	N
1. TFL	FFL	Y = 1.154 X - 3.62	0.983	25
2. TFL	SFL	Y = 1.169 X + 5.653	0.979	25
3. TFL	TFW	log. Y = 0.258 log. X + 1.872	0.813	26
4. TFL	DFW	log. Y = 0.280 log. X + 1.838	0.842	24
5. TFL	ML	Y = 28.889 X + 76.496	0.703	15
6. TFL	MH	Y = 42.308 X + 152.692	0.550	15

Table 5. (cont.)

SCATTER DIAGRAMS

1. Total length versus fork length



2. Total length versus standard length

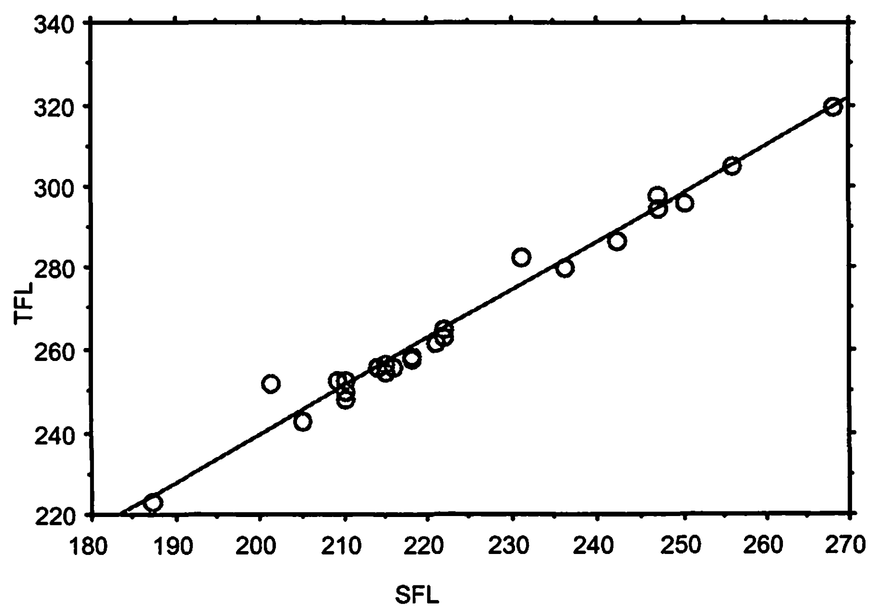
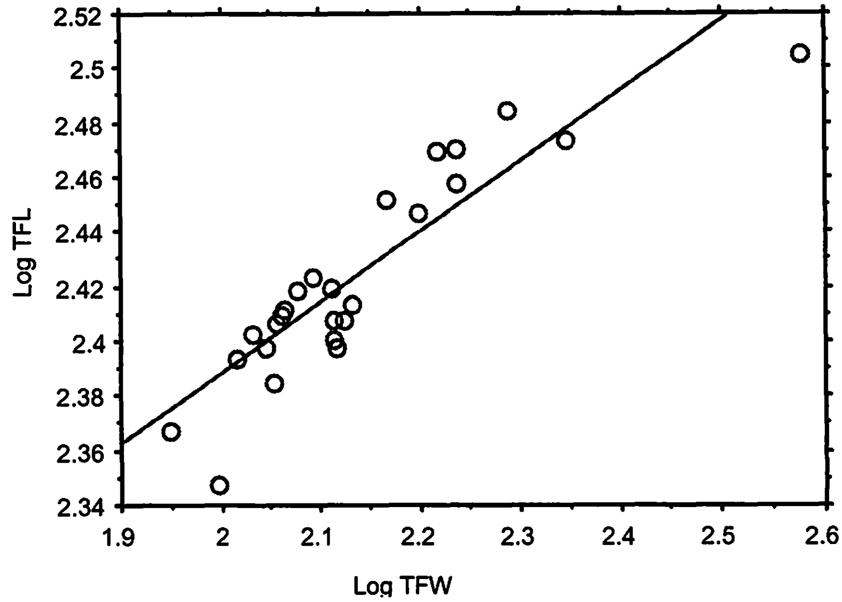
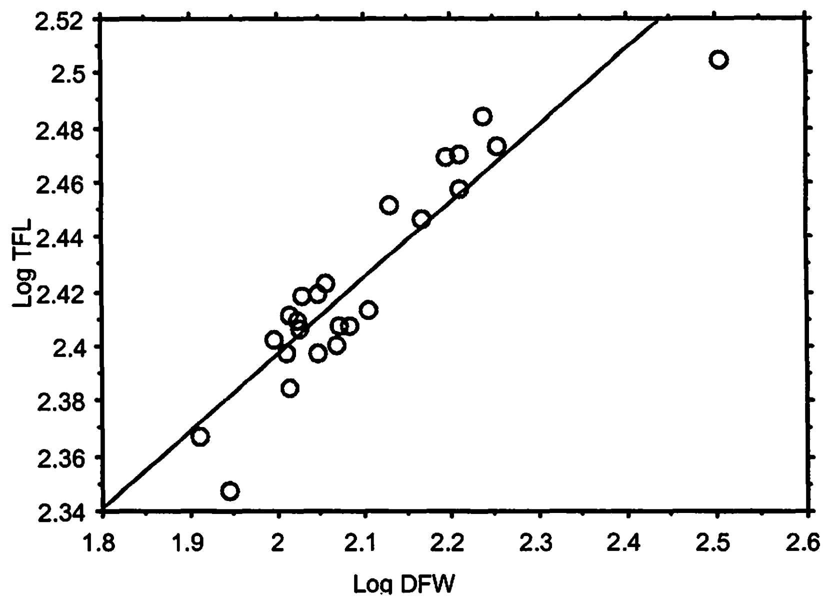


Table 5. (cont.)

3. Log. of total length versus log. of total weight



4. Log. of total length versus log. of dressed weight



The specimen #11291 was taken in St. Margaret's Bay, N. S. by trap net on Sept. 22, 1987. The remaining specimens were collected with a dip net on a tributary creek of Phillip River, Cumberland Co. July 4, 1998.

Some statistics of the total fish length for this sample are the following: Range 223-320 mm; Mean 265.39 mm; Std. Dev. 23.24; Coeff. Var. 8.755

Table 6. Original data of the live fish and the premaxillary bone, with the regression equations and the correlation coefficients (r^2) between them in gaspereau (*Alosa pseudoharengus*).

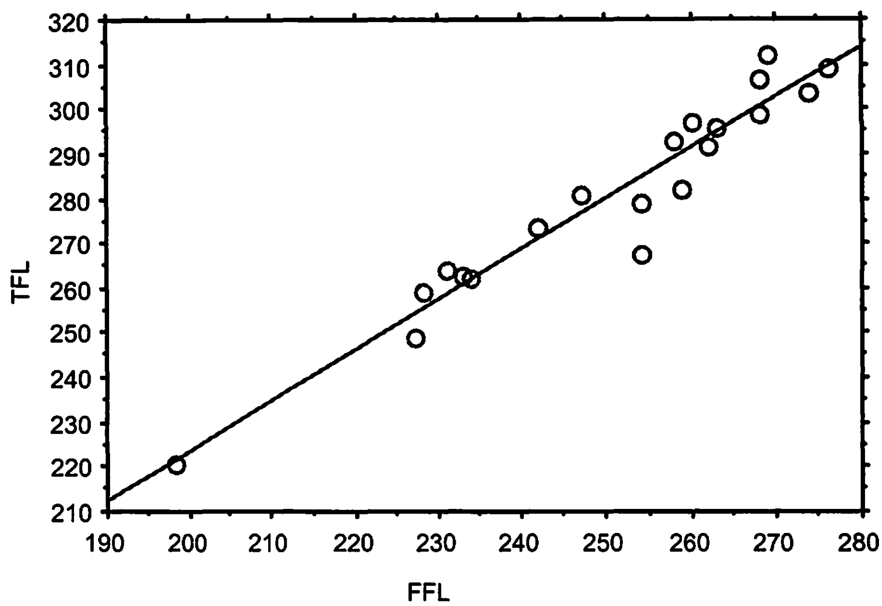
	FISH					PMA	
NSM#	TFL	FFL	SFL	TFW	DFW	ML	MH
12477	262	234	217	196.5	174.0	7.2	2.9
12478	282	259	241	273.5	240.1	7.5	3.0
12479	292	262	246	279.3	233.2	•	•
12480	268	254	240	258.5	217.8	7.6	2.5
12481	279	254	233	218.1	193.5	8.0	3.0
12482	293	258	244	266.5	225.5	7.8	2.6
12483	264	231	216	189.1	163.5	•	•
12484	263	233	219	182.5	158.3	•	•
12485	296	263	249	275.5	236.5	8.2	3.0
12486	297	260	245	239.5	213.8	8.2	3.1
12487	309	276	257	331.3	283.1	8.0	2.9
12488	281	247	228	247.2	213.5	7.3	3.0
12766	304	274	260	229.0	185.1	7.5	3.2
12767	299	268	254	245.5	189.3	•	•
12768	274	242	227	158.7	•	8.2	3.0
12800	259	228	213	145.5	133.5	7.1	2.6
12801	312	269	258	248.7	230.7	8.5	3.0
12802	249	227	206	105.2	98.2	6.7	2.5
12803	221	198	180	76.3	67.6	6.5	2.5
12804	307	268	253	225.7	213.7	8.0	3.0

VARIABLES Y	X	REGRESSION EQUATIONS	CORRELATION COEFF. r2	N
1. TFL	FFL	Y = 1.13 X + 2.151	0.933	20
2. TFL	SFL	Y = 1.084 X +26.655	0.942	20
3. TFL	TFW	log. Y = 0.209 log. X +1.961	0.740	20
4. TFL	DFW	log. Y = 0.226 log. X +1.935	0.762	19
5. TFL	ML	Y = 35.854 X + 6.729	0.684	16
6. TFL	MH	Y = 73.202 X + 70.813	0.506	16

Table 6 (cont.)

SCATTER DIAGRAMS

1. Total length versus fork length



2. Total length versus standard length

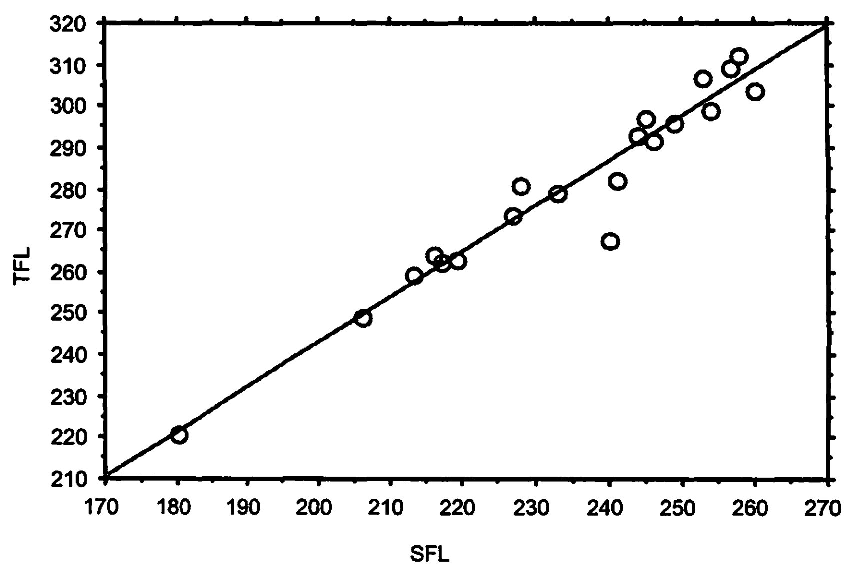
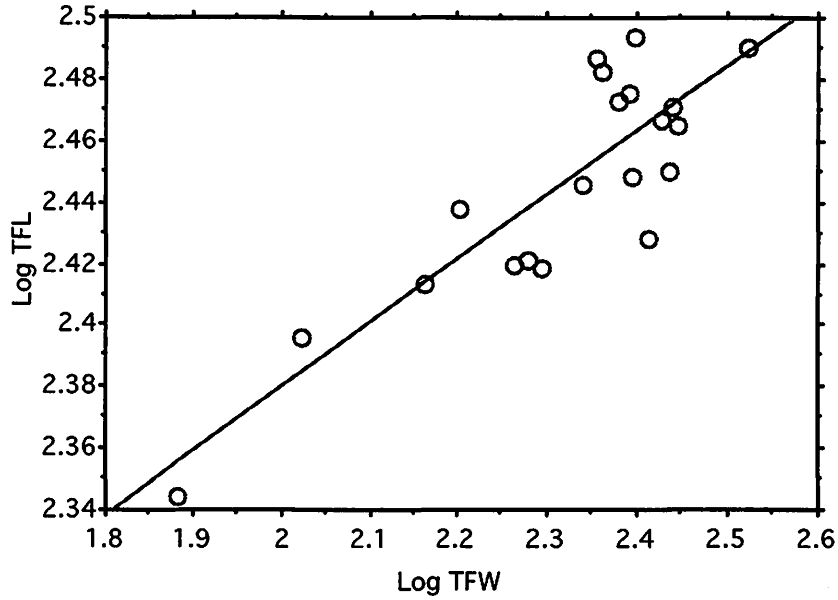


Table 6 (cont.)

3. Log. of total length versus log. of total weight



4. Log. of total length versus log. of dressed weight

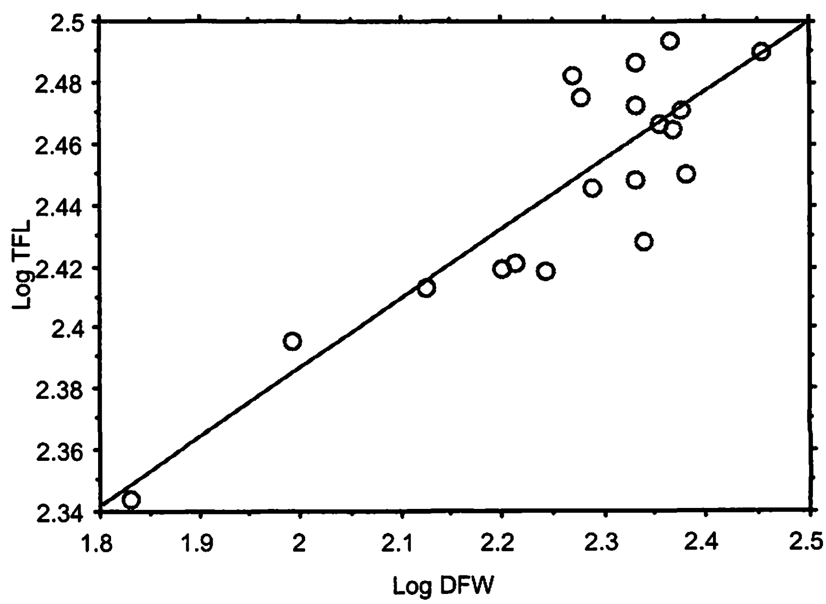


Table 6 (cont.)

Specimens #12477-12488 were caught in the Gaspereau River by trap on May 15, 1998; specimens #12766-12768 in St. Margaret's Bay, N. S. by mackerel trap on Aug. 21st, 1998; and specimens #12800-12804 also in St. Margaret's Bay, N. S. on Aug. 6, 1998.

Some statistics of the total fish length for this sample are the following: Range 221-312 mm; Mean 280.55 mm; Std. Dev. 23.307; Coeff. Var. 8.308.

Table 7. Original data of the live fish and the premaxillary bone, with the regression equations and the correlation coefficients (r^2) between them in shad (*Alosa sapidissima*)

	FISH					PMA	
NSM#	TFL	FFL	SFL	FW	DFW	ML	MH
11294	297	•	249	266.5	222.3	•	•
11295	286	•	241	201.1	178.6	•	•
11296	291	•	246	250.6	216.8	•	•
11524	533	•	•	930.0	•	12.2	5.5
11525	598	•	•	1462.0	•	12.9	6.1
12751	474	417	410	1072.8	769.4	10.2	4.0
12754	503	457	433	1516.5	1321.5	12.5	6.5

VARIABLES Y	X	REGRESSION EQUATIONS	CORRELATION COEFF. r^2	N
1. TFL	SFL	$Y = 1.12 X + 16.38$	0.999	7
2. TFL	TFW	$\log Y = 0.35 \log X + 1.637$	0.941	7
3. TFL	DFW	$\log Y = 0.313 \log X + 1.744$	0.977	5

No relationships between the fish total length and the premaxillary dimensions were studied.

Table 8. Original data of the live fish and the dimensions of the premaxillary in Atlantic salmon (*Salmo salar*)

			PMA						FISH
NSM#	TFL	FFL	SFL	TFW	DFW	ML	MH	#T	#R
12406	800	•	717	5754	5174	22.8	10.8	6	1
12499	475	452	422	•	2308	16.5	7.4	4	1
12713	576	542	516	•	1506	13.0	8.5	3	1
12862	452	442	410	•	835	10.0	5.0	5	1

Specimens #12406 caught on Aug. 27, 1987 was donated by personnel of DFO; specimen #12499 and 12713 were bought at local markets on June 19, and July 3rd, respectively (1998); and specimen #12862 was commercially reared and bought on Jan. 25, 1998.

No regressions were calculated because of the small number of specimens.

Table 9. Original data of the live fish and the premaxillary bone, with the regression equations and the correlation coefficients (r^2) between them in brook trout (*Salvelinus fontinalis*)

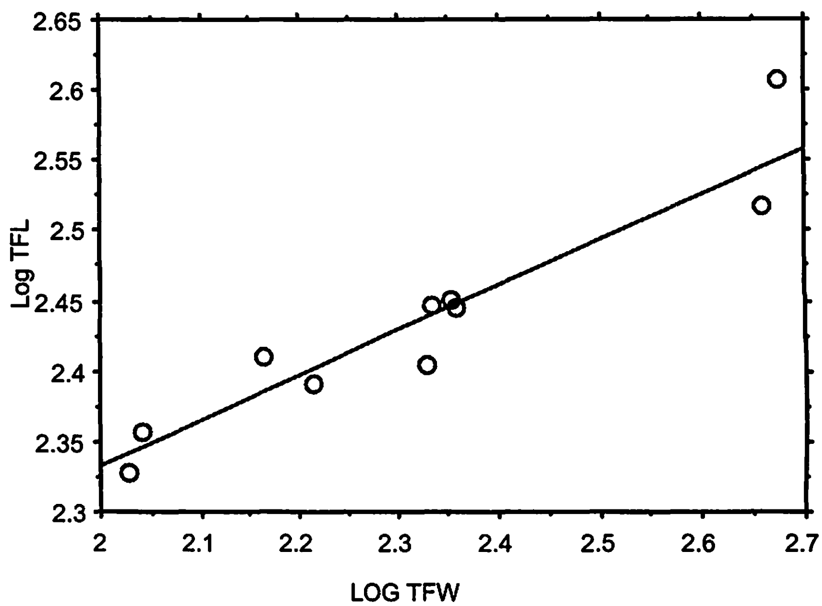
			FISH				PMA		
NSM#	TFL	FFL	SFL	TFW	DFW	ML	MH	#T	#R
12490*	279	•	•	•	•	5.1	4.2	6	1
12492**	406	•	•	471.0	•	9.2	6.2	4	1
12493**	279	•	•	226.8	•	5.6	4.2	5	1
12494**	330	•	•	454.0	•	6.9	5.0	4	1
12701*	228	209	190	109.3	99.3	6.6	6.7	6	1
12702*	266	•	•	•	•	6.2	4.4	6	1
12703**	254	•	•	•	•	5.4	4.3	5	1
12704*	254	•	•	•	•	6.4	4.5	6	1
12705**	330	•	•	454.0	•	7.8	5.5	7	1
12706*	213	204	189	106.5	94.2	7.2	2.0	11	1
12752*	247	238	219	163.5	152.0	5.7	4.2	6	1
12753*	234	•	•	•	•	5.5	4.0	7	1
12769**	280	268	244	215.0	200.8	6.4	4.5	5	1
12770*	282	271	246	224.7	205.2	6.1	4.5	5	1
12794**	258	247	227	145.6	140.1	6.4	4.5	5	1

Table 9 (cont.)

VARIABLES Y	X	REGRESSION EQUATIONS	CORRELATION COEFF. r^2	N
1. TFL	FFL	Y = 0.965 X + 20.194	0.983	6
2. TFL	SFL	Y = 1.084 X + 13.723	0.967	6
3. TFL	TFW	log. Y = 0.323 log. X + 1.687	0.889	11
4. TFL	ML	Y = 31.06 X + 76.181	0.451	15
5. TFL	MH	Y = 25.047 X + 161.354	0.295	15

SCATTER DIAGRAMS

3. Log. of total length versus log. of total weight



All specimens were taking by angling during the month of June, 1998. Specimens marked (*) were caught in Little Salmon River, Hfx. Co. N. S. Those marked (**) came from Porter's Lake, Hfx. Co. N. S.

Some statistics of the total fish length for this sample are the following: Range 213-406 mm; Mean 274.63 mm; Std. Dev. 47.28; Coeff. Var. 17.215

The premaxillary of brook trout is long but narrow and its anterior end is bent towards the middle line of the fish' body. These anatomical features make the measuring difficult and consequently not too reliable.

Table 10. Original data of the live fish and the premaxillary bone, with the regression equations and the correlation coefficients (r^2) between them in smelt *(Osmerus mordax)*

	FISH					PMA	
NSM#	TFL	FFL	SFL	TFW	DFW	SAP	SMP
12847	242	227	210	103.7	91.2	•	•
12848	225	207	192	66.6	56.6	2.1	4.4
12849	256	237	220	120.1	99.2	•	•
12850	285	267	242	194.2	•	3.2	5.9
12851	245	233	211	104.0	83.2	•	4.8

NSM#	ML	HAP	HMP	DP	#T	#R
12847	•	•	•	•	•	•
12848	8.5	2.0	•	7.3	21	1
12849	10.0	2.2	1.9	8.0	16	1
12850	11.7	2.8	2.0	9.2	15	1
12851	9.8	1.9	1.7	8.0	17	1

VARIABLES Y	X	REGRESSION EQUATIONS	CORRELATION COEFF. r^2	N
1. TFL	FFL	Y = 1.017 X + 12.457	0.983	5
2. TFL	SFL	Y = 1.21 X - 10.843	0.992	5
3. TFL	TFW	log. Y = 0.225 log. X + 1.938	0.984	5
4. TFL	DFW	Log. Y= 0.221 Log. X +1.963	0.970	5
5. TFL	ML	Y = 18.919 X + 63.561	0.986	5

All specimens were caught in St. Margaret's Bay, NS on Dec.14,1998. Main basic statistics of the total fish length for this sample are the following: Range 225-285 mm; Mean 250.6 mm; Std. Dev. 22.21; Coeff. Var. 8.863

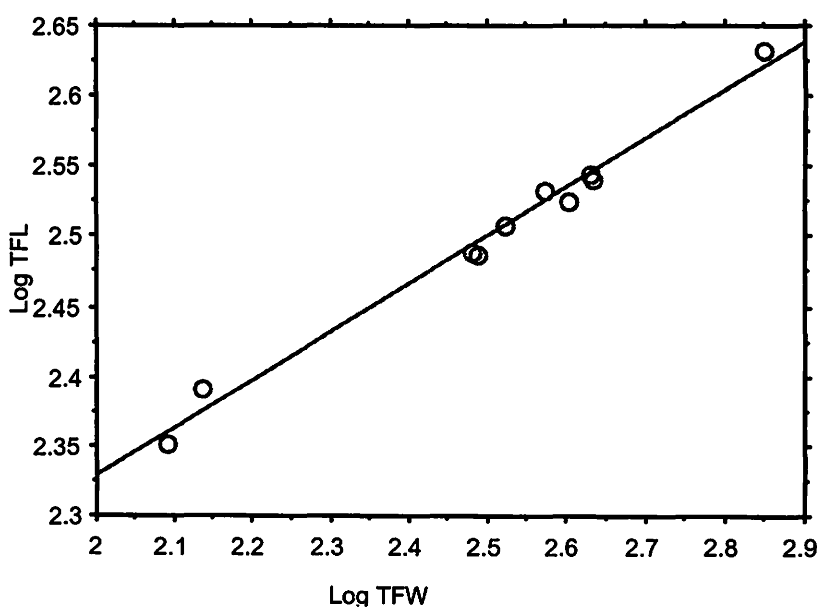
The premaxillary of the smelt in this sample shows a good correlation with the total length of the fish. A larger sample is needed to estimate a more reliable value.

Table 11. Original data of the live fish and the premaxillary bone, with the regression equations and the correlation coefficients (r^2) between them in white sucker *(Catostomus commersoni)*

	FISH					PREMAXILLARY	
NSM#	TFL	FFL	SFL	TFW	DFW	ML	MH
11271	309	286	258	302.3	363.6	5.6	8.4
11272	347	324	289	428.8	•	5.1	8.1
11273	344	318	284	•	•	7.0	10.1
11281	322	•	•	330.4	•	7.1	9.1
11284	307	•	•	307.0	•	6.0	9.2
11285	430	402	385	705.7	•	7.9	12.1
11286	336	•	•	400.0	•	8.0	11.4
11289	350	•	•	425.8	•	7.3	9.9
12495	225	199	184	122.5	104.5	5.1	7.3
12710	247	227	203	136.3	121.6	5.5	7.3
12711	342	321	288	373.3	329.3	7.3	10.7

VARIABLES Y	X	REGRESSION EQUATIONS	CORRELATION COEFF. r^2	N
1. TFL	FFL	$Y = 1.043\ X + 9.885$	0.997	7
2. TFL	SFL	$Y = 1.077\ X + 27.946$	0.987	7
3. TFL	TFW	$\log. Y = 0.332 \log. X + 1.671$	0.988	10
4. TFL	ML	$Y = 34.477\ X + 98.191$	0.485	11
5. TFL	MH	$Y = 28.371\ X + 56.34$	0.691	11

3. Log. of total length versus log. of total weight



Specimens #11271 to 11273 were caught in Noel Lake, Hants Co. N. S. on July 5, 1995. Specimens #11281-84 (Sept. 2,1987), #11285-86 (May 25,1988) and #11289 (July 15, 1988) were all captured in Sawlor Lake, Hfx. Co. N. S. Specimen #12495 was caught in Coolen Lake, Co. in April 3, 1988. Specimens #12710-11 were caught in a tributary creek of Timber Lake on June 11, 1997.

Some statistics of the total fish length for this sample are the following: Range 225-430 mm; Mean: 323.55 mm: Stand. dev.: 54.36: Coeff. Var.: 16.803

The premaxillary of the white sucker is very small and fragile and consequently it is not likely to be found in the middens.

Table 12. Original data of the live fish and the dimensions of the premaxillary in haddock *(Melanogrammus aeglefinus)*

	FISH					PMA	
NSM#	TFL	FFL	SFL	TFW	DFW	SAP	SMP
11556	591	•	534	1446	•	7.5	23.5
12845	543	516	478	•	1266	8.0	22.5
12846	455	438	408	•	742	6.4	19.6

NSM#	ML	MH	HAP	HMP	DP	#T	#R
11556	24.2	12.0	9.0	6.4	19.3	19	4
12845	23.6	10.5	8.0	6.5	19.1	16	5
12846	19.6	8.5	6.5	6.4	15.5	20	5

Specimen #11556 was caught in St. Margaret's Bay in Sept. 1987; specimen #12845 from offshore waters on Aug. 8, 1998 and specimen #12846 was bought at a local market on Dec. 10, 1998.

No regressions were calculated because of the small number of specimens.

Table 13. Original data of the live fish and the premaxillary bone, with the regression equations and the correlation coefficients (r^2) between them in pollock *(Pollachius virens)*

	FISH					PMA	
NSM#	TFL	FFL	SFL	TFW	TDW	SAP	SMP
11237	349	•	311	457.2	392.5	4.1	14.0
11238	306	•	273	256.3	228.8	3.8	11.8
11239	335	•	298	358.8	312.6	4.1	12.9
11241	251	•	228	145.5	126.6	3.1	9.6
11242	943	•	882	•	6070.0	12.0	37.3
11243	397	•	353	765.8	628.6	4.7	15.4
11259	410	•	372	841.1	723.9	5.1	15.5
11262	179	•	161	58.2	•	2.5	7.4
11263	178	•	161	51.2	•	2.3	7.3
11264	167	•	•	40.0	•	2.4	6.8
11265	162	•	147	36.2	•	2.0	6.4
12772	509	478	451	1010.0	•	6.6	20.6
12773	475	442	415	•	•	6.6	20.6
12774	466	437	408	•	•	7.0	20.2
12789	428	400	381	•	•	6.1	17.2

NSM#	ML	MH	HAP	HMP	DP	#T
11237	17.2	4.6	4.1	2.9	11.8	23
11238	15.3	4.8	3.1	2.4	11.3	20
11239	15.7	4.5	2.7	3.2	13.0	24
11241	12.3	3.2	2.8	2.3	9.1	26
11242	44.0	11.4	9.4	9.5	36.1	58
11243	19.1	5.9	4.0	3.9	8.6	31
11259	19.6	6.2	4.2	4.2	14.6	28
11262	8.9	2.8	2.0	1.5	7.5	20
11263	8.4	2.8	2.0	2.0	7.3	17
11264	8.8	2.3	2.0	1.3	6.8	22
11265	8.7	2.5	1.8	1.5	8.0	18
12772	26.3	7.7	5.7	6.1	21.1	41
12773	25.7	7.6	6.0	5.7	20.2	45
12774	24.8	7.7	5.6	6.1	19.1	36
12789	21.6	6.7	5.0	4.7	17.1	33

Table 13 (cont)

VARIABLES Y	X	REGRESSION EQUATIONS	CORRELATION COEFF. r^2	N
1. TFL	SFL	$Y = 1.074 X + 13.298$	0.998	16
2. TFL	TFW	$\log. Y = 0.317 \log. X + 1.709$	0.988	12
3. TFL	SAP	$Y = 75.356 X + 6.617$	0.978	15
4. TFL	SMP	$Y = 24.721 X + 2.81$	0.992	15
5. TFL	ML	$Y = 20.812 X - 13.169$	0.987	15
6. TFL	MH	$Y = 74.929 X - 32.787$	0.939	15
7. TFL	HAP	$Y = 93.222 X - 5.042$	0.953	15
8. TFL	HMP	$Y = 84.205 X + 48.671$	0.940	15
9. TFL	DP	$Y = 24.49 X + 24.864$	0.929	15

SCATTER DIAGRAMS

1. Total length versus standard length

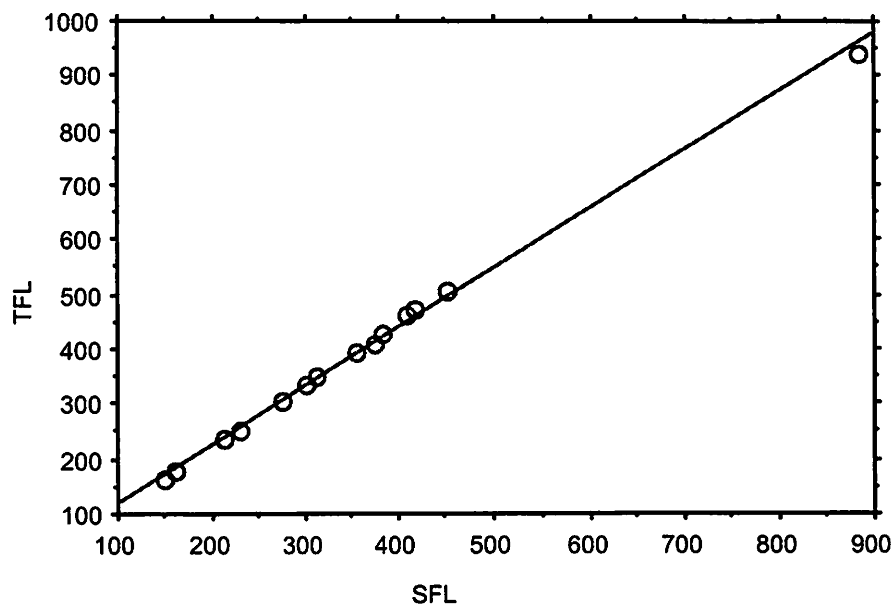
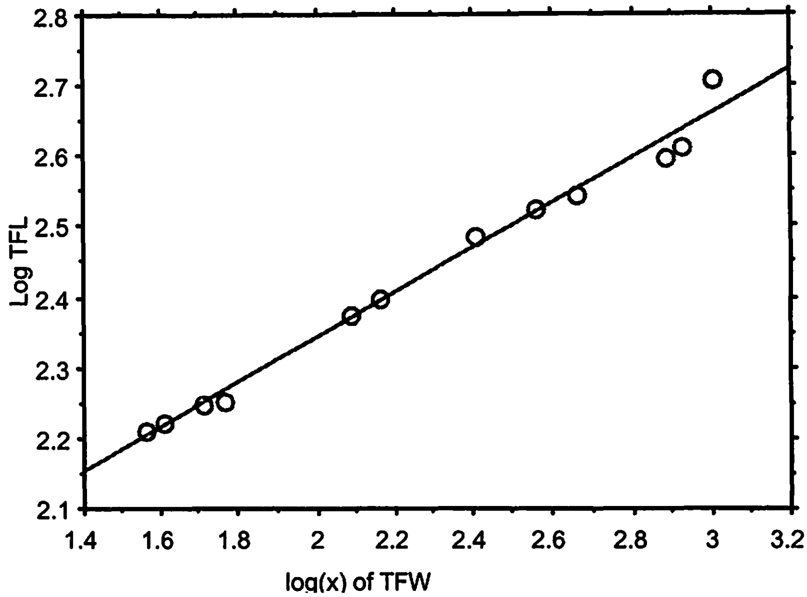


Table 13 (cont.)

2. Log. of total length versus log. of total weight



3. Total length versus SAP

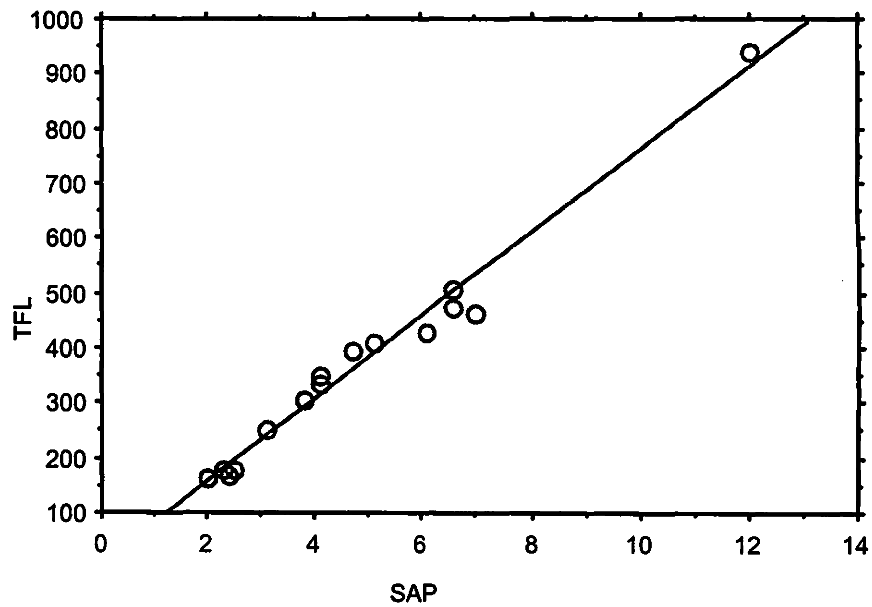
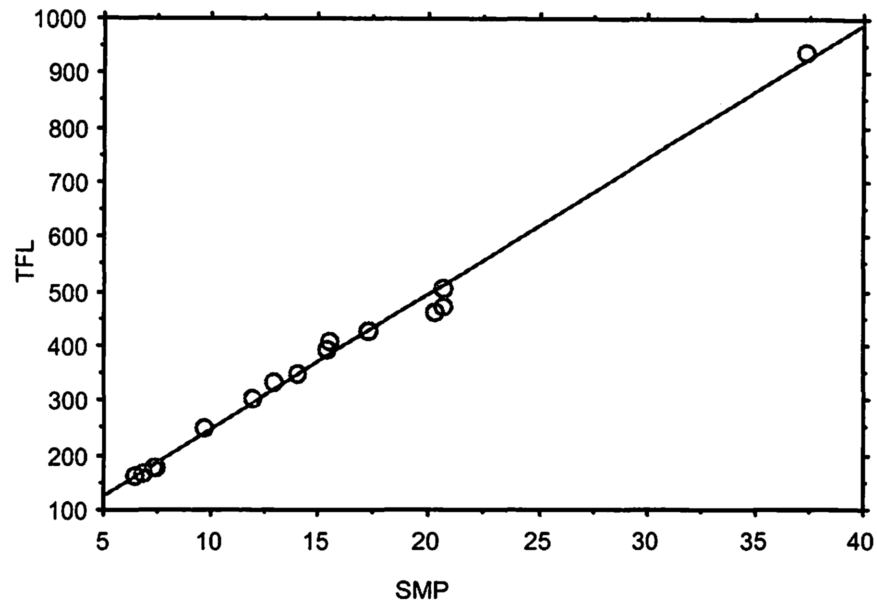


Table 13 (cont.)

4. Total length versus SMP



5. Total length versus maximum length

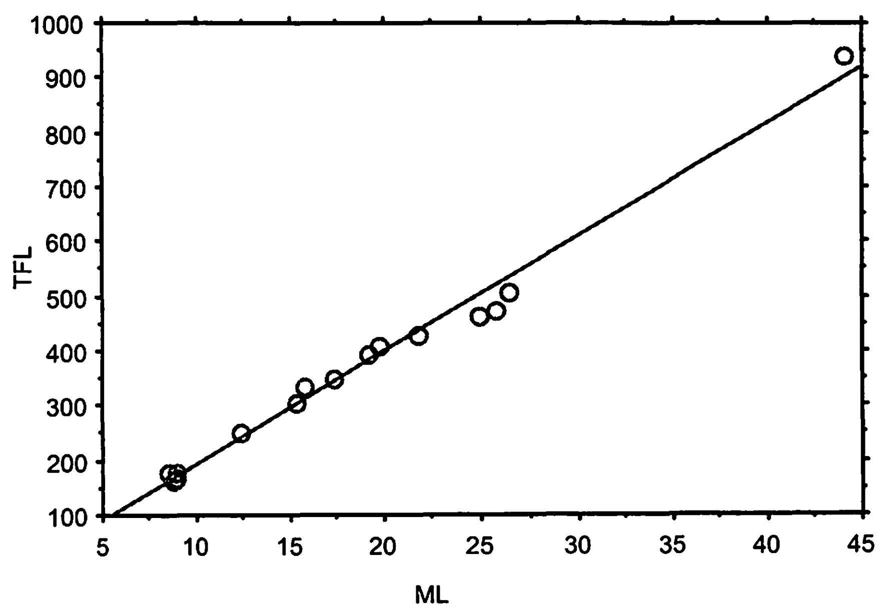
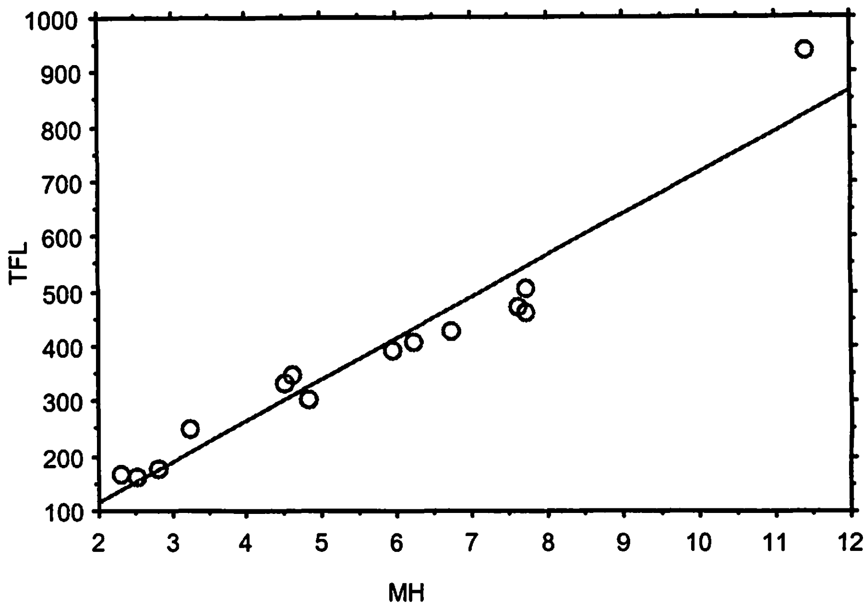


Table 13 (cont.)

6. Total length versus maximum height



7. Total length versus HAP

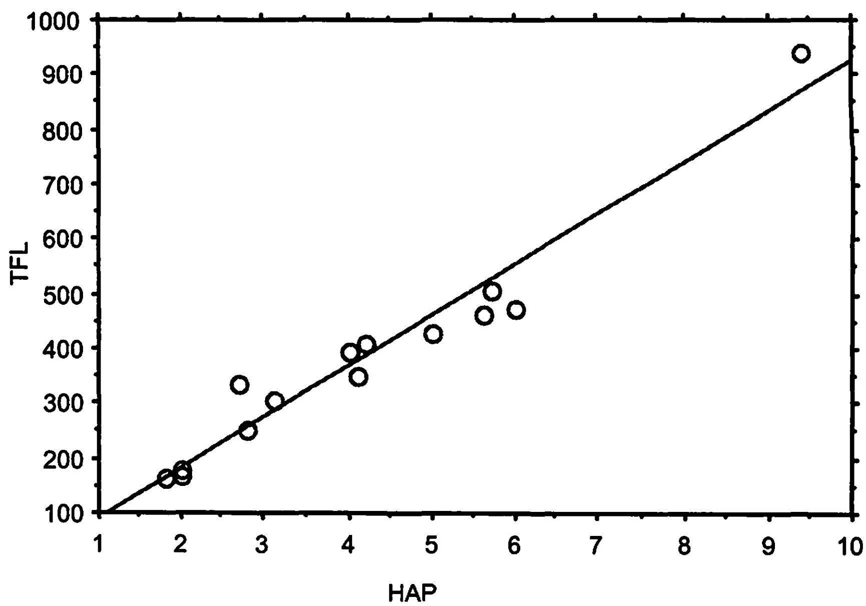
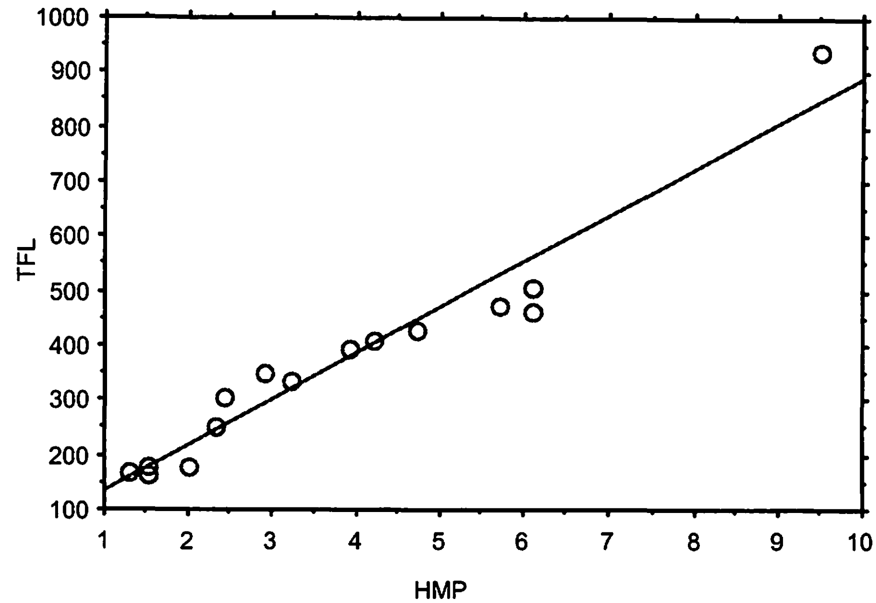
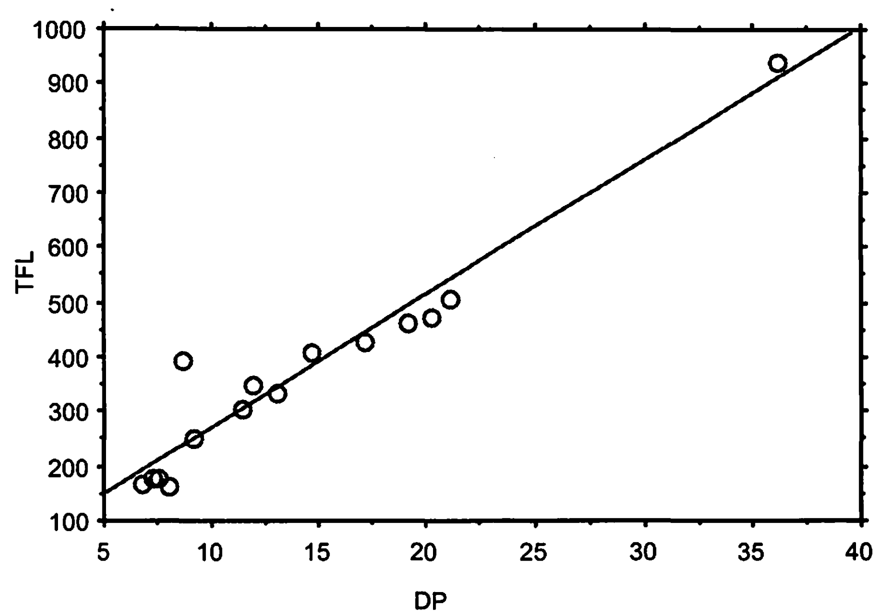


Table 13 (cont.)

8. Total length versus HMP



9. Total length versus dental plate length



Specimens #11237 to 11259 from St. Margaret's Bay, N. S. were caught between July 2nd and August 19, 1987. Specimens #11262-65 were caught in Purple's Cove, Hfx. Co. N. S. on Oct. 12, 1981. Specimens #12772-89 from St. Margaret's Bay were caught on Aug. 20 and 21st, 1998.

Some statistics of the total fish length for this sample are the following: Range 162-943 mm; Mean 362.00 mm; Std. Dev. 194.59 ; Coeff. Var. 53.755

The premaxillary of the mackerel is a sturdy bone. All measurements taken show high correlation coefficients with the total length of the fish. All are good predictors for this latter parameter.

Table 14. Original data of the live fish and the dimensions of the premaxillary in cusk *(Brosme brosme)*

	FISH					PMA	
NSM#	TFL	FFL	SFL	TFW	DFW	SAP	AMP
11544	588	554	1814	•	10.8	•	35.5
12838	751	712	•	4090	13.5	43.9	44.4

NSM#	ML	MH	HAP	HMP	#T	#R
11544	9.5	9.0	5.4	•	30	6
12838	10.7	12.8	8.7	41.3	28	6

No regressions were calculated because of the small number of specimens

Specimen #11544 was caught in offshore waters of N. S. on July 28, 1987 and the specimen #12838 was caught in Sambro, Halifax Co. N. S. Nov. 24, 1998.

Table15. Original data of the live fish and the dimensions of the premaxillary in tomcod (*Microgadus tomcod*)

	FISH				PMA	
NAM#	TFL	SFL	TFW	DFW	SAP	AMP
12839	198	178	68.0	56.2	2.0	9.8
12840	192	176	53.8	43.2	2.0	9.5
12841	186	170	57.0	42.0	3.0	9.8
12842	174	157	42.5	35.0	2.8	9.0

NSM#	ML	MH	HAP	HMP	DP
12839	11.0	3.1	2.8	1.5	9.2
12840	11.0	3.5	2.6	2.7	9.9
12841	11.3	3.0	2.3	2.9	10.0
12842	10.0	3.3	2.1	1.9	8.5

This sample was taken in King Creek, Hants Co. on Dec. 1, 1998. No regressions were calculated because of the small number of specimens.

Table 16. Original data of the live fish and the premaxillary bone, with the regression equations and the correlation coefficients (r^2) between them in silver hake (*Merluccius bilinearis*)

	FISH				PREMAXILLARY	
NMS#	TFL	SFL	TFW	DFW	SAP	SMP
11545	392	354	405.5	342.0	7.0	26.1
11546	366	328	351.3	286.9	6.9	•
11547	384	343	353.8	318.7	6.8	•
11548	368	327	277.7	257.3	5.7	24.4
11549	371	331	275.1	251.7	6.4	25.5
11550	391	352	382.4	349.5	7.0	30.7
11551	407	367	474.0	412.7	7.3	30.4
11552	381	342	370.3	327.8	6.5	27.8
11553	365	329	313.3	272.2	6.3	25.1
11557	409	•	•	•	7.0	28.8
11559	518	•	•	•	9.3	43.0
11569	459	417	630.0	498.7	7.4	•
11570	375	338	314.4	292.6	6.4	26.2
11571	364	325	253.8	•	6.0	28.4
11574	410	•	•	•	7.0	29.6

NSM#	ML	MH	HAP	HMP	DP	#T	#R
11545	40.5	4.6	6.9	5.0	37.1	•	•
11546	34.5	4.3	6.4	•	32.0	35	2
11547	39.5	4.5	6.5	•	•	•	•
11548	35.4	3.7	5.4	5.1	32.1	60	2
11549	37.0	4.0	6.6	3.9	36.0	•	2
11550	40.0	5.0	7.0	5.0	37.9	43	2
11551	41.9	5.0	7.2	4.6	38.4	40	2
11552	38.6	5.6	6.8	4.5	36.0	32	2
11553	34.7	4.1	6.4	4.6	30.6	54	2
11557	41.2	5.2	6.8	4.8	39.1	32	2
11559	55.4	7.0	9.4	7.0	53.2	40	2
11569	43.1	•	7.8	•	40.6	39	2
11570	36.6	4.3	6.8	4.2	33.4	48	2
11571	34.5	5.0	6.1	3.5	32.2	48	2
11574	40.4	4.5	7.1	5.0	38.3	60	2

Table 16 (cont.)

VARIABLES Y	X	REGRESSION EQUATIONS	CORRELATION COEFF. r^2	N
1. TFL	SFL	Y = 1.034 X + 27.245	0.997	12
2. TFL	TFW	log. Y = 0.241 log. X +1.971	0.863	12
3. TFL	DFW	log. Y = 0.304 log. X +1.824	0.895	11
4. TFL	SAP	Y = 46.696 X + 76.688	0.845	15
5. TFL	SMP	Y = 8.092 X + 162.595	0.900	13
6. TFL	ML	Y = 7.677 X + 93.695	0.920	15
7. TFL	MH	Y = 40.117 X + 201.514	0.695	14
8. TFL	HAP	Y = 44.219 X + 93.104	0.869	15
9. TFL	HMP	Y = 42.913 X + 191.364	0.763	13
10. TFL	DP	Y = 7.319 X + 128.068	0.910	14

SCATTER DIAGRAMS

1. Total length versus standard length

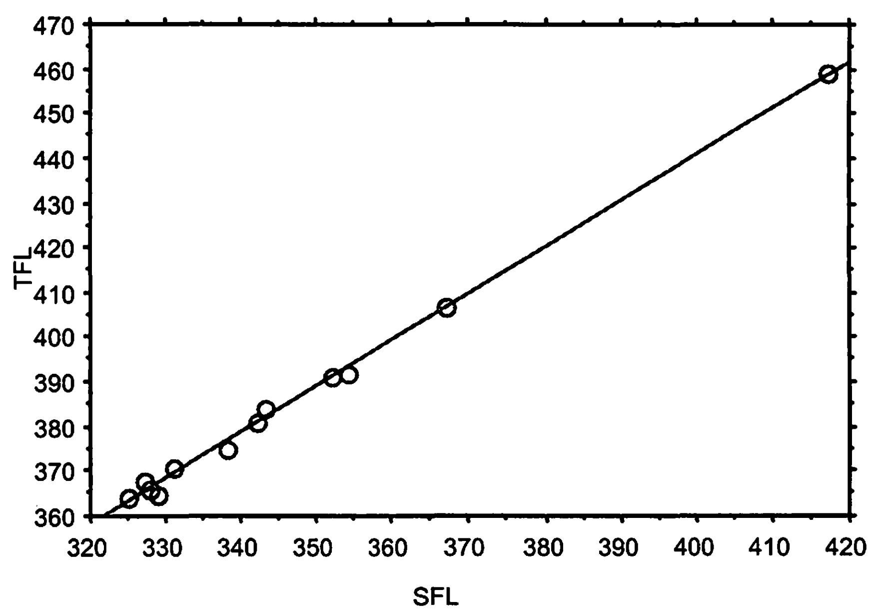
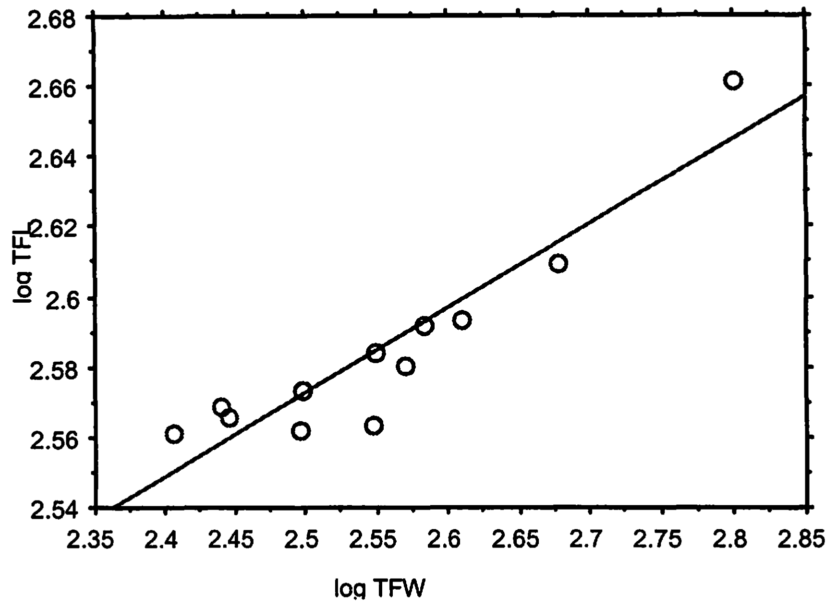


Table 16 (cont.)

2. Log. of total length versus log. of total weight



3. Log. of total length versus log. of dressed weight

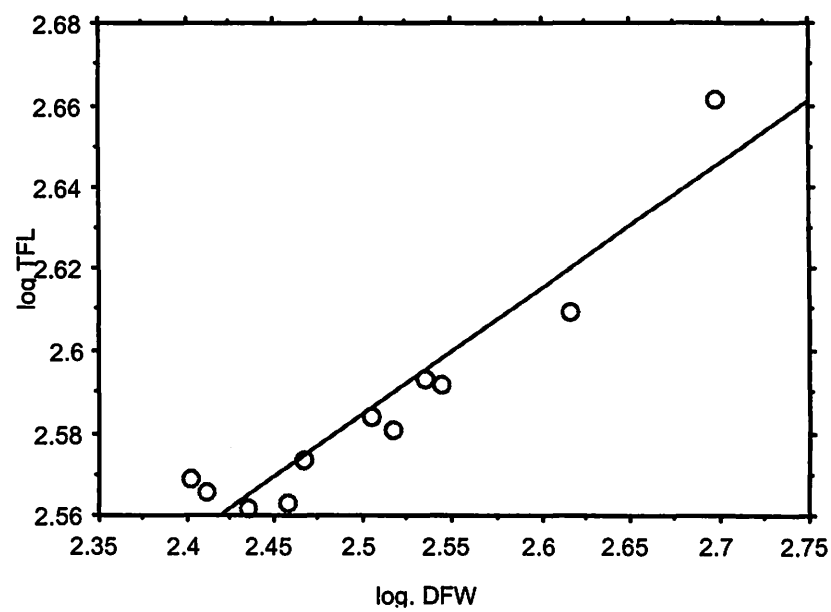
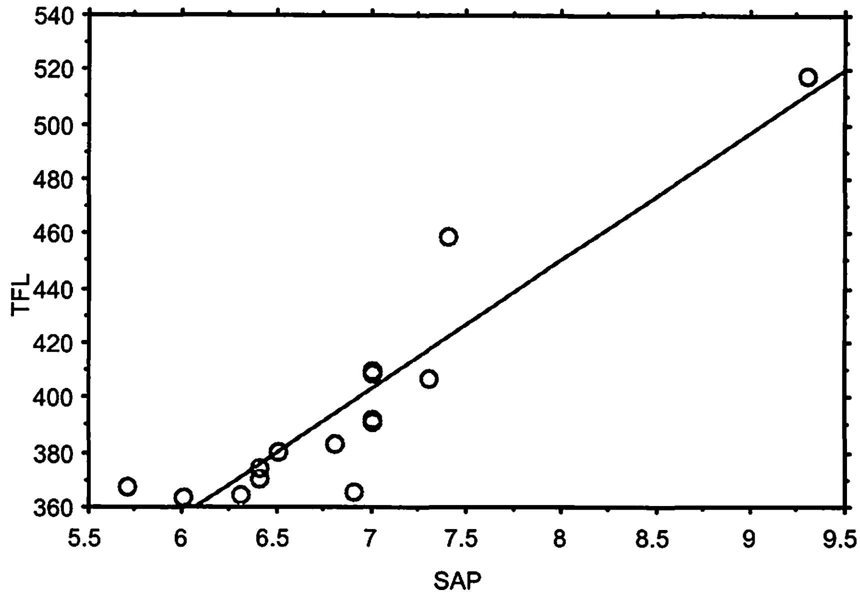


Table 16 (cont.)

4. Total length versus SAP



5. Total length versus SMP

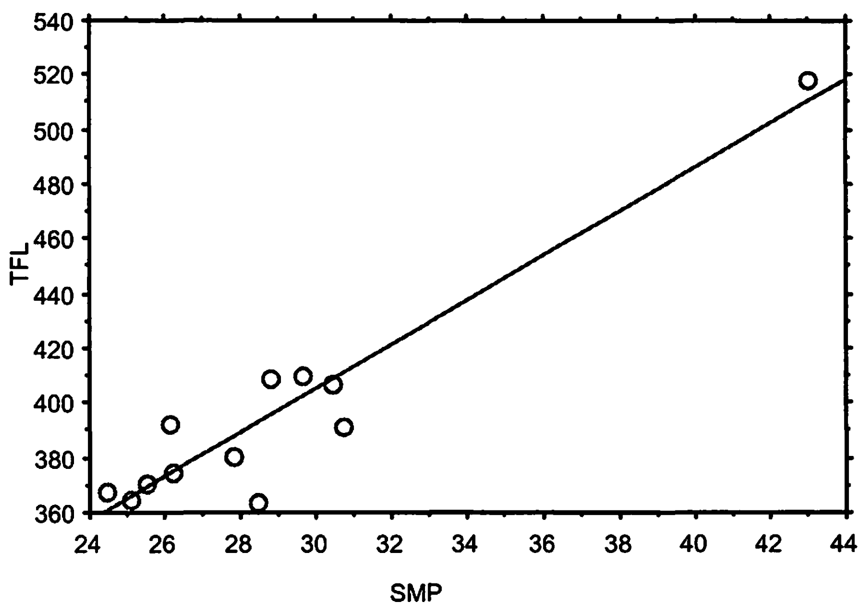
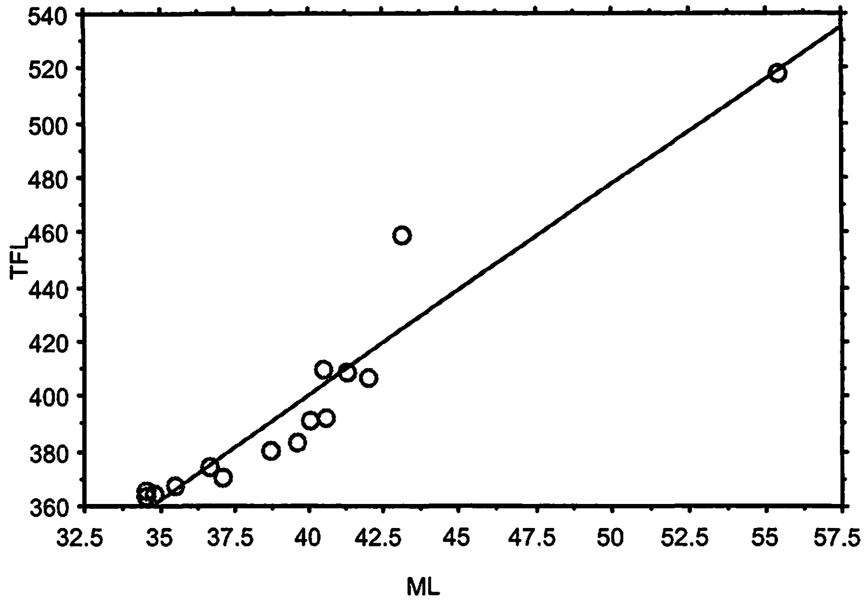


Table 16 (cont.)

6. Total length versus maximum length



7. Total length versus maximum height

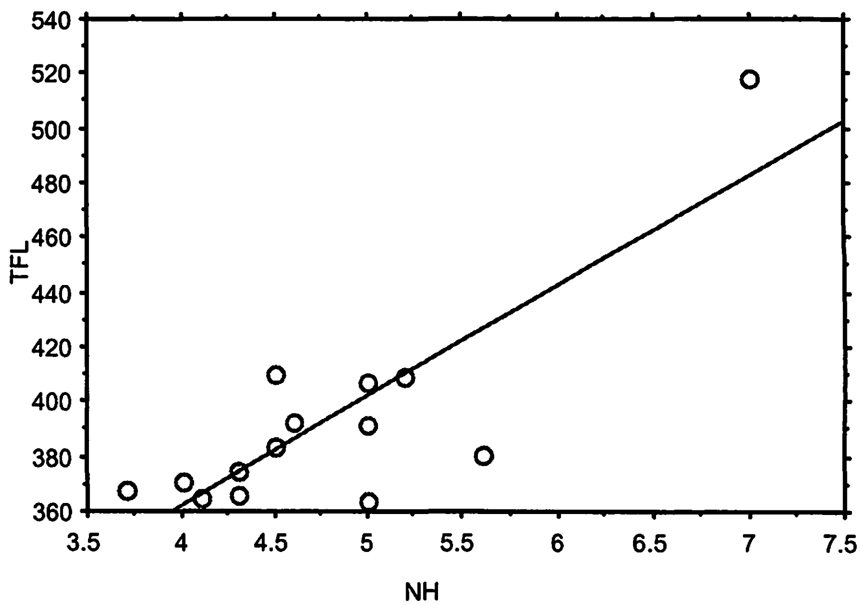
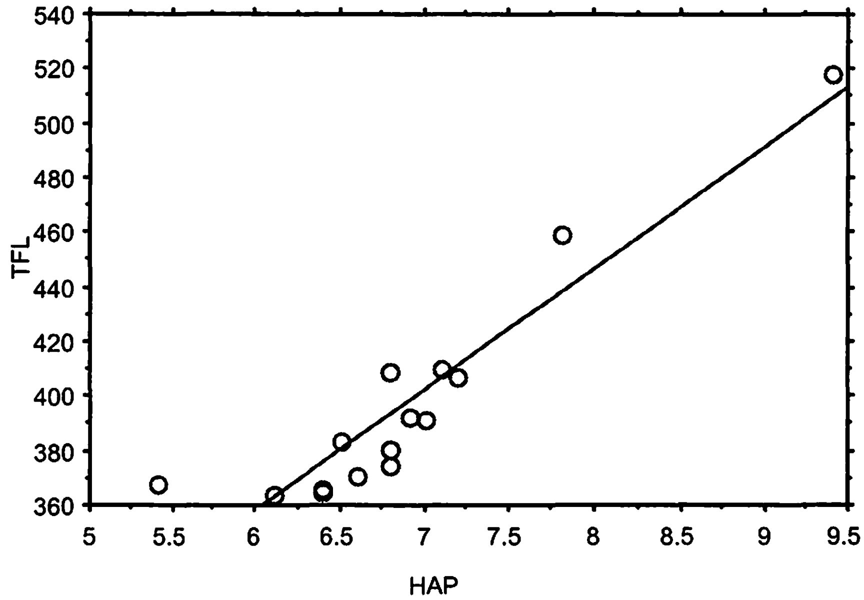


Table 16 (cont.)

8. Total length versus HAP



9. Total length versus HMP

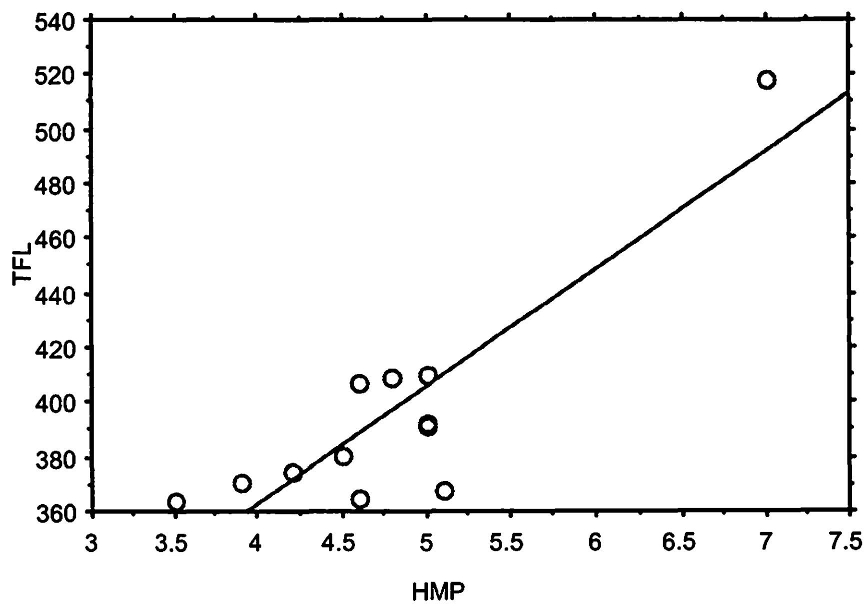
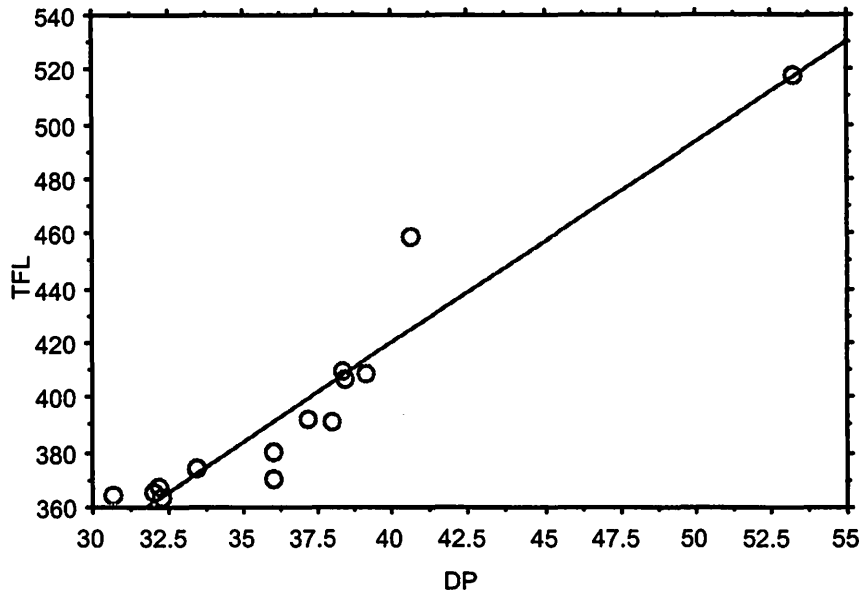


Table 16 (cont.)

10. Total length versus dental plate length



Specimens #11545 to 11553 were caught in St. Margaret's Bay in a mackerel trap during the months of August and September, 1987. Specimen # 11558 was caught in Passamaquoddy Bay, N. B. on April 15, 1977. Specimen #11559 from offshore waters of N. S., in 1976. Specimens #11568 to 11571, also from St. Margaret's Bay were caught on Sept. 30, 1987. Specimen #11574 caught in Emerald Bank, off N. S. in 1974

Some statistics of the total fish length for this sample are the following: Range 364-518 mm; Mean 397.33 mm; Std. Dev. 41.80; Coeff. Var. 10.52

Except for the maximum height and the height of the maxillary process, the remaining measurements are good predictors of the total fish length for the silver hake. The most valuable is the maximum length of the bone; unfortunately this bone is slender and breaks easily.

Table 17. Original data of the live fish and the dimensions of the premaxillary in goosefish *(Lophius americanus)*

	FISH				PREMAXILLARY	
NMS#	TFL	SFL	TFW	DFW	SMP	M
11256	765	660	7080	5570	15.8	95.5
11257	710	595	3941	3473	15.2	93.4
11258	540	456	1899	1730	13.2	69.0
11555	685	565	3742	3232	15.7	78.0

NSM#	MH	HAP	HMP	DP	#T	#R
11256	•	24.0	8.6	89.6	54	2
11257	56.5	16.5	9.3	89.3	45	2
11258	38.5	15.4	6.6	62.8	45	2
11555	•	17.6	8.1	70.0	34	2

No regressions were calculated because of the small number of specimens.

All specimens were caught in St. Margaret's Bay, N. S. in 1987. The first on Aug. 1st, and the second on Aug. 10 both in a mackerel trap; the last one came in a cod trap on Oct. 15.

Table 18. Original data of the live fish and the premaxillary bone, with the regression equations and the correlation coefficients (r^2) between them in longhorn sculpin *(Myoxocephalus octodecimspinosus)*

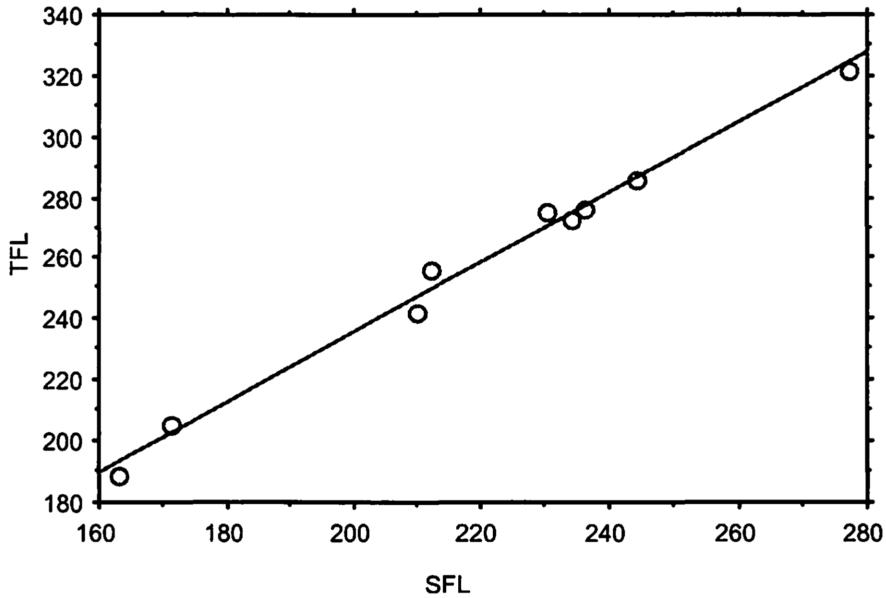
	FISH				PREMAXILLARY	
NSM#	TFL	SFL	TFW	DFW	SAP	SMP
11292	322	277	304.3	274.6	8.5	18.0
11536	275	230	156.4	143.0	7.3	16.0
11537	189	163	65.8	57.1	5.2	11.1
11541	205	171	77.0	64.5	•	•
12760	280	•	211.2	•	12.8	16.5
12761	242	210	152.4	•	7.1	14.1
12762	273	234	231.0	•	8.0	16.2
12663	256	212	179.7	•	7.3	15.7
12664	276	236	227.0	•	6.6	17.0
12765	286	244	247.5	•	8.2	17.3

NSM#	ML	MH	HAP	HMP	DP
11292	24.1	19.1	13.2	5.0	23.4
11536	20.3	15.4	10.7	4.3	•
11537	•	11.3	7.4	2.8	•
11541	•	12.5	8.2	2.8	•
12760	23.1	16.5	11.4	4.9	22.4
12761	19.0	15.5	9.3	4.4	18.2
12762	21.6	17.1	10.5	5.0	21.5
12663	20.7	15.2	9.6	4.9	19.8
12664	22.0	15.9	9.8	4.6	21.2
12765	23.1	12.9	11.4	5.5	22.0

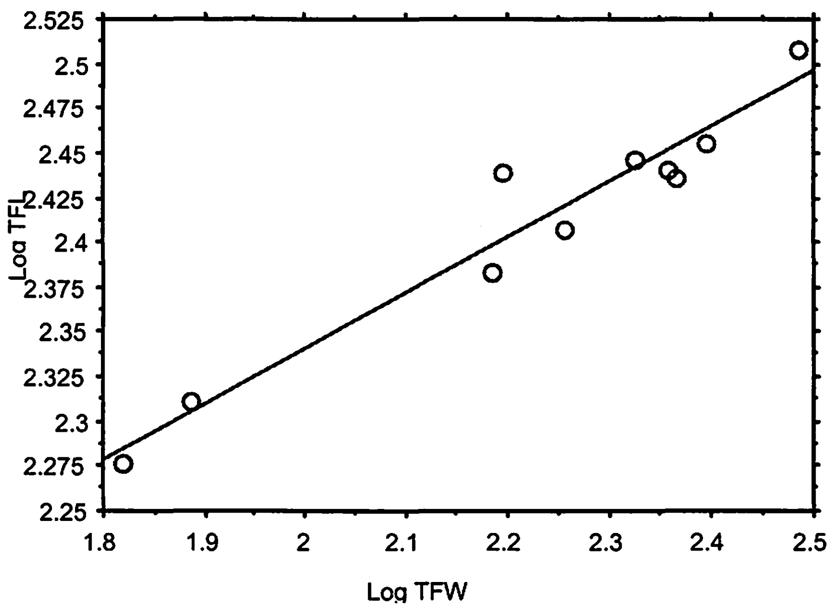
VARIABLES Y	X	REGRESSION EQUATIONS	CORRELATION COEFF. r^2	N
1. TFL	SFL	Y = 1.148 X + 6.119	0.991	10
2. TFL	TFW	log. Y = 0.311 log. X +1.719	0.939	10
3. TFL	SAP	Y = 9.298 X +193.204	0.285	8
4. TFL	SMP	Y = 17.06 X - 2.431	0.942	8
5. TFL	ML	y = 12.16 X + 11.925	0.779	7
6. TFL	MH	y = 13.647 X +53.778	0.652	10
7. TFL	HAP	y = 22.622 X + 30.79	0.929	10
8. TFL	HMP	y = 37.496 X + 94.667	0.764	10
9. TFL	DP	y = 13.527 X - 10.533	0.866	8

SCATTER DIAGRAMS

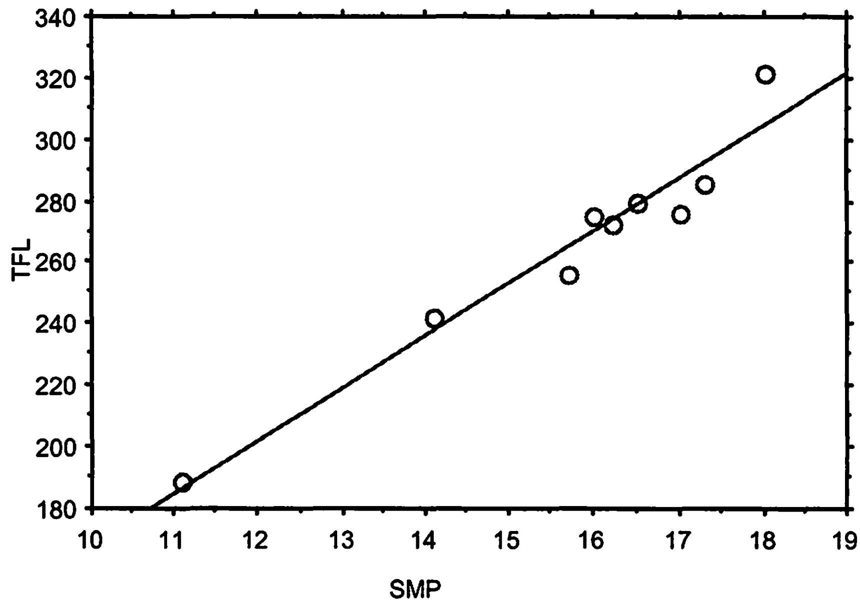
1. Total length versus standard length



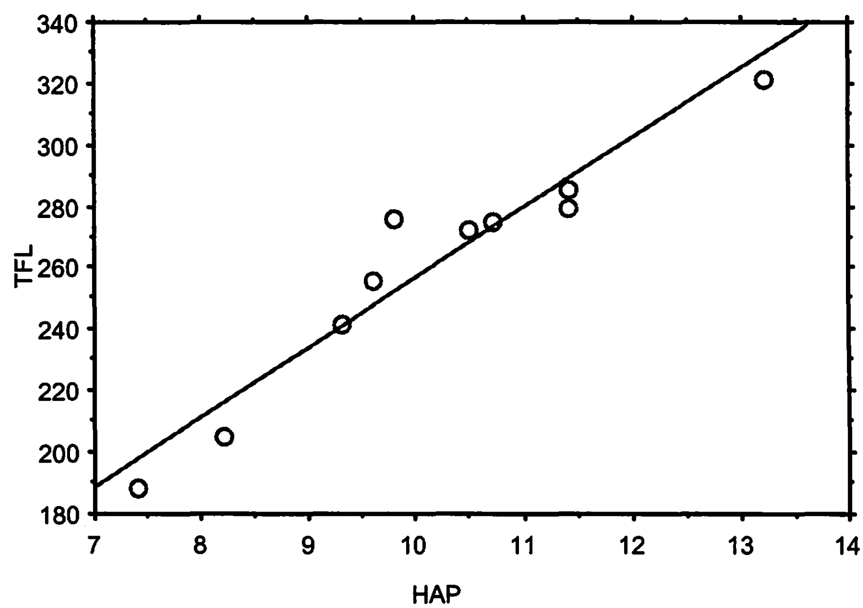
2. Log. of total length versus log. of total weight



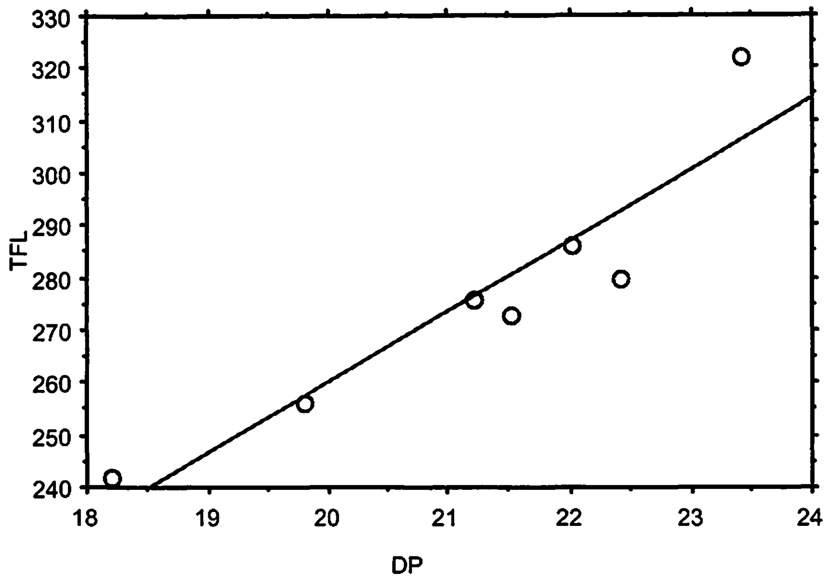
4. Total length versus SMP



7. Total length versus HAP



9. Total length versus dental plate length



Specimens #11292 to 11541 were caught in St. Margaret's Bay during the period June to July of 1987. Specimen #11593 is from Passamaquoddy Bay, N. B. The remaining specimens also from St. Margaret's Bay, were caught on Aug. 21, 1990.

Some statistics of the total fish length for this sample are the following: Range 189-322 mm; Mean 260.4 mm; Std. Dev. 39.41 ; Coeff. Var. 15.132

All measurements are good predictors for the total length of the fish, except the width of the maxillary process and the height of the ascending process.

Table 19. Original data for the live fish and the premaxillary dimension in sea raven *(Hemitripterus americanus)*

		FISH			PMA
NSM#	TFL	SFL	TFW	DFW	SAP
11266	498	•	1616.0	•	9.5
11538	256	287	711.4	478.5	6.3
11573	410	•	•	•	8.2

NSM#	ML	MH	HAP	HMP	DP
11266	50.4	26.0	15.2	3.6	50.4
11538	33.8	17.8	11.4	33.8	6.1
11573	40.5	20.7	12.0	40.5	7.0

The specimen # 11266 was caught in St. Margaret's Bay, N. S. on June 18, 1987 in a mackerel trap; the remaining specimens were caught in mackerel traps in St. Margaret's Bay, N. S. in 1987, on Aug. 10, Aug. 1st and June 18, respectively.

No regressions were calculated because of the small number of specimens.

Table 20. Original data of the live fish and the premaxillary bone, with the regression equations and the correlation coefficients (r^2) between them in mackerel *(Scomber scombrus)*

	FISH					PMA
NSM#	TFL	FFL	SFL	TFW	DFW	SAP
12476	441	403	•	437.5	298.5	7.1
12489	346	362	398	513.0	417.8	5.4
12750	393	359	345	635.0	461.5	5.1
12756	310	288	279	247.4	222.4	4.3
12758	313	286	175	248.5	220.2	5.0
12759	325	298	285	268.1	243.5	4.6
12805	425	390	367	680.8	629.8	6.2
12806	242	226	216	99.0	•	3.3
12807	302	276	260	223.5	195.6	5.0
12808	283	260	245	150.2	135.0	4.7
12809	271	249	239	161.0	148.7	4.0
12810	306	275	259	214.0	195.0	5.0
12811	285	262	244	169.5	151.5	4.0
12812	307	278	258	227.8	198.0	5.1
12813	304	279	261	237.9	215.7	4.7
12814	310	282	267	226.6	202.5	4.9
12815	392	357	338	437.1	402.0	5.1
12816	245	227	213	99.5	87.5	4.0
12817	300	276	259	212.9	182.9	4.3
12818	244	226	210	105.5	•	4.0
12819	244	223	210	97.7	•	3.5
12820	302	273	257	221.0	195.4	5.0
12821	319	291	272	220.7	191.7	5.8
12822	303	280	264	208.7	185.7	4.8
12823	263	242	230	130.5	117.2	4.0
12824	310	284	270	250.7	•	4.6
12856	254	234	227	120.5	•	4.1

NSM#	ML	MH	DP	#T	#R
12476	33.1	7.1	30.5	81	1
12489	29.2	6.2	26.7	60	1
12750	30.0	6.7	32.3	58	1
12756	24.5	6.1	23.0	43	1
12758	23.2	5.4	22.3	51	1
12759	24.6	5.5	22.4	45	1
12805	31.4	6.5	29.0	61	1
12806	19.5	4.1	18.0	51	1
12807	24.1	5.3	22.6	55	1
12808	20.6	4.6	18.9	42	1
12809	20.5	4.6	18.5	44	1

Table 20 (cont.)

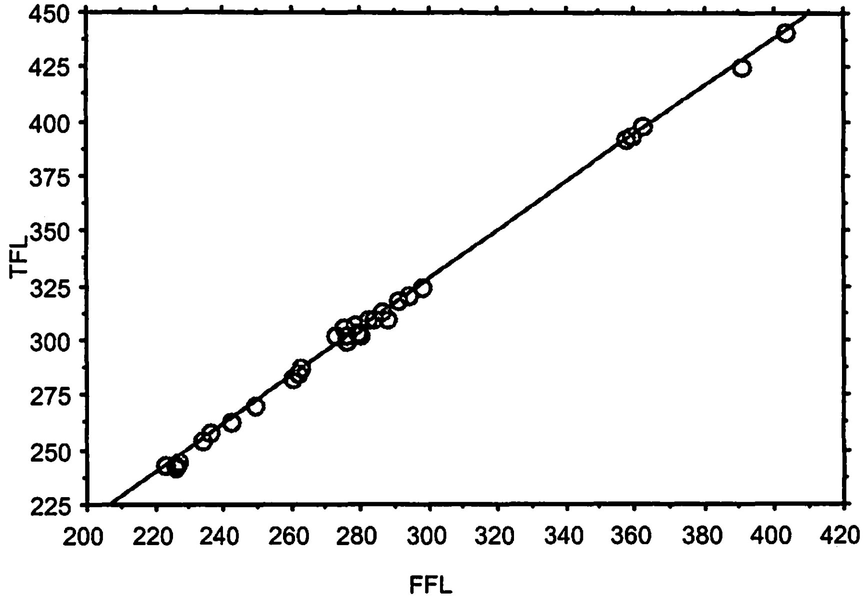
12810	23.7	4.8	22.0	51	1
12811	22.5	5.2	21.4	65	1
12812	24.6	5.5	22.4	55	1
12813	24.3	5.7	22.5	60	1
12814	22.9	5.1	20.9	48	1
12815	29.0	6.8	27.1	72	1
12816	18.7	4.3	17.2	42	1
12817	22.3	5.1	20.3	51	1
12818	18.4	4.2	16.7	40	1
12819	18.8	5.9	16.8	47	1
12820	22.7	4.6	20.9	50	1
12821	24.5	5.4	22.6	64	1
12822	24.0	5.0	19.0	58	1
12823	20.2	4.5	18.5	47	1
12824	24.1	5.3	22.0	47	1
12856	19.6	4.0.	17.0	54	1

VARIABLES Y	X	REGRESSION EQUATIONS	CORRELATION COEFF. r^2	N
1. TFL	FFL	Y = 1.109 X - 4.641	0.998	31
2. TFL	SFL	Y = 0.973 X + 50.007	0.825	30
3. TFL	TFW	log. Y = 0.300 log. X + 1.785	0.944	31
4. TFL	DFW	log. Y = 0.314 log. X + 1.769	0.873	25
5. TFL	SAP	Y = 58.181 X + 35.817	0.742	27
6. TFL	ML	y = 13.819 X + 17.307	0.973	27
7. TFL	MH	y = 55.404 X + 16.314	0.740	27
8. TFL	DP	y = 12.6 X + 34.737	0.905	27

Table 20 (cont.)

SCATTER DIAGRAMS

1. Total length versus fork length



2. Total length versus standard length

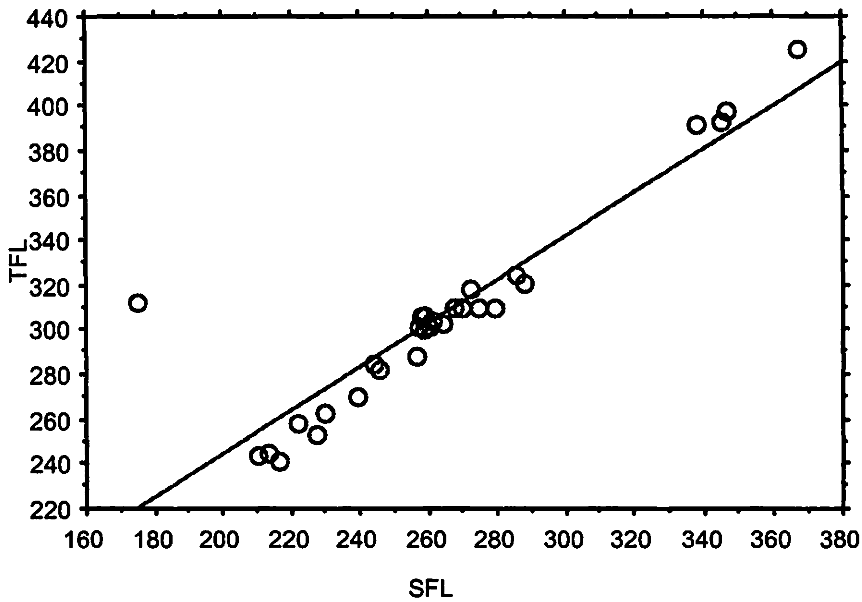
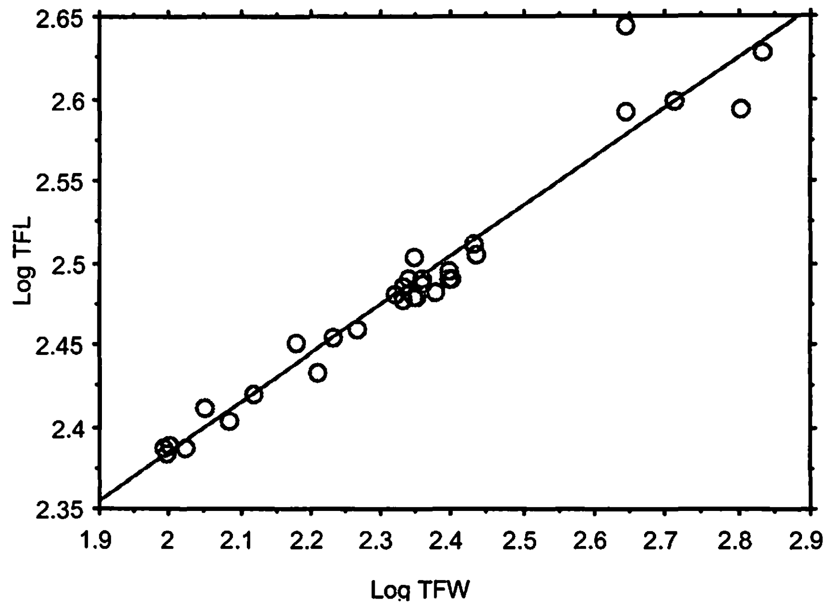


Table 20 (cont.)

3. Log. of total length versus log. of total weight



4. Log. of total length versus log. of dressed weight

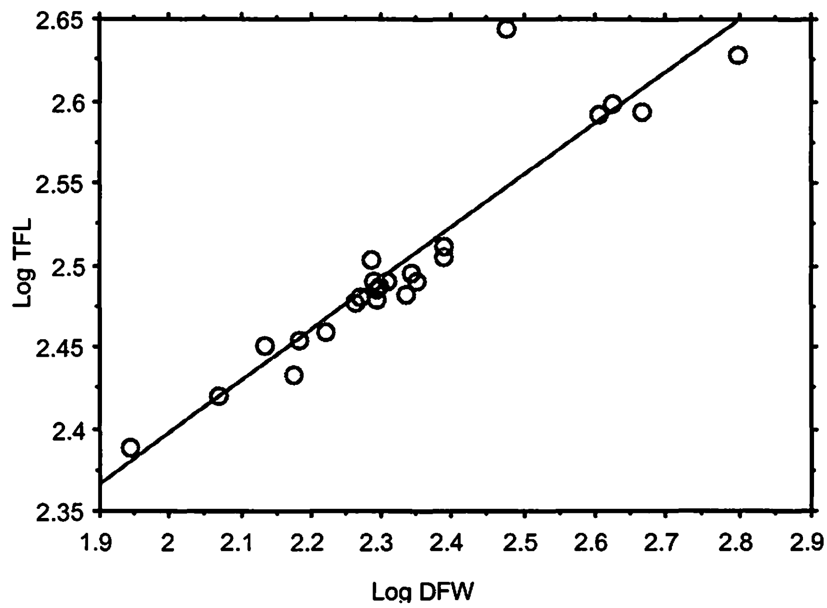
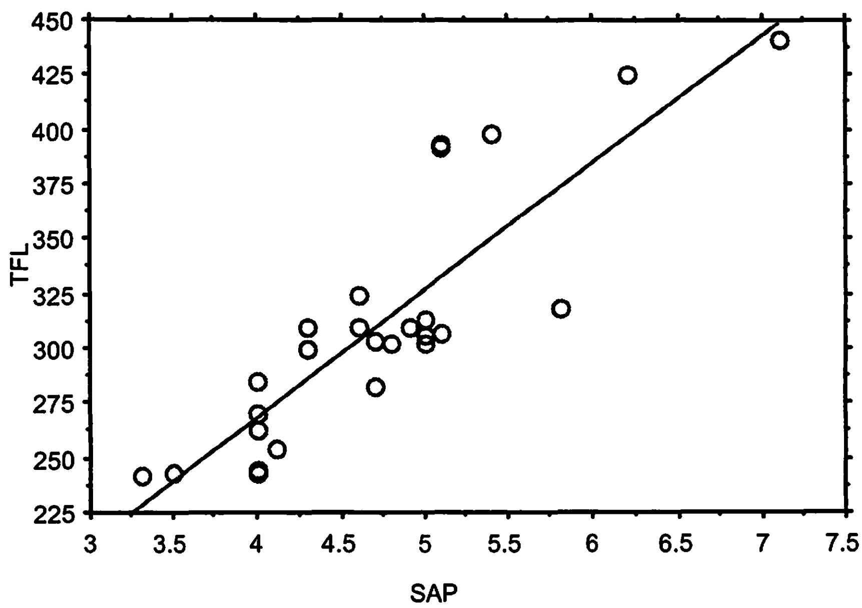


Table 20 (cont.)

5. Total length versus SAP



6. Total length versus maximum bone length

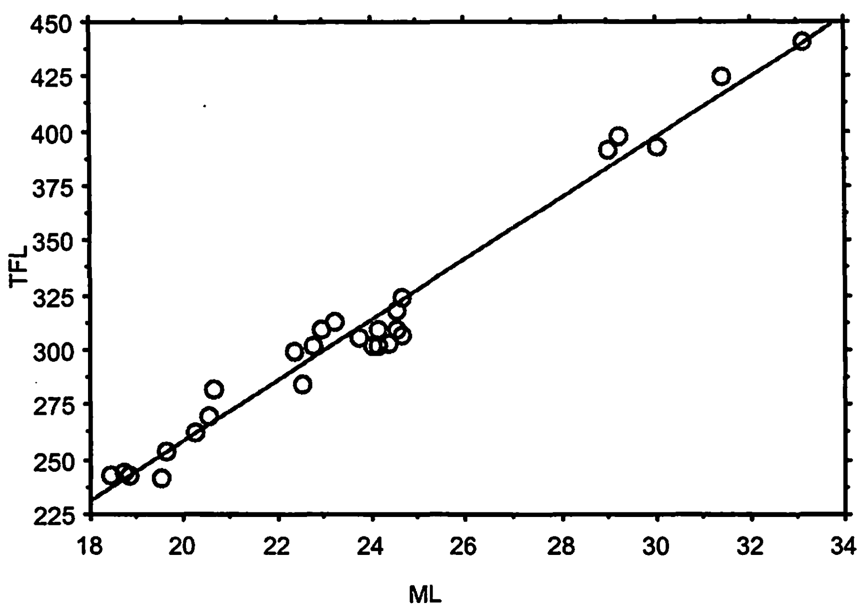
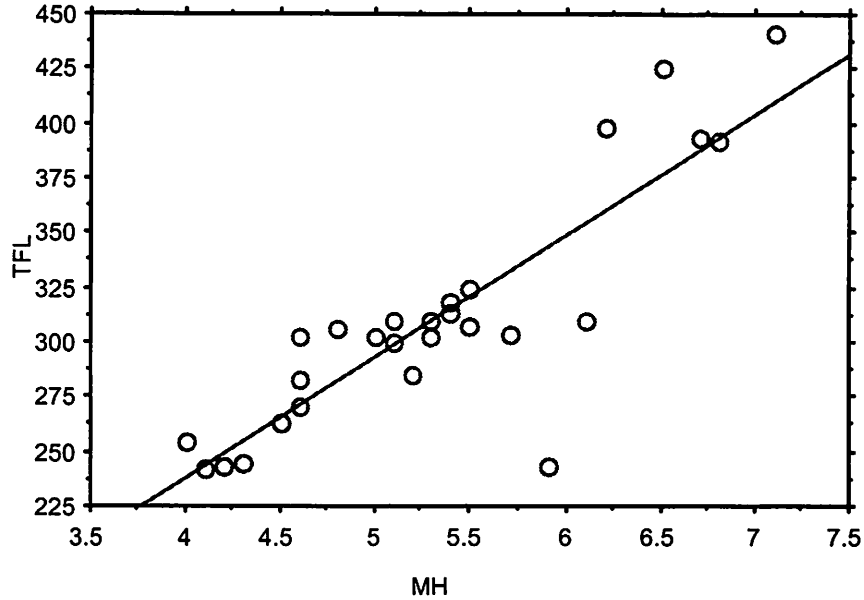
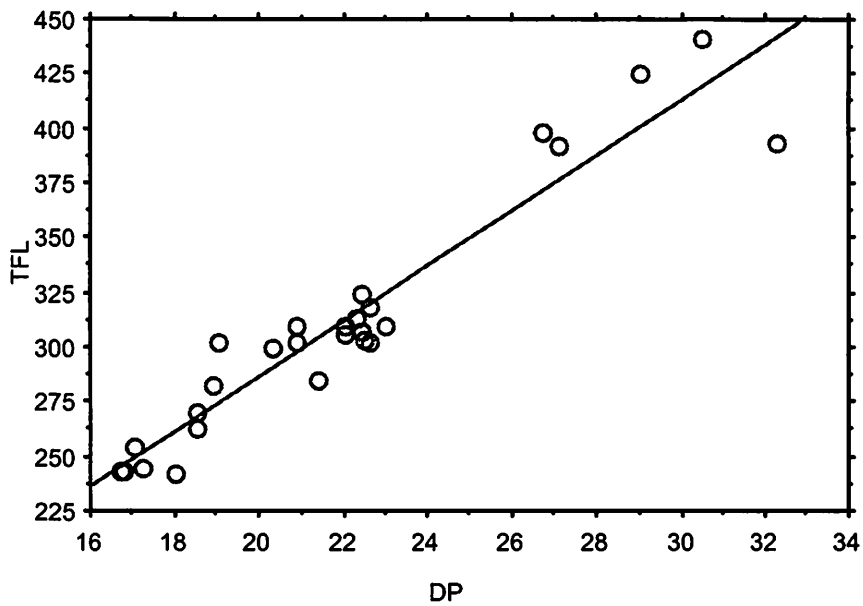


Table 20 (cont.)

7. Total length versus maximum bone height



8. Total length versus dental plate length



Specimens #12476, 12489, and 12712 were caught on offshore waters of Nova Scotia between May 21 and July 2, 1998. The specimen #12750, was caught on Nov. 20, 1993. Specimens #12755 to 12759 were caught in Mahone Bay on Sept. 26, 1998. All remaining specimens are from St. Mary's Bay, N. S. caught on Aug. 21st, 1998.

Some statistics of the total fish length for this sample are the following: Range 242-441 mm; Mean 308.65 mm; Std. Dev. 52.10; Coeff. Var. 16.88

Two of the correlations between the measurements on the premaxillary and the total length of the fish are good, while the other two can be used with caution.

Table 21. Original data of the live fish and the premaxillary bone, with the regression equations and the correlation coefficients (r^2) between them in Canadian plaice *(Hippoglossoides platessoides)*

	FISH				PMA							
NSM#	TFL	SFL	TFW	DF	SAP	ML	MH	HAP	HMP	DP	#T	#R
Left premaxilla												
12792	410	341	•	•	4.6	29.3	9.0	5.5	•	26.7	40	1
12793	414	352	485.5	•	6.2	32.6	12.0	8.2	3.6	29.7	51	1
12828	312	270	227.3	•	4.3	24.1	8.0	5.5	3.1	21.4	36	1
12843	336	277	283.0	•	4.2	25.0	7.0	5.0	2.5	21.2	37	1
12844	385	322	•	440	4.3	26.9	9.9	5.1	3.0	20.6	28	1
12852	436	363	•	•	8.4	37.7	11.8	7.0	4.8	33.2	34	1
12853	441	371	•	•	7.3	30.6	11.8	6.9	3.7	26.4	26	1
Right premaxilla												
12792	410	341	•	•	4.6	21.8	10.2	6.6	•	21.0	34	1
12793	414	352	485.5	•	5.6	25.4	12.4	7.0	3.7	22.5	41	1
12828	312	270	227.3	•	4.0	18.4	8.1	4.8	3.0	15.6	29	1
12843	336	277	283.0	•	5.4	21.8	5.6	4.5	2.5	17.6	34	1
12844	385	322	•	440	4.5	20.5	8.9	5.1	3.5	17.6	30	1
12852	436	363	•	•	8.1	30.2	11.4	7.1	4.0	27.3	35	2
12853	441	371	•	•	6.2	25.4	11.1	6.3	4.5	21.0	27	2

VARIABLES Y	X	REGRESSION EQUATIONS	CORRELATION COEFF. r^2	N
1. TFL	SFL	Y = 1.217 X - 8.473	0.988	7
2. TFL	TFW	log. Y = 0.313 log X + 1.769	0.854	7
Left side				
3. TFL	SAP	Y = 22.569 X + 263.863	0.603	7
4. TFL	ML	Y = 8.797 X + 131.434	0.706	7
5. TFL	MH	Y = 21.321 X + 178.886	0.755	7
6. TFL	HAP	Y = 26.446 X + 227.363	0.416	7
7. TFL	HMP	Y = 50.813 X + 212.027	0.567	6
8. TFL	DP	Y =7.954 X + 186.948	0.595	7

Table 21 (cont.)

Right side				
3. TFL	SAP	Y = 23.582 X + 261.204	0.428	7
4. TFL	ML	Y = 9.939 X + 158.435	0.623	7
5. TFL	MH	Y = 17.741 X + 218.988	0.693	7
6. TFL	HAP	Y = 39.578 X + 156.496	0.757	7
7. TFL	HMP	Y = 68.026 X + 146.974	0.821	6
8. TFL	DP	Y = 19.389 X + 178.934	0.671	7

Specimen #12792-12793 were caught in St. Margaret's Bay, N. S. on Aug., 21, 1998; #12828 is a commercial specimen caught on offshore waters of N. S. on Nov. 20, 1998; specimens #12843-12844 are comercial specimens from the Bay of Fundy, N. B. caught on Dec. 1st, 1998; and the last specimen comes from Shoal Bay, N. S. caught on Jan. 14, 1998.

Table 22. Original data of the live fish and the premaxillary dimensions in winter flounder *(Pseudopleuronectes americanus)*

	FISH			PMA							
NMS#	TFL	SFL	TFW	SAP	ML	MH	HAP	HMP	DP	#T	#R
Left premaxilla											
12790	256	209	200.5	2.5	8.1	8.2	5.0	•	5.7	11	1
12791	320	261	413.9	2.6	4.2	8.6	4.4	2.2	2.4	9	1
Right premaxilla											
12790	256	209	200.5	2.5	6.4	7.1	•	•	•	•	•
12791	320	261	413.9	3.2	7.8	8.1	4.1	•	•	•	•

These specimens were caught in a mackerel trap on August 21, 1998 in St. Margaret's Bay, N. S. No regressions were calculated because of the small number of specimens.

IX.4.2 Maxillary

Figure 8 shows the different measurements taken on the maxillary bone. All measurements were taken between the perpendiculars traced over the two points considered.

ML = Maximum length. Distance between the anteriormost point to the posteriormost point of the bone.

BH = Maximum body height. Distance between the most dorsal point and the most ventral of the body of the bone, including the posterior process.

HL = Head length. Distance between the anteriormost point and the most posterior of the head of the bone.

HH = Head height. Distance between the most dorsal point and the most ventral of the head of the bone.

HW = Head width. Distance between the two most lateral points of the head of the bone.

DP = Length of the dental plate.

#T = Number of teeth.

#R = Number of teeth rows.

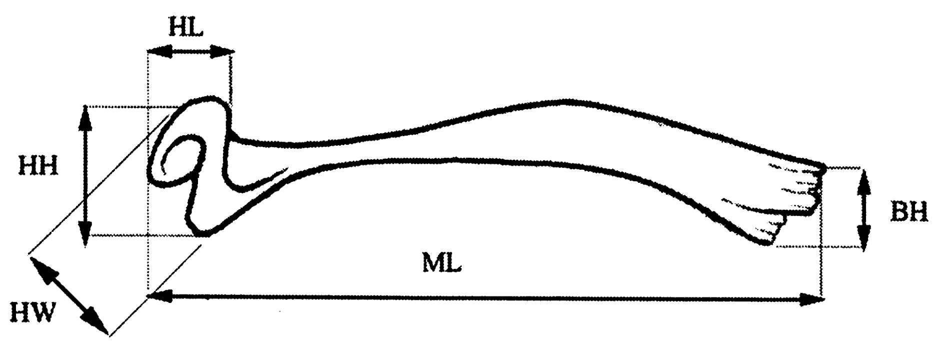


Fig. 8. Measurements taken on the maxillary bone

Table 23. Original data of the live fish and the maxillary bone, with the regression equations and the correlation coefficients (r^2) between them in Atlantic herring *(Clupea harengus)*

	FISH					MAXILLARY			
NSM#	TFL	FFL	SFL	TFW	DFW	ML	BH	HL	HH
12775	253	226	216	115.7	102.4	22.5	5.3	4.5	3.2
12776	237	213	203	93.5	83.0	20.2	4.1	4.0	2.9
12777	215	193	180	75.7	69.7	18.7	3.8	4.0	2.3
12778	237	214	198	94.0	85.8	19.8	4.0	3.4	2.9
12779	249	223	210	120.7	105.0	22.6	4.2	4.9	3.0
12780	223	198	188	86.8	78.5	19.3	4.4	3.7	2.8
12781	243	217	206	130.8	107.8	•	4.1	5.0	3.0
12782	217	194	184	80.6	72.7	18.7	4.0	4.0	3.3
12783	251	225	216	130.5	105.3	21.8	4.5	4.2	3.1
12785	247	220	210	125.1	104.0	21.4	4.4	4.3	3.2
12786	246	218	207	98.7	91.5	21.6	4.9	4.6	3.2
12787	214	194	183	72.0	64.3	19.1	4.7	4.0	2.8
12788	236	212	203	91.2	84.5	21.2	4.6	3.8	3.1

VARIABLES Y	X	REGRESSION EQUATION	CORRELATION COEFF. r^2	N
1. TFL	FFL	Y = 1.155 X - 8.006	0.989	14
2. TFL	SFL	Y = 1.121 X + 11.645	0.976	14
3. TFL	TFW	log. Y = 0.269 log. X +1.836	0.826	14
4. TFL	DFW	log. Y = 0.336 log. X + 1.721	0.89214	
5. TFL	ML	Y = 9.548 X + 38.969	0.890	12
6. TFL	BH	Y = 14.307 X +173.271	0.178	13
7. TFL	HL	Y = 16.481 X + 167.033	0.293	13
8. TFL	HH	Y = 30.48 X + 145.028	0.315	13

The best dimension to estimate the length of Atlantic herring is the length of the maxillary bone. It is not an ideal dimension because the bone is laminar and breaks easily. The other three dimensions, either because they are small or the area of the bone where they are taken is laminar, are of very little value.

Table 24. Original data of the live fish and the maxillary bone, with the regression equations and the correlation coefficients (r^2) between them in blueback herring *(Alosa aestivalis)*

	FISH					MAXILLARY			
NSM#	TFL	FFL	SFL	TFW	DFW	ML	BH	HL	HH
11291	320	•	268	376.8	319.0	23.6	5.0	5.1	3.8
12714	263	231	222	128.8	111.6	21.8	4.0	4.0	2.0
12715	248	220	210	103.3	•	19.8	4.1	4.0	2.8
12716	283	247	231	146.3	134.0	23.2	4.6	5.0	3.4
12717	305	268	256	193.7	171.5	25.5	5.5	5.4	4.1
12718	298	260	247	221.3	178.0	24.0	4.5	5.0	3.7
12719	256	223	214	132.7	121.2	20.7	4.8	4.5	3.1
12720	252	225	201	129.8	116.8	20.7	3.7	4.6	2.9
12721	295	259	247	164.3	155.7	23.0	4.7	4.7	3.5
12722	296	261	250	171.8	161.5	24.3	4.9	5.2	3.6
12723	250	219	210	130.5	111.0	20.6	3.9	3.0	4.8
12724	262	230	221	118.8	107.0	20.7	4.1	4.1	3.0
12725	257	226	215	114.5	104.9	21.4	3.9	4.6	3.0
12726	233	204	•	88.5	81.3	20.1	4.1	4.6	3.0
12727	287	250	242	171.5	160.8	24.3	4.6	4.9	3.7
12728	265	234	222	123.8	114.0	22.9	4.5	4.6	3.2
12729	223	200	187	99.0	87.8	19.0	4.0	4.9	2.6
12730	250	221	210	110.6	102.5	20.5	4.1	3.5	2.6
12731	258	229	218	115.6	102.7	20.6	4.0	4.7	3.0
12732	253	217	210	107.5	•	20.9	3.6	4.9	3.0
12733	256	225	216	130.0	118.0	21.1	4.1	4.6	3.0
12734	259	230	218	135.5	127.2	21.1	4.5	4.0	3.0
12735	255	226	215	113.0	106.0	21.0	4.4	4.6	2.9
12736	280	245	236	158.0	146.6	24.0	4.6	5.0	3.6
12737	243	214	205	112.8	103.3	20.6	4.1	5.0	3.0
12738	253	216	209	107.0	98.7	21.1	4.6	4.0	3.0

VARIABLES Y	X	REGRESSION EQUATIONS	CORRELATION COEFF. r^2	N
1. TFL	FFL	$Y = 1.154 X - 3.62$	0.983	25
2. TFL	SFL	$Y = 1.169 X + 5.653$	0.979	25
3. TFL	TFW	$\log. Y = 0.258 \log. X + 1.872$	0.813	26
4. TFL	DFW	$\log. Y = 0.280 \log. X + 1.838$	0.842	24
5. TFL	ML	$Y = 12.55 X - 8.053$	0.83026	
6. TFL	BH	$Y = 39.345 X + 94.538$	0.55326	
7. TFL	HL	$Y = 20.202 X + 173.288$	0.23026	
8. TFL	HH	$Y = 23.427 X + 190.33$	0.30726	

Similar observations as those given for Atlantic herring.

Table 25. Original data of the live fish and the maxillary bone, with the regression equations and the correlation coefficients (r^2) between them in gaspereau *(Alosa pseudoharengus)*

	FISH					MAXILLARY			
NSM#	TFL	FFL	SFL	TFW	DFW	ML	BH	HL	HH
12477	262	234	217	196.5	174	25.0	5.5	5.0	3.6
12478	282	259	241	273.5	240.1	28.6	6.2	5.0	3.8
12479	292	262	246	279.3	233.2	26.9	6.4	4.6	3.9
12480	268	254	240	258.5	217.8	26.4	6.0	3.9	4.0
12481	279	254	233	218.1	193.5	27.0	5.7	4.9	3.9
12482	293	258	244	266.5	225.5	26.9	6.3	4.1	4.1
12483	264	231	216	189.1	163.5	24.4	5.5	5.2	3.4
12484	263	233	219	182.5	158.3	24.3	5.4	5.2	3.7
12485	296	263	249	275.5	236.5	25.8	5.5	5.6	4.1
12486	297	260	245	239.5	213.8	27.3	6.1	5.0	4.2
12487	309	276	257	331.3	283.1	28.3	5.2	6.1	4.0
12488	281	247	228	247.2	213.5	27.0	5.7	6.5	5.4
12766	304	274	260	229.0	185.1	25.5	5.2	5.1	3.5
12767	299	268	254	245.5	189.3	25.3	5.1	4.7	3.6
12768	274	242	227	158.7	•	25.6	5.5	5.9	3.3
12800	259	228	213	145.5	133.5	24.1	5.3	3.5	3.4
12801	312	269	258	248.7	230.7	30.1	7.3	5.5	4.2
12802	249	227	206	105.2	98.2	22.6	5.0	4.0	3.4
12803	221	198	180	76.3	67.6	21.4	5.0	4.7	3.1
12804	307	268	253	225.7	213.7	27.8	6.4	5.1	4.5

VARIABLES Y	X	REGRESSION EQUATIONS	CORRELATION COEFF. r^2	N
1. TFL	FFL	Y = 1.13 X + 2.151	0.933	20
2. TFL	SFL	Y = 1.084 X +26.655	0.942	20
3. TFL	TFW	log. Y = 0.209 log. X + 1.961	0.740	20
4. TFL	DFW	log. Y = 0.226 log .X + 1.935	0.762	19
5. TFL	ML	Y = 9.281 X + 39.097	0.678	20
6. TFL	BH	Y = 20.124 X + 165.541	0.261	20
7. TFL	HL	Y = 11.571 X + 222.438	0.140	20
8. TFL	HH	Y = 23.749 X + 188.998	0.273	/20

Similar observations as those given for Atlantic herring.

Table 26. Original data of the live fish and the maxillary bone, with the regression equations and the correlation coefficients (r^2) between them in shad *(Alosa sapidissima)*

	FISH					MAXILLARY			
NSM#	TFL	FFL	SFL	TFW	DFW	ML	BH	HL	HH
11294	297	•	249	266.5	222.3	24.6	6.1	6.1	3.6
11295	286	•	241	201.1	178.6	24.7	7.7	5.1	4.6
11296	291	•	246	250.6	216.8	24.6	6.6	5.6	3.6
11524	533	•	•	930.0	•	56.2	8.3	7.5	6.4
11525	598	•	•	1462.0	•	57.5	8.7	8.2	7.0
12751	474	417	410	1072.8	769.4	45.1	17.7	10.0	5.8
12754	503	457	433	1516.5	1321.5	51.4	10.6	10.7	6.5

VARIABLES Y	X	REGRESSION EQUATIONS	CORRELATION COEFF. r^2	N
1. TFL	SFL	Y = 1.12 X + 16.38	0.999	7
2. TFL	TFW	log. Y = 0.35 log. X +1.637	0.941	7
3. TFL	DFW	log. Y = 0.313 log. X +1.744	0.977	5
4. TFL	ML	Y = 8.439 X + 83.492	0.9827	
5. TFL	BH	Y =13.822 X + 296.272	0.1727	
6. TFL	HL	Y = 44.614 X +86.933	0.5427	
7. TFL	HH	Y = 89.166 X - 51.673	0.9237	

Similar observations as those given for Atlantic herring.

Table 27. Original data of the live fish and the maxillary bone, with the regression equations and the correlation coefficients (r^2) between them in *(Anguilla rostrata)*

	FISH				MAXILLARY						
NSM#	TFL	SFL	TFW	DFW	ML	BH	HL	HH	DP	#T	#R
12497	552	540	282	247.0	21.0	2.1	2.3	3.9	17.0	100	4
12498	553	541	314	270.4	23.0	3.5	3.0	4.2	17.5	110	5
12829	363	•	•	82.5	10.5	1.4	1.2	2.0	7.0	•	4
12830	319	•	•	50.1	10.0	1.8	1.0	1.0	6.5	60	3
12831	334	•	•	71.0	10.1	2.1	1.2	2.0	7.0	•	•
12832	394	•	•	102.5	12.0	1.8	1.5	2.0.	8.1	75	4
12833	358	•	•	88.2	11.0	1.2	1.2	1.9	7.0	90	3
12834	320	•	•	52.1	10.0	0.9	1.1	1.8	7.2	70	4
12835	353	•	•	56.5	10.0	1.0	1.0	2.0	6.0	62	3
12836	345	•	•	81.1	12.0	1.8	1.2	2.0	6.5	•	4
12837	326	•	•	49.3	9.0	1.0	1.3	1.8	7.5	68	4

VARIABLES Y	X	REGRESSION EQUATIONS	CORRELATION COEFF. r^2	N
1. TFL	DFW	Log. Y = 0.329 log. X +1.938	0.950	11
2. TFL	ML	Y = 17.803 X + 159.046	0.959	11
3. TFL	BH	Y = 85.552 X + 238.703	0.544	11
4. TFL	HL	Y = 130.773 X +193.148	0.900	11
5. TFL	HH	Y = 87.912 X + 186.76	0.942	11
6. TFL	DP	Y = 20.022 X + 206.26	0.944	11

This bone is strong and easy to measure. The maxillary dimensions are good predictors for the length of the fish. The body height (BH) shows a weaker correlation.

Table 28. Original data of the live fish and the maxillary bone in Atlantic salmon *(Salmo salar)*

	FISH					MAXILLARY
NSM#	TFL	FFL	SFL	TFW	DFW	ML
12406	800	•	717	5754	5174	59.1
12499	475	452	422	•	2308	41.4
12713	576	542	516	•	1506	36.0
12862	452	442	410	•	835	30.5

NSM#	BH	HL	DP	#T	#R
12406	6.6	8.9	42.0	9	1
12499	5.1	6.9	26.5	•	1
12713	5.0	9.6	22.7	13	1
12862	3.6	7.8	17.6	8	1

No calculations were obtained because of the small number of specimens.

Table 29. Original data of the live fish and the maxillary bone, with the regression equations and the correlation coefficients (r^2) between them in brook trout *(Salvelinus fontinalis)*

	FISH					MAXILLARY					
NMS#	TFL	FFL	SFL	TFW	DFW	ML	BH	HL	DP	#T	#R
12490	279	•	•	•	•	25.5	2.2	4.6	17.0	21	1
12491	254	•	•	212.6	•	23.4	1.7	3.5	15.0	15	1
12493	279	•	•	226.8	•	25.0	2.1	4.1	15.0	16	1
12701	228	209	190	109.3	99.3	21.7	1.9	3.7	13.5	17	1
12702	266	•	•	•	•	27.9	2.1	4.0	19.0	21	1
12703	254	•	•	•	•	23.0	2.2	3.7	14.5	14	1
12704	254	•	•	•	•	29.1	2.5	4.6	20.0	22	1
12705	330	•	•	454.0	•	33.4	2.1	4.6	21.0	15	1
12706	213	204	189	106.5	94.2	23.2	1.9	4.1	16.0	12	1
12752	247	238	219	163.5	152.0	26.1	2.4	3.7	17.5	16	1
12753	234	•	•	•	•	23.2	2.0	4.0	15.3	21	1
12769	280	268	244	215.0	200.8	•	•	•	•	•	•
12770	282	271	246	224.7	205.2	27.5	2.3	4.4	19.0	16	1
12794	258	247	227	145.6	140.1	25.6	2.1	3.7	17.5	16	1

VARIABLES Y	X	REGRESSION EQUATIONS	CORRELATION COEFF. r^2	N
1. TFL	FFL	Y = 0.965 X + 20.194	0.983	6
2. TFL	SFL	Y = 1.084 X + 13.723	0.967	6
3. TFL	TFW	log. Y = 0.323 log. X + 1.687	0.889	11
2. TFL	ML	Y = 7.373 X + 70.071	0.63513	
3. TFL	BH	Y = 36.326 X +183.003	0.07113	
4. TFL	HL	Y = 40.82 X + 94.34	0.29613	
5. TFL	HH	Y = 7.871 X + 126.46	0.38313	

Only the maximum length of the maxillary seems somewhat valuable to estimate the length of brook trout.

Table 30. Original data of the live fish and the maxillary bone, with the regression equations and the correlation coefficients (r^2) between them in smelt *(Osmerus mordax)*

	FISH					MA
NSM#	TFL	FFL	SFL	TFW	DFW	ML
12847	242	227	210	103.7	91.2	19.5
12848	225	207	192	66.6	56.6	18.5
12849	256	237	220	120.1	99.2	20.8
12850	285	267	242	194.2	66.5	24.5
12851	245	233	211	104.0	83.2	20.5

NSM#	BH	HL	HH	DP	#T	#R
12847	2.1	4.0	1.4	13.0	35	1
12848	1.8	4.2	1.0	14.0	28	1
12849	1.9	4.3	1.4	14.5	261	
12850	3.2	5.7	2.0	15.1	281	
12851	2.1	5.2	1.4	14.6	351	

VARIABLES Y	X	REGRESSION EQUATIONS	CORRELATION COEFF. r^2	N
1. TFL	FFL	$Y = 1.017 X + 12.457$	0.983	5
2. TFL	SFL	$Y = 1.21 X - 10.843$	0.992	5
3. TFL	TFW	$\log. Y = 0.225 \log. X + 1.938$	0.984	5

No calculations were made for the dimensions of the maxillary because of the small number of specimens.

Table 31. Original data of the live fish and the maxillary bone, with the regression equations and the correlation coefficients (r^2) between them in white sucker *(Catostomus commersoni)*

	FISH					MAXILLARY			
NSM#	TFL	FFL	SFL	TFW	DFW	ML	BH	HH	HW
11271	309	286	258	302.3	363.6	15.2	7.0	5.6	5.0
11272	347	324	289	428.8	•	14.3	6.8	4.2	4.5
11273	344	318	284	•	•	18.1	7.9	5.4	5.5
11279	211	200	181	86.3	•	12.1	4.8	3.0	4.3
11280	348	•	•	396.5	•	19.1	7.8	6.6	5.9
11281	322	•	•	330.4	•	16.7	7.5	4.4	4.7
11282	341	•	•	389.1	•	17.4	6.7	5.7	5.5
11283	325	•	•	327.5	•	16.5	7.3	5.1	6.5
11284	307	•	•	307.0	•	17.2	6.8	5.0	5.1
11285	430	402	385	705.7	•	23.5	8.7	8.5	6.0
11286	336	•	•	400.0	•	17.8	6.6	4.8	4.8
11287	333	•	•	389.1	•	17.0	6.9	5.8	5.1
11288	374	•	•	514.0	•	21.3	9.1	5.7	5.6
11289	350	•	•	425.8	•	18.4	7.9	6.6	5.7
12495	225	199	184	122.5	104.5	13.2	5.0	3.2	4.0
12710	247	227	203	136.3	121.6	14.1	5.9	4.3	3.7
12711	342	321	288	373.3	329.3	19.7	8.1	4.6	5.9

VARIABLES Y	X	REGRESSION EQUATIONS	CORRELATION COEFF. r^2	N
1. TFL	FFL	Y = 1.043 X + 9.885	0.997	8
2. TFL	SFL	Y = 1.077 X + 27.946	0.987	8
3. TFL	TFW	log. Y = 0.332 log. X + 1.671	0.988	16
4. TFL	ML	Y = 16.409 X + 41.542	0.787	17
5. TFL	BH	Y = 41.578 X + 27.5343	0.805	17
6. TFL	HL	Y = 22.863 X + 146.713	0.695	17
7. TFL	HH	Y = 51.281 X + 58.151	0.537	17

The best dimensions to estimate the length of the white sucker are the maximum length and the body height of the maxillary.

Table 32. Original data of the live fish and the maxillary in haddock *(Melanogrammus aeglefinus)*

	FISH					MAXILLARY				
NSM#	TFL	FFL	SFL	TFW	DFW	ML	BH	HL	HH	HW
11556	591	•	534	1446.0	•	45.4	7.4	8.0	8.0	8.9
12845	543	516	478	•	1266.0	35.3	8.0	8.0	8.1	9.0
12846	455	438	408	•	742.0	29.3	6.0	7.9	7.0	7.8

No calculation were made due to the small number of specimens.

Table 33. Original data of the live fish and the maxillary bone, with the regression equations and the correlation coefficients (r^2) between them in pollock *(Pollachius virens)*

	FISH					MAXILLARY				
NMS#	TFL	FFL	SFL	TFW	DFW	ML	BH	HL	HH	HW
11237	349	•	311	457.2	392.5	20.4	4.9	4.5	4.0	5.0
11238	306	•	273	256.3	228.8	22.2	5.1	4.6	3.7	4.8
11240	237	•	212	121.3	107.2	15.0	3.3	2.4	3.0	3.2
11241	251	•	228	145.5	126.6	15.0	3.3	2.5	2.7	3.1
11242	943	•	882	•	6070.0.	55.0	14.0	10.2	10.1	11.5
11243	397	•	353	765.8	628.6	22.8	5.1	4.8	4.5	5.1
11259	410	•	372	841.1	723.9	24.5	5.5	5.7	4.6	5.8
11262	179	•	161	58.2	•	11.2	2.4	2.4	2.1	2.6
11263	178	•	161	51.2	•	11.4	2.3	2.5	2.0	2.4
11264	167	•	•	40	•	10.6	2.6	2.1	2.2	2.1
11265	162	•	147	36.2	•	11.0	2.6	2.0	2.2	2.4
12772	509	478	451	1010.0	•	32.0	4.1	7.1	6.2	7.1
12773	475	442	415	•	•	32.6	7.8	5.4	6.4	7.1
12774	466	437	408	•	•	30.2	7.9	6.0	6.7	7.1
12789	428	400	381	•	•	26.6	6.0	5.4	5.2	5.7

VARIABLES Y	X	REGRESSION EQUATIONS	CORRELATION COEFF. r^2	N
1. TFL	SFL	$Y = 1.074 X + 13.298$	0.998	16
2. TFL	TFW	$\log. Y = 0.317 \log. X + 1.709$	0.988	12
3. TFL	ML	$Y = 16.822 X - 18.068$	0.983	15
4. TFL	BH	$Y = 62.264 X + 44.594$	0.892	15
5. TFL	HL	$Y = 85.429 X - 21.1$	0.946	15
6. TFL	HH	$Y = 86.859 X - 16.064$	0.957	15
7. TFL	HW	$Y = 77.623 X - 24.314$	0.969	15

All maxillary dimensions of the pollock are good predictors of the length of the fish. This bone is strong and well calcified.

Table 34. Original data of the live fish and the maxillary in cusk *(Brosme brosme)*

	FISH				MAXILLARY				
NSM#	TFL	SFL	TFW	DFW	ML	HL	HH	H	W
11544	588	554	1814.0	•	52.5	13.2	7.3	6.2	8.8
12838	751	712	•	4090.0	63.8	13.5	10.7	8.9	11.5

No calculations were made due to the small number of specimens.

Table 35. Original data of the live fish and dimensions of the maxillary bone in tomcod *(Microgadus tomcod)*

	FISH				MAXILLARY				
NSM#	TFL	SFL	TFW	DFW	ML	MH	HL	HH	HW
19839	198	178	68.0	56.2	14.4	2.6	2.8	3.0	2.6
12840	192	176	53.8	43.2	14.0	2.3	2.6	2.3	2.5
12841	186	170	57.0	42.0	14.1	2.8	3.0	2.4	2.1
12842	174	157	42.5	35.0	12.7	2.8	2.6	2.2	2.1

No statistics were calculated because of the small number of specimens.

Table 36. Original data of the live fish and the maxillary bone, with the regression equations and the correlation coefficients (r^2) between them in silver hake *(Merluccius bilinearis)*

	FISH					MAXILLARY			
NSM#	TFL	SFL	TFW	DFW	ML	BH	HL	HH	HW
11545	392	354	405.5	342.0	40.7	6.6	7.3	5.2	6.1
11546	366	328	351.3	286.9	37.2	7.2	7.0	4.8	5.7
11547	384	343	353.8	318.7	39.6	6.8	7.1	4.6	5.7
11548	368	327	277.7	257.3	37.2	7.2	6.9	4.5	5.6
11549	371	331	275.1	251.7	37.2	6.4	6.3	4.6	5.7
11550	391	352	382.4	349.5	40.7	6.3	6.4	5.0	6.8
11551	407	367	474.0	412.7	40.9	•	7.6	5.2	6.5
11552	381	342	370.3	327.8	39.8	6.4	7.3	4.7	6.2
11553	365	329	313.3	272.2	35.0	6.4	6.1	4.5	5.8
11557	409	•	•	•	42.3	6.8	8.3	5.1	6.5
11559	518	•	•	•	56.9	8.5	9.4	6.5	8.2
11569	459	417	630.0	498.7	45.8	7.4	8.2	5.3	7.6
11570	375	338	314.4	292.6	37.7	6.7	6.9	4.2	5.4
11571	364	325	253.8	•	35.3	6.9	6.4	4.4	5.5
11574	410	•	•	•	41.1	5.5	8.1	5.4	5.9

VARIABLES Y	X	REGRESSION EQUATIONS	CORRELATION COEFF. r^2	N
1. TFL	SFL	$Y = 1.034 X + 27.245$	0.997	12
2. TFL	TFW	$\log. Y = 0.241 \log. X + 1.971$	0.863	12
3. TFL	DFW	$\log. Y = 0.304 \log. X + 1.824$	0.895	11
4. TFL	ML	$Y = 7.657 X + 87.538$	0.957	15
5. TFL	BH	$Y = 38.759 X + 133.358$	0.373	14
6. TFL	HL	$Y = 40.774 X + 100.223$	0.779	15
7. TFL	HH	$Y = 67.586 X + 63.911$	0.835	15
8. TFL	HW	$Y = 48.262 X + 97.463$	0.857	15

All measurements, except the body height, can be used to estimate the length of silver hake. The poor value for the BH is due to the difficulty in taking the measurements at the right place of the bone.

Table 37. Original data of the live fish and the maxillary in goosefish *(Lophius americanus)*

	FISH				MAXILLARY				
NSM#	TFL	SFL	TFW	DFW	ML	BH	HL	HH	HW
11256	765	660	7080	5570	111.0	11.0	17.0	23.5	10.4
11257	710	595	3941	3473	95.0	9.5	16.0	21.0	9.4
11258	540	456	1899	1730	80.0	7.3	11.2	19.9	7.8
11555	685	565	3742	3232	96.0	9.2	16.7	19.3	8.0

No regressions were calculated because of the small number of specimens.

Table 38. Original data of the live fish and the maxillary bone, with the regression equations and the correlation coefficients (r^2) between them in longhorn sculpin *(Myoxocephalus octodecimspinosus)*

	FISH				MAXILLARY				
NSM#	TFL	SFL	TFW	DFW	ML	BH	HL	HH	HW
11292	322	277	304.3	274.6	36.3	7.2	5.5	6.4	7.8
11536	275	230	156.4	143.0	31.0	6.4	5.5	6.6	6.5
11537	189	163	65.8	57.1	22.5	4.2	3.0	4.0	4.5
11541	205	171	77.0	64.5	24.2	5.0	3.5	4.7	5.2
12760	280	•	211.2	•	34.6	7.0	6.1	6.3	6.7
12761	242	210	152.4	•	28.9	6.9	5.0	5.2	7.0
12762	273	234	231.0	•	32.6	7.6	5.8	6.0	6.9
12763	256	212	179.7	•	30.8	6.6	6.3	6.5	7.0
12764	276	236	227.0	•	33.0	7.5	5.6	7.6	7.0
12765	286	244	247.5	•	35.7	8.2	7.1	7.4	7.5

VARIABLES Y	X	REGRESSION EQUATIONS	CORRELATION COEFF. r^2	N
1. TFL	SFL	$Y = 1.148 X + 6.119$	0.991	10
2. TFL	TFW	$\log. Y = 0.311 \log. X + 1.719$	0.939	10
3. TFL	ML	$Y = 8.264 X + 4.544$	0.941	10
4. TFL	BH	$Y = 27.357 X + 78.201$	0.713	10
5. TFL	HL	$Y = 25.391 X + 124.811$	0.641	10
6. TFL	HH	$Y = 28.078 X + 89.965$	0.658	10
7. TFL	HW	$Y = 35.385 X + 26.505$	0.825	10

The maxillary of the longhorn sculpin is a strong bone. The best measurements are the maximum length and head width. The other values could improve with a larger sample.

Table 39. Original data of the live fish and the maxillary in sea raven *(Hemitripterus americanus)*

	FISH					MAXILLARY				
NSM#	TFL	FFL	SFL	TFW	DFW	ML	BH	HL	HH	HW
11266	498	•	•	1616	•	75.3	10.3	10.8	13.0	12.0
11269	340	•	•	•	•	52.1	6.4	7.3	7.2	8.2
11538	256	•	287	711.4	478.5	51.6	7.2	7.3	8.5	8.5
11573	410	•	•	•	•	60.0	7.5	8.5	10.4	10.0

No calculations were made due to the small number of specimens. The premaxillary bone is strong and well calcified. A larger sample can produce good regressions to predict the length of the sea raven.

Table 40. Original data of the live fish and the maxillary bone, with the regression equations and the correlation coefficients (r^2) between them in mackerel *(Scomber scombrus)*

	FISH					MAXILLARY				
NSM#	TFL	FFL	SFL	TFW	DFW	ML	BH	HL	HH	HW
12476	441	403	•	437.5	298.5	35.7	5.2	6.0	5.2	3.7
12489	398	362	346	513.0	417.8	30.4	4.6	5.2	4.6	4.3
12712	310	282	274	218.3	193.7	23.9	3.5	3.7	3.7	2.5
12750	393	359	345	635.0	461.5	36.5	4.7	5.2	5.5	3.0
12756	310	288	279	247.4	222.4	26.0	4.2	4.2	3.8	3.5
12757	288	263	256	184.1	166.0	22.5	2.8	3.7	3.5	2.4
12758	313	286	275	248.5	220.2	24.7	4.0	4.7	4.6	4.1
12759	325	298	285	268.1	243.5	24.9	3.1	3.2	•	•
12805	425	390	367	680.8	629.8	32.3	5.0	5.4	4.8	5.1
12806	242	226	216	99.0	•	19.5	3.0	3.1	3.0	2.0
12807	302	276	260	223.5	195.6	25.2	3.7	4.1	3.9	3.6
12808	283	260	245	150.2	135.0	21.8	3.3	3.6	3.5	2.0
12809	271	249	239	161.0	148.7	21.6	3.1	3.6	3.5	3.4
12810	306	275	259	214.0	195.0	24.6	3.7	4.6	4.2	3.2
12811	285	262	244	169.5	151.5	20.3	4.2	3.5	3.5	2.6
12812	307	278	258	227.8	198.0	25.4	4.0	4.0	4.3	3.2
12813	304	279	261	237.9	215.7	25.5	3.2	3.7	3.7	3.1
12814	310	282	267	226.6	202.5	24.5	4.0	4.3	4.3	3.9
12815	392	357	338	437.1	402.0	31.2	4.6	4.1	4.5	3.7
12816	245	227	213	99.5	87.5	19.1	3.1	3.2	3.1	1.8
12817	300	276	259	212.9	182.9	23.6	3.9	4.0	3.7	4.0

Table 40 (cont.)

NSM#	FISH TFL	FFL	SFL	TFW	DFW	MAXILLARY ML	BH	HL	HH	HW
12818	244	226	210	105.5	•	19.6	3.0.	2.9	3.2	3.2
12819	244	223	210	97.7	•	19.2	3.4	2.9	3.0	3.0
12820	302	273	257	221.0	195.4	24.1	3.6	3.9	3.6	2.8
12821	319	291	272	220.7	191.7	25.1	4.1	4.1	4.0	3.3
12822	303	280	264	208.7	185.7	23.9	3.2	4.1	3.9	3.4
12823	263	242	230	130.5	117.2	20.1	3.2	3.6	3.2	3.5
12824	310	284	270	250.7	225.2	24.6	3.9	4.5	4.3	2.5
12825	258	236	222	112.2	100.2	20.1	3.4	3.3	3.4	2.7

VARIABLES Y	X	REGRESSION EQUATIONS	CORRELATION COEFF. r^2	N
1. TFL	FFL	Y = 1.109 X - 4.641	0.998	31
2. TFL	SFL	Y = 0.973 X + 50.007	0.825	30
3. TFL	TFW	log. Y = 0.300 log. X + 1.785	0.944	31
4. TFL	DFW	log. Y = 0.314 log. X + 1.769	0.873	25
5. TFL	ML	Y = 10.996 X + 38.659	0.924	29
6. TFL	BH	Y = 70.789 X + 44.766	0.737	29
7. TFL	HL	Y = 61.135 X + 64.72	0.770	29
8. TFL	HH	Y = 74.746 X + 17.262	0.811	28
9. TFL	HW	Y = 43.581 X + 170.249	0.366	28

The best value is the maximum length (ML). The only poor value is that of the head width (HW) of the maxillary. The others can be used with reservations to estimate the length of the fish.

Table 41. Original data of the live fish and the maxillary bone, with the regression equations and the correlation coefficients (r^2) between them in Canadian plaice *(Hippoglossoides platessoides)*

	FISH				MAXILLARY				
NSM#	TFL	SFL	TFW	DFW	ML	BH	HL	HH	HW
Left side									
12792	410	341	•	•	34.5	5.2	4.0	6.0	6.0
12793	414	352	485.5	•	41.5	6.4	5.0.	7.8	5.4
12828	312	270	227.3	•	28.3	5.0.	3.6	5.0	3.6
12843	336	277	283.0	•	28.0	4.5	3.6	4.8	4.6
12844	385	322	•	440.0	27.5	5.0	5.0.	6.0	5.5
12852	436	363	440	•	44.0	8.3	9.0	7.0	5.7
12853	441	371	754	•	37.2	6.4	5.0	7.3	5.0
Right side									
12792	410	341	•	•	29.8	5.1	3.0	6.0	6.5
12793	414	352	485.5	•	35.5	4.0	7.8	7.4	7.0
12828	312	270	227.3	•	24.0	4.5	3.5	5.0	5.8
12843	336	277	283.0	•	24.0	4.5	3.8	5.1	5.4
12844	385	322	•	440.0	31.5	5.0.	4.5	6.0	4.5
12852	436	363	440.0	•	37.2	7.5	5.2	8.0	3.4
12853	441	371	754.0	•	32.0	6.3	5.5	6.6	7.1

VARIABLES Y	X	REGRESSION EQUATIONS	CORRELATION COEFF. r^2	N
1. TFL	SFL	Y = 1.217 X - 8.473	0.988	7
2. TFL	YFW	log. Y = 0.313 log X + 1.769	0.854	7
Left side				
3. TFL	ML	Y = 4.88 X +158.755	0.672	7
4. TFL	BH	Y = 23.061 X + 193.585	0.558	7
5. TFL	HL	Y =13.369 X + 260.774	0.381	7
6. TFL	HH	Y = 32.25 X + 125.747	0.832	7
7. TFL	HW	Y = 37.087 X + 138.325	0.550	7
Right side				
3. TFL	ML	Y = 8.498 X + 130.789	0.776	7
4. TFL	BH	Y = 25.096 X + 258.28	0.382	7
5. TFL	HL	Y = 15.786 X + 315.473	0.265	7
6. TFL	HH	Y = 37.54 X + 154.027	0.718	7
7. TFL	HW	Y = 2.458 X + 376.633	0.005	7

The maxillary is large, strong and easy to measure. A larger sample could provide better values.

Table 42. Original data of the live fish and the dimensions of the maxillary in winter flounder *(Pseudopleuronectes americanus)*

	FISH			MAXILLARY				
NMS#	TFL	SFL	TFW	ML	BH	HL	HH	HW
Left side								
12790	256	209	200.5	11.3	2.1	3.2	4.2	4.8
12791	320	261	413.9	13.7	2.7	4.0	4.8	5.6
Right side								
12790	256	209	200.5	10.3	2.7	2.5	4.1	4.6
12791	320	261	413.9	13.7	3.0	6.1	4.9	5.6

No calculations were made because of the small number of specimens. The maxillary is a strong bone and at least the maximum length and body height could be used as predictor of the length of the fish.

IX.4.3 DENTARY

Figure 9 shows the different measurements taken on the dentary.
All measurements should be made between the perpendiculars traced over the two points considered.

SCP = Distance from the anteriormost point of the symphysial margin to the tip of the coronoid process or to its highest point when rounded.

SVP = Distance from the anteriormost point of the symphysial margin to the tip of the ventral process.

MH (Maximum height) = Distance from the highest point of the coronoid process to the lowest point in the ventral margin.

SH (Symphysial height) = Distance between the highest and the lowest points of the symphysial joint.

SMI = Distance between the anteriormost point of the symphysial margin to the closest point of the indentation of the medial wall.

SLI = Distance between the anteriormost point of the symphysial margin to the closest point of the indentation notch of the lateral wall.

DP = Length of the dental plate.

#T = Number of teeth.

R = Number of teeth rows.

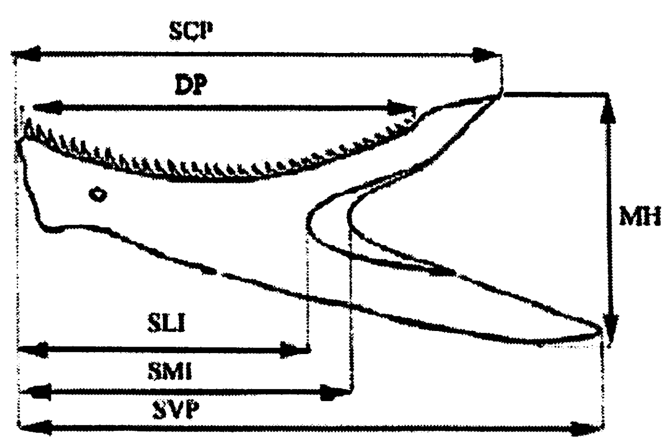


Fig. 9. Measurements taken on the dentary bone

Table 43. Original data of the live fish and the dentary bone, with the regression equations and the correlation coefficients (r^2) between them in Atlantic herring *(Clupea harengus)*

	FISH					DENTARY			
NSM#	TFL	FFL	SFL	TFW	DFW	SCP	SVP	MH	SLI
12775	253	226	216	115.7	102.4	19.6	24.5	11.3	14.6
12776	237	213	203	93.5	83.0	17.5	23.0	10.5	13.0
12777	215	193	180	75.7	69.7	16.6	20.9	10.0	11.8
12778	237	214	198	94.0	85.8	17.0	22.4	11.2	14.0
12779	249	223	210	120.7	105.0	18.1	24.1	12.0	13.7
12780	223	198	188	86.8	78.5	16.4	20.9	10.5	13.1
12781	243	217	206	130.8	107.8	18.1	22.5	10.6	12.5
12782	217	194	184	80.6	72.7	16.4	20.7	10.1	12.2
12783	251	225	216	130.5	105.3	17.8	23.9	11.1	13.7
12784	248	220	209	115.5	96.5	18.3	23.7	11.0	13.7
12785	247	220	210	125.1	104.0	•	•	•	•
12786	246	218	207	98.7	91.5	18.2	23.8	11.6	13.4
12787	214	194	183	72.0	64.3	16.1	20.3	10.4	11.9
11788	236	212	203	91.2	84.5	18.3	22.1	12.1	13.0

VARIABLES Y	X	REGRESSION EQUATION	CORRELATION COEFF. r^2	N
1. TFL	FFL	Y = 1.155 X - 8.006	0.989	14
2. TFL	SFL	Y = 1.121 X + 11.645	0.976	14
3. TFL	TFW	log. Y = 0.269 log. X +1.836	0.826	14
4. TFL	DFW	log. Y = 0.336 log. X +1.721	0.892	14
5. TFL	SCP	Y = 12.382 X +18.543	0.779	13
6. TFL	SVP	Y = 9.523 X + 21.593	0.942	13
7. TFL	MH	Y = 14.576 X + 76.416	0.481	13
8. TFL	SLI	Y = 14.032 X + 51.933	0.691	13

The dentary of the Atlantic herring is a large bone mostly laminar. The best measurement is the maximum length, in this case (SVP). A possible reason for the poor value of the maximum height is that the alar expansion is very variable in extension and shape and affects its height. All other values can improve using a larger sample.

Table 44. Original data of the live fish and the dentary bone, with the regression equations and the correlation coefficients (r^2) between them in blueback herring *(Alosa aestivalis)*

	FISH					DENTARY				
NSM#	TFL	FFL	SFL	TFW	DFW	SCP	SVP	MH	SMI	SLI
11291	320	•	268	367.8	319.0	17.3	26.1	13.5	6.3	15.4
12714	263	231	222	128.8	111.6	16.2	21.4	10.7	5.0	11.0
12715	248	220	210	103.3	94.3	16.0	22.4	10.5	5.7	12.5
12716	283	247	231	146.3	134.0	17.3	24.6	11.4	6.1	13.1
12717	305	268	256	193.7	171.5	19.2	27.7	13.6	6.8	14.5
12718	298	260	247	221.3	178.0	18.0	25.5	11.7	5.3	14.5
12719	256	223	214	132.7	121.2	14.4	22.2	10.7	5.4	11.4
12720	252	225	201	129.8	116.8	16.4	22.9	11.0	5.7	13.4
12722	296	261	250	171.8	161.5	17.3	26.5	17.1	6.3	14.1
12723	250	219	210	130.5	111.0	16.0	22.5	14.3	5.0	15.0
12724	262	230	221	118.8	107.0	16.0	22.8	15.1	5.9	17.1
12725	257	226	215	114.5	104.9	15.1	23.0	11.0	5.5	12.5
12726	233	204	•	88.5	81.3	15.2	22.7	10.3	5.3	12.7
12727	287	250	242	171.5	160.8	18.3	26.0	12.0	5.6	14.7
12728	265	234	222	123.8	114.0	18.0	23.5	11.1	5.1	13.5
12729	223	200	187	99.0	87.8	15.0	20.6	9.4	5.0	11.5
12730	250	221	210	110.6	102.5	14.5	22.4	10.5	5.5	11.6
12731	258	229	218	115.6	102.7	15.2	22.6	11.1	5.0	12.9
12732	253	217	210	107.5	•	16.0	22.5	10.3	6.0	12.1
12733	256	225	216	130.0	118.0	16.2	22.3	16.0	5.5	11.6
12734	259	230	218	135.5	127.2	17.0	23.4	11.1	4.3	11.4
12735	255	226	215	113.0	106.0.	16.1	22.1	11.0	5.3	13.2
12736	280	245	236	158.0	146.6	17.8	24.6	11.6	6.7	13.6
12737	243	214	205	112.8	103.3	15.1	22.8	10.4	5.1	12.7
12738	253	216	209	107.0	98.7	15.8	23.0	11.0	5.3	12.7

VARIABLES Y	X	REGRESSION EQUATIONS	CORRELATION COEFF. r^2	N
1. TFL	FFL	Y = 1.154 X - 3.62	0.983	25
2. TFL	SFL	Y = 1.169 X + 5.653	0.979	25
3. TFL	TFW	log. Y = 0.258 log. X +1.872	0.813	25
4. TFL	DFW	log. Y = 0.28 log. X +1.838	0.842	24
5. TFL	SCP	Y = 12.981 X + 49.793	0.765	24
6. TFL	SVP	Y = 11.905 X - 14.909	0.807	25
7. TFL	MH	Y = 5.826 X + 195.132	0.246	25
8. TFL	SMI	Y = 23.784 X + 132.246	0.366	25
9. TFL	SLI	Y = 8.522 X + 152.149	0.302	25

As in the previous species, the blueback herring's dentary is a laminar bone exposed to breaks. The best dimension is the total length (here SVP) followed by the width of the coronoid process.

Table 45. Original data of the live fish and the dentary bone, with the regression equations and the correlation coefficients (r^2) between them in gaspereau *(Alosa pseudoharengus)*

	FISH					DENTARY				
NSM#	TFL	FFL	SFL	TFW	DFW	SCP	SVP	MH	SMI	SLI
12477	262	234	217	196.5	174.0	17.7	26.3	13.5	6.4	15.5
12478	282	259	241	273.5	240.1	20.1	28.0	15.3	6.5	15.5
12479	292	262	246	279.3	233.2	19.3	28.3	14.9	6.8	16.0
12480	268	254	240	258.5	217.8	20.6	28.0.	14.2	6.8	16.3
12481	279	254	233	218.1	193.5	20.0	26.8	14.3	5.7	15.3
12482	293	258	244	266.5	225.5	19.7	28.3	15.0	7.0	17.3
12483	264	231	216	189.1	163.5	17.7	25.5	13.0	6.0	14.2
12484	263	233	219	182.5	158.3	18.2	25.3	14.0	5.5	15.0
12485	296	263	249	275.5	236.5	20.3	27.5	14.8	6.7	16.0
12486	297	260	245	239.5	213.8	20.4	29.5	15.3	7.6	16.4
12487	309	276	257	331.3	283.1	21.1	29.0	15.6	6.7	15.5
12488	281	247	228	247.2	213.5	19.3	27.3	14.6	7.0	15.5
12766	304	274	260	229.0	185.1	22.6	27.1	14.0	6.3	14.0
12767	299	268	254	245.5	189.3	21.2	26.6	14.0	6.0	16.0
12768	274	242	227	158.7	148.5	18.0	26.4	13.4	6.4	14.2
12800	259	228	213	145.5	133.5	18.2	25.6	13.0	5.6	14.0
12801	312	269	258	248.7	230.7	23.0	31.2	16.3	8.0	16.6
12802	249	227	206	105.2	98.2	16.4	23.6	13.0	5.6	12.4
12803	221	198	180	76.3	67.6	16.0	22.0	11.4	•	13.1
12804	307	268	253	225.7	213.7	21.8	28.3	15.7	7.6	16.5

VARIABLES Y	X	REGRESSION EQUATIONS	CORRELATION COEFF. r^2	N
1. TFL	FFL	Y = 1.13 X + 2.151	0.933	20
2. TFL	SFL	Y = 1.084 X +26.655	0.942	20
3. TFL	TFW	log. Y = 0.209 log. X +1.961	0.740	20
4. TFL	DFW	log. Y = 0.226 log. X +1.935	0.762	19
5. TFL	SCP	Y = 10.942 X + 66.301	0.810	20
6. TFL	SVP	Y = 9.929 X + 12.159	0.769	20
7. TFL	MH	Y = 17.528 X+ 30.508	0.775	20
8. TFL	SMI	Y = 18.486 X + 162.843	0.478	20
9. TFL	SLI	Y = 12.893 X + 83.742	0.485	20

Similar observations as in the previous species.

Table 46. Original data of the live fish and the dentary bone, with the regression equations and the correlation coefficients (r^2) between them in shad *(Alosa sapidissima)*

	FISH					DENTARY				
NMS	TFL	FFL	SFL	TFW	DFW	SCP	SVP	MH	SMI	SLI
11294	297	•	249	266.5	222.3	18.3	27.0	13.5	5.8	16.0
11295	286	•	241	201.1	178.6	18.0	26.3	13.2	6.2	15.4
11296	291	•	246	250.6	216.8	18.0	25.1	13.3	6.4	13.5
11524	533	•	•	930.0	•	•	55.1	20.1	11.5	29.0
11525	598	•	•	1462.0	•	43.5	64.2	23.1	20.0	33.4
12751	474	417	410	1072.8	769.4	41.0	51.5	21.4	16.5	29.3
12754	503	457	433	1516.5	1321.5	47.5	58.0	22.1	17.1	32.7

VARIABLES Y	X	REGRESSION EQUATIONS	CORRELATION COEFF. r^2	N
1. TFL	SFL	$Y = 1.12\,X + 16.38$	0.999	7
2. TFL	TFW	$\log. Y = 0.35 \log. X + 1.637$	0.941	7
3. TFL	DFW	$\log. Y = 0.313 \log. X + 1.744$	0.977	5
4. TFL	SCP	$Y = 8.873\,X + 132.669$	0.895	7
5. TFL	SVP	$Y = 7.644\,X + 90.542$	0.982	8
6. TFL	MH	$Y = 27.944\,X - 79.779$	0.934	8
7. TFL	SMI	$Y = 20.097\,X + 186.273$	0.833	7
8. TFL	SLI	$Y = 14.469\,X + 76.06$	0.939	8

Contrary to the two previous species, all measurements on the premaxillary of the shad are good predictors to estimate the length of the fish. This is due probably to the large size of the fish in the sample, which makes the bones more calcified and easy to measure, eliminating possible inaccuracies in the process.

Table 47. Original data of the live fish and the dentary bone, with the regression equations and the correlation coefficients (r^2) between them in eel *(Anguilla rostrata)*

	FISH				DENTARY						
NMS#	TFL	SFL	TFW	DFW	SCP	SVP	MH	SMI	DP	#T	#R
12497	552	540	282	247.0	22.0	27.0	7.0	16.5	19.0	•	•
12498	553	541	314	270.4	24.0	28.5	8.0	18.0	20.5	185	6
12829	363	•	•	82.5	11.5	14.5	3.1	9.0	10.0	106	5
12830	319	•	•	50.1	10.0	12.5	2.9	7.5	9.0	80	4
12831	334	•	•	71.0	13.0	13.0	2.5	8.0	8.0	82	5
12832	394	•	•	102.5	13.0	15.5	4.0	10.5	11.2	109	4
12833	358	•	•	88.2	11.1	14.0	2.8	9.0	9.5	•	•
12834	320	•	•	52.1	11.0	13.0	3.1	8.0	9.5	89	4
12835	353	•	•	56.5	11.5	14.0	2.9	8.5	9.0	76	5
12836	345	•	•	81.1	12.0	14.5	3.5	9.0	10.0	•	4
12837	326	•	•	49.3	10.0	12.5	3.0	9.0	90.0	80	4

VARIABLES Y	X	REGRESSION EQUATIONS	CORRELATION COEFF. r^2	N
1. TFL	DFW	log. Y = 0.329 log. X + 1.938	0.950	11
2. TFL	SCP	Y = 17.579 X + 145.094	0.951	11
3. TFL	SVP	Y = 14.875 X + 141.3	0.983	11
4. TFL	MH	Y = 45.645 X + 205.764	0.945	11
5. TFL	SMI	Y = 24.028 X + 136.53	0.976	11
6. TFL	DP	Y = 19.978 X + 156.891	0.965	11

All measurements are good predictors to calculate the length of the eel. The bones are strong and easy to measure. A larger sample could reduce a little these values.

Table 48. Original data of the live fish and the dentary dimensions in Atlantic salmon (*Salmo salar*)

	FISH					DENTARY	
NSM#	TFL	FFL	SFL	TFW	DFW	SCP	SVP
12406	800	•	717	5754	5174	57.3	68.4
12499	475	452	422	•	2308	39.1	43.3
12713	576	542	516	•	1506	35.7	42.3
12862	452	442	410	•	835	26.4	32.5

NSM#	MH	SMI	SLI	DP	#T	#R
12406	18.3	18.5	45.9	47.4	•	•
12499	16.1	14.3	29.5	28.3	9	1
12713	14.1	13.2	26.6	27.6	7	1
12862	11.4	10.1	19.1	19.6	8	1

No calculations were obtained because of the small sample.

Table 49. Original data of the live fish and the dentary bone, with the regression equations and the correlation coefficients (r^2) between them in brook trout (*Salvelinus fontinalis*)

	FISH					DENTARY	
NSM#	TFL	FFL	SFL	TFW	DFW	SCP	SVP
12490	279	•	•	•	•	21.0	27.0
12491	254	•	•	212.6	•	20.0	25.0
12492	406	•	•	471.0		31.7	40.0
12493	279	•	•	226.8	•	20.1	25.6
12494	330	•	•	454.0	•	24.6	32.3
12701	228	209	190	109.3	99.3	18.0	21.7
12702	266	•	•	•	•	22.9	29.0
12703	254	•	•	•	•	19.7	25.0
12704	254	•	•	•	•	25.0	30.4
12705	330	•	•	454.0	•	26.0	32.8
12706	213	204	189	106.5	94.2	19.2	24.4
12752	247	238	219	163.5	152.0	24.0	28.2
12753	234	•	•	•	•	18.7	23.8
12769	280	268	244	215.0	200.8	23.0	29.7
12770	282	271	246	224.7	205.2	23.0	28.2
12794	258	247	227	145.6	140.1	21.6	27.1

Table 49 (cont.)

NSM#	MH	SMI	SLI	DPL	#T	#R
12490	7.5	8.8	18.2	18..0	13.0	1
12491	6.4	6.9	16.2	16.6	10.0	1
12492	11.0	10.6	26.4	26.4	14.0	1
12493	7.3	8.3	17.4	17.3	11.0	1
12494	8.0	9.2	21.3	20.2	14.0	1
12701	6.5	7.5	15.6	15.2	11.0	1
12702	8.0	10.0	20.2	20.1	10.0	1
12703	7.2	6.9	17.0	16.2	10.0	1
12704	8.2	8.8	20.6	20.5	13.0	1
12705	9.7	9.5	21.2	22.0	12.0	1
12706	6.4	8.0	16.4	16.6	12.0	1
12752	8.4	9.6	18.6	18.7	15.0	1
12753	7.2	7.5	15.8	16.0	12.0	1
12769	8.3	9.0	20.3	19.2	12.0	1
12770	7.6	10.0	19.2	19.7	11.0	1
12794	8.1	9.1	19.1	18.5	11.0	1

VARIABLES Y	X	REGRESSION EQUATIONS	CORRELATION COEFF. r^2	N
1. TFL	FFL	Y = 0.965 X + 20.194	0.983	6
2. TFL	SFL	Y = 1.084 X + 13.723	0.967	6
3. TFL	TFW	log. Y = 0.323 log. X + 1.687	0.889	11
4. TFL	SCP	Y = 11.764 X + 11.047	0.738	16
5. TFL	SVP	Y = 9.757 X + 0.095	0.826	16
6. TFL	MH	Y = 33.37 X + 12.251	0.712	16
7. TFL	SMI	Y = 26.843 X + 40.254	0.407	16
8. TFL	SLI	Y = 15.153 X - 12.808	0.783	16
9. TFL	DP	Y = 14.945 X - 6.709	0.771	16

All measurents are acceptable, except the SMI (length of the internal wall), due probably to its small size and the difficulty in finding the right spot to measure it.

Table 50. Original data of the live fish and the dentary bone, with the regression equations and the correlation coefficients (r^2) between them in smelt *(Osmerus mordax)*

	FISH					DENTARY	
NSM#	TFL	FFL	SFL	TFW	DFW	SCP	SVP
12847	242	227	210	103.7	91.2	22.0	24.5
12848	225	207	192	66.6	56.6	20.6	23.1
12849	256	237	220	120.1	99.2	22.7	27.3
12850	285	267	242	194.2	66.5	28.5	32.1
12851	245	233	211	104.0	83.2	•	25.4

NSM#	MH	SMI	SLI	DP	#T	#R
12847	8.3	7.0	16.3	16.0	19	2
12848	7.0	•	16.8	14.0	21	2
12849	9.0	5.6	18.0	14.0	16	2
12850	10.8	8.0	21.0	18.0	12	2
12851	18.7	7.0	17.1	15.0	18	2

VARIABLES Y	X	REGRESSION EQUATIONS	CORRELATION COEFF. r^2	N
1. TFL	FFL	Y = 1.017 X + 12.457	0.983	5
2. TFL	SFL	Y = 1.21 X - 10.843	0.992	5
3. TFL	TFW	log. Y = 0.225 log. X + 1.938	0.984	5

No calculations were made due to the small number of specimens.

Table 51. Original data of the live fish and the dentary bone, with the regression equations and the correlation coefficients (r^2) between them in white sucker *(Catostomus commersoni)*

	FISH					DENTARY				
NSM#	TFL	FFL	SFL	TFW	DFW	SCP	SVP	MH	SMI	SLI
11271	309	286	258	302.3	363.6	12.4	13.0	9.1	6.4	11.4
11272	347	324	289	428.8	•	12.1	13.0	9.3	9.2	10.0
11273	344	318	284	•	•	14.6	17.4	13.2	8.7	15.0
11279	211	200	181	86.3	•	9.3	10.0	8.3	5.0	8.3
11280	348	•	•	396.5	•	15.3	16.5	12.5	8.3	15.0
11281	322	•	•	330.4	•	13.7	14.7	11.0	7.4	8.6
11282	341	•	•	389.1	•	13.9	15.8	11.3	8.1	14.1
11283	325	•	•	327.5	•	13.9	15.3	11.9	7.0	13.0
11284	307	•	•	307.0	•	14.3	15.7	12.0	7.5	8.6
11285	430	402	385	705.7	•	19.3	21.3	14.1	9.0	18.4
11286	336	•	•	400.0	•	13.2	15.5	12.0	7.0	13.0
11287	333	•	•	389.1	•	13.9	15.8	11.3	8.1	14.1
11288	374	•	•	514.0	•	16.6	17.5	12.7	8.4	15.1
11289	350	•	•	425.8	•	15.0	16.7	12.8	8.2	15.3
12495	225	199	184	122.5	104.5	11.1	11.4	9.6	6.1	10.3
12710	247	227	203	136.3	121.6	12.9	11.4	10.3	6.4	10.1
12711	342	321	288	373.3	329.3	17.2	17.3	13.0	8.2	16.1

VARIABLES Y	X	REGRESSION EQUATIONS	CORRELATION COEFF. r^2	N
1. TFL	FFL	$Y = 1.043 X + 9.885$	0.997	8
2. TFL	SFL	$Y = 1.077 X + 27.946$	0.987	8
3. TFL	TFW	$\log Y = 0.332 \log X + 1.671$	0.988	16
4. TFL	SCP	$Y = 19.411 X + 50.443$	0.715	17
5. TFL	SVP	$Y = 17.65 X + 54.818$	0.835	17
6. TFL	MH	$Y = 25.082 X + 36.176$	0.589	17
7. TFL	SMI	$Y = 40.998 X + 11.898$	0.762	17
8. TFL	SLI	$Y = 13.487 X + 151.315$	0.579	17

All values are acceptable, except the maximum height and the length of the lateral wall (SLI) due to the difficulty in finding the right place to measure them.

Table 52. Original data of the live fish and the dentary bone dimensions in haddock *(Melanogrammus aeglefinus)*

	FISH					DENTARY	
NMS#	TFL	FFL	SFL	TFW	DFW	SCP	SVP
11556	591	•	534	1446	•	30.6	40.7
12845	543	516	478	•	1266	30.8	41.4

NSM#	MH	SMI	SLI	DP	#T	#R
11556	17.8	16.1	16.2	18.7	40	2
12845	17.4	20.7	15.4	19.7	30	2

No calculations were obtained because of the small number of specimens.

Table 53. Original data of the live fish and the dentary bone, with the regression equations and the correlation coefficients (r^2) between them in pollock (Pollachius virens)

	FISH					DENTARY	
NSM#	TFL	FFL	SFL	TFW	DFW	SVP	SVP
11237	349	•	311	457.2	392.5	22.9	28.2
11238	306	•	273	256.3	228.8	21.1	26.0
11239	335	•	298	358.8	312.6	22.5	27.6
11240	237	•	212	121.3	107.2	15.5	19.4
11241	251	•	228	145.5	126.6	16.3	20.2
11242	943	•	882	•	6070.0	70.2	84.6
11243	397	•	353	765.8	628.6	27.3	32.5
11259	410	•	372	841.1	723.9	28.2	32.9
11262	179	•	161	58.2	•	11.7	14.4
11263	178	•	161	51.2	•	12.3	15.3
11264	167	•	•	40.0	•	11.1	14.5
11265	162	•	147	36.2	•	10.4	13.2
11772	509	478	451	1010.0	•	36.6	45.8
11773	475	442	415	•	•	37.3	43.2
11774	466	437	408	•	•	35.7	44.0
11789	428	400	381	•	•	31.3	37.3

NSM#	MH	SMI	SLI	DP	#T	#R
11237	8.2	14.5	12.0	14.9	27	1
11238	8.3	13.7	11.0	15.4	30	1
11239	8.2	13.7	12.3	15.0	23	1
11240	5.7	9.3	8.9	10.8	24	1
11241	6.0	10.0	9.0	11.1	27	2
11242	25.2	46.4	39.8	50.3	90	1
11243	9.6	17.4	15.5	17.4	40	2
11259	11.1	17.8	15.8	18.0	40	2
11262	5.4	•	•	•	20	1
11263	5.1	7.2	7.0	7.9	16	1
11264	5.1	7.5	5.8	7.9	20	1
11265	4.3	•	•	•	•	•
11772	16.1	23.4	20.5	23.0	73	2
11773	15.6	23.2	21.3	23.6	49	2
11774	16.9	22.5	20.3	23.0	55	2
11789	13.6	20.1	17.2	20.1	59	2

VARIABLES		REGRESSION	CORRELATION	N
Y	X	EQUATIONS	COEFF. r^2	
1. TFL	SFL	Y = 1.074 X + 13.298	0.998	16
2. TFL	TFW	log.Y = 0.317 log. X + 1.709	0.988	12
3. TFL	SCP	Y = 12.831 X + 32.89	0.994	16
4. TFL	SVP	Y = 10.772 X + 25.981	0.993	16
5. TFL	MH	Y = 32.305 X + 30.063	0.929	16
6. TFL	SMI	Y = 19.219 X + 50.698	0.993	14
7. TFL	SLI	Y = 22.203 X + 46.169	0.988	14
8. TFL	DP	Y = 18.111 X + 55.083	0.986	14

All measurements are good predictors for the length of pollock.

Table 54. Original data of the live fish and the dentary bone dimensions in cusk *(Brosme brosme)*

	FISH				DENTARY	
NSM#	TFL	SFL	TFW	DFW	SCP	SVP
11544	588	554	1814.0	•	24.3	53.3
12838	751	712	•	4090.0	71.1	75.3

NSM#	MH	SMI	SLI	DPL	#T	#R
11544	18.0	26.4	37.7	•	•	4
12838	27.1	32.5	48.6	62.4	100	6

No calculations were obtained because of the small number of specimens.

Table 55. Original data of the live fish and the dentary bone dimensions in tomcod *(Microgadus tomcod)*

	FISH				DENTARY	
NSM#	TFL	SFL	TFW	DFW	SCP	SVP
12839	198	178	68.0	56.2	12.0	14.5
12840	192	176	53.8	43.2	12.5	15.1
12841	186	170	57.0	42.0	13.0	14.5
12842	174	157	42.5	35.0	12.1	13.8

NSM#	MH	SMI	SLI	DPL	#T	#R
12389	6.9	7.0	5.5	8.4	37	2
12840	6.6	8.0	6.5	9.0	40	2
12841	6.9	6.9	6.1	8.5	36	2
12842	5.2	7.2	5.8	9.0	41	2

No calculation were obtained because of the small number of specimens.

Table 56. Original data of the live fish and the dentary bone, with the regression equations and the correlation coefficients (r^2) between them in silver hake *(Merluccius bilinearis)*

	FISH				DENTARY	
NSM#	TFL	SFL	TFW	DFW	SCP	SVP
11545	392	354	405.5	342.0	41.8	42.1
11547	384	343	353.8	318.7	38.7	43.2
11548	368	327	277.7	257.3	35.7	38.5
11549	371	331	275.1	251.7	37.4	42.3
11550	391	352	382.4	349.5	40.5	46.0
11551	407	367	474.0	412.7	42.4	43.7
11552	381	342	370.3	327.8	39.1	41.8
11553	365	329	313.3	272.2	37.2	43.1
11557	409	•	•	•	42.9	45.0
11558	300	•	•	•	34.0	•
11559	518	•	•	•	58.1	63.1
11569	459	417	630.0	498.7	46.6	48.5
11570	375	338	314.4	292.6	36.5	40.0
11571	364	325	253.0	•	37.7	39.3
11574	410	•	•	•	42.4	43.7

NSM#	MH	SMI	SLI	DP	#T	#R
11545	11.1	27.9	29.6	32.2	22	1
11547	9.8	28.0	29.6	31.2	•	•
11548	9.8	25.2	27.2	27.7	52	2
11549	10.4	25.5	27.1	29.4	30	2
11550	11.4	28.7	31.0.	32.5	40	2
11551	11.1	29.3	31.3	34.3	26	2
11552	11.2	27.2	28.7	31.3	25	1
11553	11.0	26.3	26.2	28.7	45	2
11557	10.0	30.5	32.0	33.0	31	2
11558	8.2	21.0	•	26.1	22	2
11559	15.2	40.2	43.5	48.2	25	2
11569	11.0	32.9	36.7	37.7	30	2
11570	11.0	25.7	27.2	29.4	39	2
11571	11.0	26.4	27.3	29.2	40	2
11574	11.1	29.3	31.3	34.3	26	2

Table 56 (cont.)

VARIABLES Y	X	REGRESSION EQUATIONS	CORRELATION COEFF. r^2	N
1. TFL	SFL	Y = 1.034 X + 27.245	0.997	12
2. TFL	TFW	log. Y = 0.241 log. X +1.971	0.863	12
3. TFL	DFW	log. Y = 0.304 log. X +1.824	0.895	11
4. TFL	SCP	Y = 7.926 X + 70.072	0.915	16
5. TFL	SVP	Y = 6.601 X + 107.095	0.875	14
6. TFL	MH	Y = 27.66 X + 91.809	0.697	16
7. TFL	SMI	Y = 11.113 X + 78.722	0.969	16
8. TFL	SLI	Y = 9.107 X + 120.691	0.985	14
9. TFL	DP	Y = 8.775 X + 109.085	0.924	16

Most measurements are good predictors for the total length of the fish, except for the maximum height of the dentary. The possible reason is the laminar character of the posterior end of the bone that breaks easily.

Table 57. Original data of the live fish and the dentary bone dimensions in goosefish *(Lophius americanus)*

	FISH				DENTARY	
NSM#	TFL	SFL	TFW	DFW	SCP	SVP
11256	765	660	7080	5570	101.9	95.0
11257	710	595	3941	3473	123.5	105.8
11258	540	456	1899	1730	77.3	76.2
11555	685	565	3742	3232	100.6	95.5

NSM#	MH	SMI	SLI	DP	#T
11256	17.5	75.0	58.6	92.0	36
11257	18.6	90.0	70.	106.9	39
11258	11.1	57.1	48.2	67.1	33
11555	14.3	76.8	58.0	91.0	34

No calculations were obtained because of the small sample.

Table 58. Original data of the live fish and the dentary bone, with the regression equations and the correlation coefficients (r^2) between them in longhorn sculpin *(Myoxocephalus octodecimspinosus)*

	FISH				DENTARY					
NSM#	TFL	SFL	TFW	DFW	SCP	SVP	MH	SMI	SLI	DP
11292	322	277	304.3	274.6	32.5	32.7	10.8	15.5	17.3	28.2
11536	275	230	156.4	143.0	27.0	28.0	9.0	11.9	14.3	24.5
11537	189	163	65.8	57.1	19.5	20.2	6.7	9.0	11.0	15.0
11541	205	171	77.0	64.5	19.0	21.0	6.5	10.4	10.2	•
12760	280	•	211.2	•	29.3	30.6	12.0	13.2	16.7	26.7
12761	242	210	152.4	•	25.6	26.8	9.8	11.4	12.7	23.5
12762	273	234	231.0	•	29.2	30.6	12.0	12.2	15.6	27.4
12763	256	212	179.7	•	26.6	28.2	9.9	11.4	15.0	24.8
12764	276	236	227.0	•	29.0	30.6	10.9	12.4	15.7	26.2

VARIABLES Y	X	REGRESSION EQUATIONS	CORRELATION COEFF. r^2	N
1. TFL	SFL	Y = 1.148 X + 6.119	0.991	10
2. TFL	TFW	log. Y = 0.311 log. X +1.719	0.939	10
3. TFL	SCP	Y = 8.763 X + 26.105	0.949	8
4. TFL	SVP	Y = 8.987 X + 9.216	0.930	8
5. TFL	MH	Y = 16.362 X + 98.302	0.667	8
6. TFL	SMI	Y = 21.47 X + 1.343	0.910	8
7. TFL	SLI	Y = 15.433 X + 37.209	0.884	8
8. TFL	DP	Y = 8.488 X + 55.857	0.861	7

Good values, except for the maximum height of the dentary, since the coronoid process ends in a soft, long spine, often broken.

Table 59. Original data of the live fish and the dentary bone dimensions in sea raven *(Hemitripterus americanus)*

	FISH				DENTARY
NSM#	TFL	SFL	TFW	DFW	SCP
11266	498	•	1616.0	•	75.0
11269	340	•	•	•	50.6
11538	256	287	711.4	478.5	50.0
11573	410	•	•	•	58.3

NSM#	SVP	MH	SMI	SLI	DP
11266	66.7	25.3	23.3	34.0	66.6
11269	45.0	12.0	17.5	25.0	45.7
11538	44.1	13.0	16.1	24.6	47.1
11573	49.6	12.0	19.2	28.8	53.5

No calculations were obtained because of the small sample.

Table 60. Original data of the live fish and the dentary bone, with the regression equations and the correlation coefficients (r^2) between them in (*Scomber scombrus*)

	FISH					DENTARY	
NMS#	TFL	FFL	SFL	TFW	DFW	SCP	SVP
12476	441	403	•	437.5	298.5	32.3	36.6
12489	398	362	346	513.0	417.8	27.4	32.2
12712	310	282	274	218.3	193.7	21.3	24.8
12750	393	359	345	635.0	461.5	28.5	33.2
12755	321	294	288	270.2	243.7	23.7	28.5
12756	310	288	279	247.4	222.4	23.2	26.1
12757	288	263	256	184.1	166.0	20.3	23.4
12758	313	286	275	248.5	220.2	23.1	26.3
12759	325	298	285	268.1	243.5	22.3	25.9
12805	425	390	367	680.8	629.8	31.1	34.0
12806	242	226	216	99.0	•	14.0	20.7
12808	283	260	245	150.2	135.0	21.0	24.3
12809	271	249	239	161.0	148.7	20.0	23.5
12810	306	275	259	214.0	195.0	23.5	26.9
12811	285	262	244	169.5	151.5	21.0	23.5
12812	307	278	258	227.8	198.0	23.4	26.6
12813	304	279	261	237.9	215.7	24.0	27.6
12814	310	282	267	226.6	202.5	22.7	25.4
12815	392	357	338	437.1	402.0	28.3	32.1
12816	245	227	213	99.5	87.5	17.9	20.6
12817	300	276	259	212.9	182.9	21.8	25.1
12819	244	223	210	97.7	•	17.8	20.9
12820	302	273	257	221.0	195.4	22.0	25.2
12821	319	291	272	220.7	191.7	23.0	27.1
12822	303	280	264	208.7	185.7	22.0	25.8
12823	263	242	230	130.5	117.2	19.2	22.3
12825	258	236	222	112.2	100.2	18.1	21.7

NSM#	MH	SMI	SLI	DP	#T	#R
12476	15.9	13.2	19.7	27.0	54	1
12489	13.9	12.3	17.5	24.3	55	1
12712	11.3	8.8	13.7	18.0	39	1
12750	15.0	12.1	18.0	24.5	49	1
12755	12.1	10.8	15.0	20.5	37	1
12756	12.7	10.0	14.2	21.0	40	1
12757	9.6	8.0	13.0	17.5	38	1
12758	10.5	9.7	15.0	19.0	41	1
12759	10.3	8.5	14.6	19.0	36	1
12805	13.6	13.0	19.1	26.5	51	1
12806	9.0	7.7	12.0	15.5	34	1
12808	9.0	9.0	13.0	17.2	37	1
12809	9.6	7.1	12.2	17.5	41	1

Table 60 (cont.)

12810	10.7	9.4	14.6	21.0	43	1
12811	11.0	9.4	13.0	17.3	45	1
12812	11.5	10.5	14.3	20.5	48	1
12813	11.6	11.1	15.0	21.5	50	1
12814	11.7	9.9	14.0	20.0	47	1
12815	13.4	11.7	17.1	24.5	53	1
12816	9.1	8.7	11.4	16.4	34	1
12817	10.5	9.0	13.3	19.0	40	1
12819	8.3	7.4	11.2	15.0	39	1
12820	11.3	9.3	12.8	18.5	50	1
12821	12.4	10.2	14.6	20.0	49	1
12822	10.8	9.3	13.6	19.5	41	1
12823	9.0	9.1	13.2	16.7	44	1
12825	9.2	8.3	11.7	16.0	33	1

VARIABLES Y	X	REGRESSION EQUATIONS	CORRELATION COEFF. r^2	N
1. TFL	FFL	Y = 1.109 X - 4.641	0.998	31
2. TFL	SFL	Y = 0.973 X + 50.007	0.825	30
3. TFL	TFW	log. Y = 0.300 log. X + 1.785	0.944	31
4. TFL	DFW	log. Y = 0.314log. X + 1.769	0.873	25
5. TFL	SCP	Y = 12.633 X + 26.492	0.938	27
6. TFL	SVP	Y = 12.508 X - 15.796	0.963	27
7. TFL	MH	Y = 25.302 X + 29.31	0.853	27
8. TFL	SMI	Y = 29.332 X + 26.998	0.875	27
9. TFL	SLI	Y = 23.179 X - 18.806	0.953	27
10. TFL	DP	Y = 15.726 X + 2.589	0.926	27

All values are good predictors of the length of mackerel.

Table 61. Original data of the live fish and the dentary bone, and correlation coefficients (r^2) and regression equations between them in Canadian plaice *(Hippoglossoides platessoides)*

	FISH				DENTARY	
NSM#	TFL	SFL	TFW	DFW	SCP	SVP
Left side						
12792	410	341	•	•	33.9	34.0
12793	414	352	485.5	•	37.1	37.6
12828	312	270	227.3	•	25.4	25.7
12843	336	277	283.0	•	25.5	27.2
12844	385	322	•	440.0	29.1	29.6
12852	436	363	•	440.0	40.1	40.2
12853	441	371	•	754.0	33.2	35.4
NSM#	MH	SMI	SLI	DPL	#T	#R
12792	13.1	21.0	24.8	31.1	44	1
12793	15.5	22.5	27.0	32.9	42	1
12828	10.5	16.1	18.4	23.9	24	1
12843	10.0	17.0	19.0	22.1	37	1
12844	11.6	18.5	21.3	24.6	33	1
12852	16.3	25.1	29.7	46.7	27	1
12853	12.2	19.4	25.4	27.3	24	1
NSM#	TFL	SFL	TFW	DFW	SCP	SVP
Right side						
12792	410	341	•	•	25.7	28.5
12793	414	352	485.5	•	28.2	30.5
12828	312	270	227.3	•	18.5	20.6
12843	336	277	283.0	•	20.2	21.4
12844	385	322	•	440.0	21.8	25.1
12852	436	363	•	440.0	31.2	32.1
12853	441	371	•	754.0	25.8	30.1
NSM#	MH	SMI	SLI	DPL	#T	#R
12792	15.3	15.6	19.0	21.4	28	1
12793	17.3	17.1	20.3	22.5	24	1
12828	10.6	11.6	14.0	14.7	17	1
12843	11.0	12.5	14.7	16.4	20	1
12844	12.3	14.3	15.6	17.4	•	1
12852	7.9	18.4	20.3	26.1	17	1
12853	9.1	15.4	19.3	21.3	14	1

Table 61 (cont.)

VARIABLES Y	X	REGRESSION EQUATIONS	CORRELATION COEFF. r^2	N
1. TFL	SFL	Y = 1.217 X - 8.473	0.988	7
2. TFL	TFW	log. Y = 0.313 log X + 1.769	0.854	7
Left side				
3. TFL	SCP	Y = 7.724 X + 143.073	0.774	7
4. TFL	SVP	Y = 8.339 X + 116.946	0.841	7
5. TFL	MH	Y = 15.578 X + 192.06	0.570	7
6. TFL	SMI	Y = 12.62 X + 138.89	0.650	7
7. TFL	SLI	Y = 10.693 X + 137.604	0.831	7
8. TFL	DP	Y = 3.894 X + 274.525	0.437	7
Right side				
3. TFL	SCP	Y = 9.726 X + 152.422	0.794	7
4. TFL	SVP	Y = 10.464 X +109.102	0.937	7
5. TFL	MH	Y = 14.169X + 182.95	0.875	5
5. TFL	SMI	Y = 18.482 X + 113.608	0.808	7
7. TFL	SLI	Y = 17.049 X + 91.248	0.854	7
8. TFL	DP	Y = 11.124 X + 168.412	0.798	7

Good values, except for the maximum height on the left side.

Table 62. Original data of the live fish and the dentary bone dimensions in winter flounder (*Pseudopleuronectes americanus*)

	FISH			DENTARY		
NSM#	TFL	SFL	TFW	SCP	SVP	MH
Left side						
12790	256	209	200.5	10.4	10.9	7.8
12791	320	261	413.9	11.9	11.7	8.7

NSM#	SMI	SLI	DP	$T	#R
12790	7.3	8.0	7.3	15	1
12791	8.0	9.4	10.0	14	1

No calculations were obtained due to the small number of specimens.

IX.4.4 ANGULAR

Figure 10 shows the different measurements taken on the angular.

All measurements should be taken between the perpendiculars traced over the two points considered.

CPP = Distance between the anteriormost point of the bone and the most anterior point of the coronoid process.

DIP = Distance between the most anterior point of the bone and the most receding point of the dorsal incisure.

VIP = Distance between the most anterior point of the bone and the most receding point of the ventral incisure.

VPP = Distance between the anteriormost point of the bone and the most anterior point of the ventral process

ML = Maximum length. Distance between the anteriormost point of the anterior process and the posteriormost point of the bone.

MH = Maximum height. Distance between the most dorsal point and the most ventral point of the bone.

VPPA = Distance between the extreme points of the postarticular process and the tip of the ventral process.

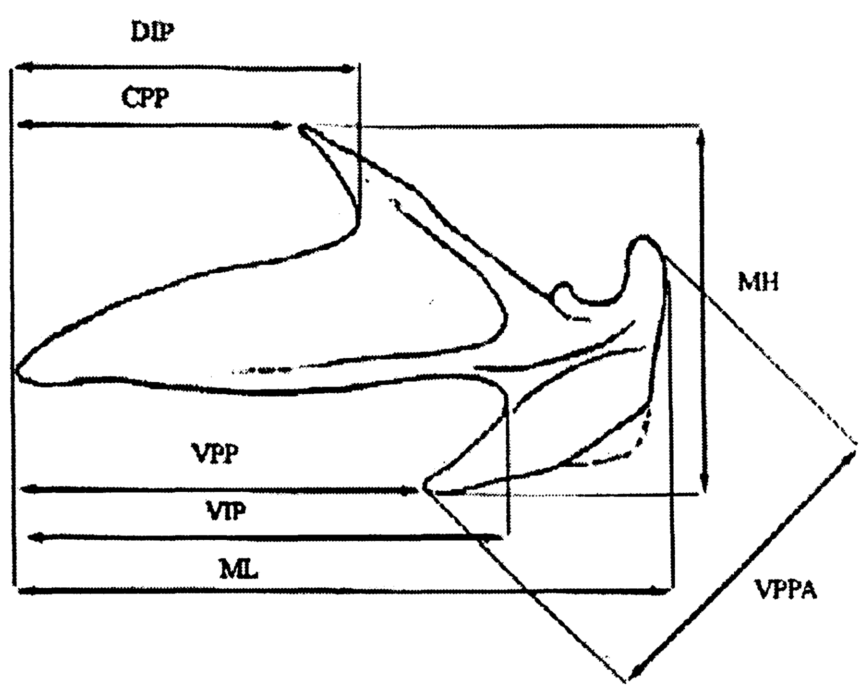


Fig. 10. Measurements taken on the angular bone.

Table 63. Original data of the live fish and the angular bone, with the regression equations and the correlation coefficients (r^2) between them in Atlantic herring *(Clupea harengus)*

	FISH					ANGULAR				
NSM#	TFL	FFL	SFL	TFW	DFW	CPP	DIP	VPP	ML	MH
12775	253	226	216	115.7	102.4	10.2	8.7	•	•	7.9
12776	237	213	203	93.5	83.0	9.7	9.1	•	15.8	7.0
12777	215	193	180	75.7	69.7	7.9	7.5	4.9	13.9	7.0
12778	237	214	198	94.0	85.8	9.5	9.0	5.0	16.0.	7.9
12779	249	223	210	120.7	105.0	9.5	9.9	5.5	16.6	8.0.
12780	223	198	188	86.8	78.5	8.3	8.2	5.4	15.8	6.5
12781	243	217	206	130.8	107.8	•	8.2	5.0	15.5	8.2
12782	217	194	184	80.6	72.7	8.2	8.0	5.0	15.9	6.8
12783	251	225	216	130.5	105.3	9.1	8.5	5.2	16.8	8.1
12784	248	220	209	115.5	96.5	9.2	9.0	5.2	17..0	8.8
12785	247	220	210	125.1	104.0	9.6	8.8	5.2	15.3	8.4
12786	246	218	207	98.7	91.5	9.0	8.5	5.8	15.9	8.0
12787	214	194	183	72.0	64.3	8.0	7.4	5.2	13.1	6.6
12788	236	212	203	91.2	84.5	9.0	8.6	5.4	15.6	8.5

VARIABLES Y	X	REGRESSION EQUATION	CORRELATION COEFF. r^2	N
1. TFL	FFL	Y = 1.155 X - 8.006	0.989	14
2. TFL	SFL	Y = 1.121 X + 11.645	0.976	14
3. TFL	TFW	log. Y = 0.269 log. X +1.836	0.826	14
4. TFL	DFW	log. Y = 0.336 log. X +1.721	0.892	14
5. TFL	CPP	Y = 17.472 X + 78.868	0.753	13
6. TFL	DIP	Y = 15.775 X + 102.323	0.547	14
7. TFL	VIP	Y = 22.018 X + 120.271	0.156	12
8. TFL	ML	Y = 9.251 X + 91.017	0.531	13
9. TFL	MH	Y = 15.02 X + 121.313	0.661	14

The angular of the Atlantic herring has an ample area of laminar bone with a pointed anterior process. These two facts are possibly responsible for the variability in relative growth of the bone making the correlation with the fish length rather low. The correlation for the dimension of the ventral process (VIP) is too low due to the difficulty in taking the measurements.

Table 64. Original data of the live fish and the angular bone, with the regression equations and the correlation coefficients (r^2) between them in blueback herring *(Alosa aestivalis)*

	FISH					ANGULAR					
NSM#	TFL	FFL	TFL	TFW	DFW	CPP	DIP	VPP	ML	MH	VPPA
11291	320	•	268	367.8	319.0	13.0	10.8	6.5	18.1	9.4	7.0
12714	263	231	222	128.8	111.6	9.1	8.9	5.0	15.1	8.0	5.4
12715	248	220	210	103.3	94.3	9.0	8.5	5.0	15.6	7.5	5.5
12716	283	247	231	146.3	134.0	10.5	9.4	5.9	16.3	9.0	6.0
12717	305	268	256	193.7	171.5	12.6	11.7	6.9	19.6	10.0	7.0
12718	298	260	247	221.3	178.0	11.1	9.7	6.1	18.1	9.2	6.1
12719	256	223	214	132.7	121.2	9.5	8.6	5.0	14.5	8.3	5.1
12720	252	225	201	129.8	116.8	9.1	8.8	5.0	15.5	7.5	5.6
12721	295	259	247	164.3	155.7	11.0	9.8	6.0	18.5	9.5	6.4
12722	296	261	250	171.8	161.5	10.2	9.9	6.0	17.5	10.0	7.0
12723	250	219	210	130.5	111.0	9.5	9.8	4.9	15.6	7.2	6.5
12724	262	230	221	118.8	107.0	8.9	8.0	4.9	15.0	7.8	5.1
12725	257	226	215	114.5	104.9	10.5	9.1	5.2	16.9	8.5	5.9
12726	233	204	•	88.5	81.3	9.0	8.3	5.0	15.1	8.0	5.2
12727	287	250	242	171.5	160.8	11.2	9.9	6.2	17.2	9.8	6.5
12728	265	234	222	123.8	114.0	10.5	9.2	6.0	16.2	8.2	6.4
12729	223	200	187	99.0	87.8	8.8	7.8	4.8	16.3	7.3	4.7
12730	250	221	210	110.6	102.5	9.0	8.2	4.5	15.2	8.2	5.0
12731	258	229	218	115.6	102.7	9.8	8.6	5.5	16.0	8.0	6.0
12732	253	217	210	107.5	•	10.0	8.5	5.0	15.3	7.5	5.5
12733	256	225	216	130.0	118.0	10.1	8.9	6.0	16.6	8.2	5.9
12734	259	230	218	135.5	127.2	9.1	8.5	5.5	15.5	8.5	6.0
12735	255	226	215	113.0	106.0	10.3	8.9	5.2	15.0	8.0	6.0
12736	280	245	236	158.0	146.6	11.2	9.8	6.0	18.2	9.0	6.5
12737	243	214	205	112.8	103.3	10.1	9.5	5.2	15.8	8.0	5.8
12738	253	216	209	107.0	98.7	10.1	8.8	5.1	16.1	7.8	5.6

VARIABLES Y	X	REGRESSION EQUATIONS	CORRELATION COEFF. r^2	N
1. TFL	FFL	Y = 1.154 X - 3.62	0.983	25
2. TFL	SFL	Y = 1.169 X + 5.653	0.979	25
3. TFL	TFW	log. Y = 0.258 log. X +1.872	0.813	26
4. TFL	DFW	log. Y = 0.28 log. X +1.838	0.842	24
5. TFL	CPP	Y = 17.754 X + 85.661	0.700	26
6. TFL	DIP	Y = 21.605 X + 67.695	0.664	26
7. TFL	VPP	Y = 32.273 X + 88.627	0.721	26
8. TFL	ML	Y = 13.76 X + 40.561	0.601	26
9. TFL	MH	Y = 24.316 X + 61.129	0.762	26
10. TFL	VPPA	Y = 28.906 X + 94.505	0.623	26

The predictor values for the length of the blueback herring are a little low but still acceptable. Further study is needed to establish the reason for this result and the possibility of improving it.

Table 65. Original data of the live fish and the angular bone, with the regression equations and the correlation coefficients (r^2) between them in gaspereau *(Alosa pseudoharengus)*

	FISH					ANGULAR					
NSM#	TFL	FFL	SFL	TFW	DFW	CPP	DIP	VPP	ML	MH	VPPA
12477	262	234	217	196.5	174.0	10.1	9.8	6.0	18.0	10.0	6.0
12478	282	259	241	273.5	240.1	10.9	10.0	6.0	19.0	10.0	6.6
12479	292	262	246	279.3	233.2	12.0	10.7	6.0	17.6	10.0	6.1
12480	268	254	240	258.5	217.8	12.0	10.2	5.9	20.0	11.0	6.2
12481	279	254	233	218.1	193.5	11.0	10.0	6.0	18.8	11.3	6.5
12482	293	258	244	266.5	225.5	11.2	10.0	6.8	19.0	11.2	7.0
12483	264	231	216	189.1	163.5	10.0	9.6	5.9	17.8	9.8	6.0
12484	263	233	219	182.5	158.3	10.5	9.2	5.5	17.0	10.2	6.0
12485	296	263	249	275.5	236.5	10.3	10.0	6.0	18.9	11.0	7.0
12486	297	260	245	239.5	213.8	11.9	10.8	6.0	19.8	10.9	6.2
12487	309	276	257	331.3	283.1	10.5	9.8	6.0	19.8	12.4	6.8
12488	281	247	228	247.2	213.5	10.5	9.0	6.0	18.1	12.1	6.0
12766	304	274	260	229.0	185.1	10.5	10.2	6.1	20.0	9.5	6.8
12767	299	268	254	245.5	189.3	10.6	10.0	6.0	19.1	9.5	6.0
12768	274	242	227	158.7	•	10.6	9.3	5.5	17.7	11.5	6.0
12800	259	228	213	145.5	133.5	9.4	8.6	6.7	16.6	10.5	6.0
12801	312	269	258	248.7	230.7	12.5	11.9	6.5	21.0	11.8	6.4
12802	249	227	206	105.2	98.2	9.9	8.8	5.0	16.0	10.1	5.8
12803	221	198	180	76.3	67.6	9.0	8.2	5.0	14.8	8.0	5.0
12804	307	268	253	225.7	213.7	10.1	9.2	6.8	19.0	12.2	7.0

VARIABLES Y	X	REGRESSION EQUATIONS	CORRELATION COEFF. r^2	N
1. TFL	FFL	Y = 1.13 X + 2.151	0.933	20
2. TFL	SFL	Y = 1.084 X +26.655	0.942	20
3. TFL	TFW	log. Y = 0.209 log. X + 1.961	0.740	20
4. TFL	DFW	log. Y = 0.226 log. X + 1.935	0.762	19
5. TFL	CPP	Y = 15.001 X +120.416	0.331	20
6. TFL	DIP	Y = 19.452 X + 90.602	0.490	20
7. TFL	VPP	Y = 30.836 X + 95.997	0.419	20
8. TFL	ML	Y = 13.177 X + 38.097	0.731	20
9. TFL	MH	Y = 12.652 X + 145.804	0.354	20
10. TFL	VPPA	Y = 37.342 X + 46.414	0.638	20

The best value is the maximum length of the angular to estimate the length of the fish.

Table 66. Original data of the live fish and the angular bone, with the regression equations and the correlation coefficients (r^2) between them in shad *(Alosa sapidissima)*

	FISH					ANGULAR				
NSM#	TFL	FFL	SFL	FWS	DFW	CPP	DIP	VPP	ML	MH
11294	297	•	249	266.5	222.3	11.2	10.0	7.0	17.7	11.2
11295	286	•	241	201.1	178.6	10.7	10.0	6.4	17.0	9.1
11296	291	•	246	250.6	216.8	11.5	10.0	6.6	16.6	10.0
11524	533	•	•	930.0	•	19.2	17.9	16.4	37.0	16.4
11525	598	•	•	1462.0	•	22.1	20.3	18.2	43.3	19.1
12751	474	417	410	1072.8	769.4	18.9	16.1	13.2	27.2	17.1
12754	503	457	433	1516.5	1321.5	21.8	18.4	17.0	42.6	18.2

VARIABLES Y	X	REGRESSION EQUATIONS	CORRELATION COEFF. r^2	N
1. TFL	SFL	Y = 1.12 X + 16.38	0.999	7
2. TFL	TFW	log. Y = 0.35 log. X +1.637	0.941	7
3. TFL	DFW	log. Y = 0.313 log. X +1.744	0.977	5
4. TFL	CPP	Y = 24.783 X + 17.441	0.943	7
5. TFL	DIP	Y = 28.794 X + 3.547	0.987	7
6. TFL	VPP	Y = 24.388 X + 130.562	0.973	7
7. TFL	ML	Y = 10.307 X + 129.464	0.903	7
8. TFL	MH	Y = 30.27 X + 11.185	0.932	7

In contrast with the other clupeids studied, the shad shows the best results. Probably because this is a small sample and the bones are of large size, well calcified, and easy to measure.

Table 67. Original data of the live fish and the angular bone, with the regression equations and the correlation coefficients (r^2) between them in eel *(Anguilla rostrata)*

	FISH				ANGULAR			
NSM#	TFL	SFL	TFW	DFW	CPP	VPP	ML	MH
12497	552	540	282	247.0	7.5	7.6	17.7	6.0
12498	553	541	314	270.4	6.1	10.1	18.5	6.0
12829	363	•	•	82.5	3.0	3.2	9.5	2.7
12830	319	•	•	50.1	2.5	3.2	8.1	1.9
12831	334	•	•	71.0	2.7	3.6	8.5	1.9
12832	394	•	•	102.5	3.5	5.0	10.1	3.0
12833	358	•	•	88.2	3.0	3.9	8.9	2.1
12834	320	•	•	52.1	2.8	3.5	9.2	2.0
12835	353	•	•	56.5	3.2	3.9	9.1	2.2
12836	345	•	•	81.1	2.6	3.5	9.0	2.5
12837	326	•	•	49.3	2.9	3.4	8.1	2.3

VARIABLES Y	X	REGRESSION EQUATIONS	CORRELATION COEFF. r^2	N
1. TFL	DFW	log. Y = 0.329 log. X + 1.938	0.950	11
2. TFL	CPP	Y = 51.506 X + 197.005	0.941	11
3. TFL	VPP	Y = 37.242 X + 211.034	0.913	11
4. TFL	ML	Y = 22.728 X + 142.237	0.974	11
5. TFL	MH	Y = 55.555 X + 218.719	0.979	11

Good values to estimate the length of the eel. Although the sample is small, the fact that the bones are sturdy and easy to measure could be the reason for the high results.

Table 68. Original data of the live fish and the angular bone dimensions in Atlantic salmon (*Salmo salar*)

	FISH					ANG
NSM#	TFL	FFL	SFL	TFW	DFW	CPP
12406	800	•	717	5754	5174	28.1
12499	475	452	422	•	2308	18.3
12713	576	542	516	•	1506	21.0
12862	452	442	410	•	835	15.4

NSM#	DIP	VIP	VPP	ML	MH	VPPA
12406	27.3	20.0	21.2	57.7	20.0	23.3
12499	17.4	11.4	13.4	38.7	16.3	15.8
12713	20.2	10.2	12.8	35.5	13.8	15.8
12862	15.0	8.0	9.0	28.4	9.6	10.5

No calculation were made because of the small number of specimens.

Table 69. Original data of the live fish and the angular bone, with the regression equations and the correlation coefficients (r^2) between them in *(Salvelinus fontinalis)*

FISH

NSM#	TFL	FFL	SFL	TFW	DFW
12490	279	•	•	•	•
12491	254	•	•	212.6	•
12492	406	•	•	471.0	•
12493	279	•	•	226.8	•
12494	330	•	•	454.0	•
12701	228	209	190	109.3	99.3
12702	266	•	•	•	•
12703	254	•	•	•	•
12704	254	•	•	•	•
12705	330	•	•	454.0	•
12706	213	204	189	106.5	94.2
12752	247	238	219	163.5	152.0
12753	234	•	•	•	•
12769	280	268	244	215.0	200.8
12770	282	271	246	224.7	205.2
12794	258	247	227	145.6	140.1

ANGULAR

NSM#	CPP	VPP	ML	MH	CPPA
12490	12.8	8.4	22.6	9.0	9.3
12491	11.1	8.2	22.0	7.1	8.4
12492	•	14.3	39.0	13.7	14.5
12493	12.4	8.0	22.0	9.0	8.9
12494	16.8	11.4	29.1	10.0	11.7
12701	•	••	•	•	
12702	13.0	9.0	24.5	8.6	9.9
12703	12.0	7.8	22.0	7.8	8.1
12704	12.4	8.5	24.5	9.0	9.1
12705	16.4	11.5	27.8	11.0	11.4
12706	9.2	6.2	19.1	7.0	7.0
12752	2.8	8.7	24.5	8.7	9.3
12753	11.0	7.2	21.0	7.5	8.0
12769	14.3	9.0	27.0	9.4	9.9
12770	12.6	9.9	25.0	9.1	10.0
12794	11.6	8.2	24.0	8.2	8.8

Table 69 (cont.)

VARIABLES Y	X	REGRESSION EQUATIONS	CORRELATION COEFF. r^2	N
1. TFL	FFL	Y = 0.965 X + 20.194	0.983	6
2. TFL	SFL	Y = 1.084 X + 13.723	0.967	6
3. TFL	TFW	log. Y = 0.323 log. X + 1.687	0.889	11
2. TFL	CPP	Y = 15.054 X + 76.742	0.880	14
3. TFL	VPP	Y = 22.773 X + 70.805	0.936	15
4. TFL	ML	Y = 9.37 X + 43.865	0.873	15
5. TFL	MH	Y = 26.853 X + 35.879	0.912	15
6. TFL	VPPA	Y = 25.109 X + 36.184	0.941	15

The measurements on the angular are good predictors for the length of brook trout.

Table 70. Original data of the live fish and the angular bone dimensions in smelt (*Osmerus mordax*)

	FISH					ANGULAR				
NSM#	TFL	FFL	SFL	TFW	DFW	VIP	VPP	ML	MH	VPPA
12847	242	227	210	103.7	91.2	3.0	4.2	17.9	6.5	4.5
12848	225	207	192	66.6	56.6	4.0	4.5	15.1	5.5	5.0
12849	256	237	220	120.1	99.2	•	5.0	19.3	5.0	5.4
12850	285	267	242	194.2	166.5	4.0	5.3	23.0	7.5	6.4
12851	245	233	211	104.0	83.2	3.9	5	19.0	6.0	5.3

VARIABLES Y	X	REGRESSION EQUATIONS	CORRELATION COEFF. r^2	N
1. TFL	FFL	Y = 1.017 X +12.457	0.983	5
2. TFL	SFL	Y = 1.21 X -10.843	0.992	5
3. TFL	TFW	log. Y = 0.225 log. X +1.938	0.984	5

No calculations for the bone dimensions were made because of the small number of specimens.

Table 71. Original data of the live fish and the angular bone, with the regression equations and the correlation coefficients (r^2) between them in white sucker *(Catostomus commersoni)*

	FISH					ANGULAR	
NSM#	TFL	FFL	SFL	TFW	DFW	ML	MH
11271	309	286	258	302.3	363.6	10.0	4.5
11272	347	324	289	428.8	•	9.5	4.5
11273	344	318	284	•	•	12.6	5.0
11279	211	200	181	86.3	•	8.7	3.6
11280	348	•	•	396.5	•	11.2	4.3
11281	322	•	•	330.4	•	10.5	4.3
11283	325	•	•	327.5	•	11.3	5.0
11284	307	•	•	307.0	•	12.5	4.4
11285	430	402	385	705.7	•	15.5	6.4
11286	336	•	•	400.0	•	12.4	4.8
11287	333	•	•	389.1	•	10.2	5.2
11288	374	•	•	514.0	•	13.5	5.0
11289	350	•	•	425.8	•	11.5	5.2
12495	225	199	184	122.5	104.5	9.5	3.9
12710	247	227	203	136.3	121.6	9.5	4.2
12711	342	321	288	373.3	329.3	13.3	5.5

VARIABLES Y	X	REGRESSION EQUATIONS	CORRELATION COEFF. r^2	N
1. TFL	FFL	$Y = 1.043 X + 9.885$	0.997	8
2. TFL	SFL	$Y = 1.077 X + 27.946$	0.987	8
3. TFL	TFW	$\log. Y = 0.332 \log. X + 1.671$	0.988	16
4. TFL	ML	$Y = 25.508 X + 54.917$	0.619	16
5. TFL	MH	$Y = 68.713 X + 3.654$	0.715	16

The angular of the white sucker is small compared to the dentary and the maxillary. The erosion of the bone and its size could be the reasons for the lower degree of correlation with the total length of the fish.

Table 72. Original data of the live fish and the angular bone dimension in haddock *(Melanogrammus aeglefinus)*

	FISH					ANG
NSM#	TFL	FFL	SFL	TFW	DFW	CPP
11556	591	•	534	1446	•	19.8
12845	543	516	478	•	1266	18.2
12846	455	438	408	•	742	14.1
NSM#	DIP	VIP	VPP	ML	MH	VPPA
11556	17.8	9.6	15.1	37	18.2	17.3
12845	17.7	9.8	13.1	36.1	15.8	13.7
12846	13.8	8.1	10.3	29.6	14.5	12.1

No calculation were made due to the small number of specimens.

Table 73. Original data of the live fish and the angular bone, with the regression equations and the correlation coefficients (r^2) between them in pollock *(Pollachius virens)*

FISH

ANGULAR

NSM#	TFL	FFL	SFL	TFW	DFW	CPP
11237	349	•	311	457.2	392.5	13.2
11238	306	•	273	256.3	228.8	12.2
11239	335	•	298	358.8	312.6	13.0
11240	237	•	212	121.3	107.2	9.5
11241	251	•	228	145.5	126.6	9.5
11242	943	•	882	•	6070.0	37.0
11243	397	•	353	765.8	628.6	14.6
11259	410	•	372	841.1	723.9	15.8
11262	179	•	161	58.2	•	7.6
11263	178	•	161	51.2	•	6.6
11264	167	•	•	40.0	•	7.0
11265	162	•	147	36.2	•	6.5
11772	509	478	451	1010.0	•	19.6
11773	475	442	415	•	•	18.5
11774	466	437	408	•	•	18.2
11789	428	400	381	•	•	17.0

NSM#	DIP	VIP	VPP	ML	MH	VPPA
11237	12.1	7.7	9.2	25.3	11.9	10.8
11238	11.8	6.5	8.7	20.0	9.1	8.6
11239	12.2	7.0	8.2	24.1	10.5	10.1
11240	8.8	4.9	5.7	17.0	7.2	6.8
11241	9.2	5.1	6.6	17.2	8.0	7.6
11242	33.0	21.4	26.1	72.1	31.0	27.4
11243	13.1	9.2	10.5	28.1	13.3	12.5
11259	14.8	9.0	11.6	30.1	14.1	13.0
11262	7.0	4.1	5.2	19.0	5.8	5.9
11263	6.2	3.9	4.4	13.5	5.4	5.5
11264	6.7	3.7	4.8	13.6	5.7	5.5
11265	5.9	3.4	4.1	12.8	5.8	5.0
11772	18.2	11.6	13.7	40.2	16.2	16.0
11773	18.0	12.0	14.9	39.1	16.9	16.7
11774	17.8	10.5	14.6	38.0	16.0	17.1
11789	16.1	8.9	12.0	33.3	14.2	14.0

Table 73 (cont.)

VARIABLES Y	X	REGRESSION EQUATIONS	CORRELATION COEFF. r^2	N
1. TFL	SFL	Y = 1.074 X + 13.298	0.998	16
2. TFL	TFW	log. Y = 0.317 log. X +1.709	0.988	12
3. TFL	CPP	Y = 25.712 X + 0.857	0.997	16
4. TFL	DIP	Y = 28.483 X + 13.447	0.992	16
5. TFL	VIP	Y = 42.53 X + 19.365	0.990	16
6. TFL	VPP	Y = 34.203 X +19.333	0.982	16
7. TFL	ML	Y = 12.784 X + 7.723	0.979	16
8. TFL	MH	Y = 29.69 X + 7.388	0.992	16
9. TFL	VPPA	Y = 32.12 X - 4.414	0.971	16

All dimensions selected for the angular give good correlations with the total length of fish.

Table 74. Original data of the live fish and the angular bone dimensions in cusk (*Brosme brosme*)

	FISH					ANG
NSM#	TFL	FFL	SFL	TFW	DFW	DIP
11544	588	554	1814	•	24.6	23.2
12838	751	712	•	4090	29.0	27.8

NSM#	VIP	VPP	ML	MH	VPPA
11544	17.4	8.6	49.6	16.1	20.6
12838	25.0	27.1	66.9	22.3	28.2

No calculation were made due to the small number of specimens.

Table 75. Original data of the live fish and the angular bone dimensions in tomcod *(Microgadus tomcod)*

	FISH				ANGULAR	
NSM#	TFL	SFL	TFW	DFW	CPP	DIP
12839	198	178	68.0	56.2	5.1	5.2
12840	192	176	53.8	43.2	5.5	5.9
12841	186	170	57.0	42.0	5.8	6.4
12842	174	157	42.5	35.0	5.2	5.0

NSM#	VIP	VPP	ML	MH	VPPA
12839	3.0	4.0	13.8	6.8	5.9
12840	3.0	3.9	12.2	6.2	5.5
12841	3.2	4.0.	12.0	7.5	5.9
12842	3.0	4.0	11.5	6.0	•

No calculation were made due to the small number of specimens.

Table 76. Original data of the live fish and the angular bone, with the regression equations and the correlation coefficients (r^2) between them in silver hake *(Merluccius bilinearis)*

	FISH					ANGULAR	
NSM#	TFL		SFL	TFW	DFW	CPP	DIP
11545	392		354	405.5	342.0	15.6	14.6
11546	366	328	351.3	286.9	14.0	13.2	
11547	384	343	353.8	318.7	15.4	13.5	
11548	368		327	277.7	257.3	15.2	12.6
11549	371	331	275.1	251.7	14.3	13.5	
11550	391	352	382.4	349.5	15.6	13.6	
12551	407	367	474.0	412.7	17.4	16.1	
12552	381		342	370.3	327.8	15.0	14.0
12553	365	329	313.3	272.2	14.3	13.5	
11557	409	•	•	•	17.8	17.0	
11558	300		•	•	•	12.7	12.3
11559	518	•	•	•	21.9	19.6	
11569	459	417	630.0	498.7	17.8	15.7	
11570	375	338	314.4	292.6	16.4	14.1	
11571	364	325	253.8	•	13.8	13.2	
11574	410	•	•	•	18.5	16.0	

NSM#	VIP		VPP	ML	MH	VPPA
11545	13.0		25.2	34.5	13.0	25.6
11546	12.0		20.0	28.9	12.3	20.5
11547	12.1	20.1	30.3	11.7	21.4	
11548	12.0		18.6	28.7	11.8	19.0
11549	11.1	17.2	30.0	11.8	18.0	
11550	13.2	20.6	32.7	13.0	19.3	
11551	13.5	23.0	34.4	19.2	23.6	
11552	12.0		19.2	34.1	13.0	19.6
11553	11.1	19.1	32.1	11.4	19.0	
11557	13.9	20.9	38.7	11.7	21.6	
11558	9.6	15.5	•	10.0	15.6	
11559	16.4	27.4	47.0	17.8	27.5	
11569	14.6	24.0	36.5	•	24.0	
11570	10.6		17.6	30.4	11.2	18.0
11571	9.6		18.0	29.8	11.0	18.2
11574	14.0		22.0	40.9	15.1	23.6

VARIABLES Y	X	REGRESSION EQUATIONS	CORRELATION COEFF. r^2	N
1. TFL	SFL	$Y = 1.034 X + 27.245$	0.997	12
2. TFL	TFW	$\log. Y = 0.241 \log. X + 1.971$	0.863	12
3. TFL	DFW	$\log. Y = 0.304 \log. X + 1.824$	0.895	11
4. TFL	CPP	$Y = 17.703 X + 110.544$	0.846	15
5. TFL	DIP	$Y = 20.045 X + 103.072$	0.809	15

6. TFL	VIP	Y = 21.375 X + 127.87	0.789	15
7. TFL	VPP	Y = 11.886 X + 149.401	0.704	15
8. TFL	ML	Y = 7.191 X + 153.322	0.772	15
9. TFL	MH	Y = 11.248 X + 245.102	0.510	14
10. TFL	VPPA	Y = 11.389 X + 155.206	0.660	15

All dimensions taken on the angular of silver hake are resonable predictors to calculate the length of the fish. The maximum height is the poorest due probably to the slender and fragile coronoid process.

Table 77. Original data of the live fish and the angular bone dimensions in goosefish *(Lophius americanus)*

	FISH				ANGULAR		
NSM#	TFL	SFL	TFW	DFW	CPP	ML	MH
11256	765	660	7080	5570	56	126.5	20.0
11257	710	595	3941	3473	54	116.0	18.0
11258	540	456	1899	1730	36	81.5	14.6
11555	685	565	3742	3232	44	100.5	16.1

No regressions were calculated because of the small number of specimens.

Table 78. Original data of the live fish and the angular bone, with the regression equations and the correlation coefficients (r^2) between them in longhorn sculpin *(Myoxocephalus octodecimspinosus)*

	FISH				ANGULAR	
NSM#	TFL	SFL	TFW	DFW	CPP	DIP
11292	322	277	304.3	274.6	13.8	9.1
11536	275	230	156.4	143.0	9.2	7.0
11537	189	163	65.8	57.1	6.0	4.9
11541	205	171	77.0	64.5	7.5	5.8
12760	280	•	211.2	•	11.2	7.8
12761	242	210	152.4	•	8.0	6.6
12762	273	234	231.0	•	15.4	7.3
12763	256	212	179.7	•	9.6	7.0
12764	276	236	227.0	•	9.6	7.4
12765	286	244	247.5	•	9.6	8.8

NSM#	VIP	VPP	ML	MH	VPPA
11292	10.4	14.2	27.8	16.0	15.5
11536	9.2	12.0	22.8	12.4	13.2
11537	5.2	7.6	15.9	9.3	8.6
11541	6.8	9.3	18.5	9.8	10.3
11593	10.4	13.0	24.6	14.0	14.2
12760	8.8	13.7	25.0	15.0	14.8
12761	8.0	12.7	23.2	12.2	13.0
12762	8.8	13.4	25.3	14.0	14.1
12763	8.5	12.1	23.2	13.4	13.0
12764	8.3	12.7	24.4	13.7	13.4
12765	10.0	14.2	24.9	14.6	15.4

VARIABLES Y	X	REGRESSION EQUATIONS	CORRELATION COEFF. r^2	N
1. TFL	SFL	Y = 1.148 X + 6.119	0.991	10
2. TFL	TFW	log. Y = 0.311 log. X +1.719	0.939	10
3. TFL	CPP	Y = 10.498 X + 155.526	0.571	10
4. TFL	DIP	Y = 29.796 X + 46.763	0.906	10
5. TFL	VIP	Y = 24.937 X + 50.933	0.912	10
6. TFL	VPP	Y = 16.842 X + 55.098	0.849	10
7. TFL	ML	Y = 10.896 X + 8.7	0.922	10
8. TFL	MH	Y = 17.428 X + 33.138	0.916	10
9. TFL	VPPA	Y = 17.117 X + 35.634	0.902	10

Most dimensions on the angular are good predictors for the total length of the fish. The dimension CPP has been affected here by the fragile and slender character of the coronoid process.

Table 79. Original data of the live fish and the angular bone dimensions in sea raven *(Hemitripterus americanus)*

	FISH				ANGULAR				
NSM#	TFL	SFL	TFW	DFW	CCP	DIP	VPP	ML	MH
11266	498	•	1616	•	18.5	17.6	21.9	59.9	31.4
11269	340	•	•	•	12.7	11.1	15.6	39.6	21.3
11538	256	287	711.4	478.5	12.3	10.2	15.5	39.0	23.0
11573	410	•	•	•	18.3	14.5	19.1	48.3	25.0

No regressions were calculated because of the small number of specimens.

Table 80. Original data of the live fish and the angular bone, with the regression equations and the correlation coefficients (r^2) between them in mackerel *(Scomber scombrus)*

	FISH					ANG
NSM#	TFL	FFL	SFL	TFW	DFW	CPP
12476	441	403	•	437.5	298.5	16.4
12489	398	362	346	513.0	417.8	14.1
12712	310	282	274	218.3	193.7	12.2
12750	393	359	345	635.0	461.5	14.6
12755	321	294	288	270.2	243.7	14.0
12756	310	288	279	247.4	222.4	13.0
12757	288	263	256	184.1	166.0	10.0
12758	313	286	175	248.5	220.2	12.3
12759	325	298	285	268.1	243.5	12.5
12805	425	390	367	680.8	629.8	15.0
12806	242	226	216	99.0	•	12.2
12807	302	276	260	223.5	195.6	12.5
12808	283	260	245	150.2	135.0	11.7
12809	271	249	239	161.0	148.7	11.3
12810	306	275	259	214.0	195.0	12.1
12811	285	262	244	169.5	151.5	11.4
12812	307	278	258	227.8	198.0	11.0
12813	304	279	261	237.9	215.7	12.4
12814	310	282	267	226.6	202.5	12.0
12815	392	357	338	437.1	402.0	14.2
12816	245	227	213	99.5	87.5	11.3
12817	300	276	259	212.9	182.9	12.3
12818	244	226	210	105.5	•	10.2
12819	244	223	210	97.7	•	10.0
12820	302	273	257	221.0	195.4	12.0
12821	319	291	272	220.7	191.7	13.3
12822	303	280	264	208.7	185.7	12.9
12923	263	242	230	130.5	117.2	11.0
12824	310	284	270	250.7	225.2	14.3
12825	258	236	222	112.2	100.2	11.0

NSM#	DIP	VIP	VPP	ML	MH
12476	13.4	14.6	20.7	37.7	15.3
12489	13.2	13.2	20.5	37.0	15.0
12712	10.5	10.0	14.6	28.5	11.8
12750	13.2	14.2	18.7	36.0	16.0
12755	11.4	11.3	13.7	31.3	11.9
12756	11.4	11.7	15.5	28.5	11.9
12757	9.9	10.8	15.0	27.0	10.0
12758	11.6	11.2	15.8	28.3	11.4
12759	10.6	11.8	15.4	30.0	11.9
12805	13.7	15.9	20.0	35.1	15.7
12806	9.1	9.1	13.2	24.6	9.1
12807	10.3	11.4	15.6	31.3	12.6
12808	10.4	9.6	14.2	27.3	11.1
12809	9.1	10.0	14.1	26.1	9.7
12810	11.0	10.9	15.5	29.7	11.4
12811	10.5	10.5	15.0	27.2	11.0
12812	10.5	11.0	16.0	29.0	11.8
12813	11.0	10.8	16.1	30.2	11.6
12814	10.4	11.1	15.3	28.3	11.5
12815	13.2	13.7	19.9	36.0.	13.6
12816	9.2	9.4	12.7	24.3	9.5
12817	11.1	10.6	15.5	27.4	11.5
12818	8.8	9.3	13.2	23.6	14.6
12819	9.3	8.6	12.0	24.3	8.8
12820	11.1	10.6	14.0	25.7	11.4
12821	11.6	11.4	17.3	30.6	12.3
12822	11.2	10.7	15.0	30.1	11.3
12823	9.4	9.0	13.2	24.2	9.8
12824	11.4	12.0	17.2	30.0	12.0
12825	9.3	8.6	13.0	24.0	9.4

VARIABLES Y	X	REGRESSION EQUATIONS	CORRELATION COEFF. r^2	N
1. TFL	FFL	$Y = 1.109 X - 4.641$	0.998	31
2. TFL	SFL	$Y = 0.973 X + 50.007$	0.825	30
3. TFL	TFW	$\log. Y = 0.300 \log. X + 1.785$	0.944	31
4. TFL	DFW	$\log. Y = 0.314 \log. X + 1.769$	0.873	25
5. TFL	CPP	$Y = 29.452 X - 55.919$	0.752	30
6. TFL	DIP	$Y = 35.823 X - 79.765$	0.908	30
7. TFL	VIP	$Y = 28.132 X - 1.803$	0.918	30
8. TFL	VPP	$Y = 20.703 X - 12.429$	0.883	30
9. TFL	ML	$Y = 12.339 X - 48.71$	0.908	30
10. TFL	MH	$Y = 22.337 X + 46.216$	0.691	30

The values are high, except for the maximum height.

Table 81. Original data of the live fish and the angular bone, with the regression equations and the correlation coefficients (r^2) between them in Canadian plaice *(Hippoglossoides platessoides)*

	FISH				ANGULAR					
NSM#	TFL	SFL	TFW	DFW	CPP	DIP	VPP	ML	MH	VPPA
Left side										
12792	410	341	•	•	15.0	15.0	14.0	31.5	11.9	16.2
12793	414	352	485.5	•	•	•	•	•	•	•
12828	312	270	227.3	•	12.0	11.3	13.2	23.5	9.0	13.7
12843	336	277	283.0	•	13.5	12.1	11.5	25.0	9.2	11.6
12844	385	322	•	440	12.8	11.0	12.8	26.4	11.0	13.7
12852	436	363	440.0	•	17.5	16.8	16.2	38.0	13.7	18.3
12853	441	371	754.0.	•	17.5	15.8	13.5	32.7	11.4	15.0
Right side										
12792	410	341	•	•	17.0	16.7	11.3	29.5	13.6	14.0
12793	414	352	485.5	•	19.0	18.1	14.0	31.5	16.5	16.5
12828	312	270	227.3	•	14..0	13.1	11.1	23.6	9.2	11.7
12843	336	277	283.0	•	13.5	13.0	9.9	22.2	9.7	11.1
12844	385	322	•	440	17.3	14.4	10.6	24.6	11.2	12.2
12852	436	363	440.0	•	21.9	19.0.	15.4	34.6	16.0	11.7
12853	441	371	754.0	•	18.8	17.6	12.3	32.7	11.4	15.0

VARIABLES Y	X	REGRESSION EQUATIONS	CORRELATION COEFF. r^2	N
1. TFL	SFL	Y = 1.217 X - 8.473	0.988	7
2. TFL	TFW	log. Y = 0.313 log X + 1.769	0.854	7
Left side				
3. TFL	CPP	Y = 20.024 X + 91.984	0.801	6
4. TFL	DIP	Y = 17.952 X + 141.324	0.717	6
5. TFL	VPP	Y = 22.27 X + 85.276	0.427	6
6. TFL	ML	Y = 8.671 X + 130.724	0.814	6
7. TFL	MH	Y = 26.88 X + 90.086	0.795	6
8. TFL	VPPA	Y = 17.189 X + 133.128	0.565	6
Right side				
3. TFL	CPP	Y = 15.19 X + 126.919	0.811	7
4. TFL	DIP	Y = 18.674 X + 92.059	0.863	7
5. TFL	VPP	Y = 17.017 X + 184.911	0.458	7
6. TFL	ML	Y = 9.252 X + 127.96	0.836	7
7. TFL	MH	Y = 12.487 X + 234.306	0.541	7
8. TFL	VPPA	Y = 14.327 X + 201.861	0.344	7

There is some discrepancy between some values for each dimension between both sides of the fish. No explanation will be attempted in this report to explain it.

Table 82. Original data of the live fish and the angular dimensions in winter flounder *(Pseudopleuronectes americanus)*

	FISH			ANGULAR					
NSM#	TFL	SFL	TFW	CPP	DIP	VPP	ML	MH	VPPA
Left side									
12790	256	209	200.5	7.8	7.8	8.0	14.1	7.8	8.1
12791	320	261	413.9	9.0	9	8.1	15.2	8.2	9.6
Right side									
12790	256	209	200.5	8.0	8.0	4.9	13.0	6.5	6.1
12791	320	261	413.9	9.8	9.6	6.2	15.0	7.0	9.9

No regressions were calculated because of the small number of specimens.

X BONE IDENTIFICATION: KEYS AND PLATES

X.I Introduction

The following keys are intended as a guide in the identification of the bones of the buccal apparatus. Bear in mind that they are valid only for the species studied in this report and for the sizes of the fish prepared. Every feature selected is addressed with two opposing statements numbered on the left side of the page. When the bone has the feature considered, go to the right side of the page, until you get the species name or another number, in order to continue the identification process.

For a better understanding of the descriptions, refer to the numbered plates of the bones given at the end of the report.

A glossary, provided at the end of the last key, will further clarify the terms used for the identification process.

X.2 IDENTIFICATION KEY FOR THE PREMAXILLARY

1	Without teeth	2
	With teeth	7
2	Well-developed ascending process	3
	Without well-developed ascending process	4
3	Long, straight symphysial margin	*Catostomus commersoni*
	Short, curved symphysial margin	*Pseudopleuronectes americanus* (right premaxillary)
4	Dorsal margin with one prominence; convex outline	*Clupea harengus*
	Dorsal margin with two prominences; sinuous outline	5
5	Ventral margin curved	*Alosa sapidissima*
	Ventral margin mostly straight	6
6	Total length three times or more the height	*Alosa pseudoharengus*
	Total length less than three times the height	*Alosa aestivalis*
7	Ascending process very small or absent	8
	Two or three processes well developed	9
8	With a small ascending process; dorsal margin convex	*Salmo salar*
	No ascending process; dorsal margin pointed; curved backward	*Salvelinus fontinalis*
9	A long alar membrane on its dorsal margin	*Osmerus mordax*
	Well-developed processes on its dorsal margin	10
10	Ascending and articular processes fused	*Scomber scombrus*
	Three totally or partially distinct processes on its dorsal margin	11
11	Only one row of teeth	12
	Two or more rows of teeth	13
12	Teeth thin and long; maximum height of bone two or more times in maximum length	*Hippoglossoides platessoides*
	Teeth flat; maximum height and maximum length almost equal in size	*Pseudopleuronectes americanus* (left premaxillary)
13	Ascending process long and pointed, more than twice the length of the articular process; teeth caniniform; anterior teeth long; a row of small teeth on the posterior section of the bone	*Lophius americanus*
	Ascending process longer (no more than twice) or of the same length as the articular process	14
14	Caudal process not differentiated	15
	Caudal process well differentiated	16

15 Maxillary process subtriangular in shape; close to the articular process *Myoxocephalus octodecimspinosus*

Maxillary process elongated with its dorsal margin convex; far from the articular process *Hemitripterus americanus*

16 Caudal process long and pointed, ending farther than the maxillary process 17

Caudal process ending more or less at the same level as the maxillary process 18

17 Maximum length of the bone more than 4 times the maximum height; one or two rows of teeth *Merluccius bilinearis*

Maximum length less than four times the maximum height; several rows of teeth *Pollachius virens*

18 Small bone; maxillary process membranous and joined at the base to the caudal process which extends a little farther *Microgadus tomcod*

Strong bone; maxillary process well-ossified 19

19 Ascending and articular processes of the same height; maxillary process long, separated almost completely from the caudal process *Brosme brosme*

Ascending process higher than the articular process 20

20 Ascending process massive and round; articular, round *Gadus morhua*

Ascending process elongated and blunt; articular, pointed *Melanogrammus aeglefinus*

X.3 IDENTIFICATION KEY FOR THE MAXILLARY

1	With teeth	2
	Without teeth	5
2	With several rows of teeth	*Anguilla rostrata*
	One row only	3
3	Maxillary crest prominent; caudal section enlarged	*Salmo salar*
	Maxillary crest not noticeable	4
4	Head of the bone curved downward	*Salvelinus fontinalis*
	Head of the bone curved upward	*Osmerus mordax*
5	Head of the bone flattened, curved inward and set at an angle with the body of the bone	6
	Head of the bone massive	9
6	Ventral margin of the bone straight; bone long and narrow	*Alosa sapidissima*
	Ventral margin convex; bone short and wide	7
7	Very short neck; upper margin of neck and body continuous	*Clupea harengus*
	Neck clearly defined	8
8	Long bone	*Alosa pseudoharengus*
	Short bone	*Alosa aestivalis*
	(1) The maxillaries of the last three species are very similar and difficult to set apart.	
9	Two crests, dorsal and ventral present; no external process; bone short and massive	*Catostomus commersoni*
	One dorsal crest, more or less pronounced	10
10	Caudal process subquadrangular clearly defined; directed downward	11
	Caudal process not subquadrangular or absent	14
11	Posterior caudal margin not bilobular	*Brosme brosme*
	Posterior caudal margin bilobular	12
12	Lower lobe smaller than the upper	*Pollachus virens*
	Lower lobe larger than the upper	13
13	Internal process larger than the external process	*Gadus morhua*
	Internal and external processes of same size; bone small	*Microgadus tomcod*

14 Dorsal crest running the whole length of the bone *Melanogrammus aeglefinus*
Dorsal crest not running the whole length of the bone 15

15 External process absent; body curved downward; posterior section expanded, round, extending downward; body of bone flat *Scomber scombrus*
External process present 16

16 Internal process much higher than the articular crest *Lophius americanus*
Articular crest higher than both processes 17

17 A small barb on the anterior part of the dorsal margin 18
Barb absent 19

18 Long bone; height more than 5 times in length *Hippoglossoides platessoides*
Short bone; height less than 5 times in length *Pseudopleuronectes americanus*

19 Maximum length of bone around 5 times the maximum height of the bone's head *Myoxocephalus octodecimspinosus*
Maximum length of the bone around 7 times the height of the bone's head *Hemitripterus americanus*

X.4 IDENTIFICATION KEY FOR THE DENTARY

1	Without teeth	2
	With teeth	7
2	Coronoid process laminar and transparent, except for its anterior margin	3
	Coronoid process thick, well ossified throughout	6
3	Anterior section of the laminar coronoid process ossified into a narrow band; remaining part transparent	*Clupea harengus*
	Anterior section of the laminar coronoid process ossified into a wide band; remaining section transparent	4
4	The length of the lamina is longer than its height	*Alosa sapidissima*
	The length and height of the band are of equal or almost equal size	5
5	Coronoid process subquadrangular; upper margin straight	*Alosa pseudoharengus*
	Coronoid process sinuous; upper margin round	*Alosa aestivalis*
6	Coronoid process points backward; smaller than ventral process	*Pseudopleuronectes americanus* (right dentary)
	Coronoid process vertical; ventral process points downward.	*Catostomus commersoni*
7	One row of teeth	8
	More than one row of teeth	13
8	Coronoid and ventral processes of equal or almost equal length	9
	Coronoid and ventral processes of unequal length	10
9	Coronoid process larger than the ventral; teeth long of uniform size	*Hippoglossoides platessoides*
	Coronoid process smaller than the ventral; teeth small	*Pseudopleuronectes americanus* (left dentary)
10	Small and closely set teeth; coronoid process slender than ventral	*Scomber scombrus*
	Large and widely set teeth	11
11	Body of the bone laminar, transparent; coronoid process wider than ventral process	*Osmerus mordax*
	Body of the bone thick and opaque	12
12	Symphysial margin long, inclined and pointing backward;	*Salmo salar*
	Symphysial process short, more or less vertical	*Salvelinus fontinalis*
13	Coronoid and ventral processes not well defined; posterior margin trilobular, with narrow and short incisures	*Anguilla rostrata*
	Coronoid and ventral processes well defined and forming a deep and wide angle	14

14 Coronoid and ventral processes ending more or less at the same level 15
Coronoid and ventral processes ending at different levels 17

15 The deep Meckelian incisure reaches up to the middle of the bone length
Myoxocephalus octodecimspinosus

Myoxocephalus octodecimspinosus
The Meckelian incisure not reaching the middle of the bone length 16

16 Bone thin and fragile; height more than three times in bone's length; ventral process pointed *Merluccius bilinearis*
Bone strong; height less than three times in bone's length; ventral process blunt
Brosme brosme

17 Coronoid process longer than ventral 18
Coronoid process shorter than ventral 19

18 Long, curved, caniniform teeth; mental foramen opens in mid length of the bone; coronoid process bent upward; bone light, porous *Lophius americanus*
Small teeth; mental foramen close to the symphysial margin; coronoid process straight *Hemitripterus americanus*

19 Small, membranous, fragile bone; coronoid and ventral processes form a wide angle
Microgadus tomcod
Large, well ossified bone 20

20 Dental plate ending before the mesial incisure *Melanogrammus aeglefinus*
Dental plate ending farther than both incisures 21

21 Ventral process blunt; prominent mental knob *Gadus morhua*
Ventral process pointed; posterior margin receding forwards *Pollachius virens*

X.5 IDENTIFICATION KEY FOR THE ANGULAR

1	Postarticular process horizontal	2
	Postarticular process growing upwards	5
2	Coronoid process absent	*Catostomus commersoni*
	Coronoid process present	3
3	Coronoid process fused with the alar section of the body; postarticular process round; bone of spongy consistency	*Lophius americanus*
	Coronoid process surpassing the membrane	4
4	Coronoid process ending farther back than the tip of the ventral process	*Anguilla rostrata*
	Coronoid process more advanced than the tip of the ventral process	*Melanogrammus aeglefinus*
5	Coronoid process fused with the alar membrane	*Osmerus mordax*
	Coronoid process well-differentiated; coronoid incisure present	6
6	Coronoid process ending farther back than the tip of the ventral process	7
	Coronoid process ending before the tip of the ventral process	8
7	Ventral process wide, short and pointed; an extra prong on the inner wall visible in lateral view; coronoid process, thin and long; anterior process pointed	*Myoxocephalus octodecimspinosus*
	Ventral process long and pointed; anterior process truncated or round	*Scomber scombrus*
8	Subarticular sulcus present	9
	Subarticular sulcus absent	13
9	Subarticular sulcus covered partially by a bridge	*Brosme brosme*
	Subarticular sulcus open its whole length	10
10	Sulcus parallel to the inferior "rib" (actually this "rib" forms the upper "lip" of the sulcus)	*Merluccius bilinearis*
	Sulcus running obliquely	11
11	Sulcus wide and short; bone small, delicate	*Microgadus tomcod*
	Sulcus long and narrow; bone strong, well ossified	12
12	Coronoid process. thin; ventral margin of ventral process pointing horizontally	*Pollachius virens*
	Coronoid process robust, round; ventral margin of the ventral process convex, round	*Gadus morhua*
13	Ventral process, pentagonal in outline; pointing downward	*Hemitripterus americanus*
	Ventral process subquadrangular; ventral process pointed or truncated	14
14	Prearticular process present; small	15
	Prearticular process absent	16

15	Coronoid process very small; postarticular process pointed; bone stout; maximum height less than 3 times in maximum length	*Salmo salar*
	Coronoid process well developed; bone slender; maximum height more than 3 times in maximum length	*Salvelinus fontinalis*
16	Postarticular processs vertical	17
	Postarticular process inclined forward	18
17	Anterior process pointed; postarticular process long	*Hippoglossoides platessoides*
	Anterior process round; postarticular process small	*Pseudopleuronectes americanus*
18	Alar membrane length more than 4 times its height	*Alosa sapidissima*
	Alar membrane length less than 4 times its height	19
19	Coronoid process round	*Clupea harengus*
	Coronoid process pointed	20
20	A small protuberance behind the postarticular process	*Alosa pseudoharengus*
	Without small protuberance behind the postarticular process	*Alosa aestivalis*

X.6 PLATES

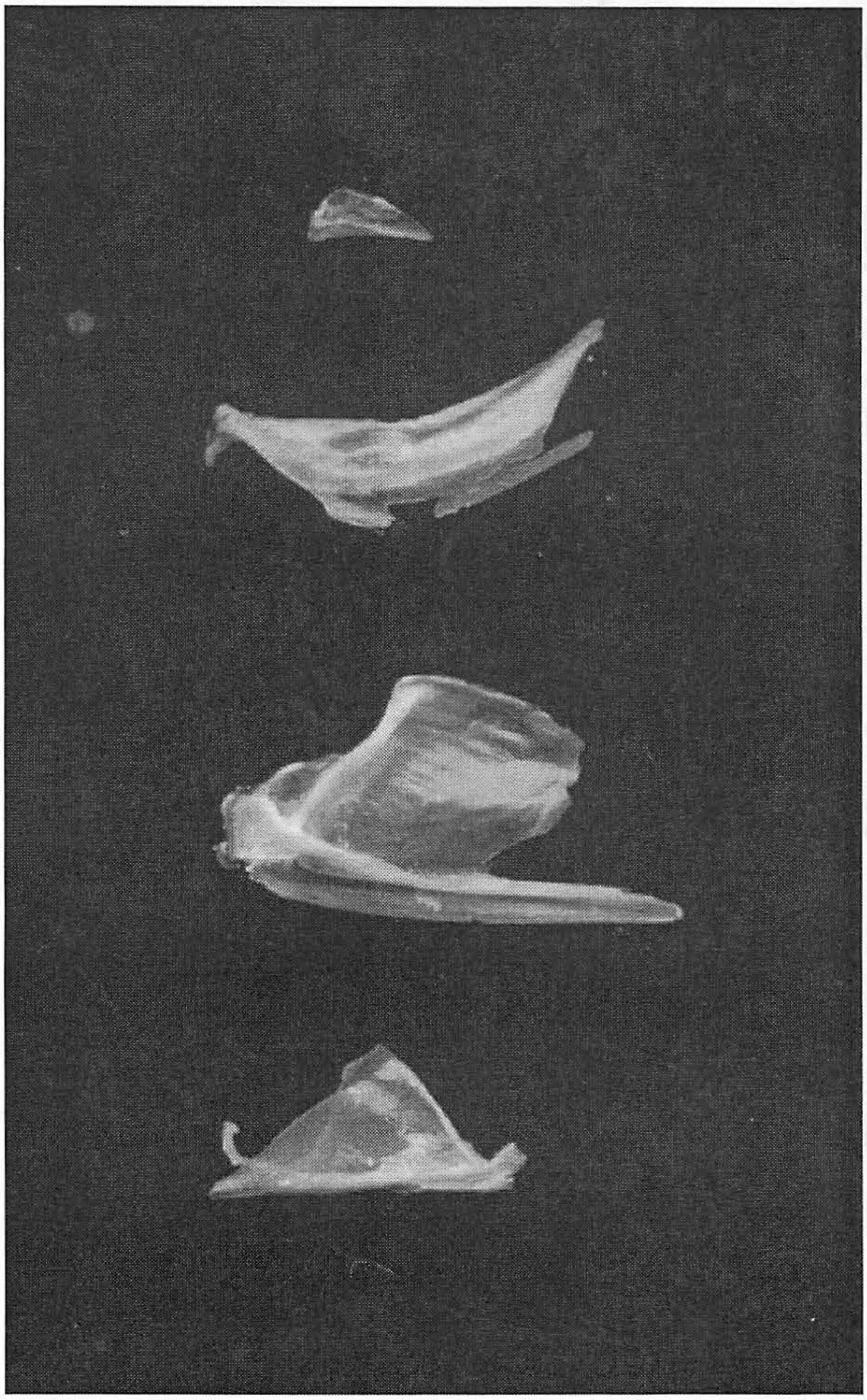


Plate 1. Left side of the buccal apparatus of *Clupea harengus.* Top to bottom: PMA (NSM# 12788); MA, DE, ANG (NSM# 12787)

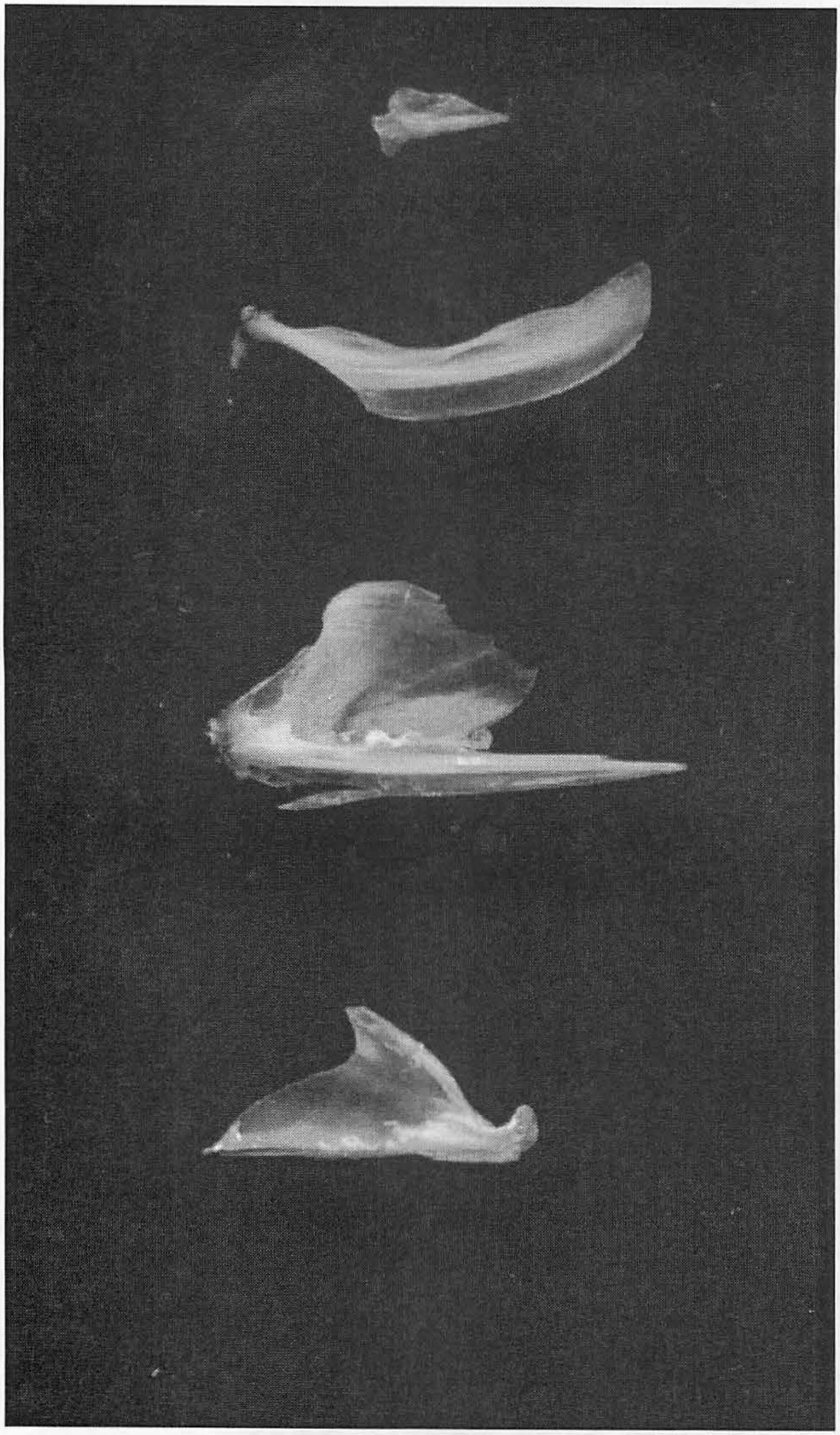


Plate 2. Left side of the buccal apparatus of *Alosa aestivalis.* Top to bottom: PMA (NSM# 12727); MA, DE, ANG (NSM# 12723)

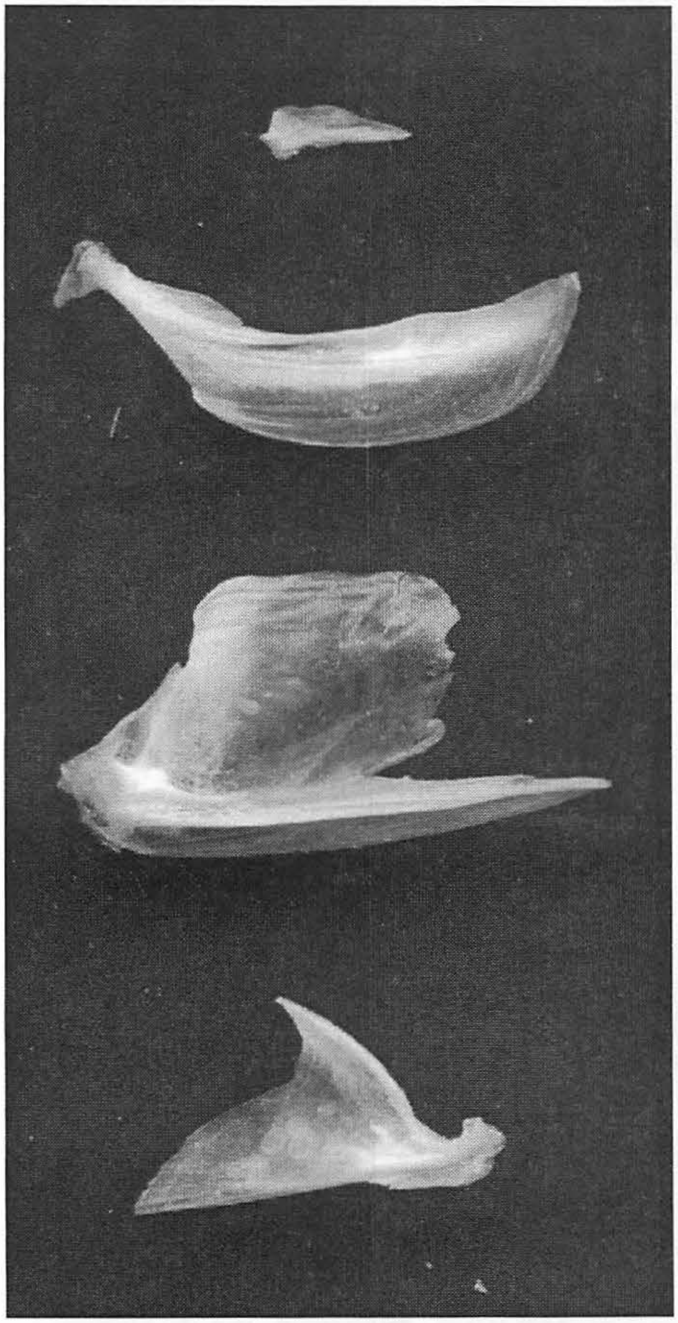


Plate 3. Left side of the buccal apparatus of *Alosa pseudoharengus.* Top to bottom: PMA, MA, DE, ANG (NSM# 12801)

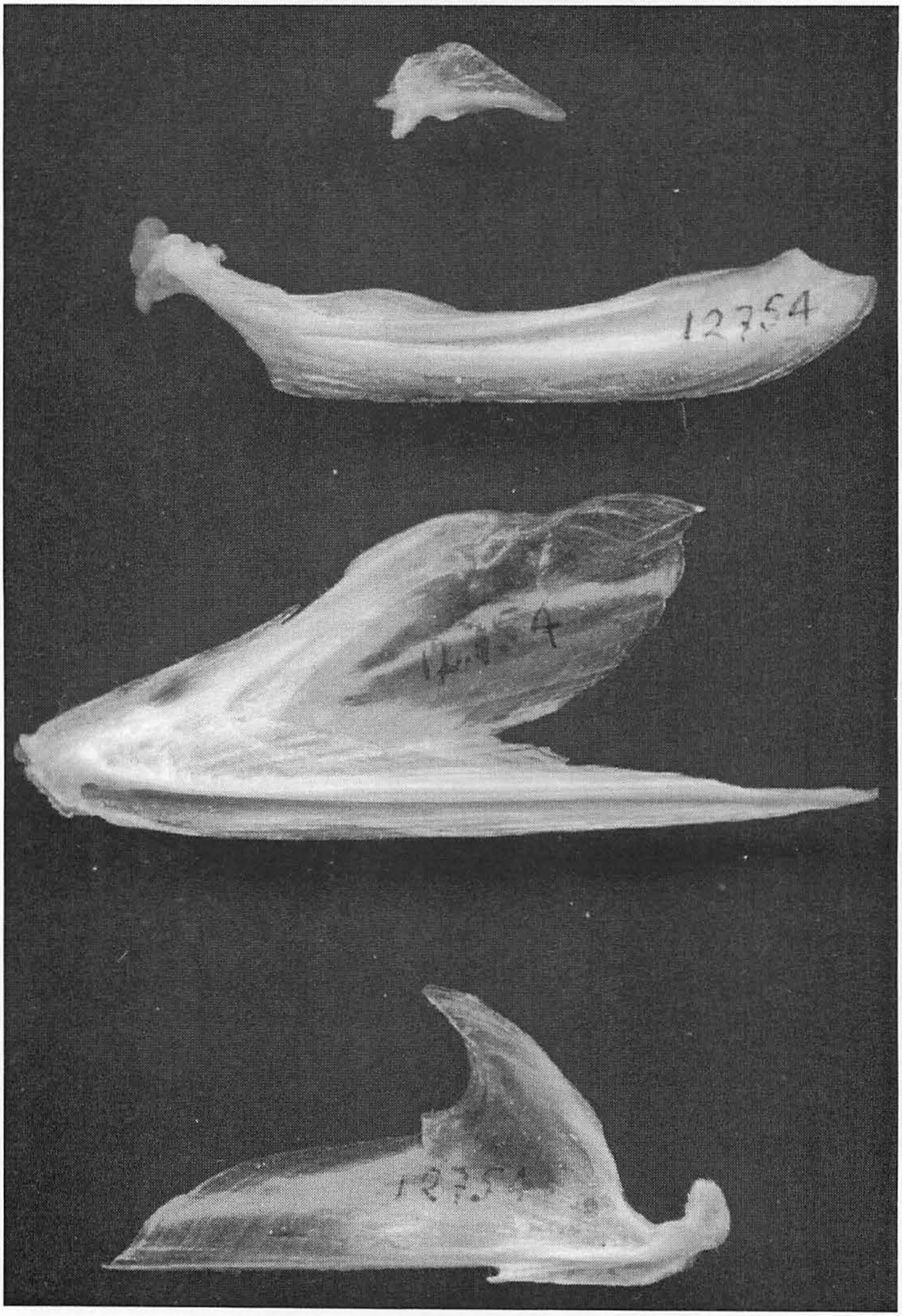


Plate 4. Left side of the buccal apparatus of *Alosa sapidissima.* Top to bottom: PMA, MA, DE, ANG (NSM# 12754)

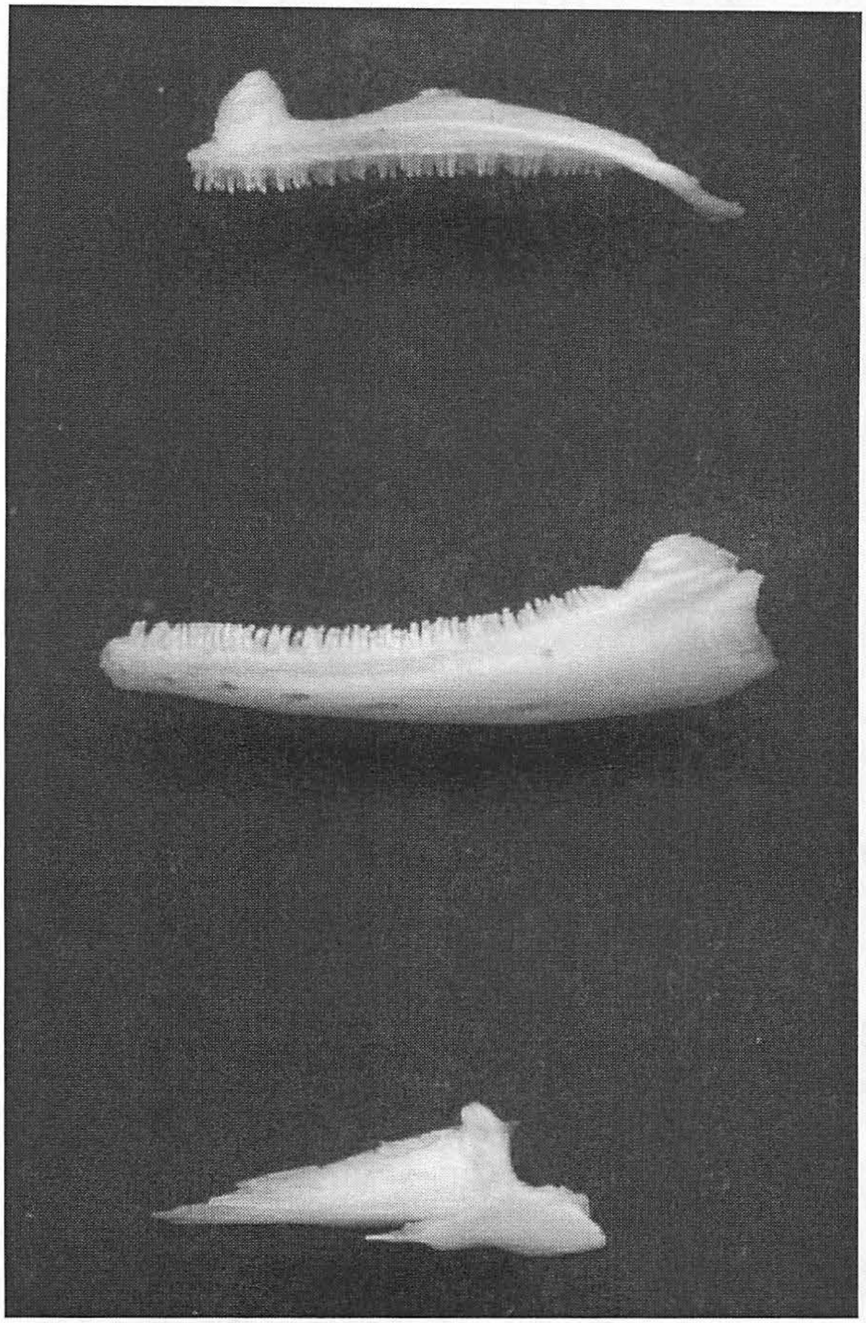


Plate 5. Left side of the buccal apparatus of *Anguilla rostrata.* Top to bottom: MA, DE, ANG (NSM# 12498)

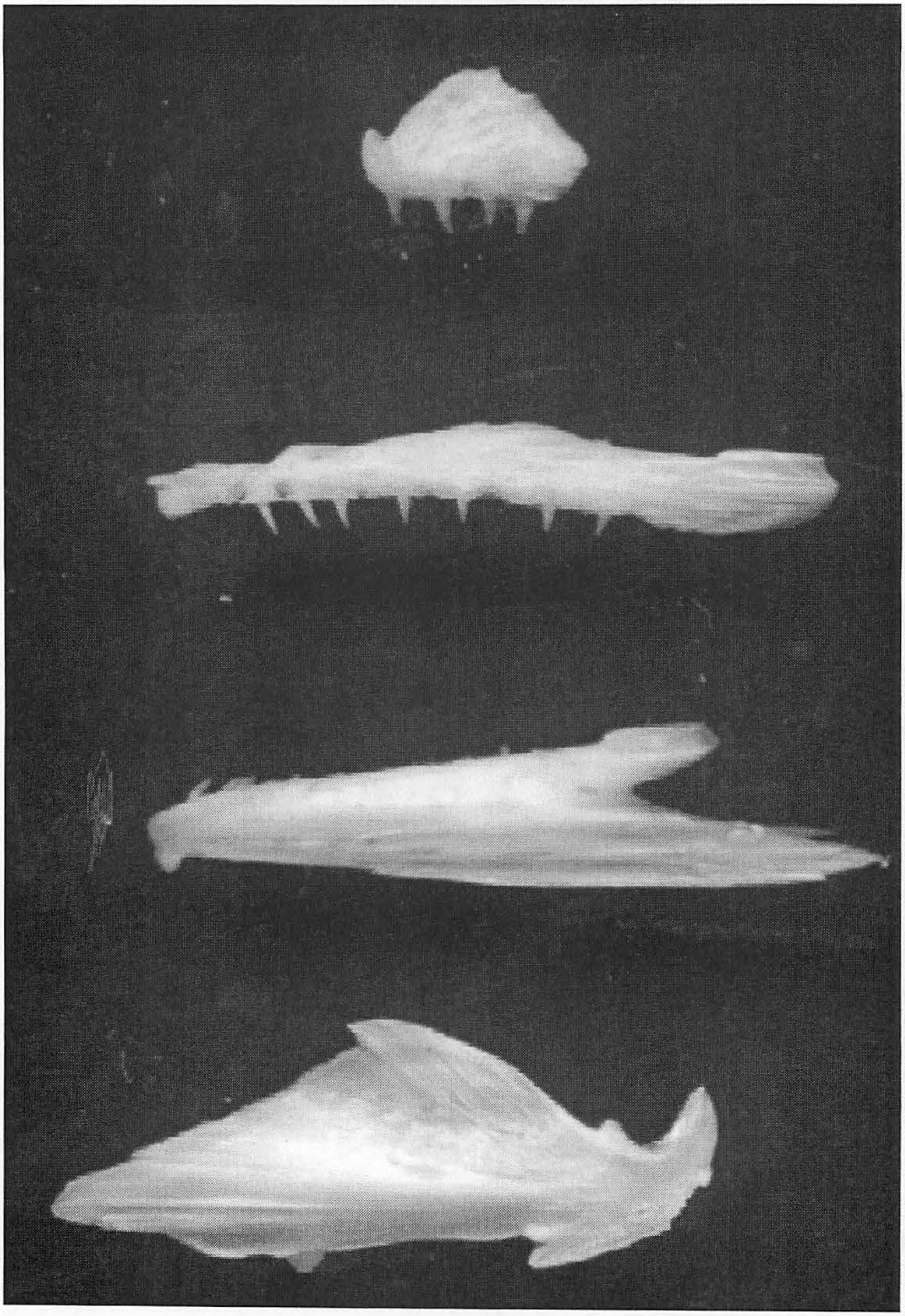


Plate 6. Left side of the buccal apparatus of *Salmo salar*. Top to bottom: PMA, MA, DE, ANG (NSM# 12862)

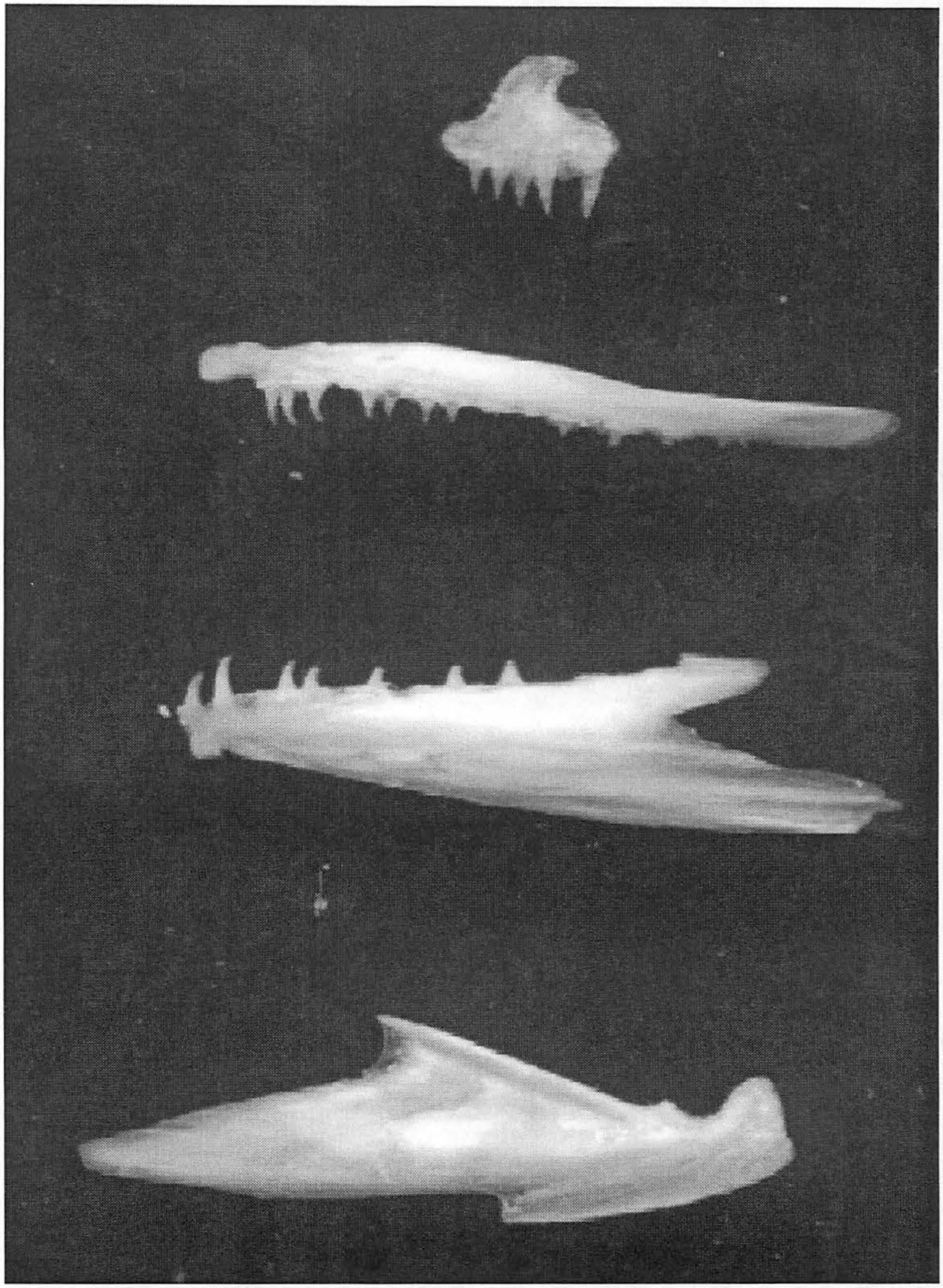


Plate 7. Left side of the buccal apparatus of *Salvelinus fontinalis*. Top to bottom: PMA, MA, DE, ANG (NSM# 12769)

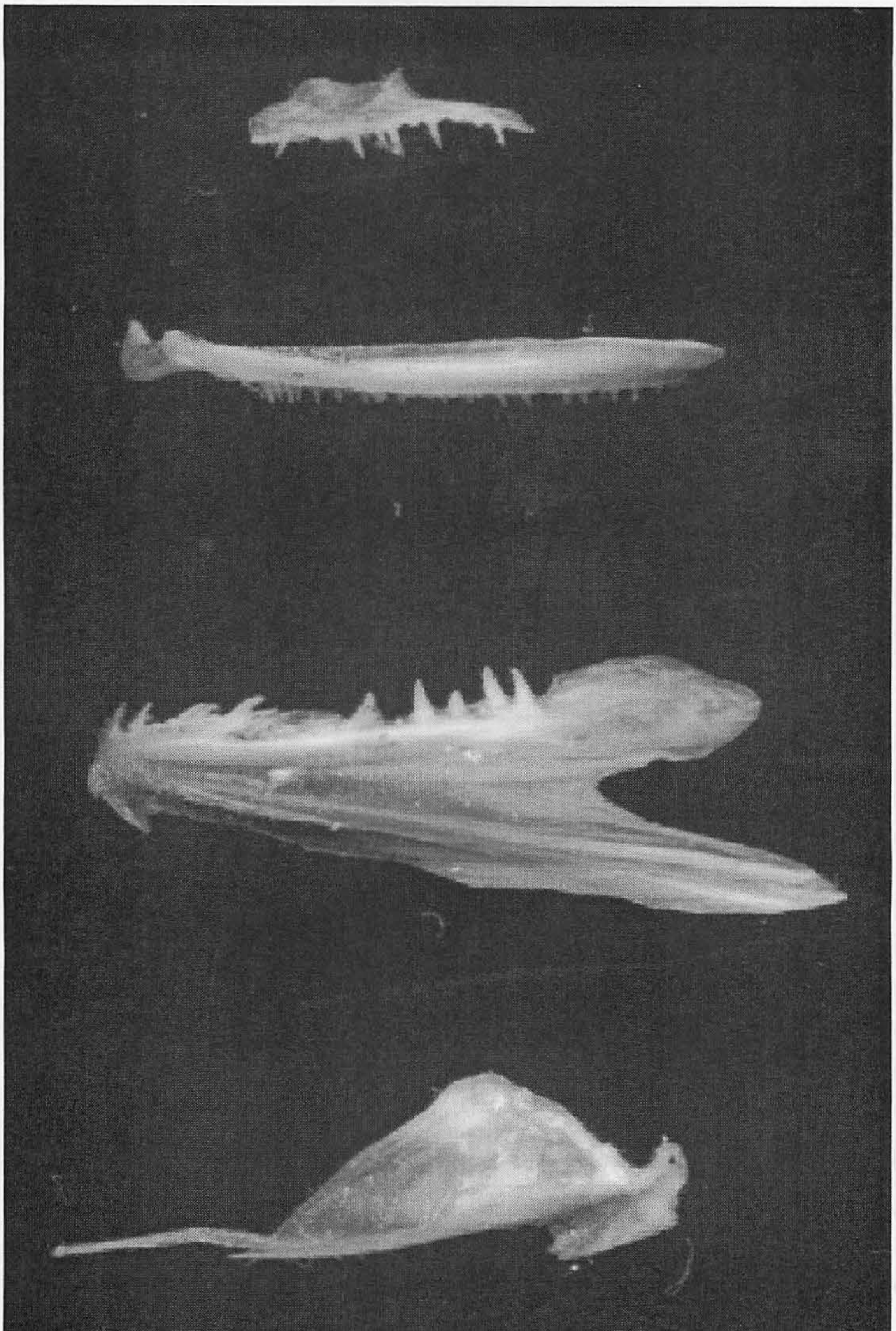


Plate 8. Left side of the buccal apparatus of *Osmerus mordax.* Top to bottom: PMA, MA, DE, ANG (NSM# 12849)

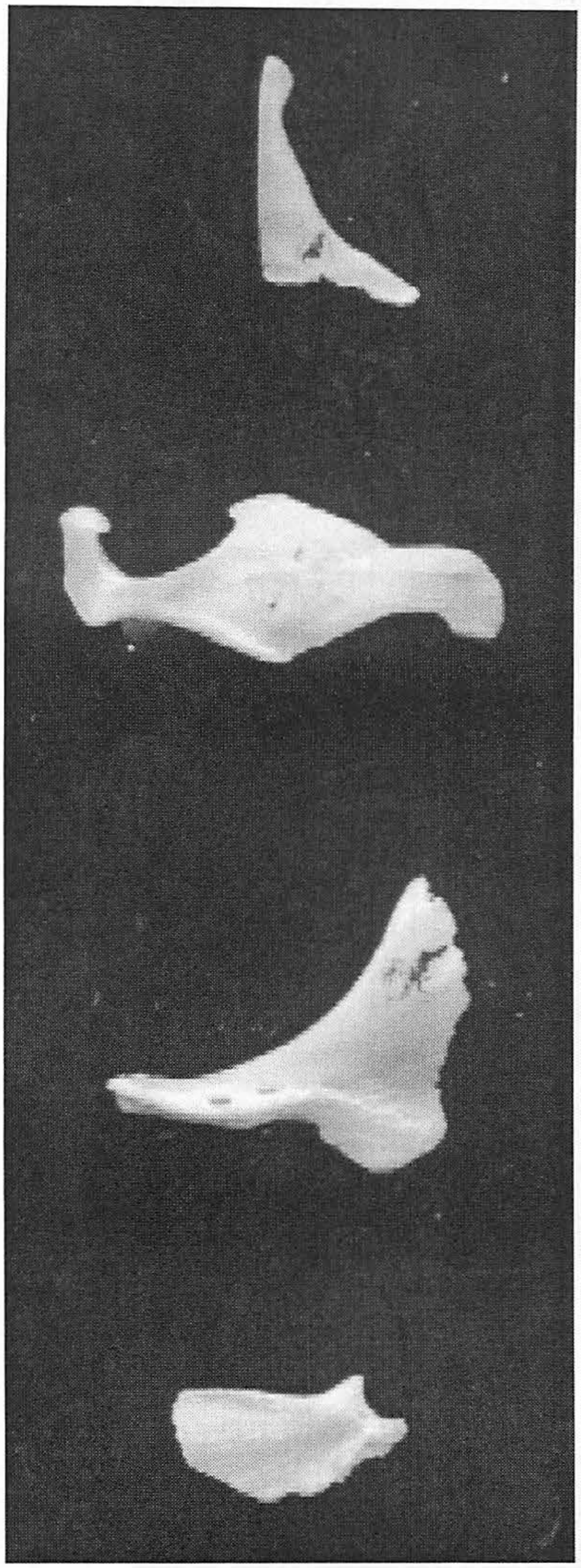


Plate 9. Left side of the buccal apparatus of *Catostomus commersoni.* Top to bottom: PMA, MA, DE, ANG (NSM# 11286)

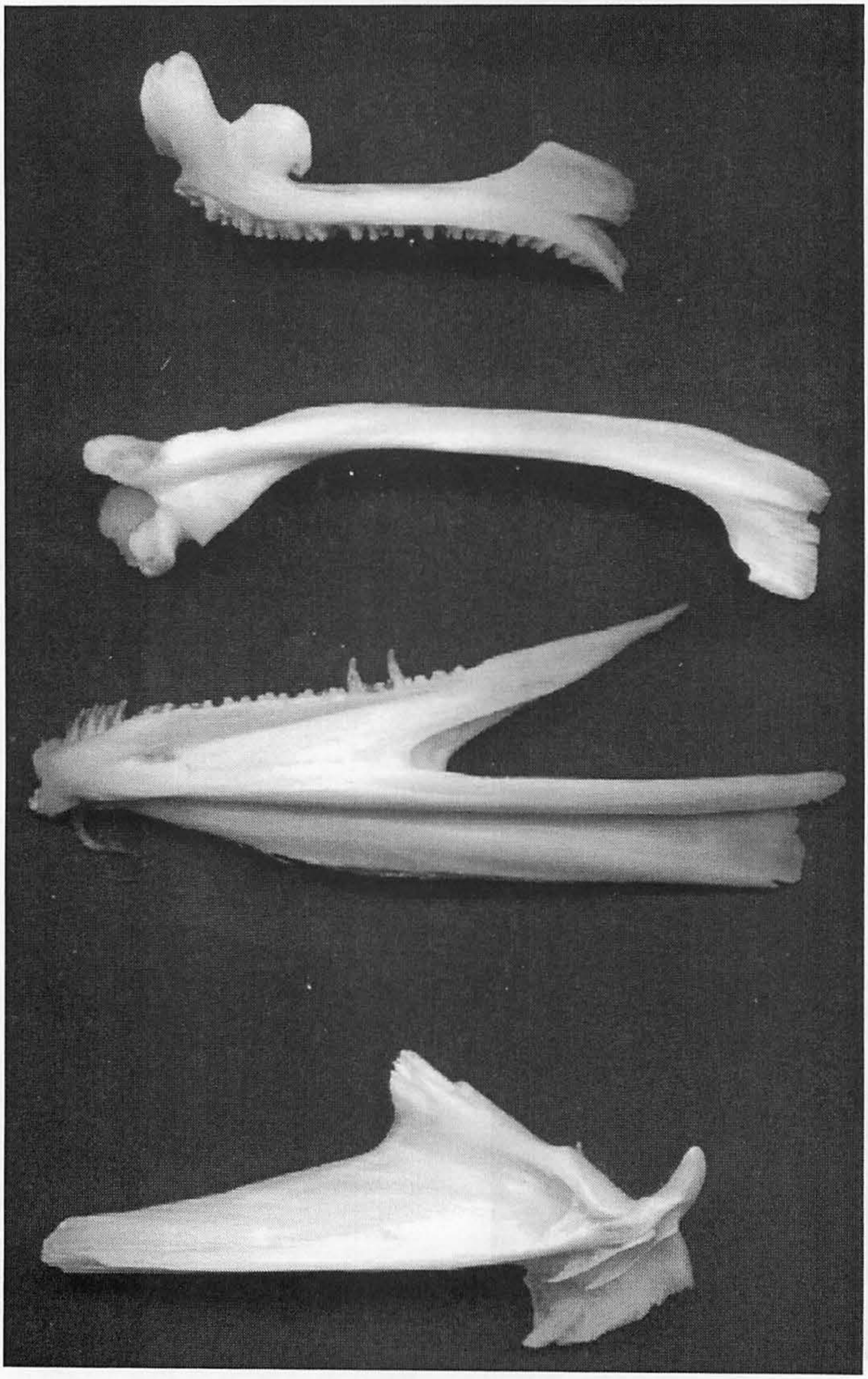


Plate 10. Left side of the buccal apparatus of *Gadus morhua.* Top to bottom: PMA, MA, DE, ANG (AR# 1000)

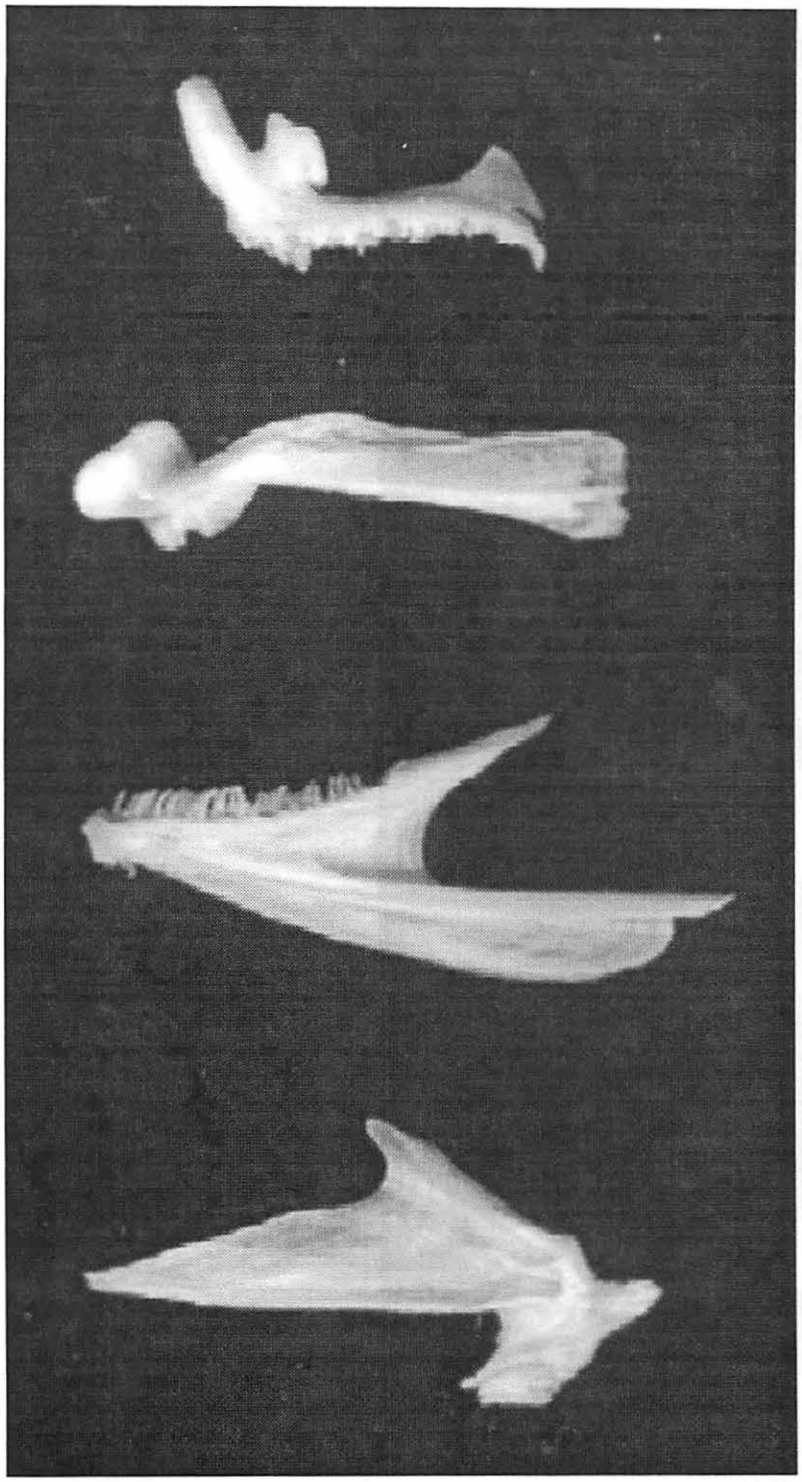


Plate 11. Left side of the buccal apparatus of *Melanogrammus aeglefinus*. Top to bottom: PMA, MA, DE, ANG (NSM# 11556)

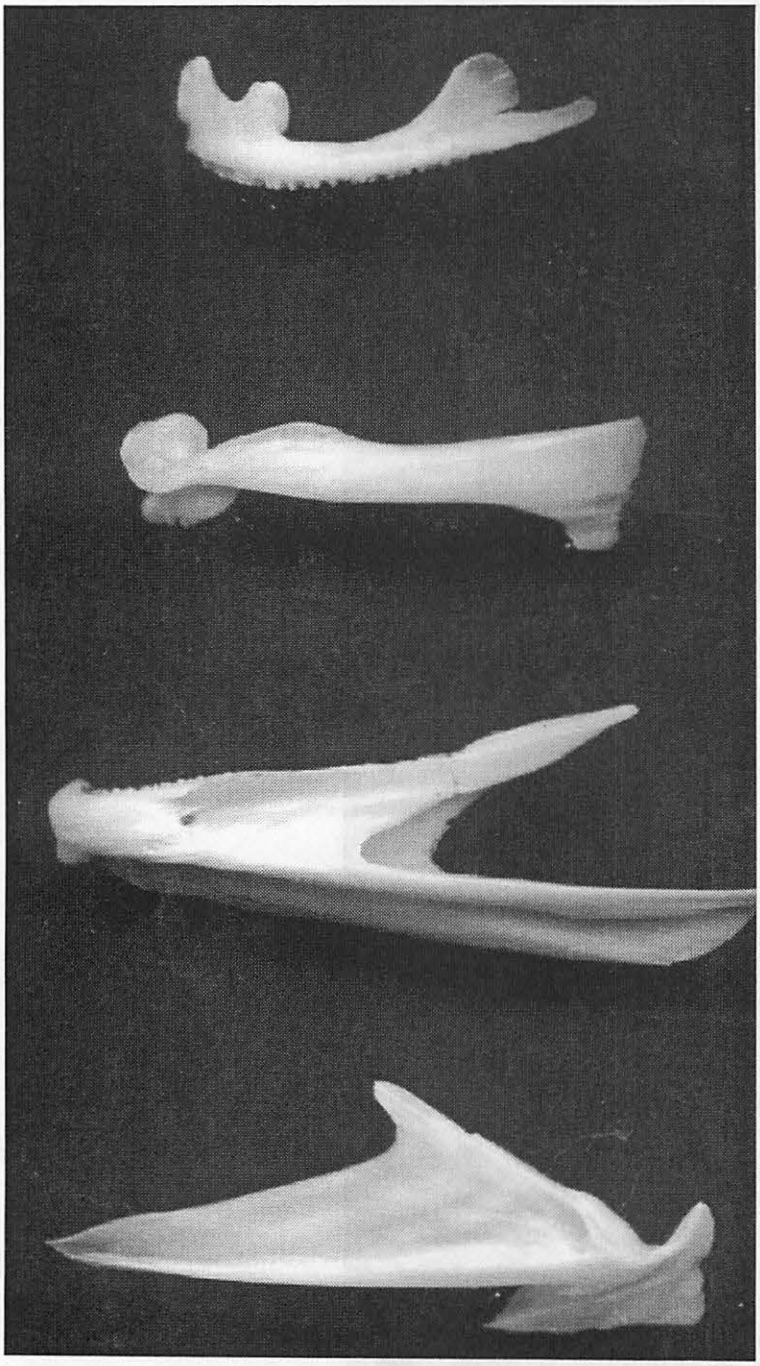


Plate 12. Left side of the buccal apparatus of *Pollachius virens*. Top to bottom: PMA, MA, DE, ANG (NSM# 12772)

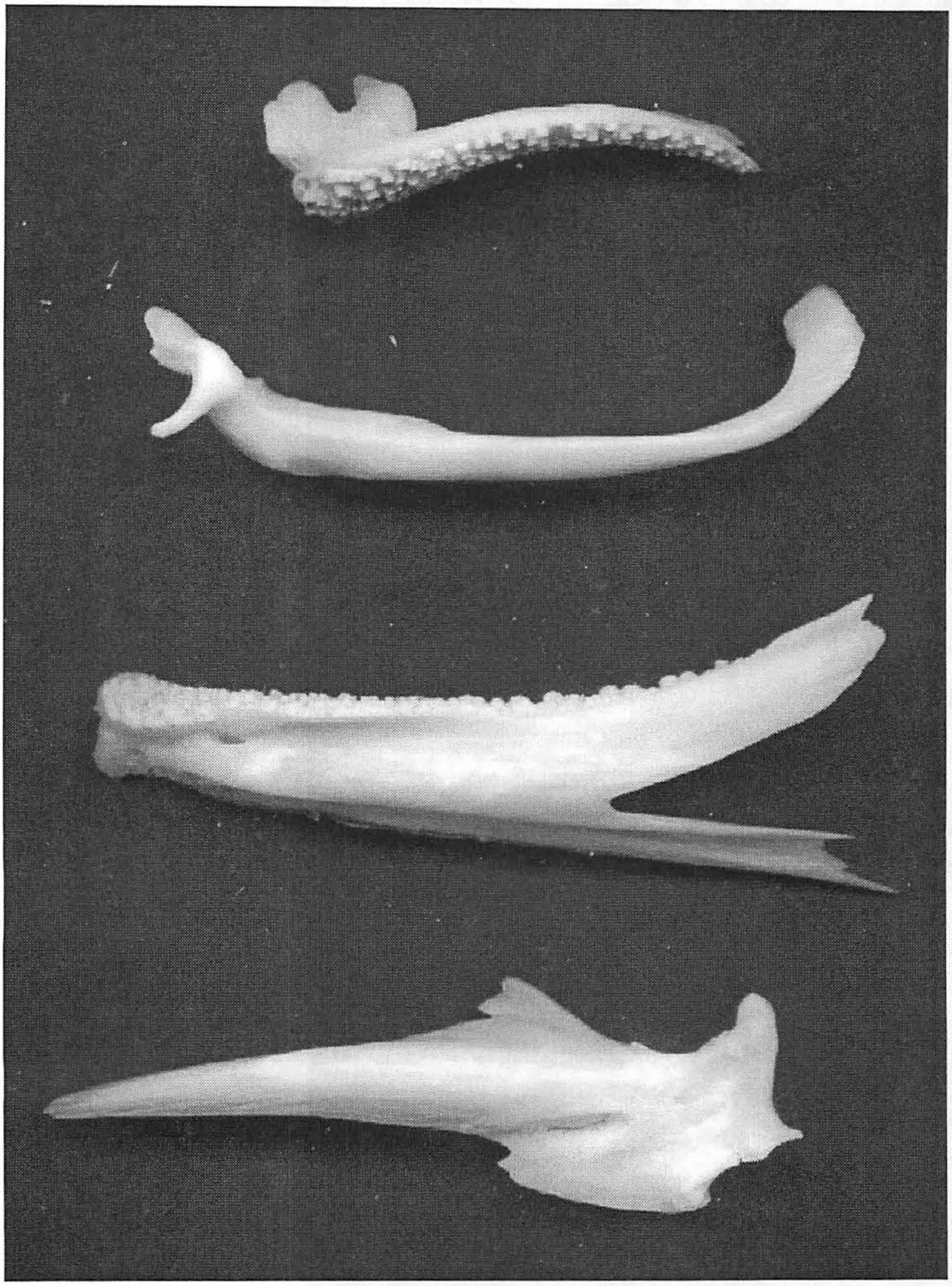


Plate 13. Left side of the buccal apparatus of *Brosme brosme.* Top to bottom: PMA, MA, DE, ANG (NSM# 12838)

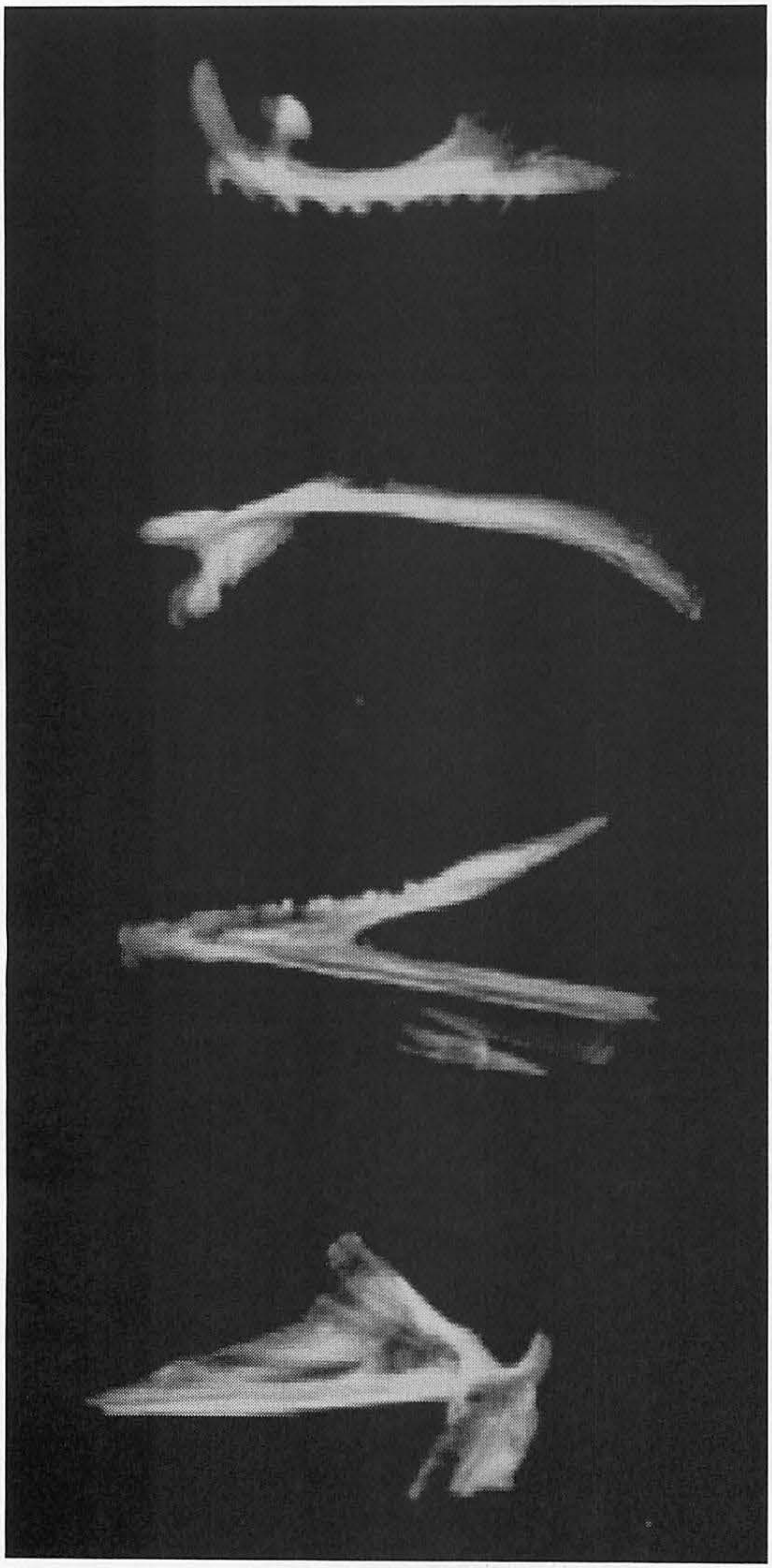


Plate 14. Left side of the buccal apparatus of *Microgadus tomcod.* Top to bottom: PMA, MA, DE, ANG (NSM# 12841)

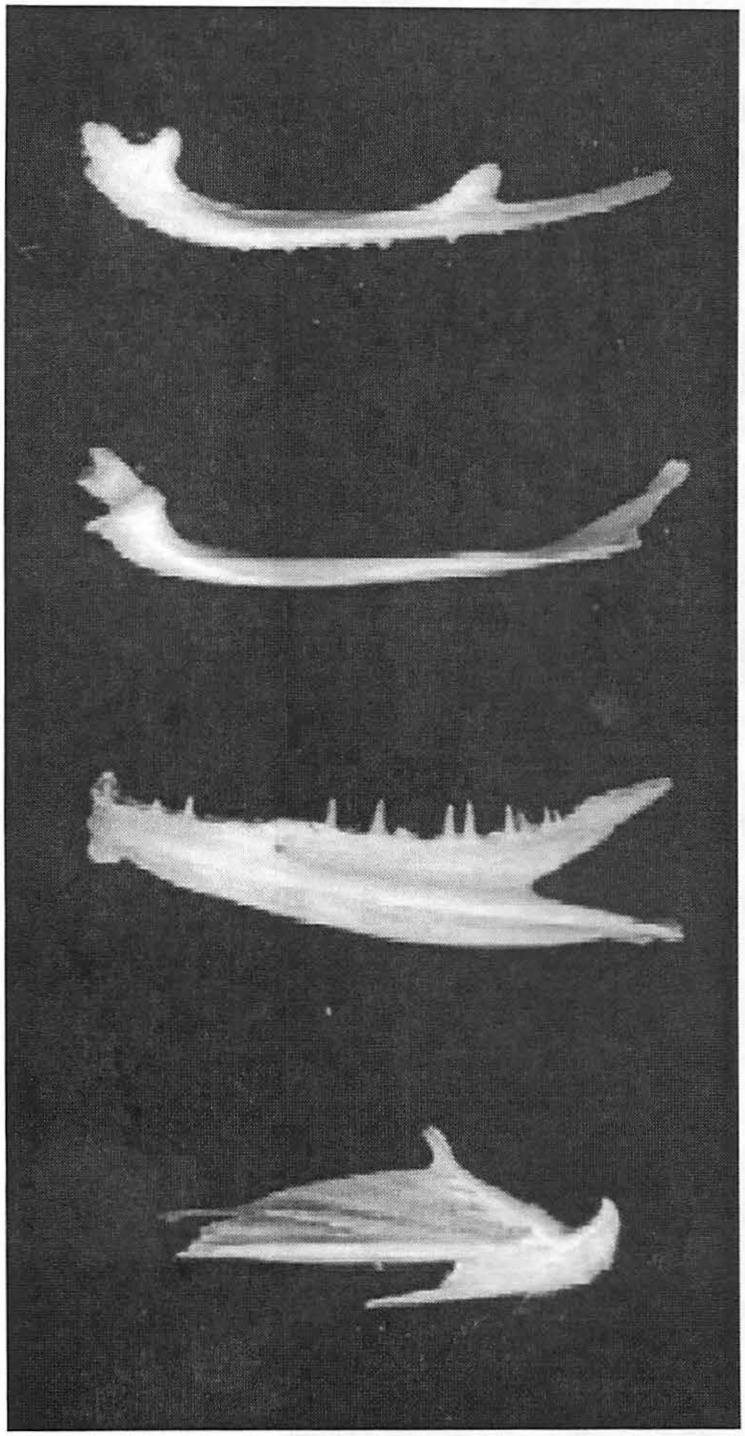


Plate 15. Left side of the buccal apparatus of *Merluccius bilinearis.* Top to bottom: PMA and MA (NSM# 11557); DE (NSM#11550); ANG (NSM# 12847)

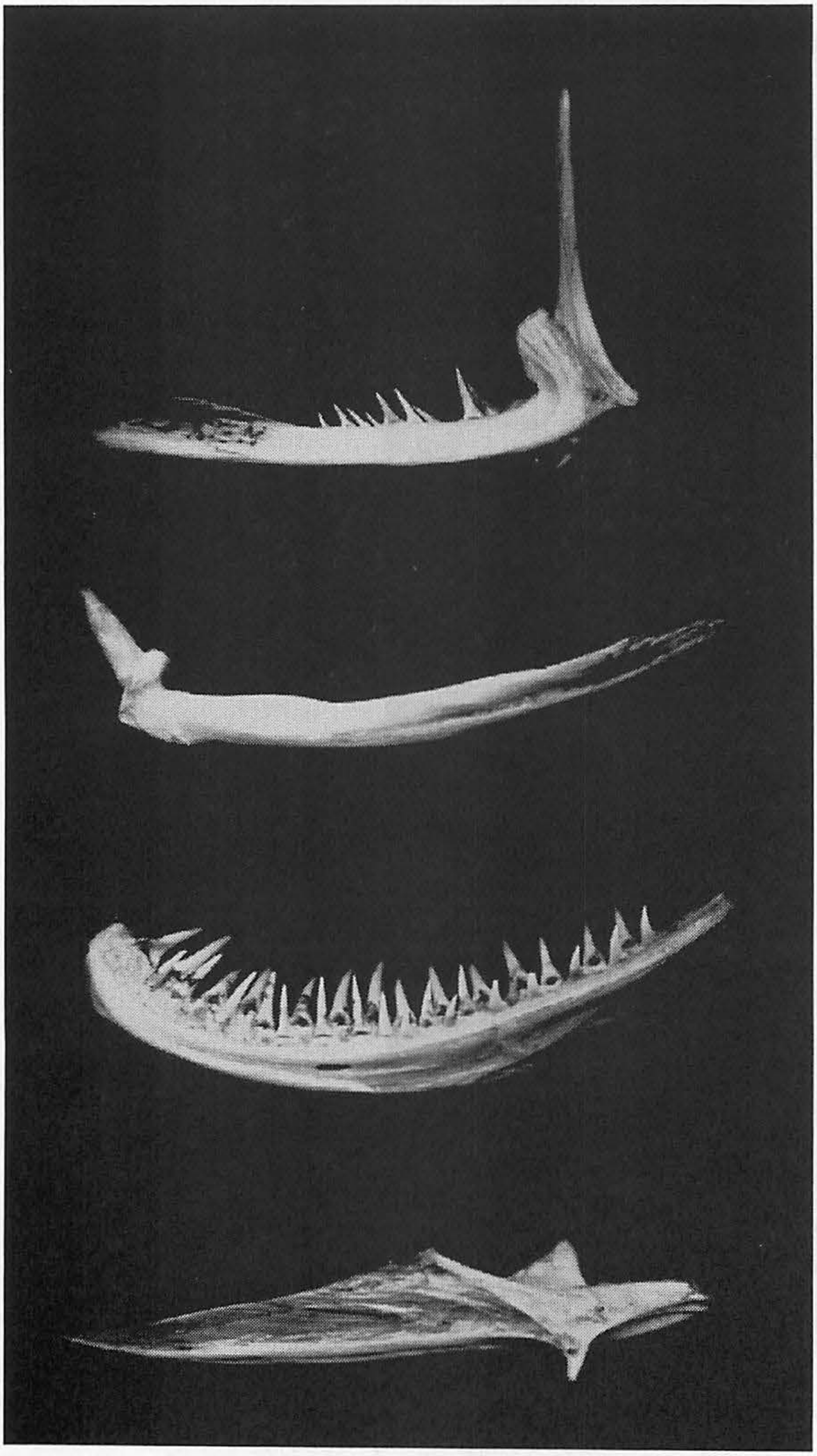


Plate 16. Left side of the buccal apparatus of *Lophius americanus*. Top to bottom: PMA (NSM# 11257); MA (AR# 100); DE and ANG (NSM# 12557)

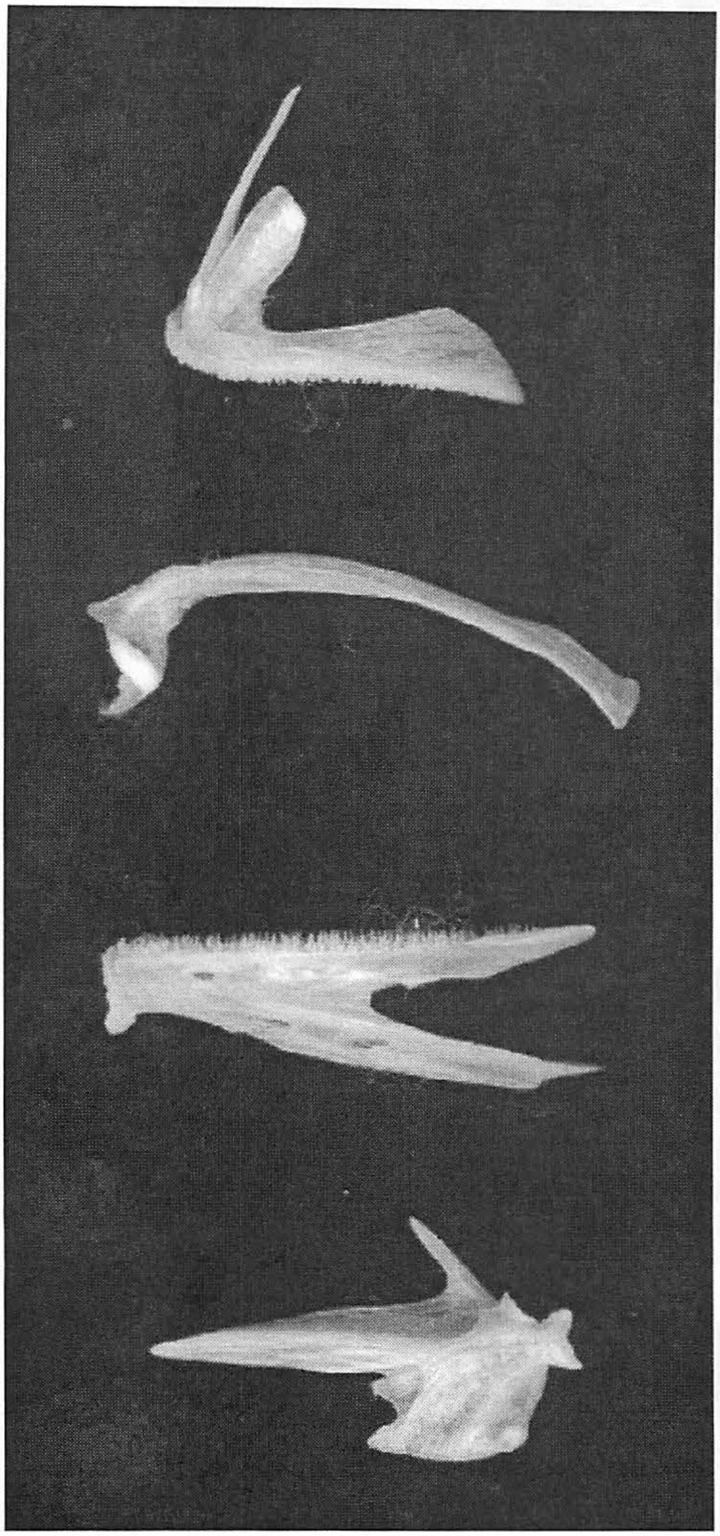


Plate 17. Left side of the buccal apparatus of *Myoxocephalus octodecimspinosus.* Top to bottom: PMA, MA, DE, ANG. (NSM# 11292)

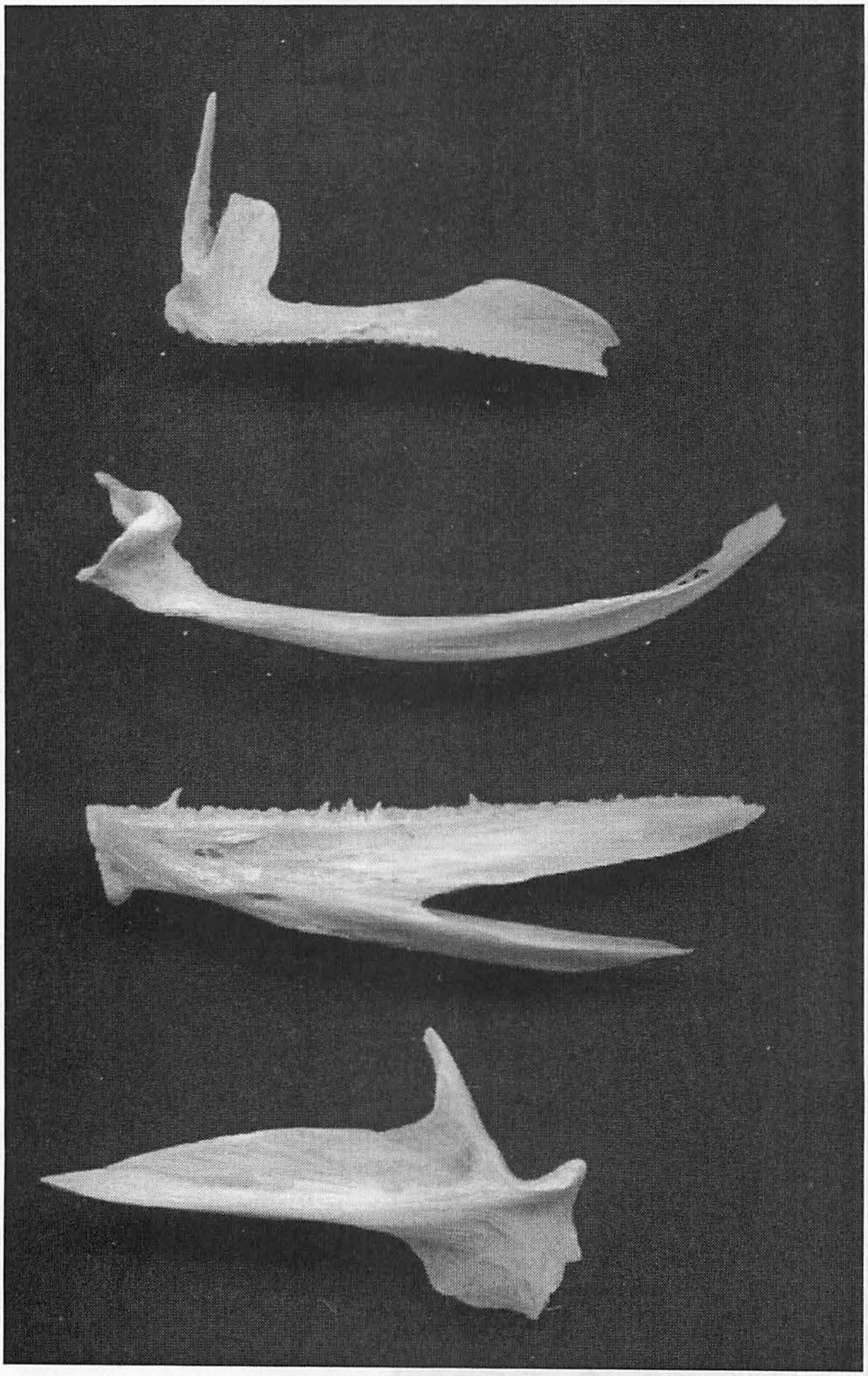


Plate 18. Left side of the buccal apparatus of *Hemitripterus americanus.* Top to bottom: PMA, MA, DE, ANG (NSM# 12538

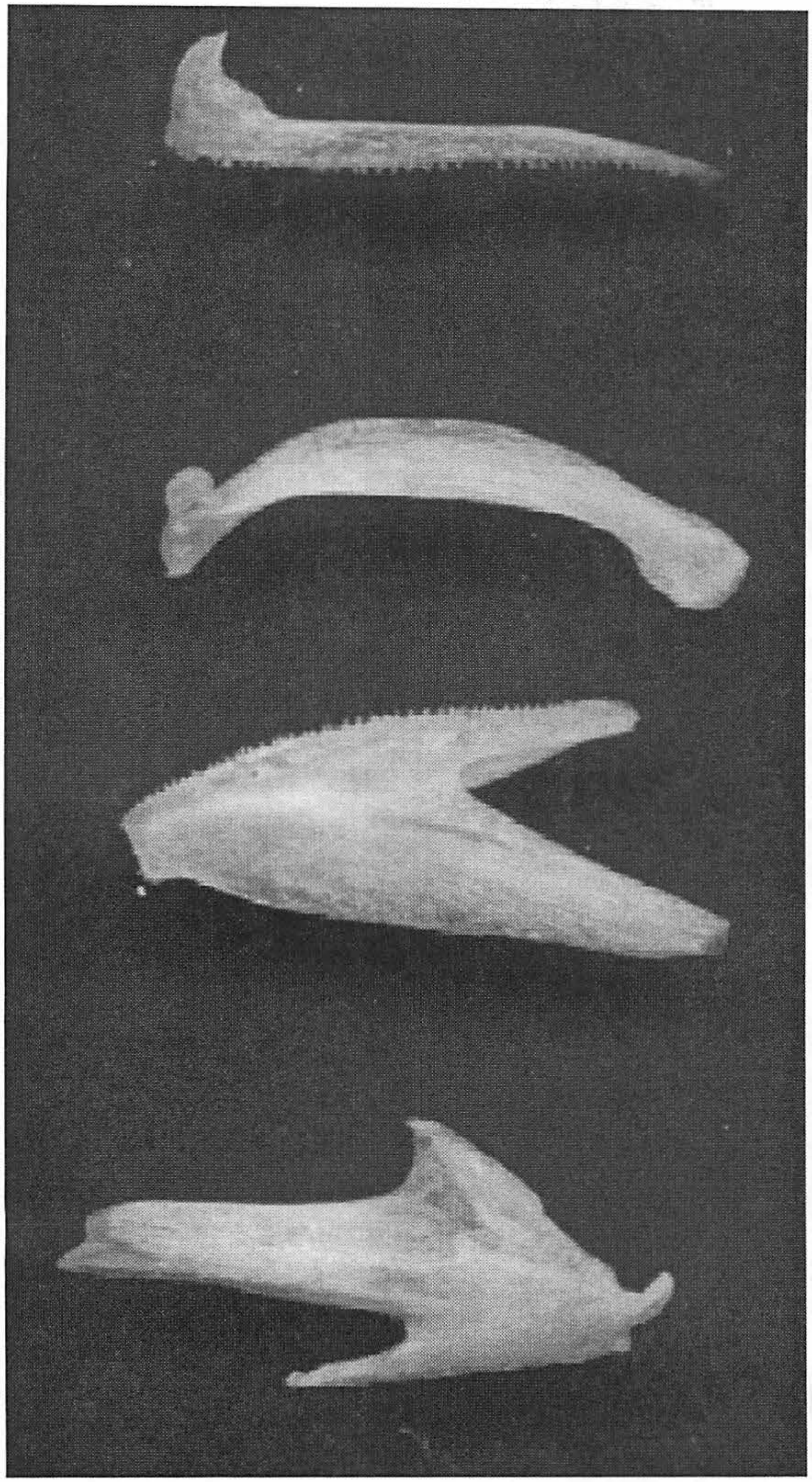


Plate 19. Left side of the buccal apparatus of *Scomber scombrus.* Top to bottom: PMA, MA, DE, ANG (NSM# 12849)

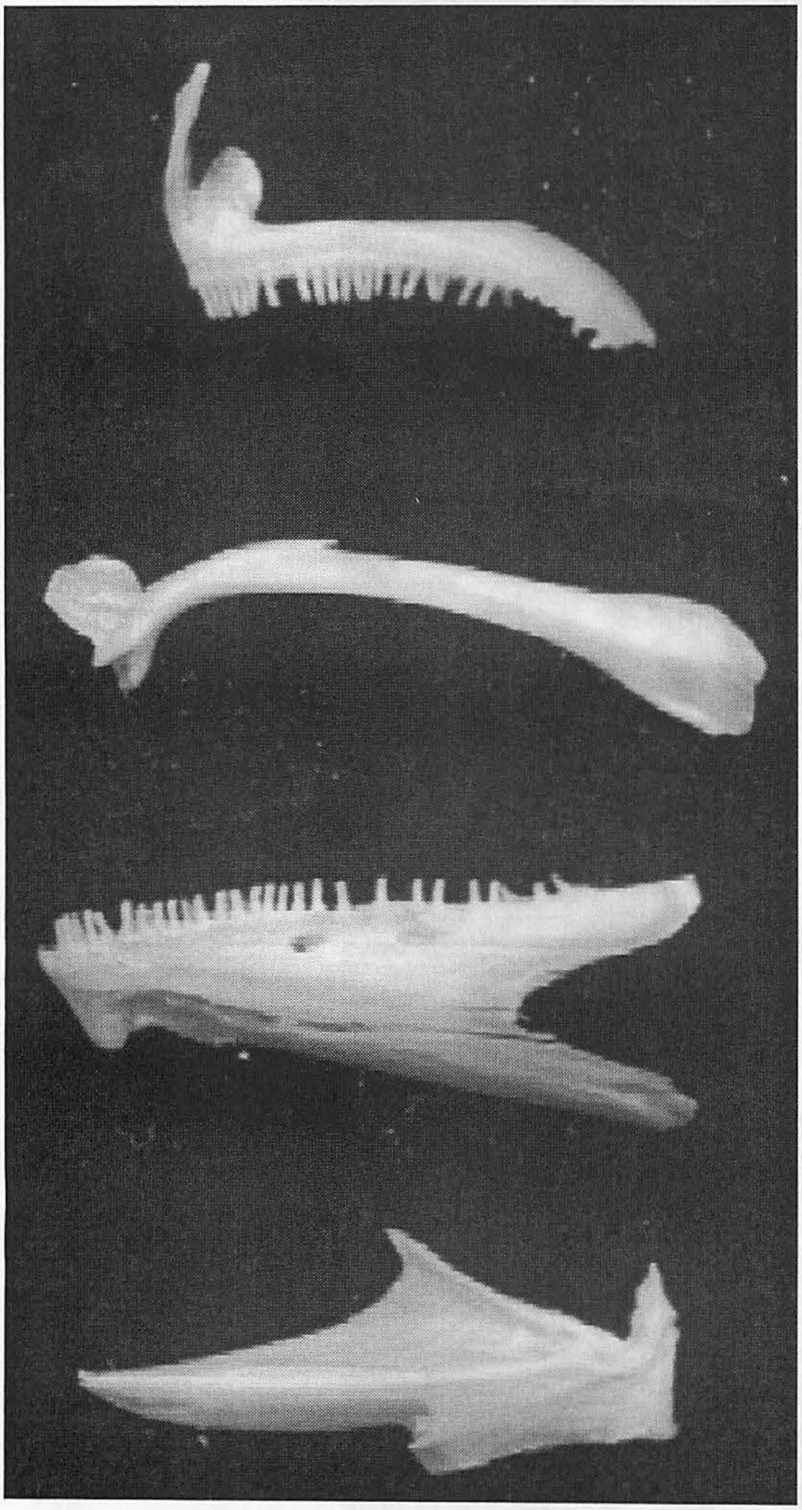


Plate 20. Left side of the buccal apparatus of *Hippoglossoides platessoides.* Top to bottom: PMA, MA, DE, ANG (NSM# 12849)

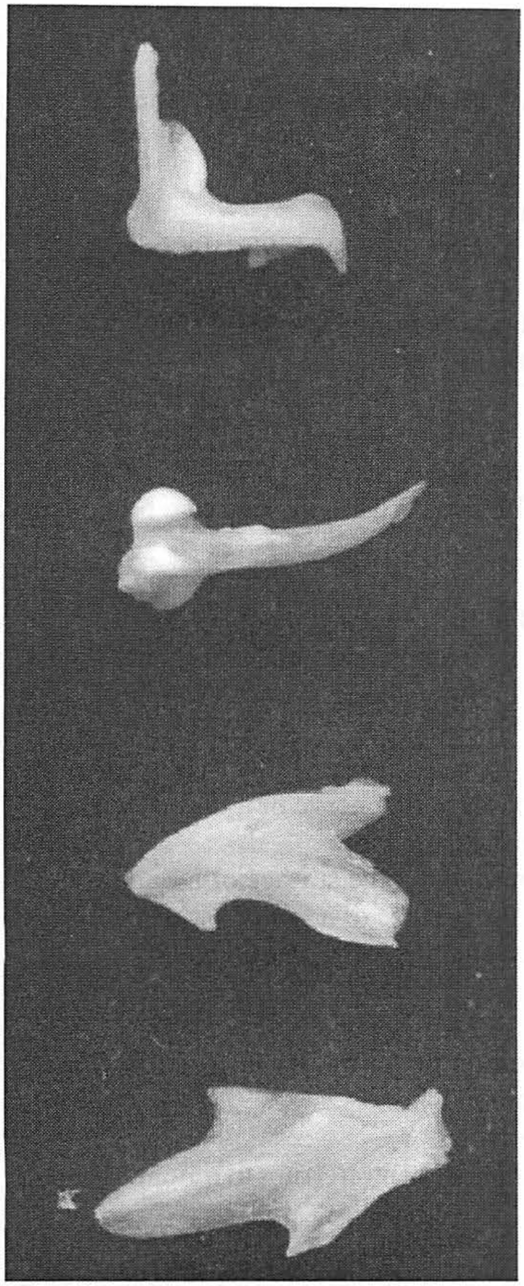


Plate 21. Left side of the buccal apparatus of *Pseudopleuronectes americanus.* Top to bottom: PMA, MA, DE, ANG (NSM# 12791)

X.7 GLOSSARY

acrodont	Teeth fixed onto the top surface of a dermal plate; usually connected or fused to a bone.
alar	Term referring to a wing-shaped expansion in a bone.
anterior	Nearer the front of the bone or the fish.
apophysis (pl.-es)	Any protuberance or process arising from the body of a bone.
backward(s)	Growing towards the tail of the fish.
barb	A pointed process curving back from its origin.
bilobe, bilobate, bilobated, bilobular	Having two lobes.
condyle	A rounded process at the end of a bone with which it articulates with another bone.
crest	A raised ridge on the surface of a bone.
dorsal	Located on or near the back of the fish. When referring to a bone structure, it is equivalent to upper.
edentulous	Lacking teeth.
face	Any surface of a bone presented to the observer.
facet	A small flat or curved surface where a bone articulates with another.
fissure	A more or less long and narrow cleft in a bone.
fontanel	(See fontanelle)
fontanelle	A large opening in a bone or an open space framed by two or more bones.
foramen (pl. foramina)	Small opening for the passage of a nerve or a blood vessel.
forward(s)	Growing toward the front of the fish.
fossa (pl. fossae)	Latin term for a cavity or depression on the surface of a bone.
furrow	A long depression or groove on the surface of a bone.
incisure	A deep indentation on the border of a bone. A cut, notch, slit or cleft, depending on its length or width.
indentation	A notch or a jagged cut.
knob	A small, rounded growth at the extremity or on the surface of a bone.
lamina (pl. laminae)	Latin term for any thin plate in a bone.
laterad	Growing towards the side of the fish.
lateral	Located in or on the side of the fish. When referring to a bone structure, it is equivalent to external.
margin	The edge or border of a bone.
median	Occupying the middle part of a bone or located closer to the median plane of a fish.
mental	Related to the lower part of the symphysial border of the dentary.
mesal	(See mesial)
mesial	Facing the middle line of the fish body. When referring to a bone structure, it is equivalent to internal.
mesiad	Growing towards the middle line of the fish body.
mental foramen	Opening located in the dentary close to the symphysial margin.
norma	Latin term for face or view.
pore	Small opening in the surface of a bone.
posterior	Located near the posterior end of the fish or the bone.
process	Thick expansion of a bone. It takes different names: head, if located in anterior part; condyle, when it is rounded and articulates with a bone; tuberosity, when attached to a muscle or ligament.
rib	Long and narrow thickening of a bone surface.
sensory canal	A narrow channel that encloses sensory organs located in a bone or under the fish's skin

shelf	A horizontal and narrow laminar expansion on the surface of a bone.
spine	Long, stout, and pointed growth on the surface or margin of a bone. Usually spines pierce and project outside the skin.
spur	Small and pointed growth on the surface of a bone.
sulcus (pl. sulci)	Latin term for furrow.
suture	The junction of two bones forming an immovable articulation.
symphyseal	Related to a symphysis.
symphysis	Articulation between two bones that allows very little movement.
symphysial (See symphyseal)	
upward	Growing towards the upper part of a fish body.
ventral	Located near the lower part of the fish body. When referring to a bone, it is equivalent to lower.

Note: The words small, stout, large, etc. are used as relative terms, applied to fish of commercial size. For example, when saying that a dentary is large, it could refer to a cod or tuna, never to a herring or tomcod.

XI. DISCUSSION

The two basic problems in dealing with fish remains in archaeological research are first, the ability to recognize the biological material and second, the possibility of recovering the vital characteristics of the live fish.

In this work, I have tried to solve the first problem by the preparation of disarticulated skeletons that will constitute the basis for a reference collection. Even this solution has its disadvantages, since it will serve mainly those researchers living in close proximity to the collection. The alternative for those unable to use it directly has been the presentation of detailed descriptions of the bones and of accurate drawings and plates that will save time and effort in the identification process.

The second problem, that of estimating the live size of the fish, is more complex. Since fishes are biological entities, each individual fish and each assemblage of fishes respond to environmental pressures in a variety of ways.

Growth is one of the animal functions most sensitive to internal and external agents. Growth rates for individual fishes and populations of the same species vary at different times, places, and habitats. The samples collected for this work vary widely in their usefulness as predictive factors, due to the number of individuals that comprises them, the distribution of sexes at the particular time when they were collected, their diversity of origin, the range of sizes of individual fish, etc.

The formulae, ratios, and coefficients calculated depend on the variables mentioned. The data presented are valuable for fish remains collected in geographical areas close to those of the samples provided here and for fish bones of similar size as those studied in this report. Their value as predictors decreases when the archaeological material comes from further places and time than the samples studied. The future addition of new specimens to those presented now will increase the accuracy of the results.

Some of the dimensions selected are very good as predictors. Other have to be reevaluated with larger samples and more sophisticated analysis, since we don't know yet the kind of relationship that exists between the growth of the whole fish and that of each individual bone. Meanwhile, the data presented here can be useful in many cases and will hopefully inspire further studies.

XII. CONCLUSIONS

In spite of the exploratory character of this report, it offers information that can be useful for the study of fish remains in archaeology.

The identification of the bones can be made by the use of the descriptions, the comparison with the plates and the use of the keys provided. Only in a few cases will problems arise in assigning certain bones to the right species, when these species belong to the same genus.

In relation to the objective of estimating the live size of the fish, it should be kept in mind, that although in some cases the samples are not large enough for biological studies, the parameters of the fish (total, fork, and standard lengths, and the total and dressed weights) are, in all cases, very well correlated. The relationships and correlations between those same parameters and the linear dimensions of each bone of the buccal apparatus vary widely. There is obviously a need to investigate the type of relationship and the degree of correlation for each species and each bone.

No statistical analyses were made for species with very small samples. Unfortunately, some of those species (salmon, cod, haddock, cusk, tomcod, goosefish, and American plaice) are well represented in the middens of the Atlantic region or have a great probability of appearing in the digs. The reason for the lack of biological material in the present study is their high commercial price and the difficulty in obtaining a large sample from the same locality and time.

For cod, the most abundant of these species both in the past and in modern times, see Rojo (1986) where ten bones were studied from a sample of 110 specimens ranging from 30 to 1,150 mm in total fish length and from 700 to 12,700 grams in total weight. This sample was taken 8-10 km south of Prospect Bay, Halifax Co., N. S. in depths of 30 fathoms, from August 5 to September 1st, 1982.

The following are the results obtained for the bones of the buccal apparatus.

VARIABLES Y	X	REGRESSION EQUATIONS	CORRELATION COEFF. r^2	N
PREMAXILLARY				
TFL	ML	Y = 13.098 X + 95.13	0.971	110
TFL	MH	Y = 50.285 X + 54.83	0.958	110
TFL	BH (1)	Y = 137.719 X + 145.88	0.899	110

(1) The height of the body of the premaxillary bone was not taken in the present report.

MAXILLARY Y	X			N
TFL	ML	Y = 9.779 X + 86.70	0.980	110
DENTARY				
TFL	ML	Y = 9.098 X +105.38	0.979	110
TFL	SVP	Y = 23.864 X + 153.39	0.940	110
ANGULAR				
TFL	ML	Y = 10.336 X +102.03	0.977	110

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