

**ASOCIAȚIA ROMÂNĂ DE ARHEOLOGIE**  
**STUDII DE PREISTORIE**  
***SUPPLEMENTUM***

**1 / 2005**

**Valentin RADU**

**ATLAS**  
**FOR THE IDENTIFICATION OF**  
**BONY FISH BONES**  
**FROM ARCHAEOLOGICAL SITES**

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2005



# ASOCIAȚIA ROMÂNĂ DE ARHEOLOGIE

STUDII DE PREISTORIE

*Supplementum I / 2005*

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The editorial board of „Studii de Preistorie” (Studies in Prehistory) reaches a long-planned milestone, achieves a long-pursued goal and, at the same time, fulfills a duty of honor by initiating the „Supplementum” series. We open this new publishing avenue with the declared scope of encouraging detailed specialty and interdisciplinary studies in the field of archeology, and as a more focused vehicle of dissemination for the results of these studies.

The series is opened by the first atlas of identification of fish remains from archeological sites ever to be published. The author of this atlas, Dr. Valentin Radu, is the only Romanian specialist working in the field of archeoichthyology, to whom we owe our better understanding of, and new perspectives on, the interactions of human communities with the aquatic environments over bygone millenia. These environments – rivers, lakes, ponds, or swamps – whether located in the immediate vicinity or farther away from settlements, provided important food resources and not only. In-depth knowledge of the exploitation and management of these resources and environments represents an important step in understanding of the life style of prehistoric populations.

This atlas is meant to facilitate taxonomic identification of the fish remains discovered on archeological sites, and by that to broaden the scope of studies of prehistory. One of the lesser emphasized corollaries of this endeavor for modern archeological field studies is the necessity of careful and detailed sampling of remains of the aquatic fauna. In a very timely manner, Dr. Radu’s contribution builds succssfully on the „Atlas of compared anatomy” published by Gheție et al. (1954) more than half a century ago.

Silvia Marinescu-Bîlcu  
Editor-in-Chief

## PRÉFACE

La publication d'une nouvelle série « Supplementum » dans la revue *Studii de Preistorie* est une bonne nouvelle pour la communauté archéologique, et son premier volume consacré à l'archéozoologie mérite d'être largement diffusé.

Avec cet atlas d'identification des poissons osseux issus des sites archéologiques, Valentin Radu inaugure de la plus brillante manière le premier numéro de cette nouvelle collection.

Il comble une lacune importante pour l'Europe centrale, car, s'il existait déjà ce genre d'atlas pour les mammifères, les oiseaux ou même les batraciens, ce n'était pas encore le cas pour le vaste domaine des poissons.

Cet atlas consacré aux poissons d'eau douce les plus communs de Roumanie, et les plus importants dans la paléo-économie des sites archéologiques, présente les principaux ossements retrouvés sur les anciens gisements; les nombreux et excellents dessins, figurant les os sous leurs différentes faces, seront d'une aide précieuse à tous les chercheurs confrontés à des problèmes de diagnose, qu'ils soient archéologues ou archéozoologues.

Les 26 taxons du Danube représentés débordent par ailleurs les frontières de la Roumanie, et cet ouvrage sera apprécié par tous ceux qui, dans l'ensemble de l'Europe, sont appelés à déterminer des restes osseux de poissons d'eaux douces.

Nul doute que Valentin Radu, archéoichthyologue de haut niveau de par sa double formation en zoologie et en archéologie, était particulièrement habilité à la réalisation de cet ouvrage, grâce à sa parfaite maîtrise de ces faunes dulçaquicoles.

On ne peut que se réjouir de cet ouvrage de grande qualité, et souhaiter que cet effort soit poursuivi, et pourquoi pas étendu par la suite à d'autres faunes, comme par exemple les poissons de mer.

Nathalie DESSE-BERSET  
Sophia Antipolis, Valbonne (France)  
Octobre, 2005

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## INTRODUCTION

The skeleton of freshwater fishes is generally well known, yet a taxonomically comprehensive comparative presentation of each component was not attempted to date. Such comparisons have been published sporadically and only for a few species. This work presents over twenty freshwater and anadromous<sup>1</sup> fish species encountered in the Danube and its tributaries, and compares the anatomy of several of their skeletal parts.

Previous studies on this subject that are used in the field of zooarchaeology stemmed mainly from instances where an interest in the identification of fish bones led to description of only the most representative skeletal components for a certain species. Such are the studies of Libois and collaborators (1987) and of Libois and Hallet-Libois (1988) on fish remains in regurgitation pellets of predatory birds, or those of Desse and Desse-Berset (Desse and al., 1987; Desse and al., 1990) published in the *Fiches d'ostéologie animale pour l'archéologie* series, on size reconstruction in fishes. Cyprinid and percid bones are sporadically mentioned by Brinkhuizen (1989), Heinrich (1987) and Le Gall (1984). Benecke (1987), Vasilieva and Ustarvecov (1991) and Radu (1996) reported on bream (*Abramis brama*) bones, Bartosiewicz and Takacs (1997) on sturgeon (*Huso huso*), and Gruzdeva and Vasilieva (1988) on pike (*Esox lucius*). Information on the morphology of skeletal elements of freshwater fishes can be found in *The Freshwater Fishes of Europe*, a series of volumes edited by Bănăraşcu (1999, 2001) for Cyprinidae and by Hoestlandt (1991) for Clupeidae. Drawings of lateral profiles of vertebrae, as well as radiographs of main regions of the fish spine were published by Desse and Du Buit (1970), Desse and Desse (1976, 1983), Desse (1984), and Radu (1998), while Le Gall (1984) has proposed criteria for taxonomic identification of this type of remains.

The present work is not meant as an exhaustive presentation of the totality of components of the fish skeleton. I decided to limit the focus to presentation of the skeletal components that are commonly found and studied in archaeological sediments. Not surprisingly, these are usually also the best preserved types of fish remains on archaeological sites. I hope that this contribution will raise the awareness of archaeologists on fish remains, and that it will be of interest to biologists working on fish taxonomy and ichthyophagous animals.

A very important step in every archaeozoological study is the taxonomic identification of bones. This is most easily realized by comparison with reference material in the lab. When and where a reference collection is not readily available, a publication that would provide rapid and reliable access to bone anatomical information could be highly useful. Such a publication would be useful also for persons with minimal education in the field, as well as for zooarchaeology students and archaeologists. Even though the bone material is very commonly fragmented so determination to the

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<sup>1</sup> Species that live in the Black Sea and migrate annually upstream on the Danube River and its tributaries for reproduction or feeding.

## THE FISH SKELETON

The internal skeleton (fig. 1) of teleost fishes (fishes with a bony skeleton) comprises the axial skeleton (*skeleton axialis*) including the *neurocranium*, *branchiocranium* (*viscerocranium*) and spine (*columna vertebralis*) with ribs (*costae*), the fins (*skeleton pinnarum*), and the appendicular skeleton (*zonoskeleton anterius* and *basipterygium*).

<b>Family</b>	<b>Species</b>	<b>Vernacular name</b>	<b>Individuals observed</b>	
Acipenseridae	<i>Acipenser ruthenus</i>	sterlet	2	
	<i>Acipenser stellatus</i>	stellate sturgeon	2	
Salmonidae	<i>Salmo trutta lacustris</i>	trout	4	
Clupeidae	<i>Alosa pontica</i>	Danube shad	5	
Esocidae	<i>Esox lucius</i>	pike	24	
Cyprinidae	<i>Abramis brama</i>	bream	41	
	<i>Alburnus alburnus</i>	bleak	4	
	<i>Aspius aspius</i>	asp	9	
	<i>Barbus barbus</i>	barbel	5	
	<i>Blicca bjoerkna</i>	white bream	12	
	<i>Carassius auratus</i>	goldfish	2	
	<i>Chalcalburnus chalcoides mento</i>	Danubian bleak	5	
	<i>Chondrostoma nasus</i>	nase	3	
	<i>Cyprinus carpio</i>	common carp	34	
	<i>Leuciscus idus</i>	ide, orfe	13	
	<i>Pelecus cultratus</i>	ziege	3	
	<i>Rutilus rutilus</i>	roach	14	
	<i>Scardinius erythrophthalmus</i>	rudd	3	
	<i>Tinca tinca</i>	tench	4	
	<i>Vimba vimba carinata</i>	Baltic vimba	3	
	Siluridae	<i>Silurus glanis</i>	wels catfish	22
	Percidae	<i>Acerina schraetser</i>	schreatzer	4
		<i>Aspro zingel</i>	zingel	2
		<i>Gymnocephalus (Acerina) sp.</i>	ruffe	4
		<i>Perca fluviatilis</i>	perch	14
	<i>Stizostedion lucioperca</i>	pikeperch	25	

**Table 1.** Species illustrated in this book.

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I am indebted to Nathalie Desse-Berset and Jean Desse (Laboratoire d'archéozoologie, Centre d'études Préhistoire, Antiquité, Moyen Âge-CNRS, Valbonne, France), Bernard Randoïn (Ministère de la culture et de la communication, Direction de l'architecture et du patrimoine, Sous-direction de l'archéologie, Paris, France), Yannick Riolland (Direction régionale des affaires culturelles d'Auvergne, Service régional de l'archéologie, Clermont-Ferrand, France) and Dragomir Popovici (Romanian National History Museum) for supporting financially and logistically the acquisition of most of the study material. I would also like to express my gratitude to the direction of the Romanian National History Museum (Crişan Muşeteanu, General Director) for supporting this work.

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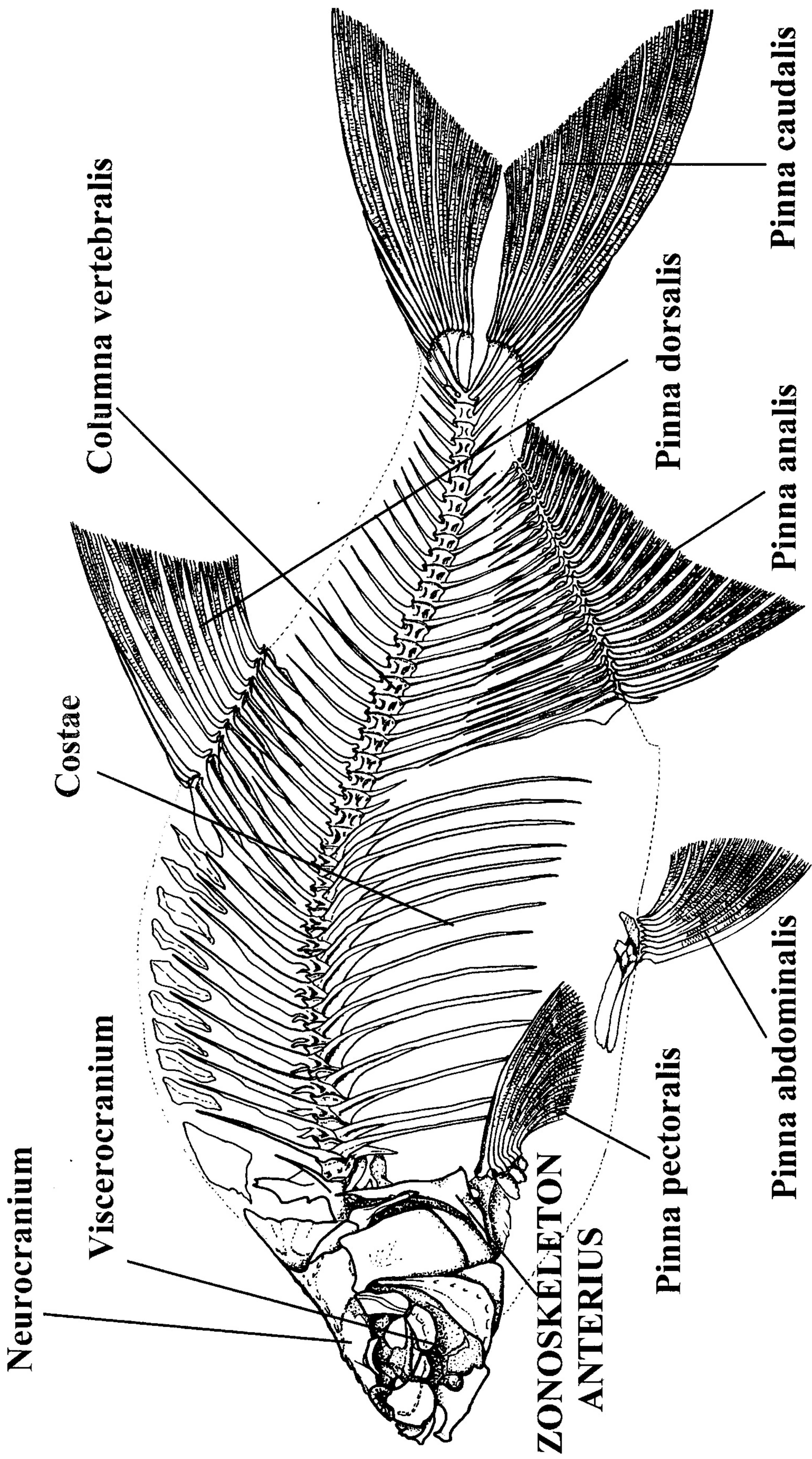
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# PLATES

## THE FISH SKELETON

The internal skeleton (fig. 1) of teleost fishes (fishes with a bony skeleton) comprises the axial skeleton (*skeleton axialis*) including the *neurocranium*, *branchiocranium* (*viscerocranium*) and spine (*columna vertebralis*) with ribs (*costae*), the fins (*skeleton pinnarum*), and the appendicular skeleton (*zonoskeleton anterius* and *basipterygium*).

**SKELETON AXIALIS**



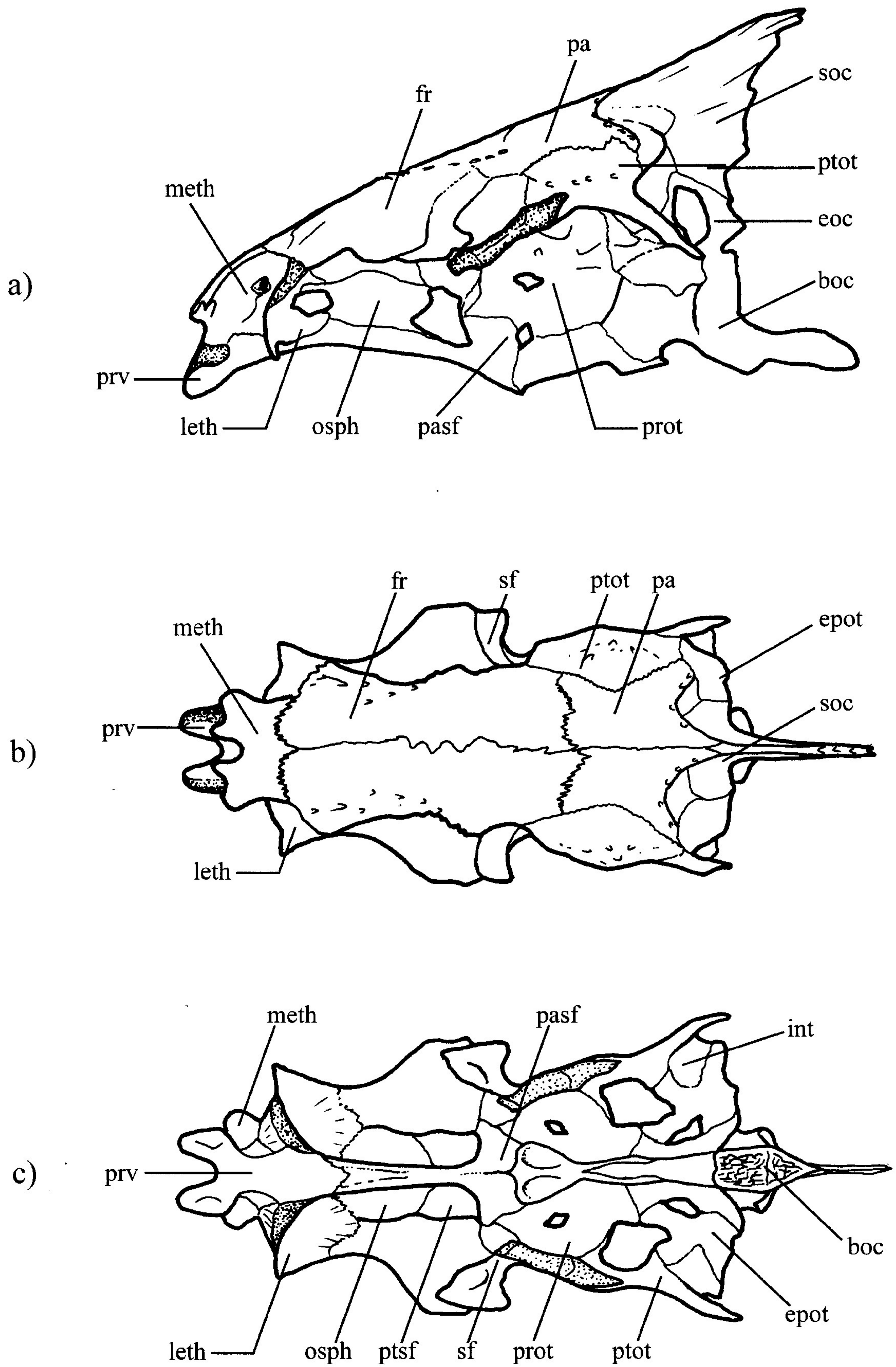
**SKELETON PINNARUM**

**Fig. 1.** Bream, *Abramis brama* (lateral view). Whole skeleton.

## THE AXIAL SKELETON

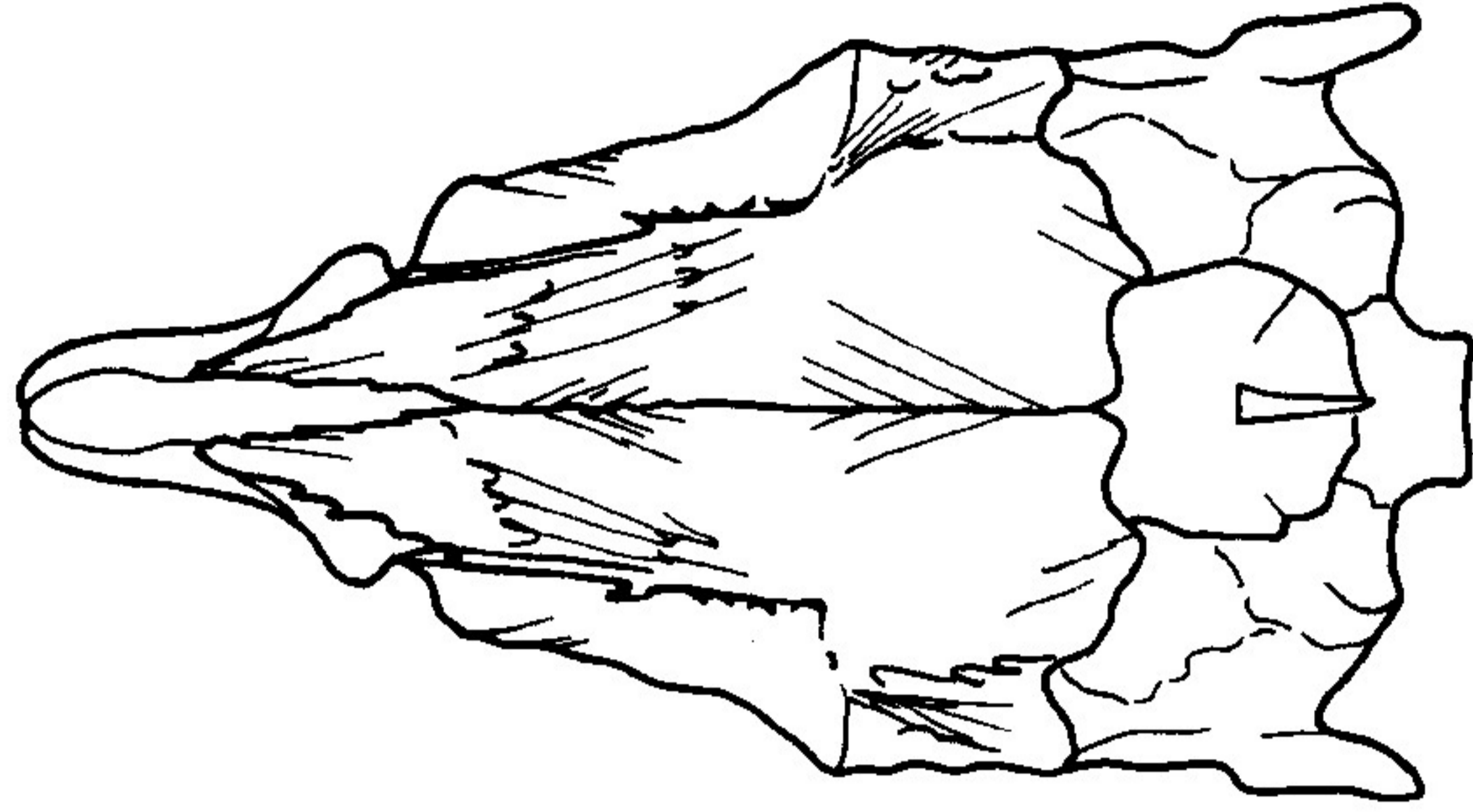
The **neurocranium** (fig. 2) houses the brain and part of the sensory organs. It includes four regions each of them consisting of several bones.

Element	Abbreviation	Names from Lepiksaar (1983)
<i>Olfactory region</i>		
mesethmoid	meth	ethmoideum
lateral ethmoid	leth	ethmoide lateral
<b>prevomer</b>	<b>prv</b>	<b>praevomer</b>
<i>Orbital region</i>		
frontal	fr	frontal
pterosphenoid	ptsf	pterosphenoideum
orbitosphenoid	osph	orbitosphenoideum
circumorbital series	corb	infraorbitalia
<b>parasphenoid</b>	<b>pasf</b>	<b>parasphenoideum</b>
sphenotic	sf	sphenoticum
<i>Otic region</i>		
epiotic	epot	epioticum
prootic	prot	prooticum
intercalare/opisthotic	int	intercalare/opisthooticum
pterotic	ptot	pteroticum
parietal	pa	parietale
<i>Occipital region</i>		
<b>basioccipital</b>	<b>boc</b>	<b>basioccipitale</b>
exoccipital	eoc	exoccipitale
supraoccipital	soc	supraoccipitale

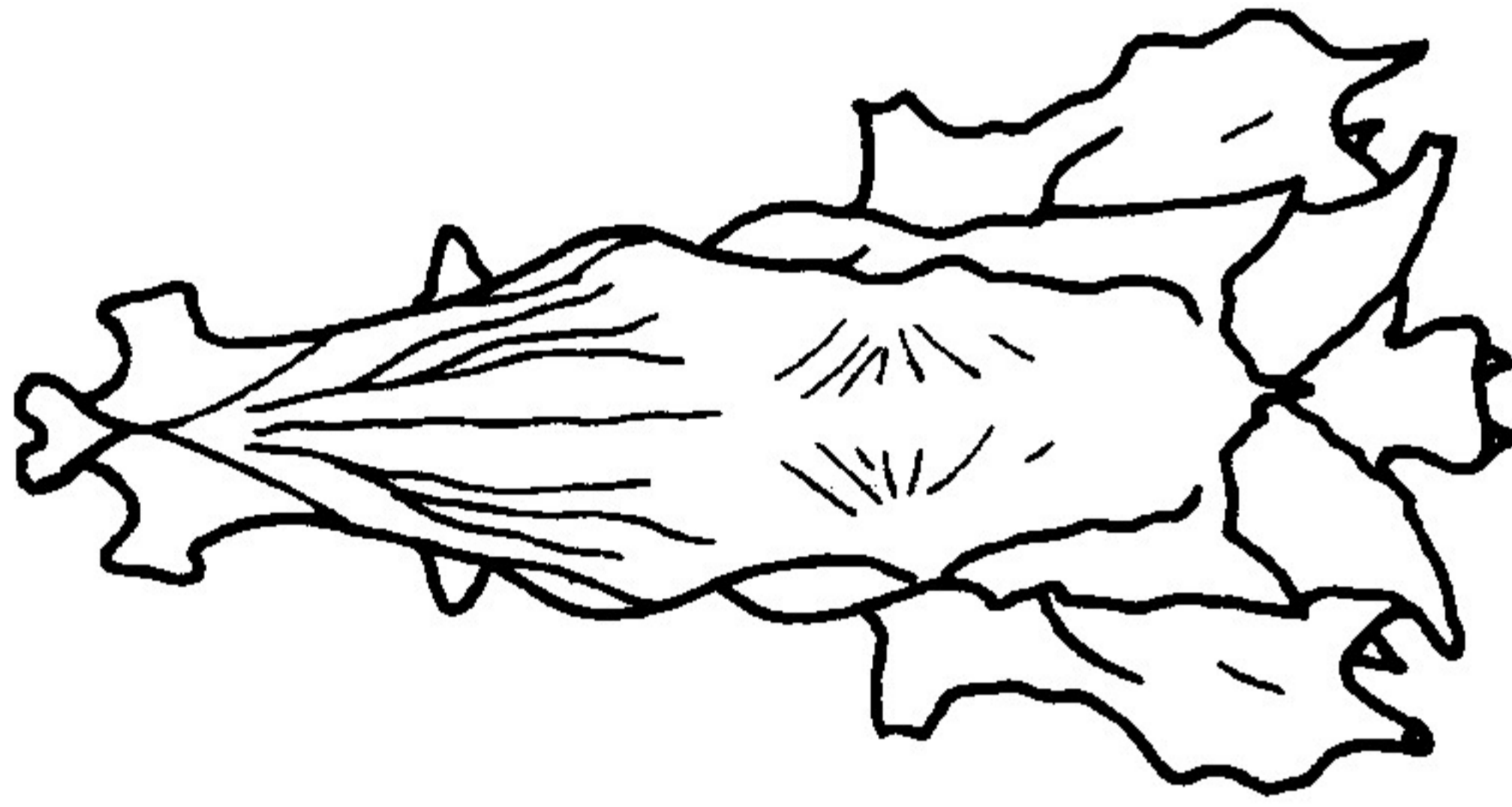


**Fig. 2.** Bream, *Abramis brama*. Neurocranium.  
 a) Lateral view. b) Dorsal view. c) Ventral view.

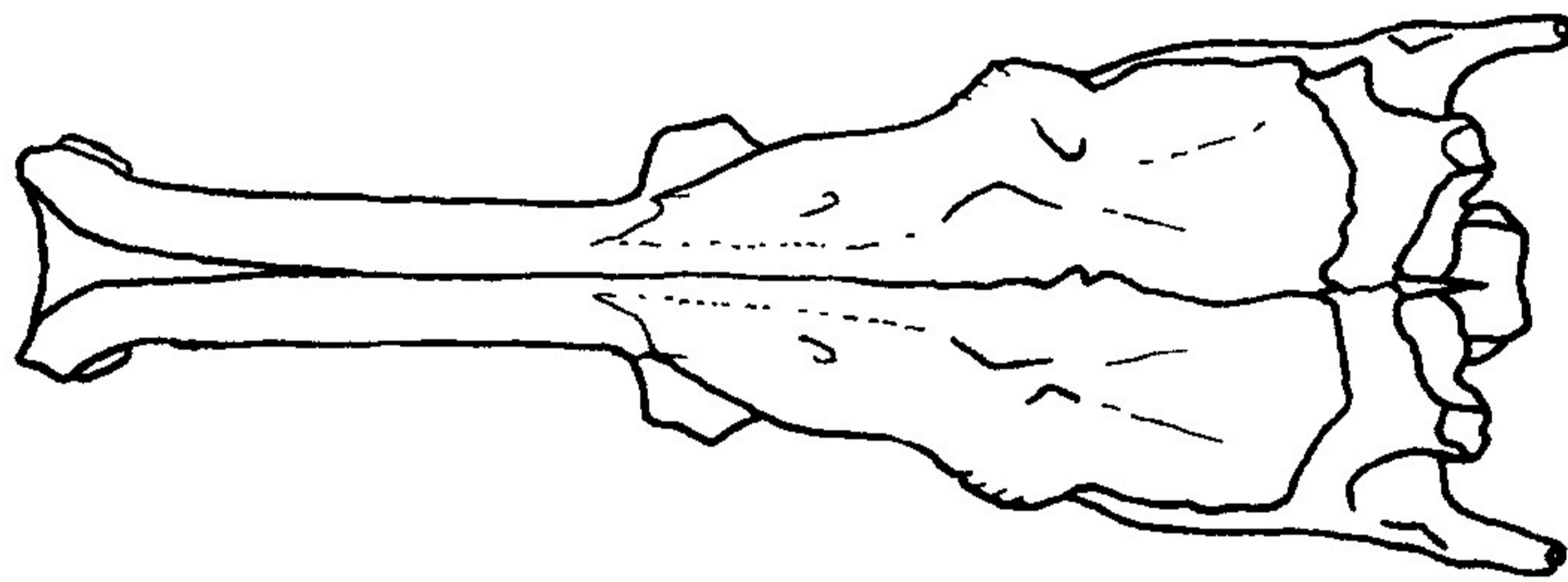
**NEUROCRANIUM**  
*NORMA SUPERIOR*



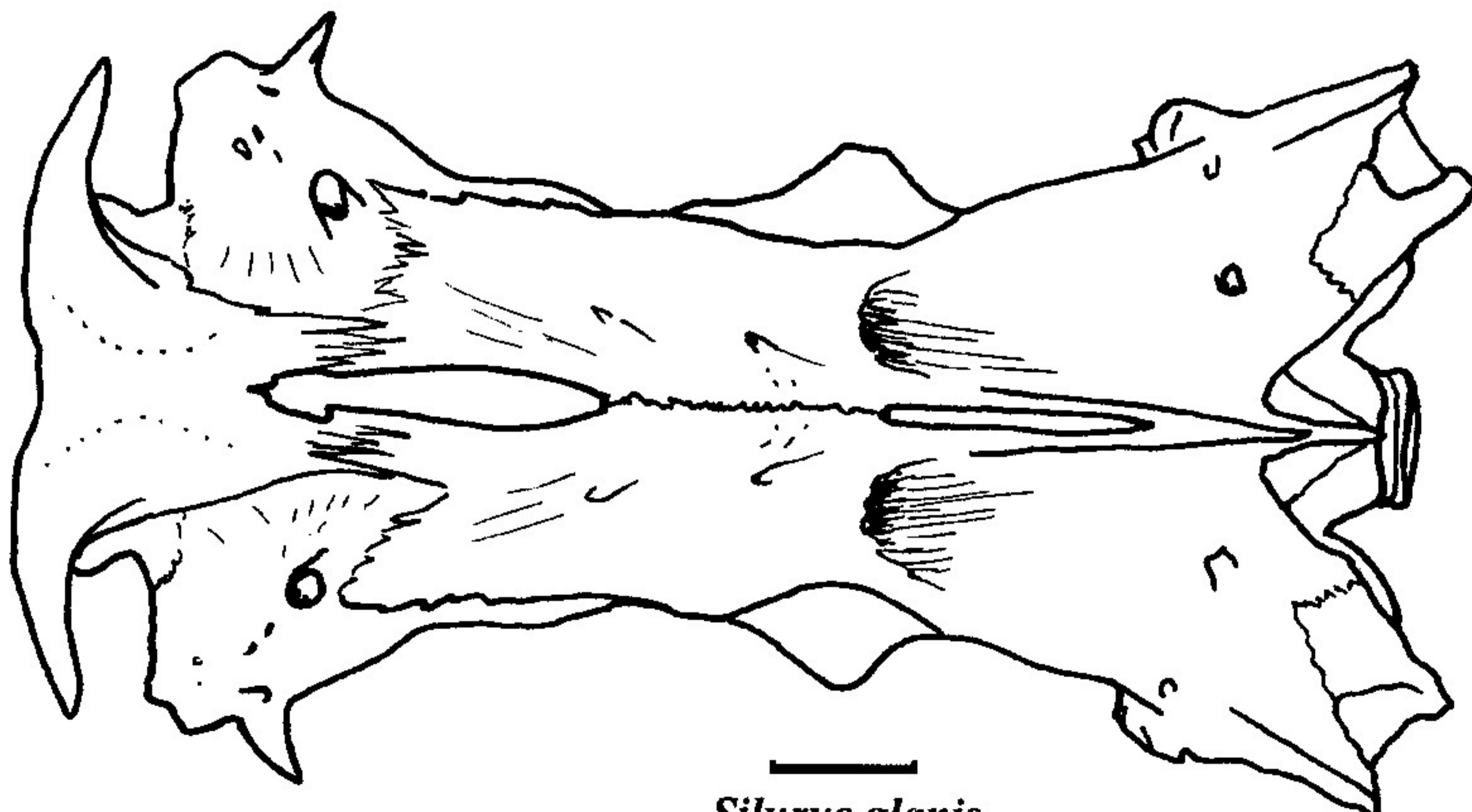
*Salmo trutta lacustris*



*Alosa pontica*



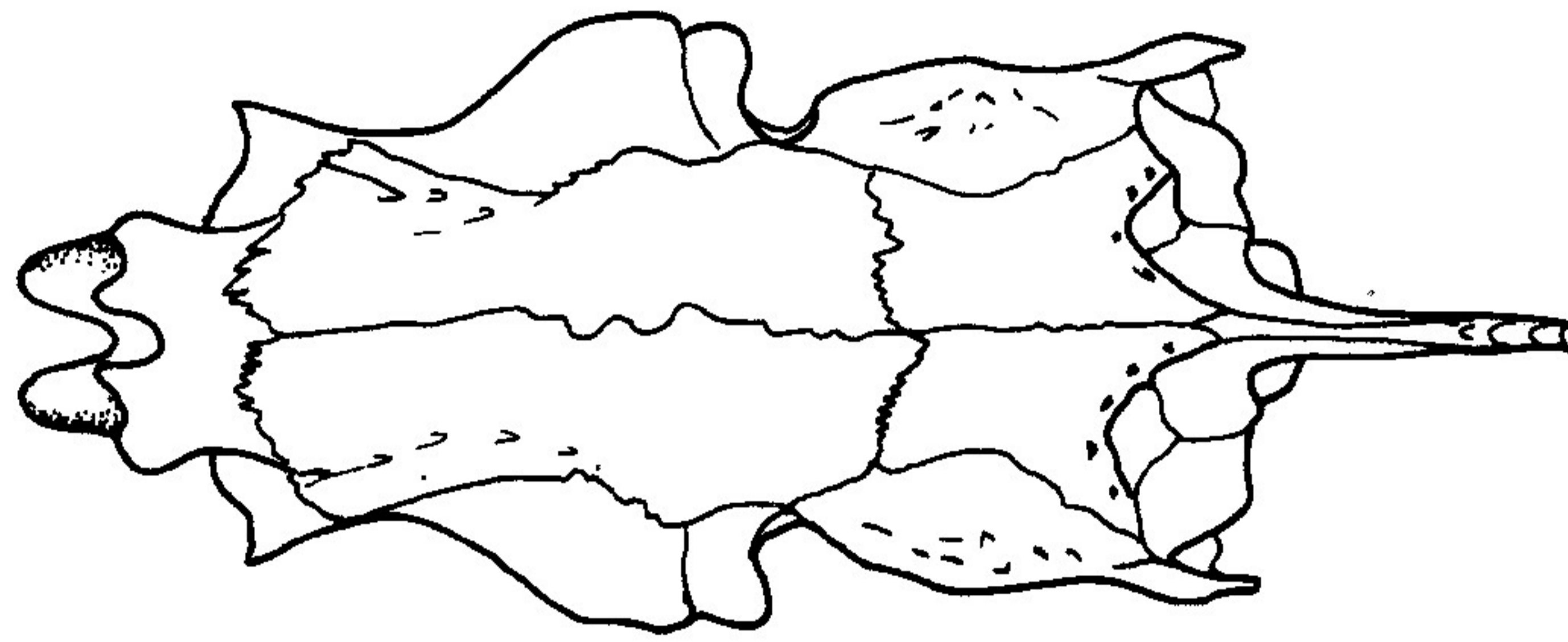
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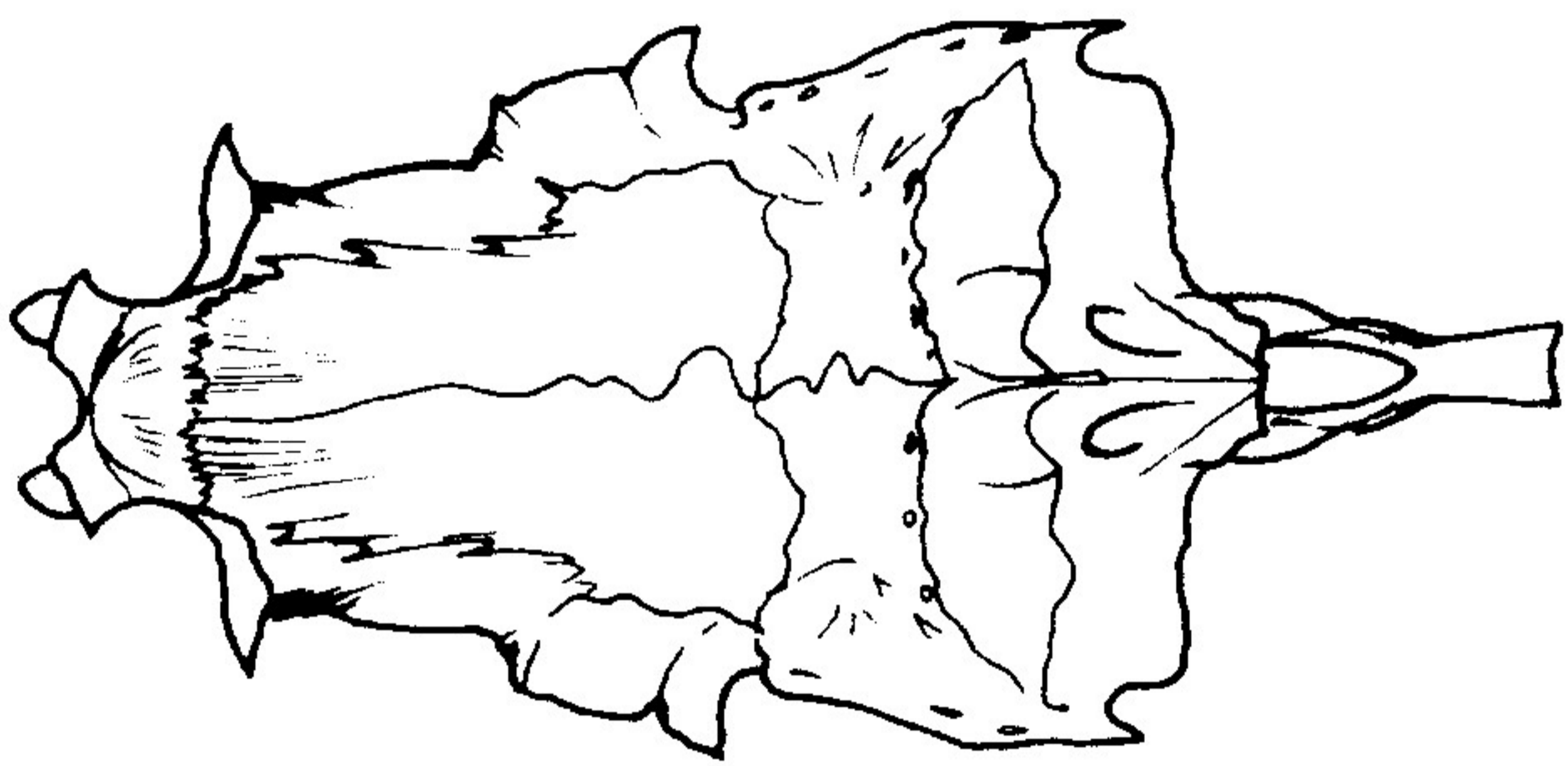
*Silurus glanis*

# NEUROCRANIUM

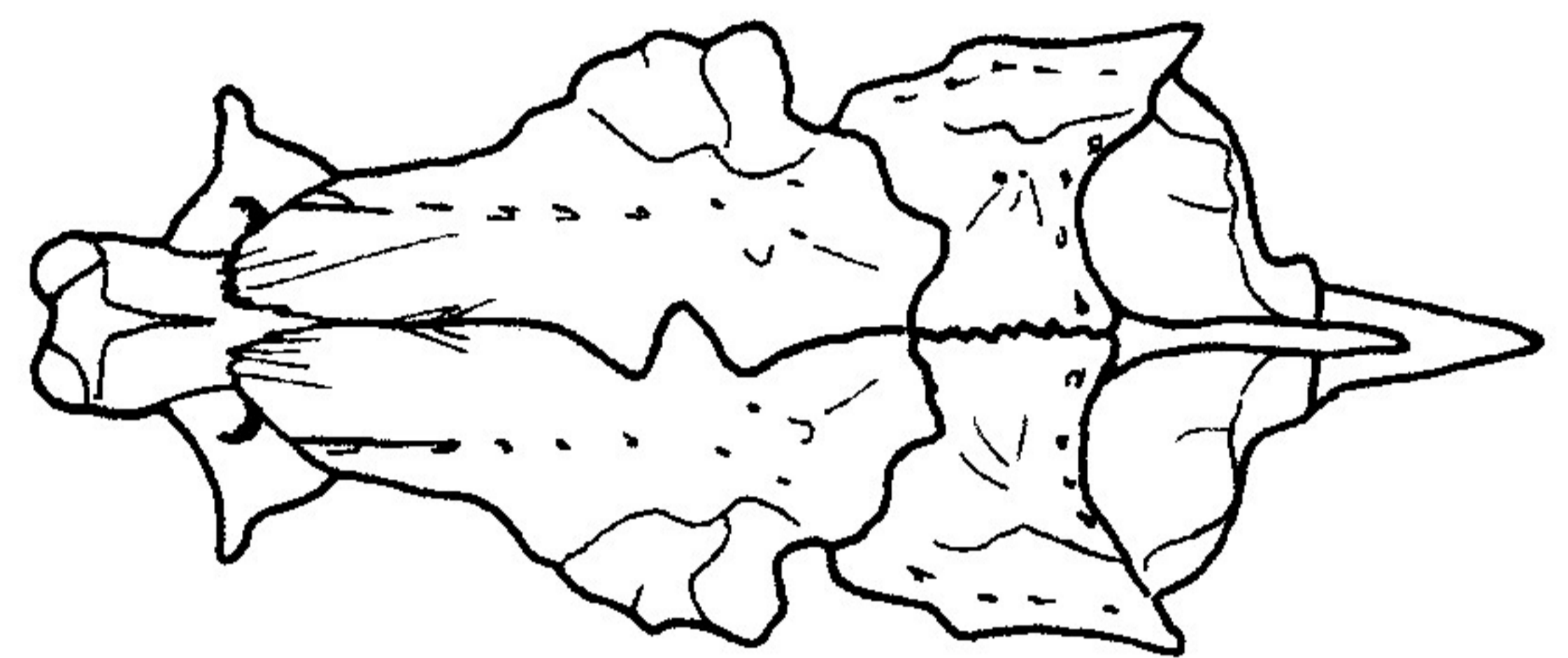
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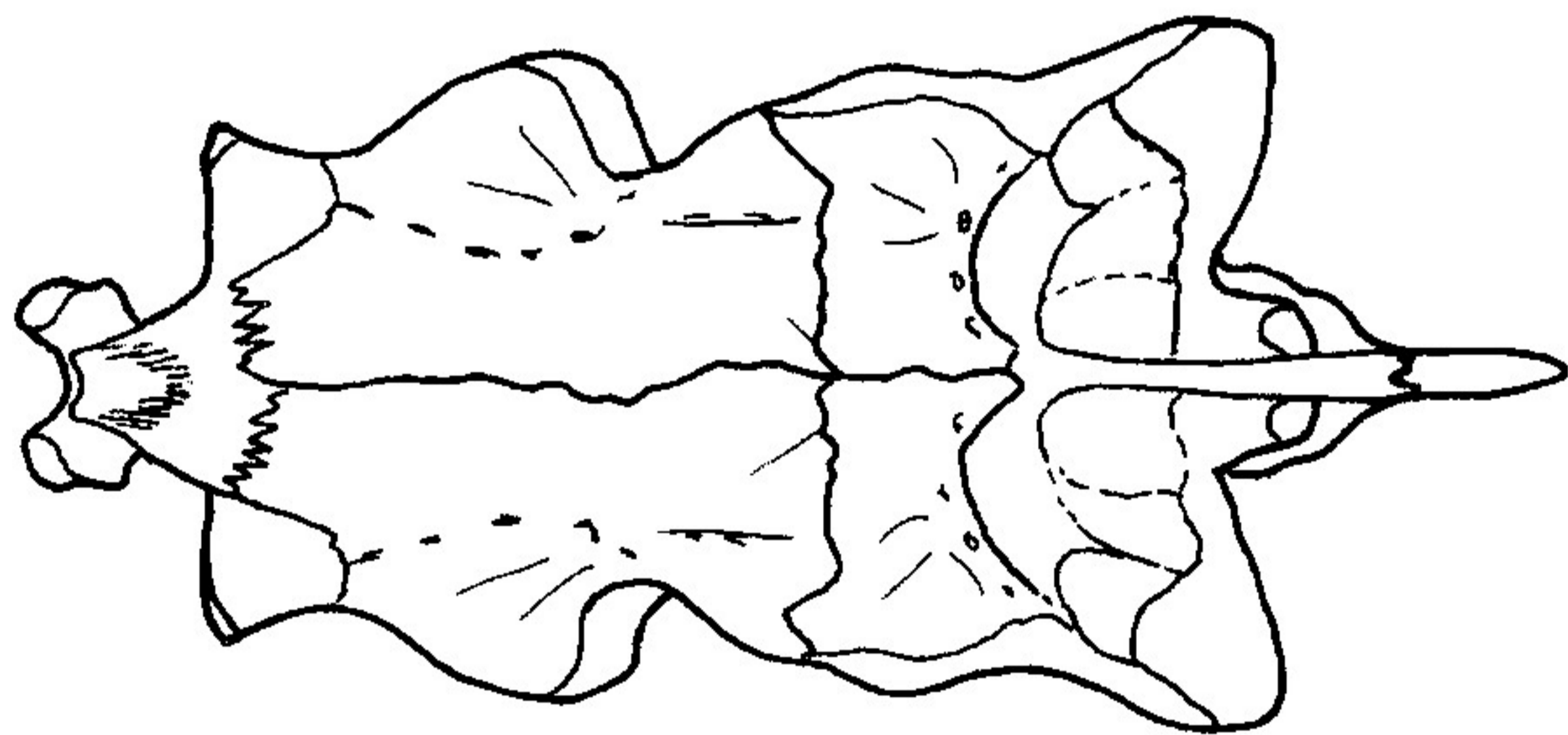
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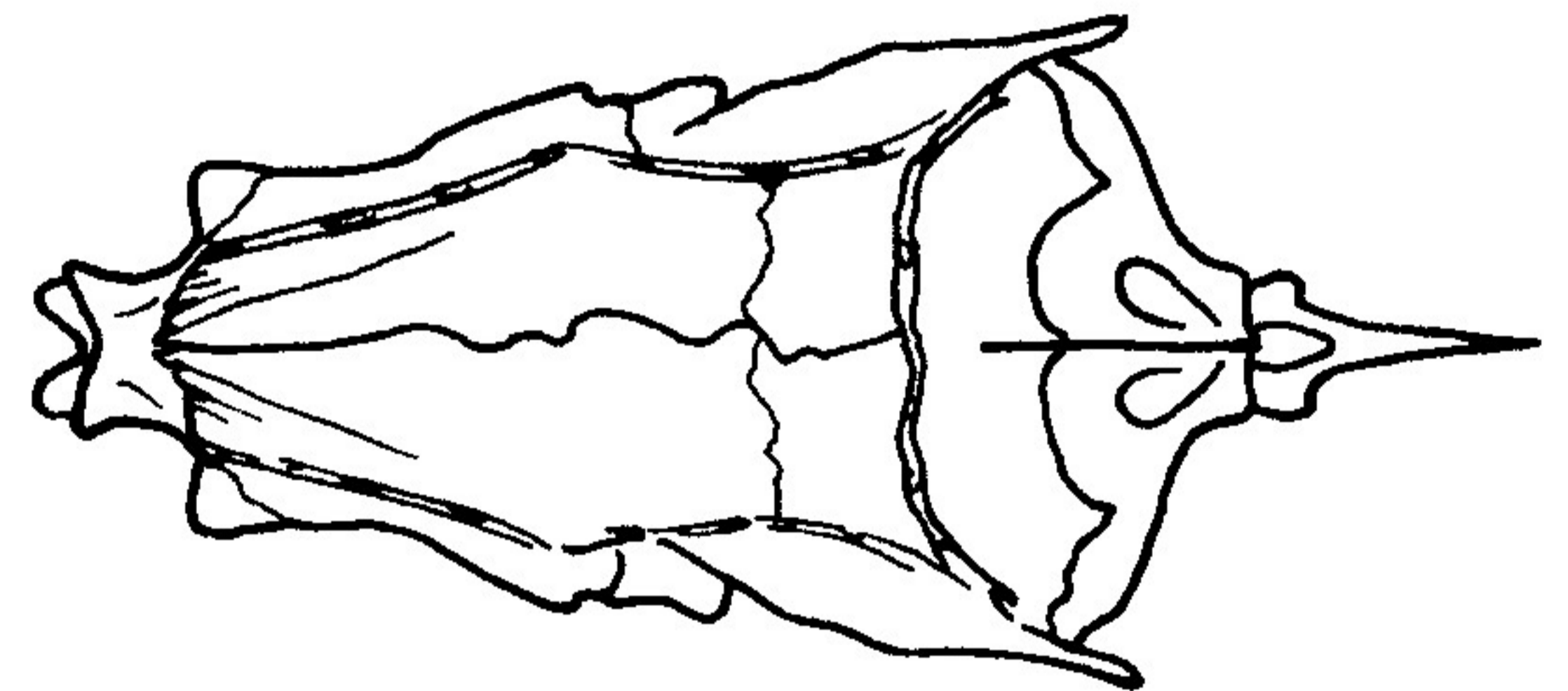
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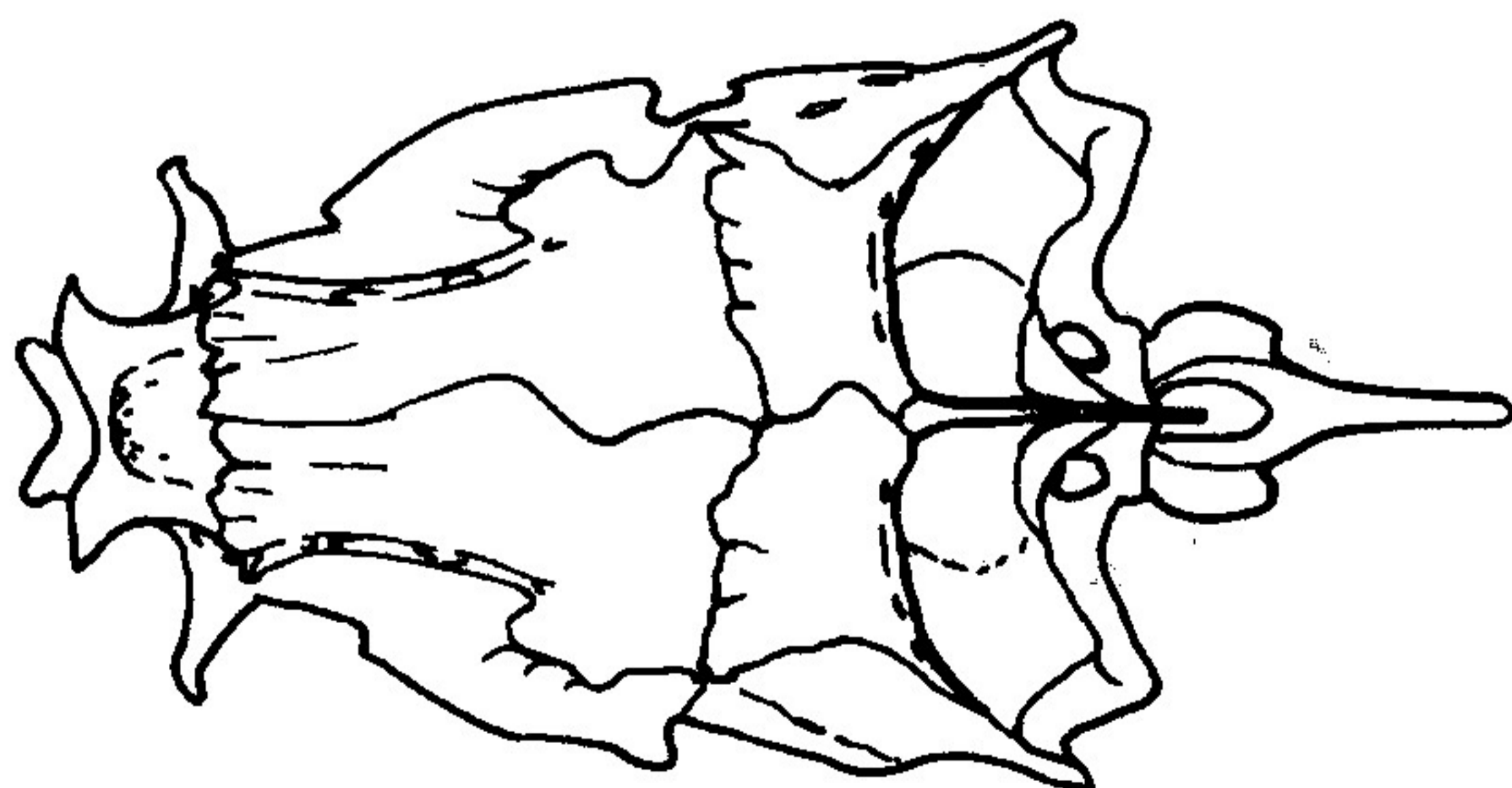
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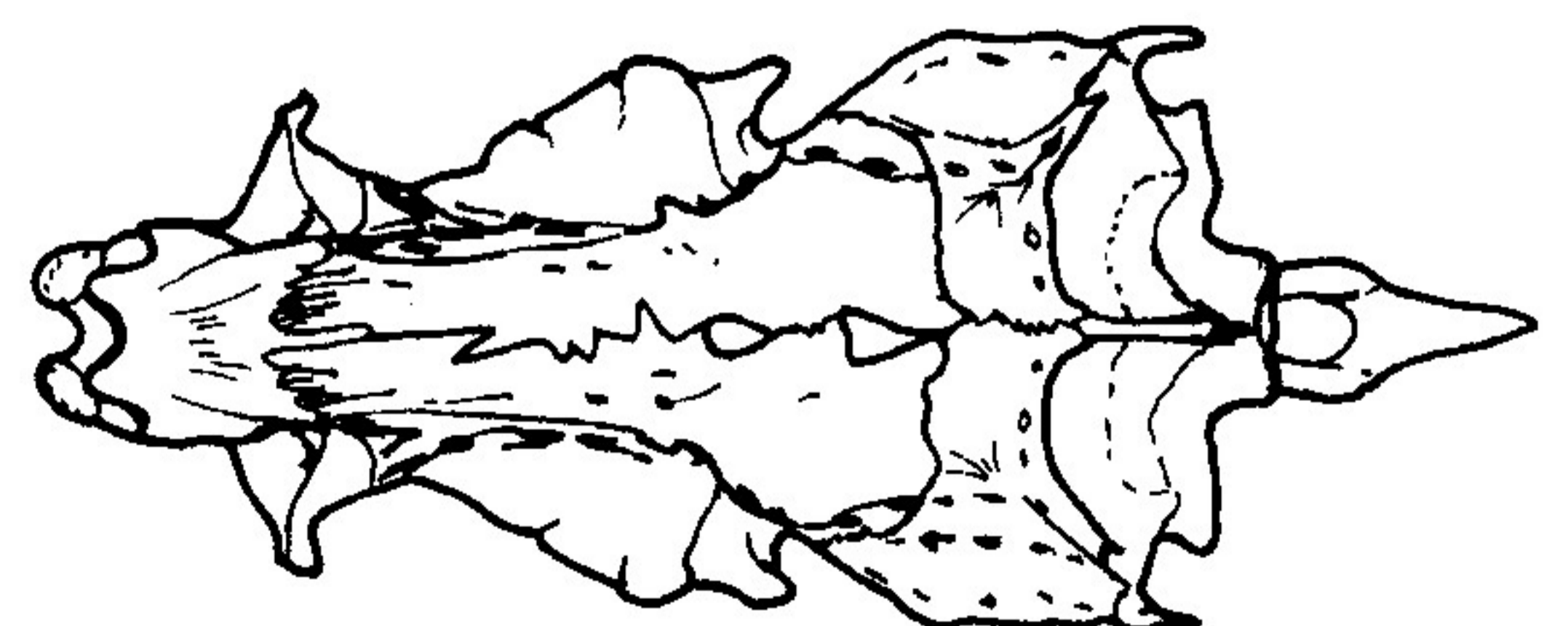
*Carassius auratus*



*Chalcaburnus chalcoides mento*



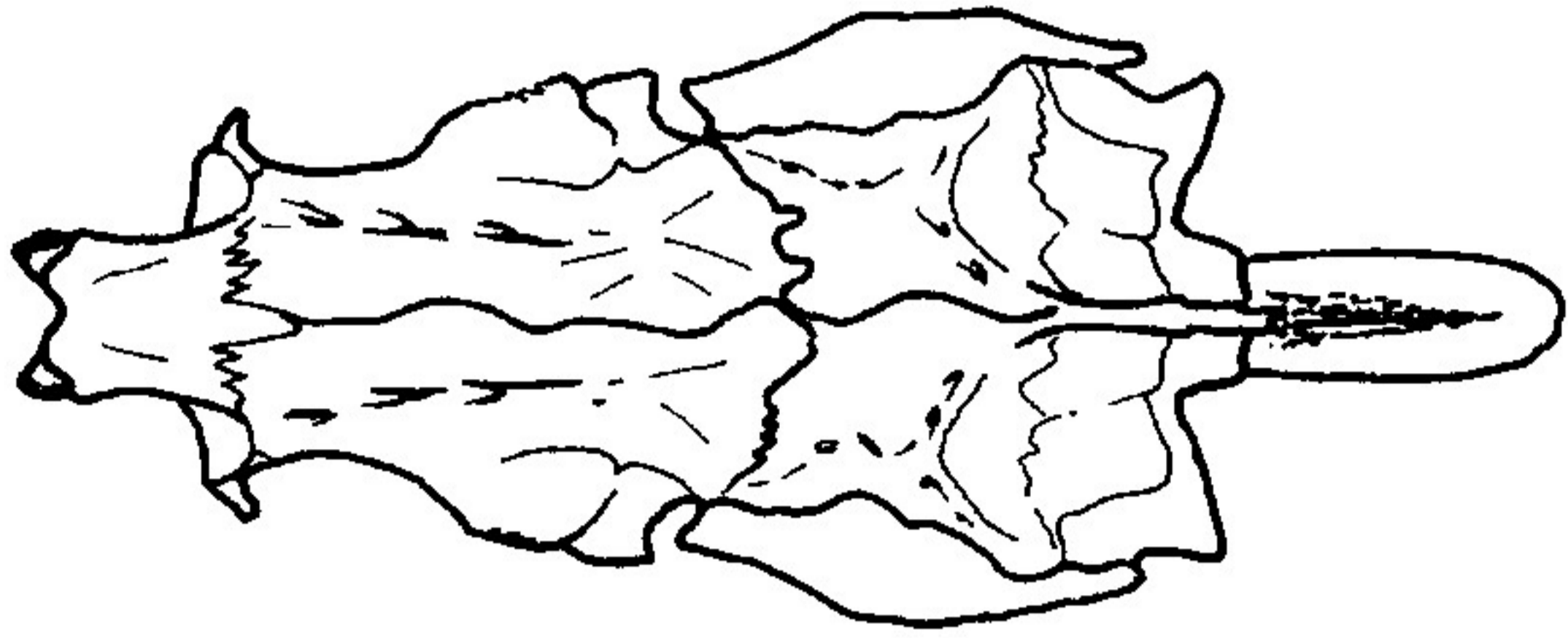
*Scardinius erythrophthalmus*



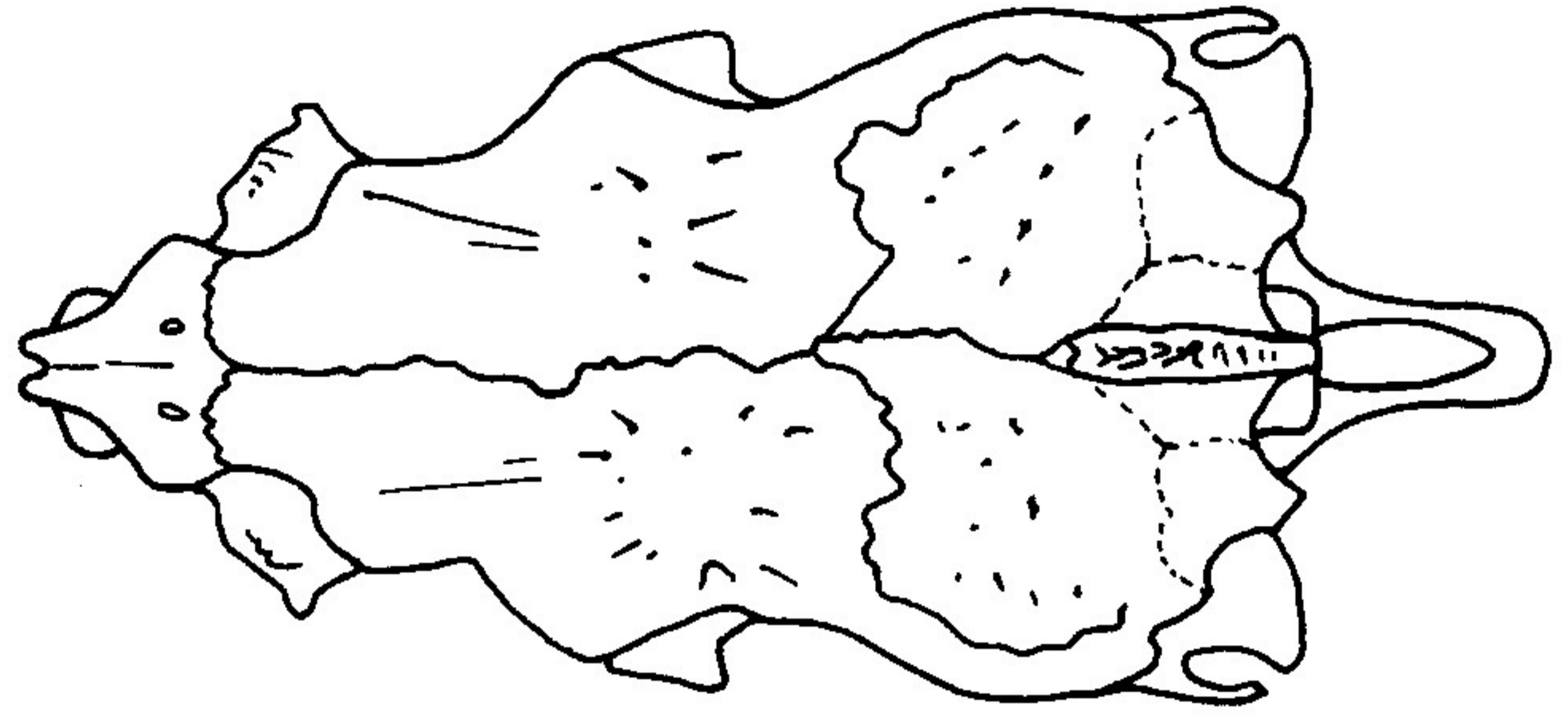
*Vimba vimba carinata*

# NEUROCRANIUM

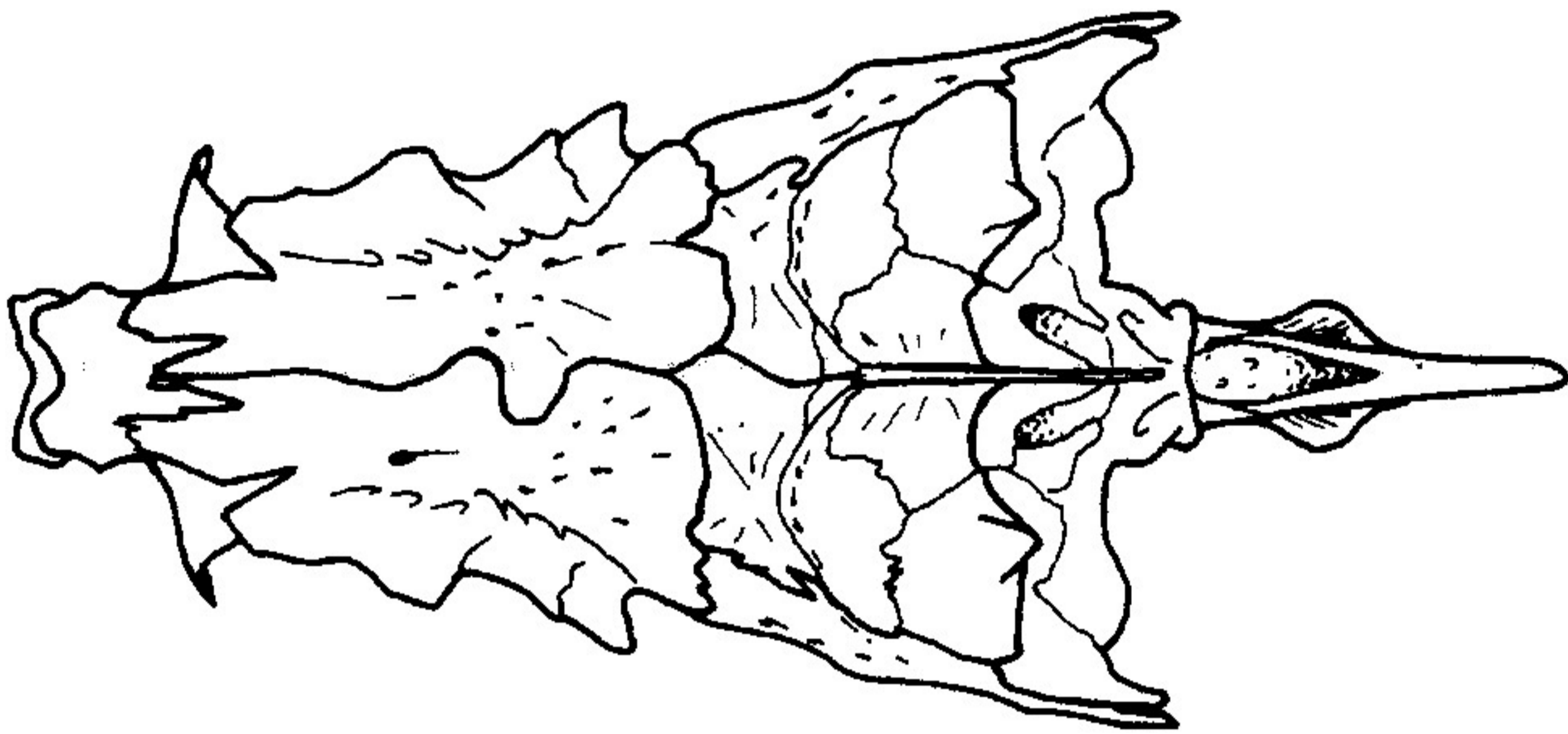
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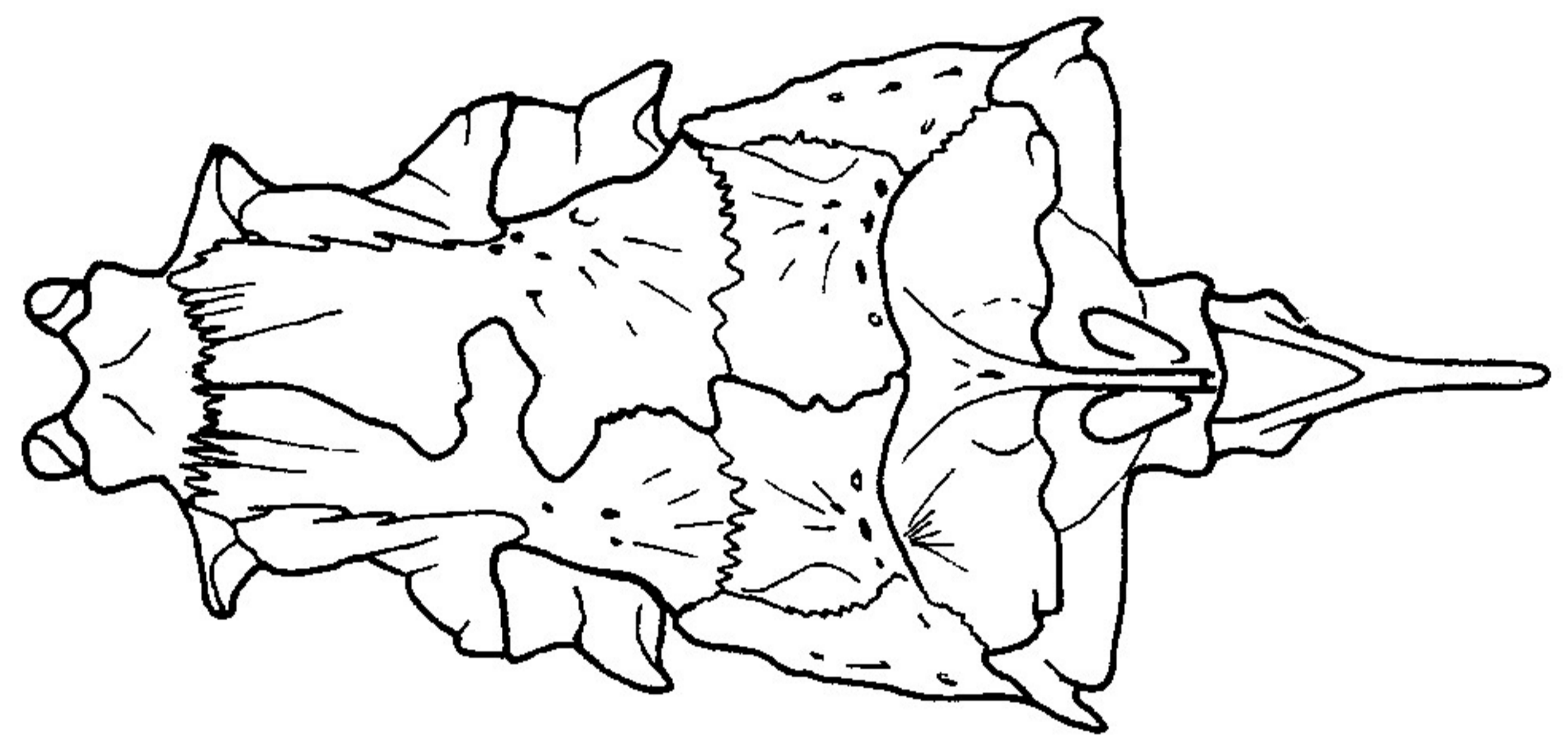
*Chondrostoma nasus*



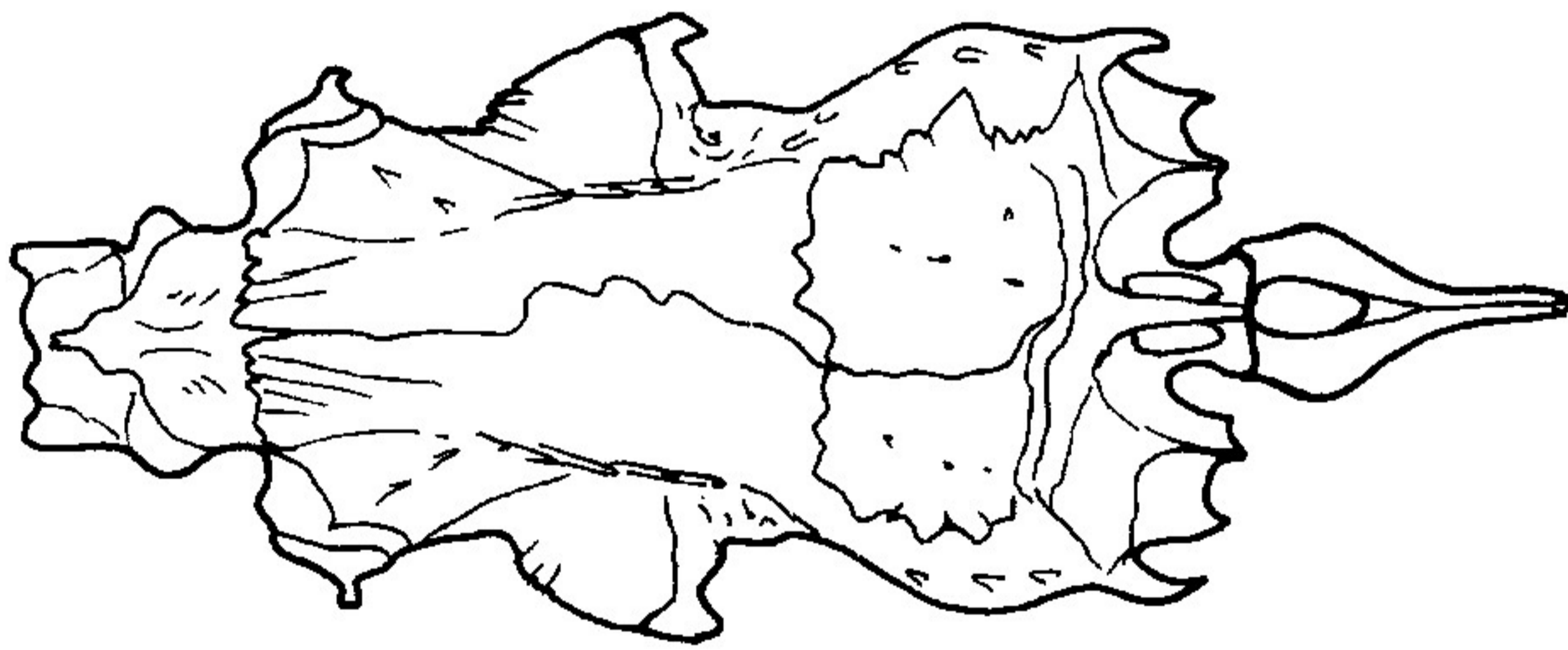
*Cyprinus carpio*



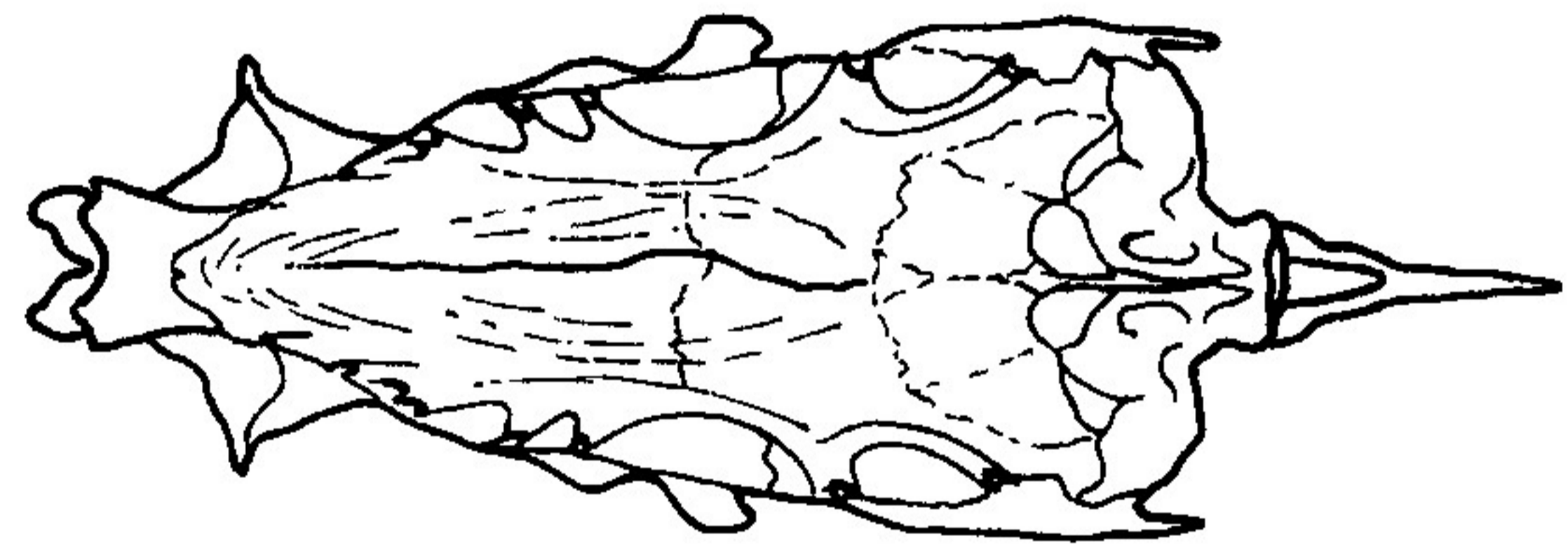
*Aspius aspius*



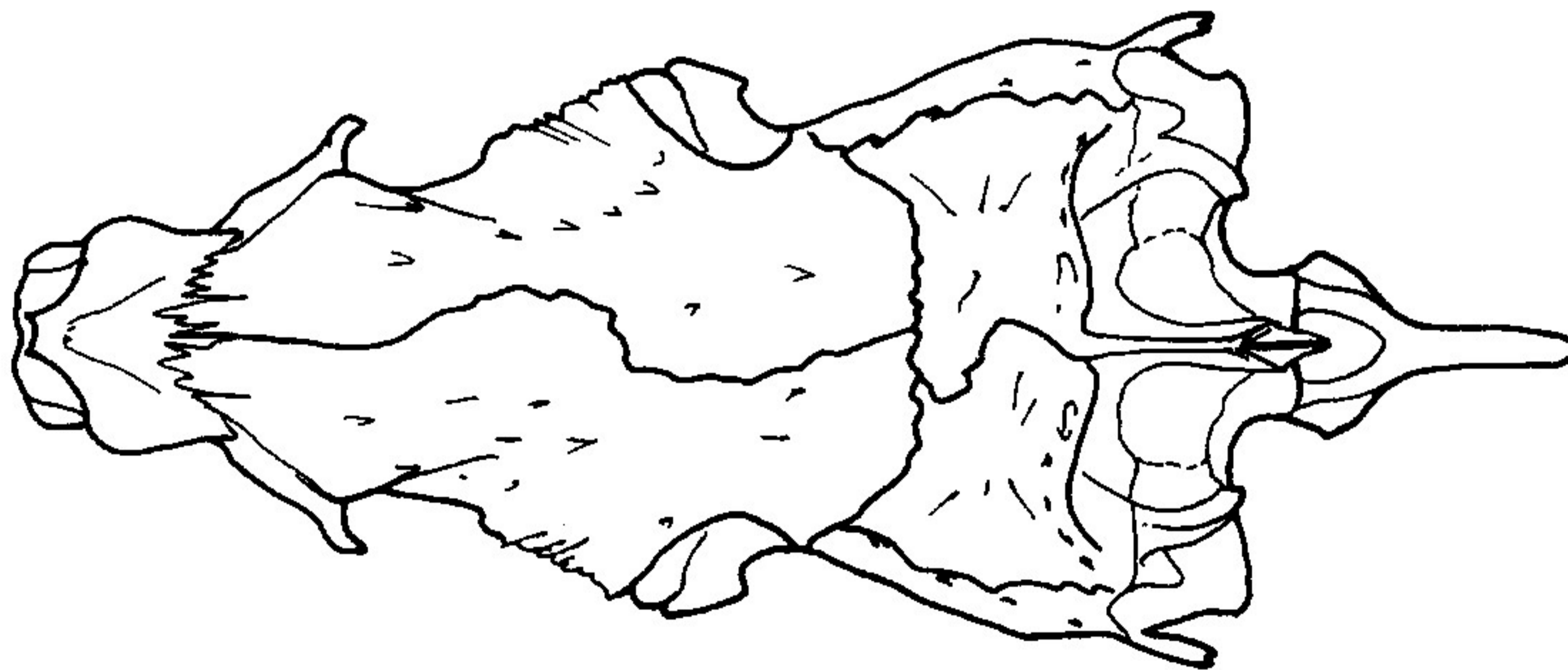
*Leuciscus idus*



*Tinca tinca*

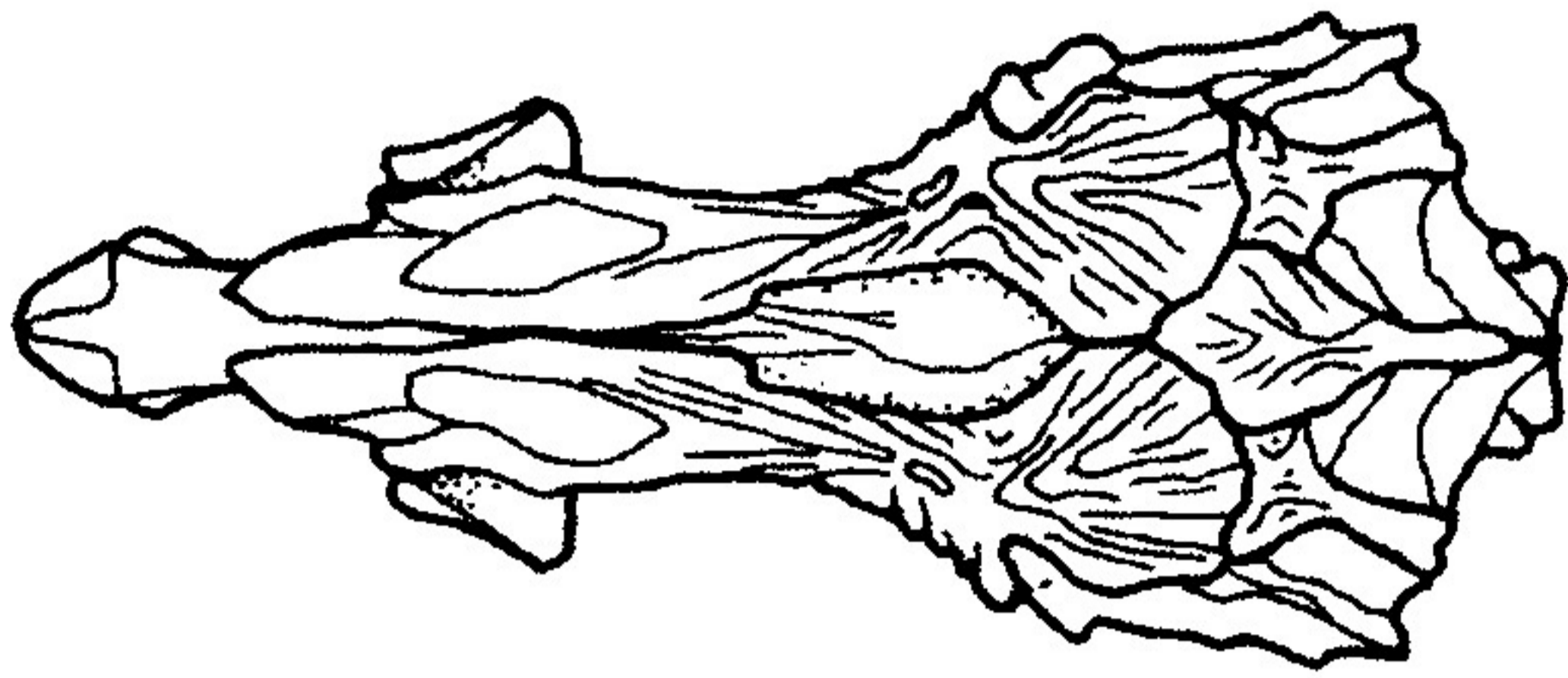


*Pelecus cultratus*

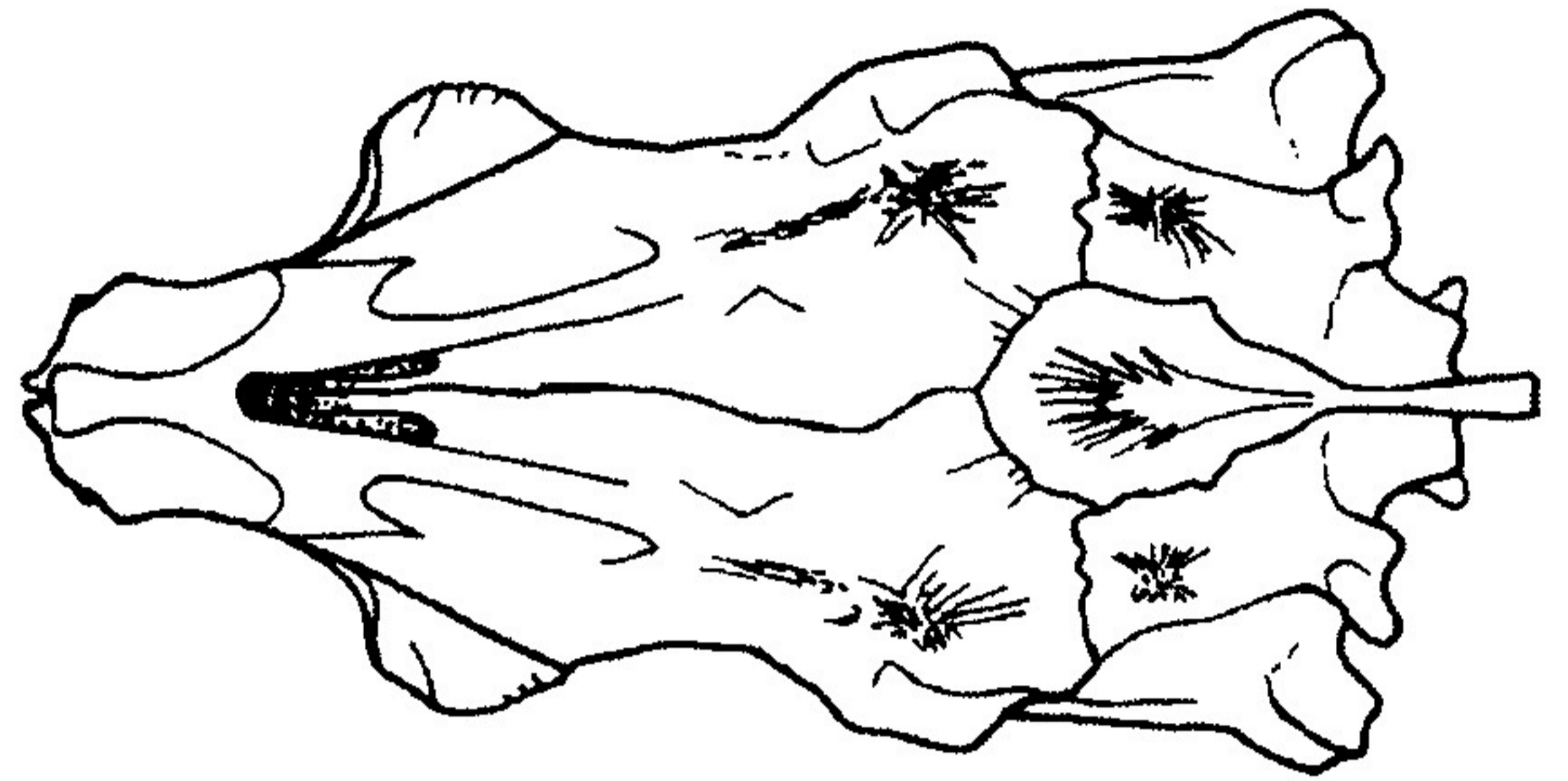


*Barbus barbus*

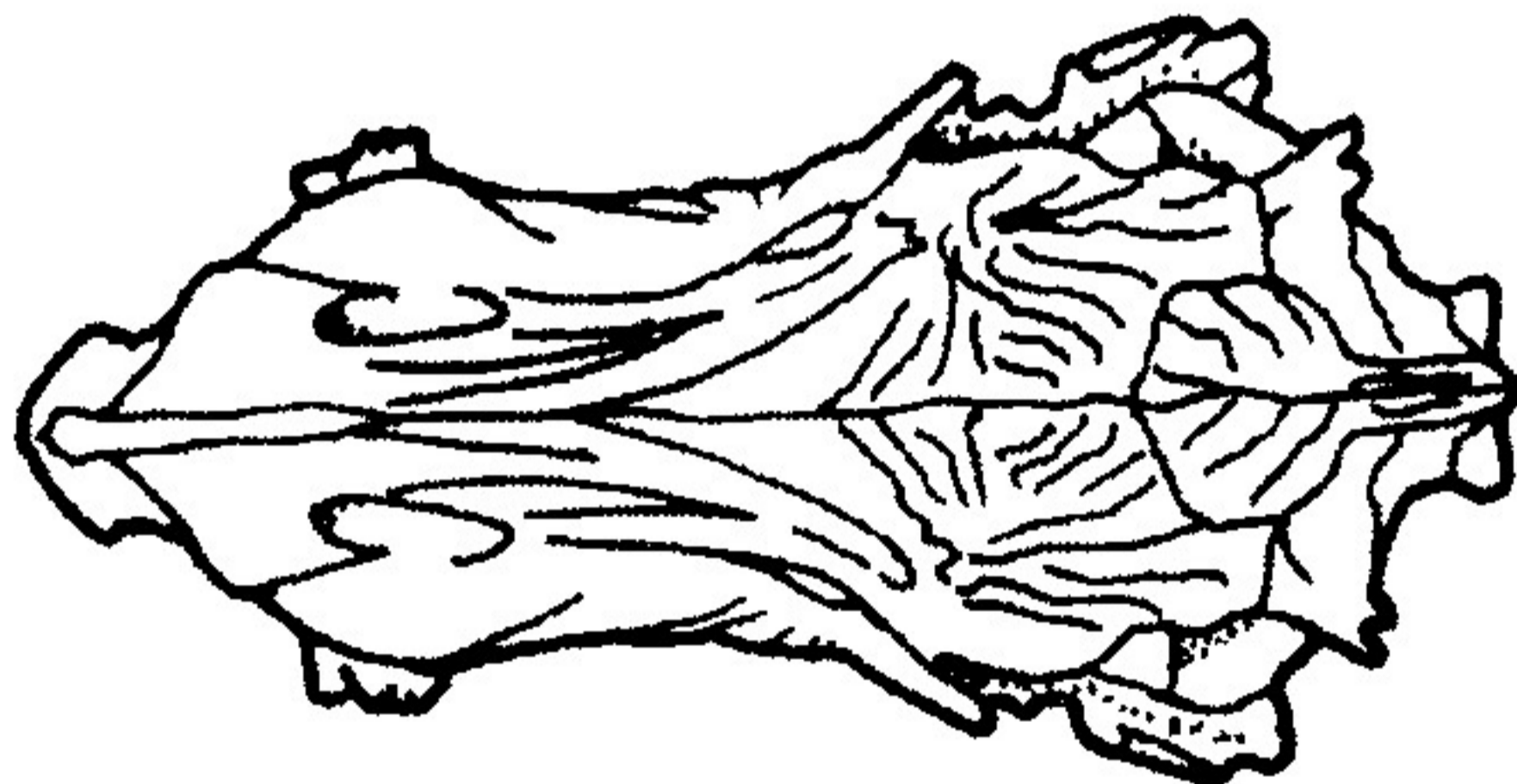
NEUROCRANIUM  
NORMA SUPERIOR



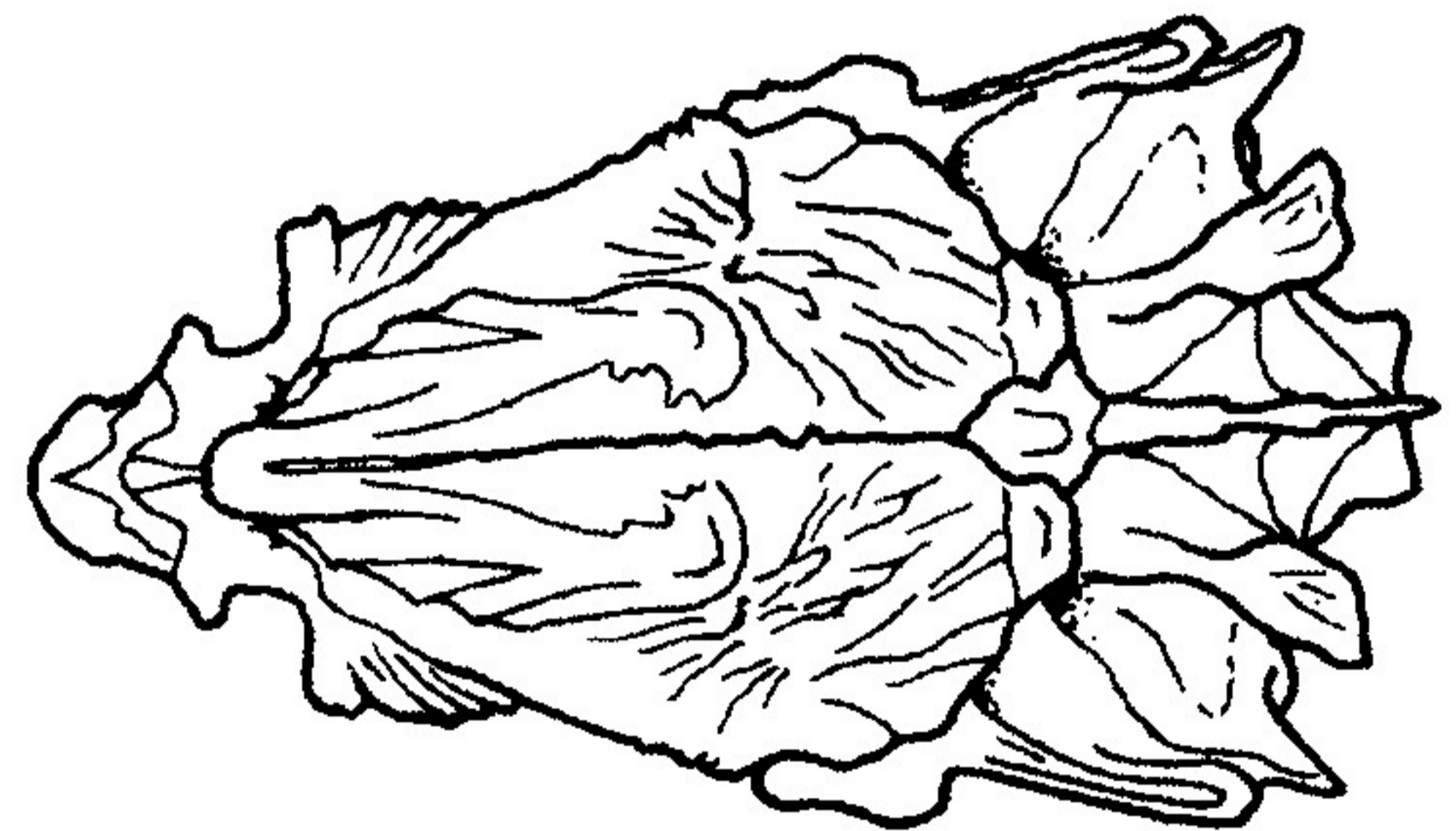
*Acerina schraetser*



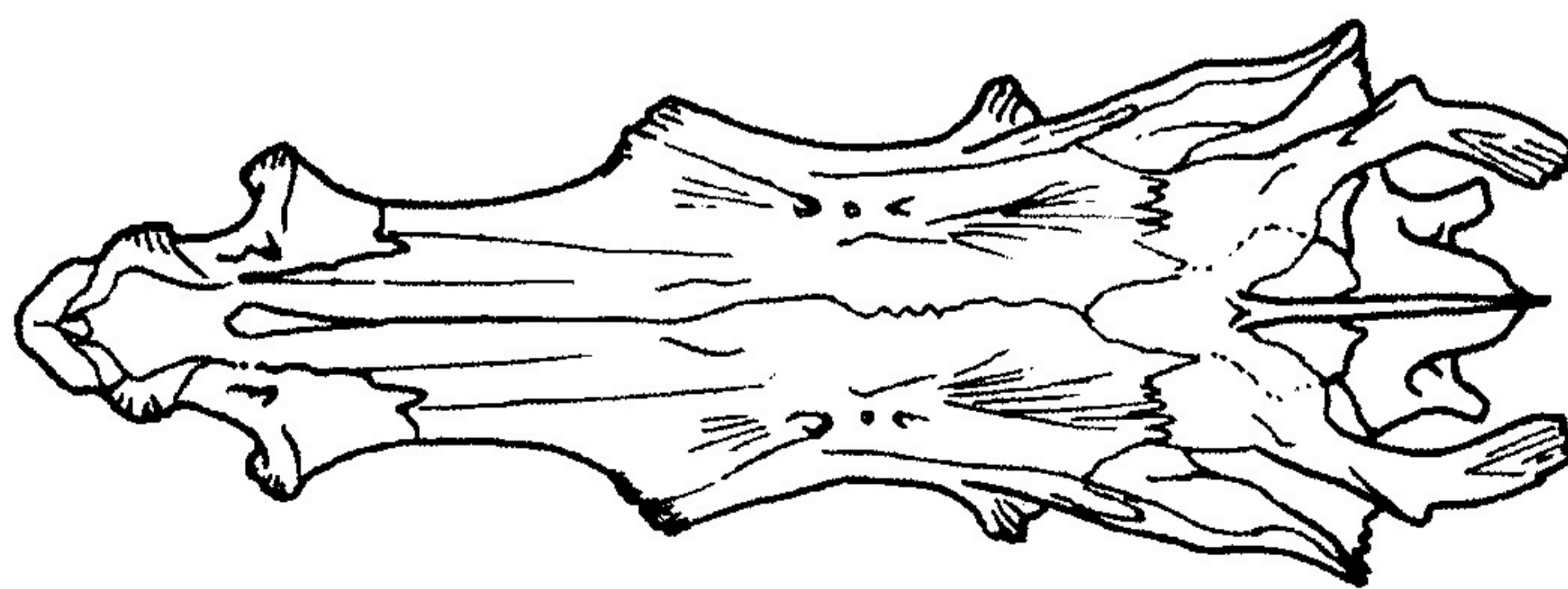
*Aspro zingel*



*Gymnocephalus* sp.



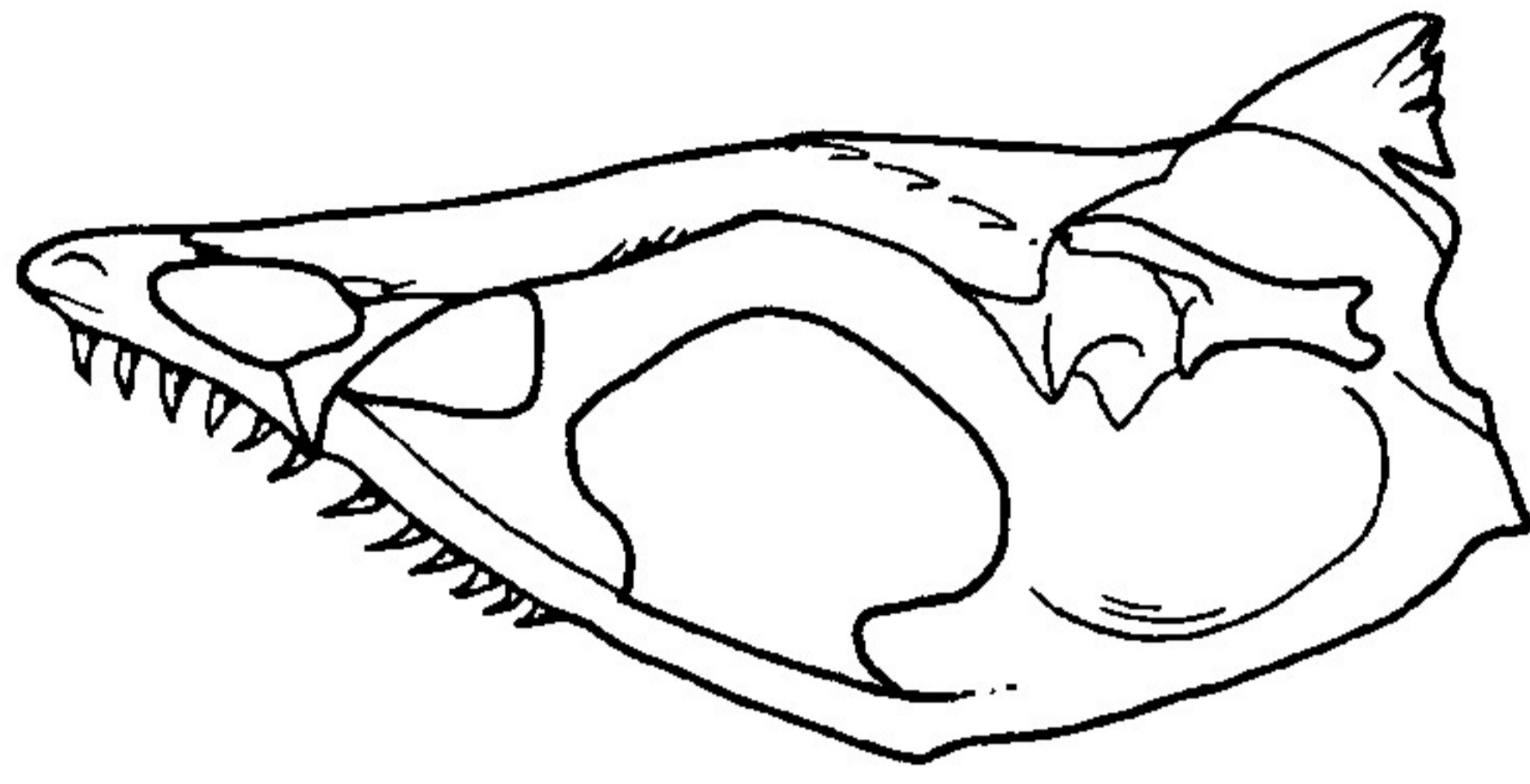
*Perca fluviatilis*



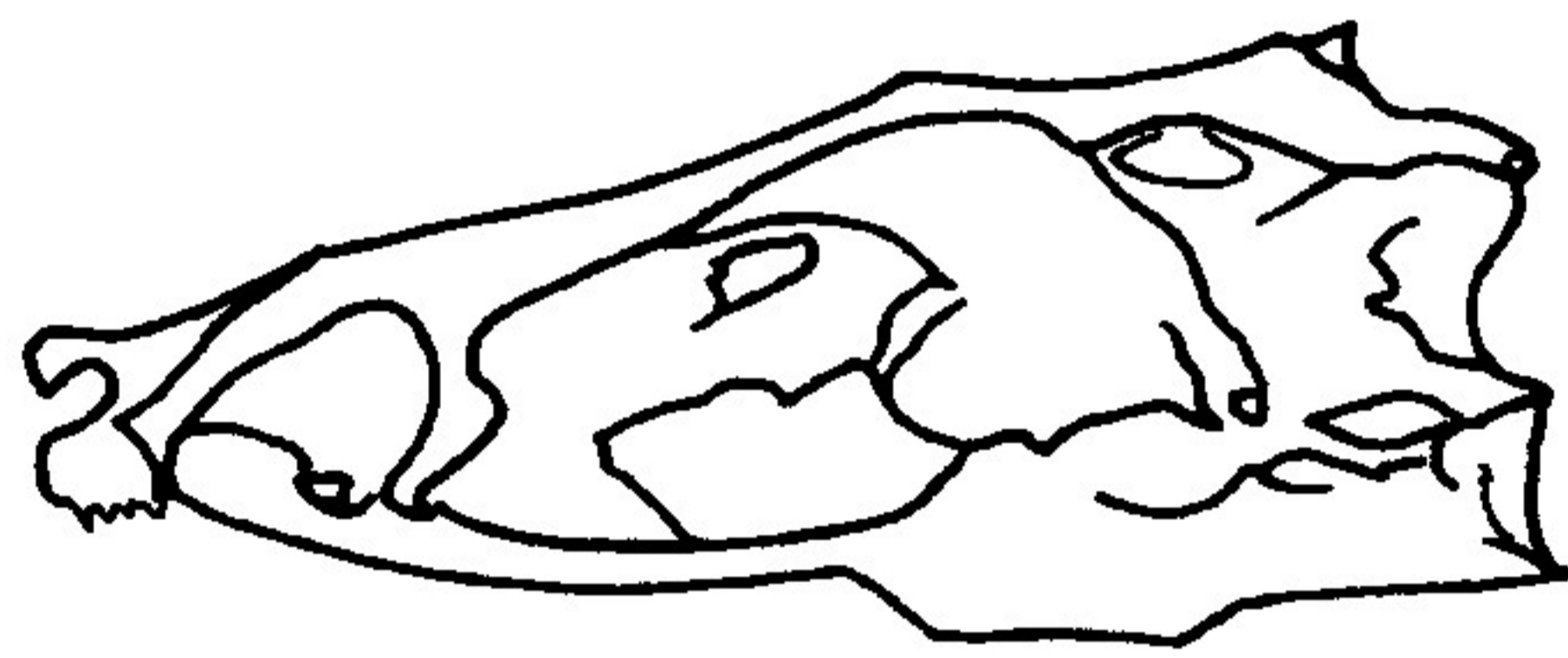
*Stizostedion lucioperca*

# NEUROCRANIUM

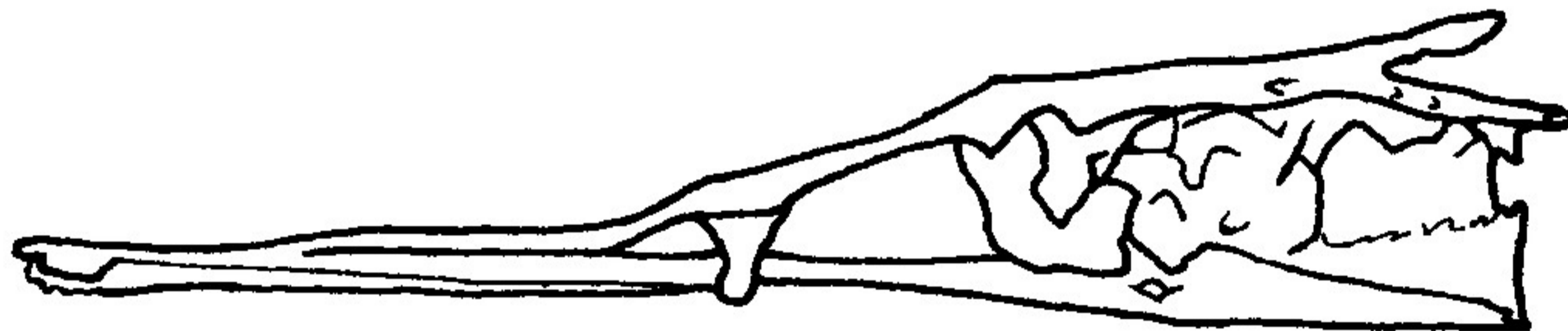
## NORMA LATERALIS



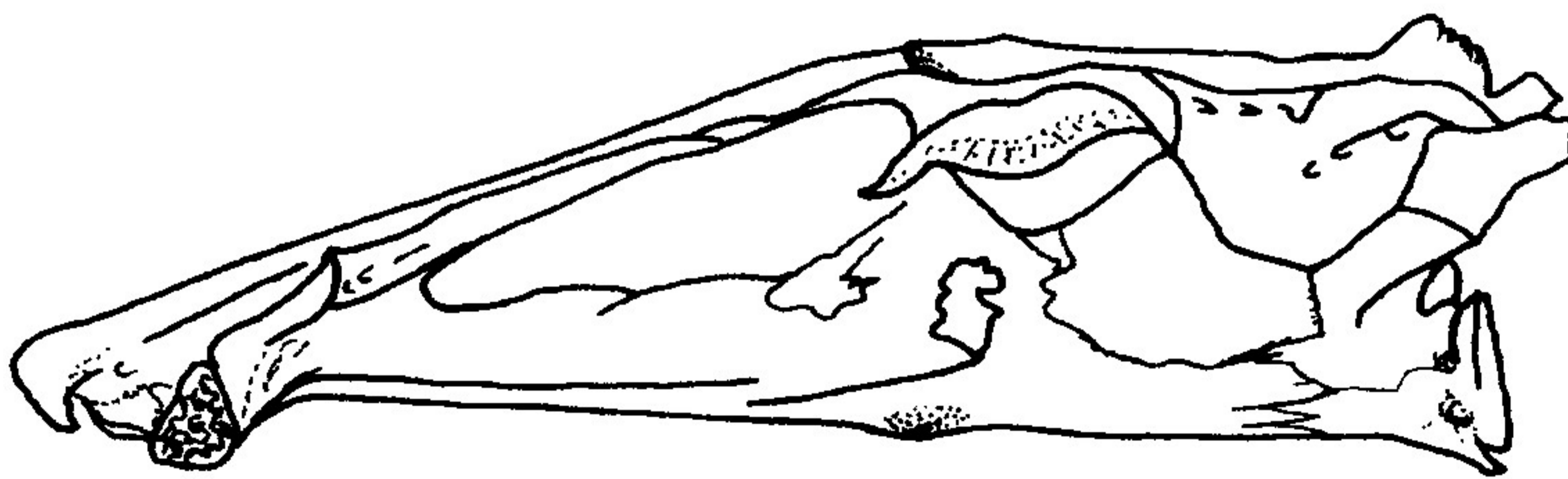
*Salmo trutta lacustris*



*Alosa pontica*

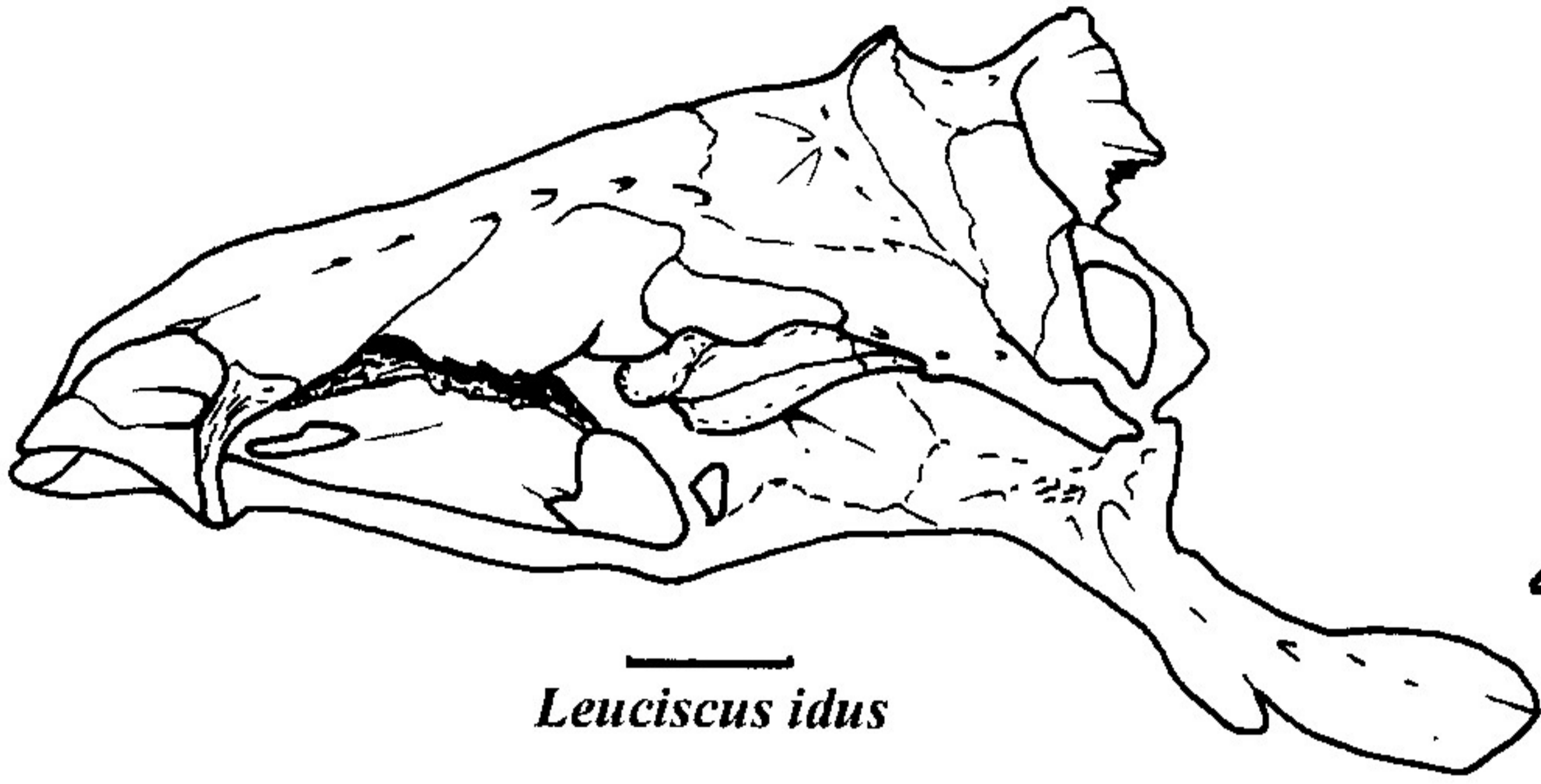


*Esox lucius*

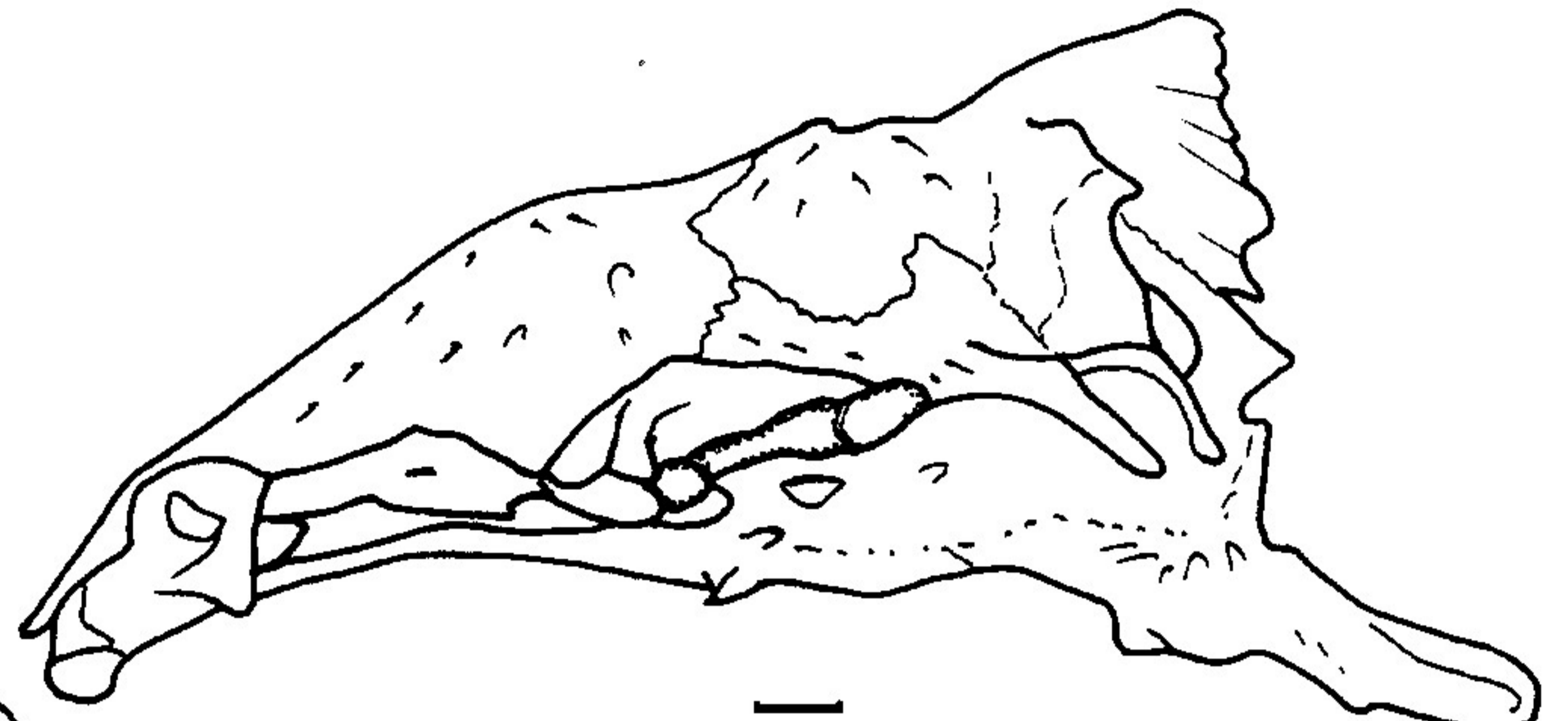


*Silurus glanis*

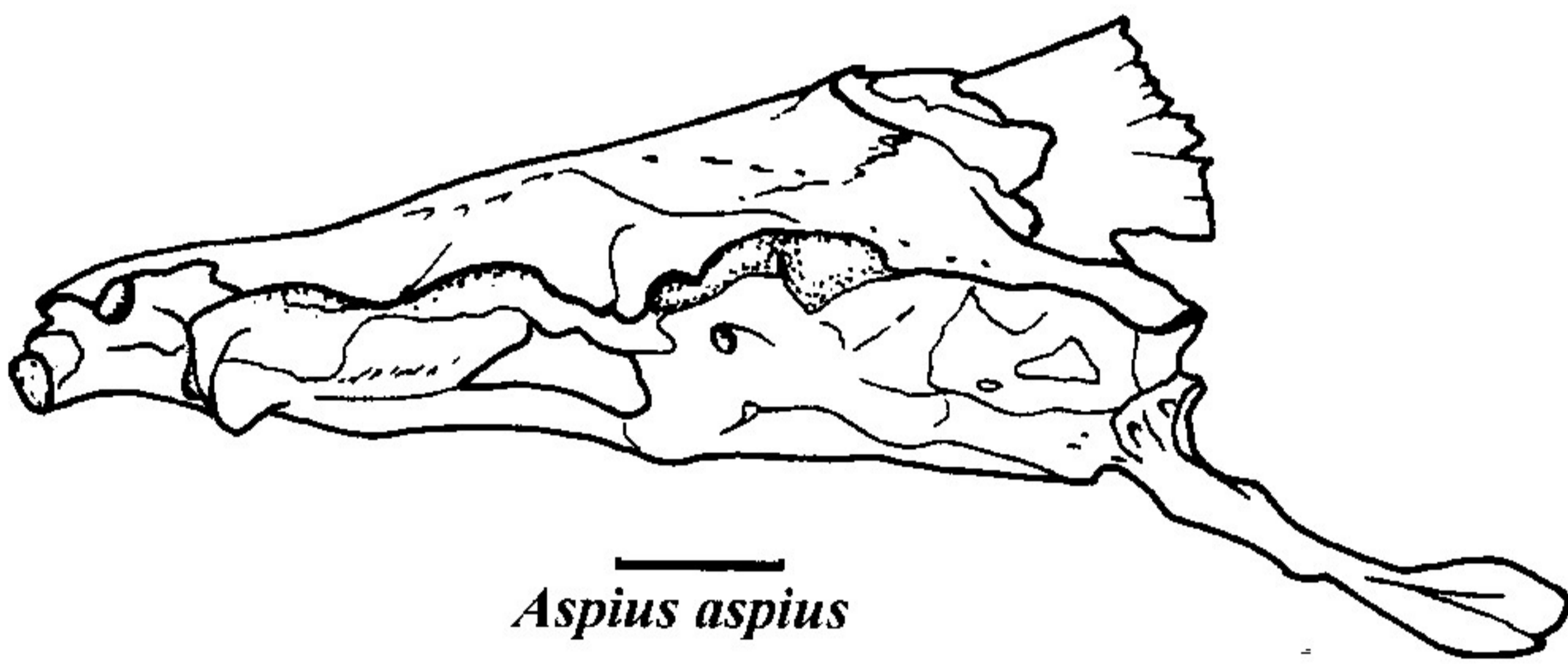
NEUROCRANIUM  
NORMA LATERALIS



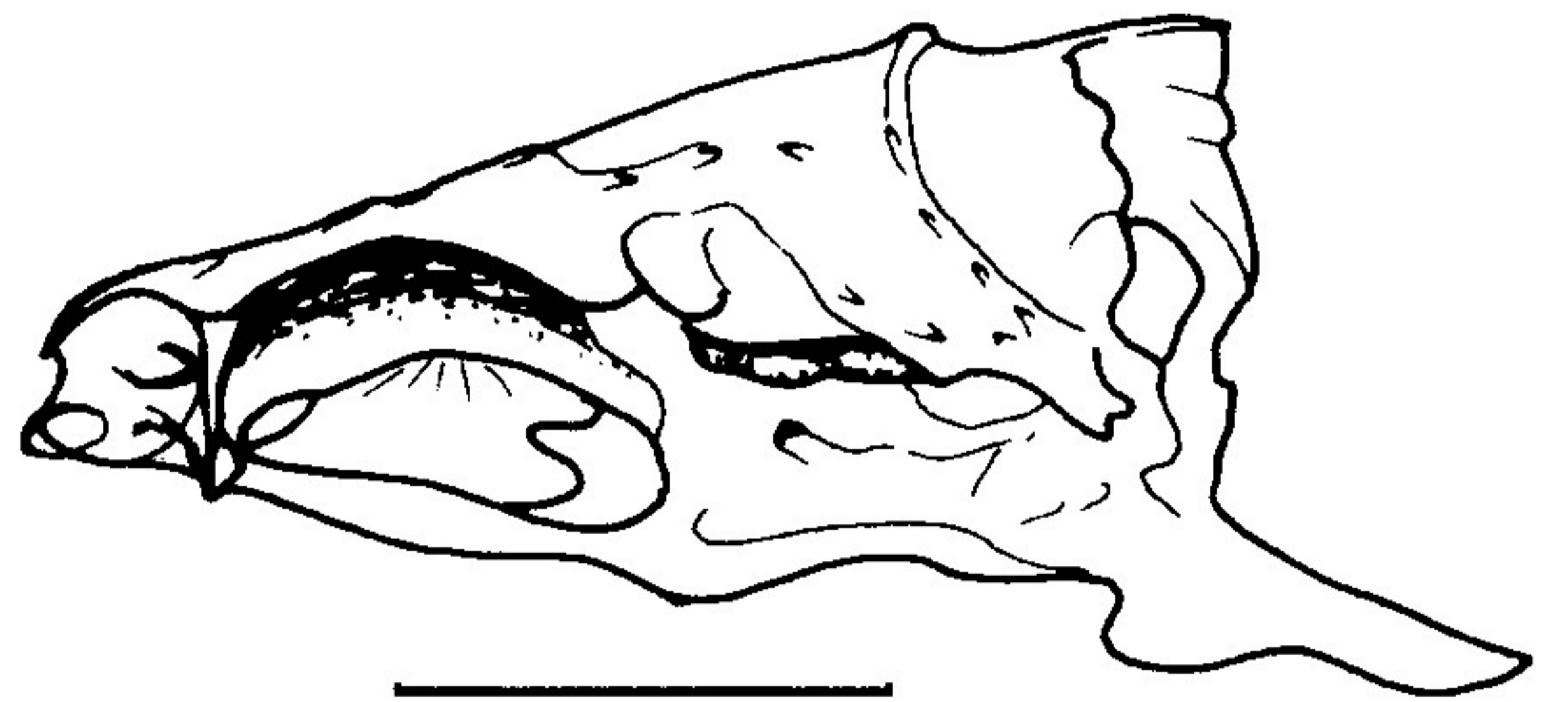
*Leuciscus idus*



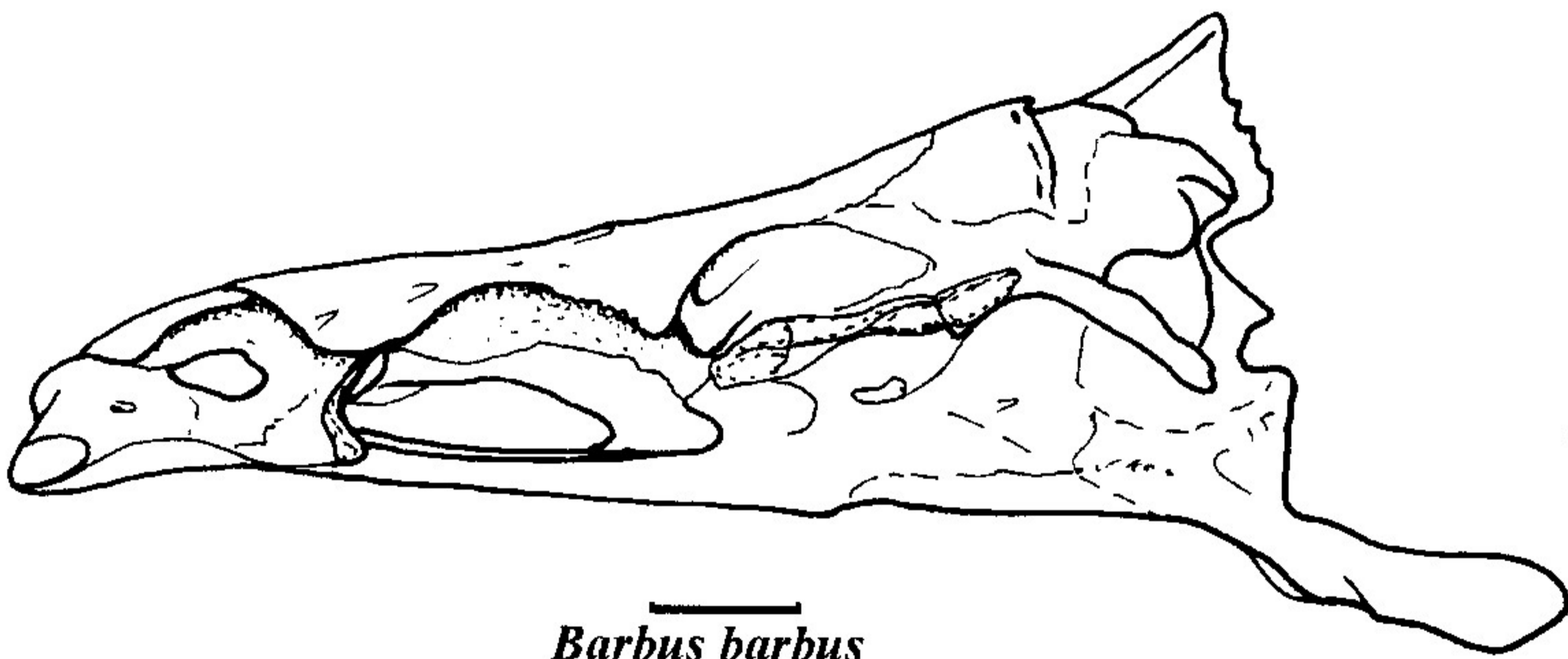
*Cyprinus carpio*



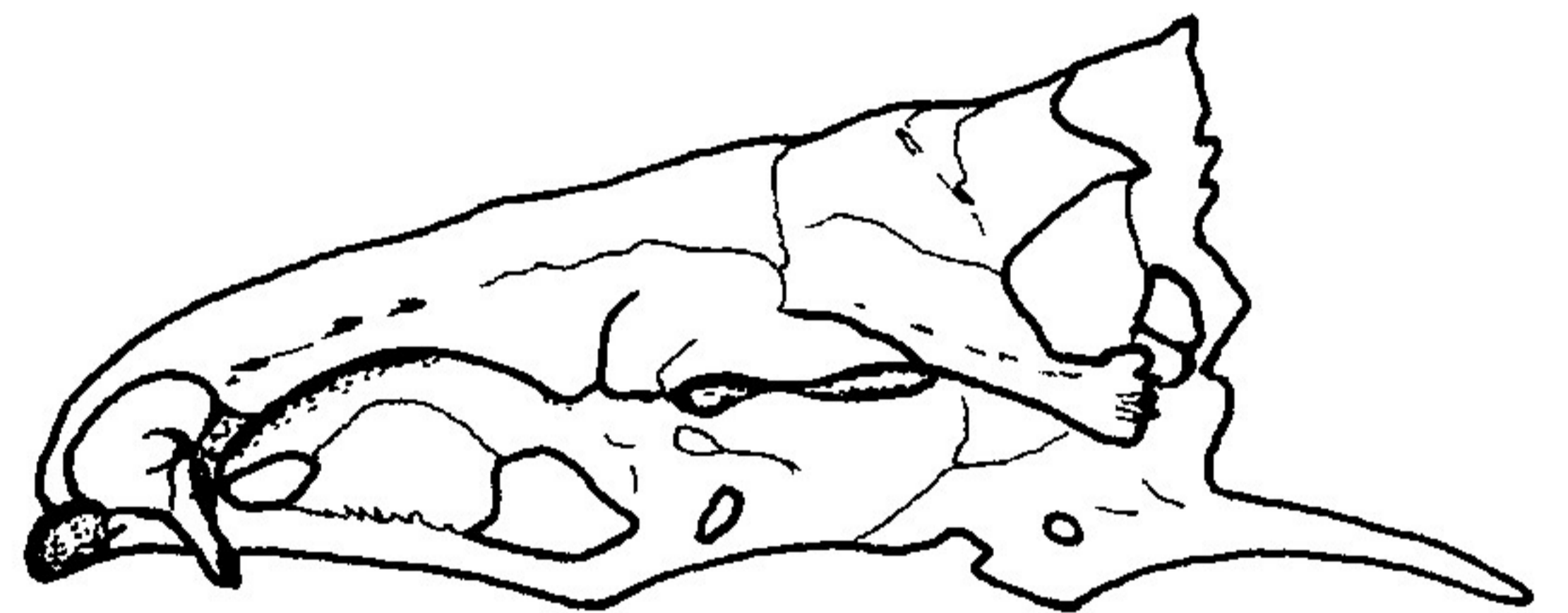
*Aspius aspius*



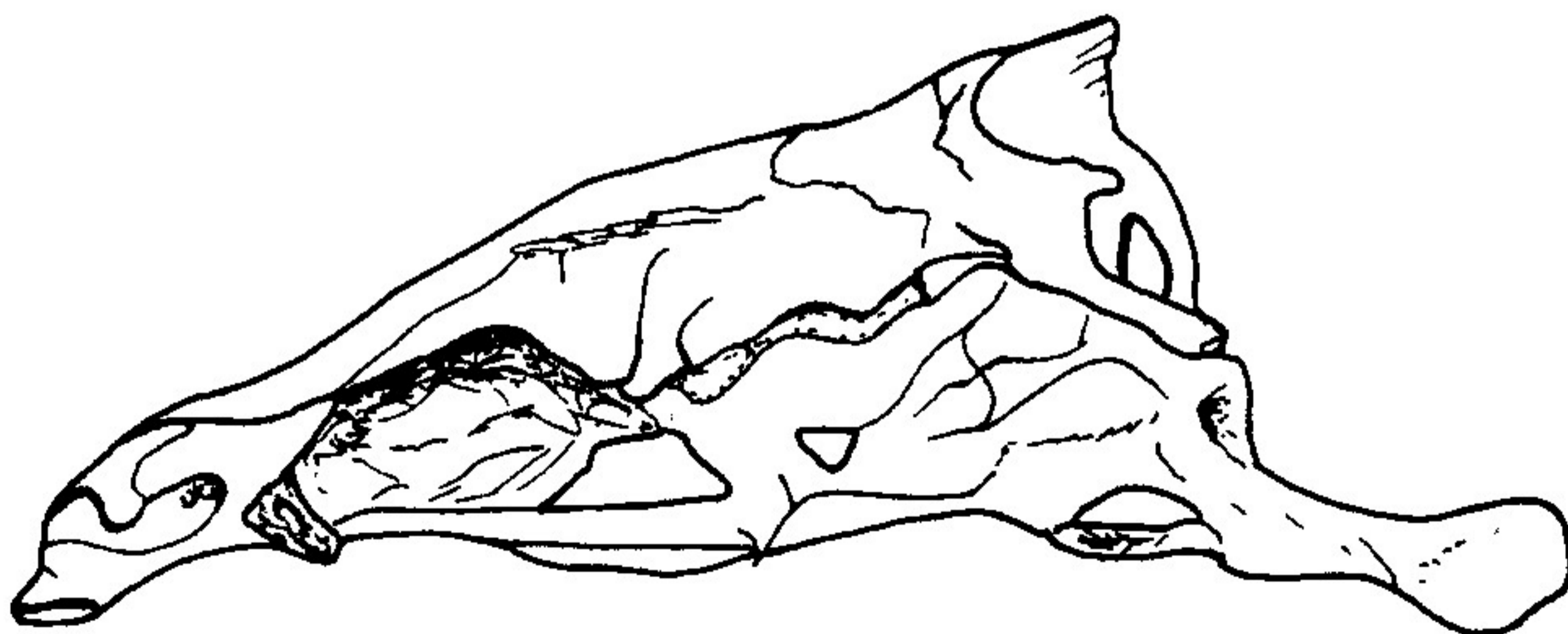
*Rutilus rutilus*



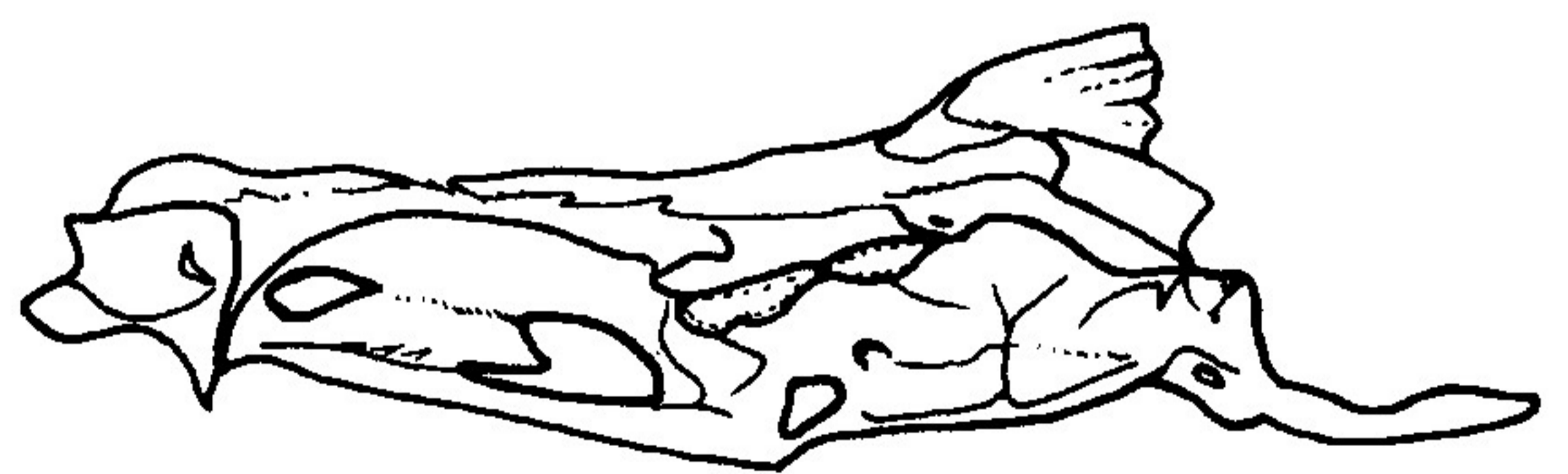
*Barbus barbus*



*Chondrostoma nasus*

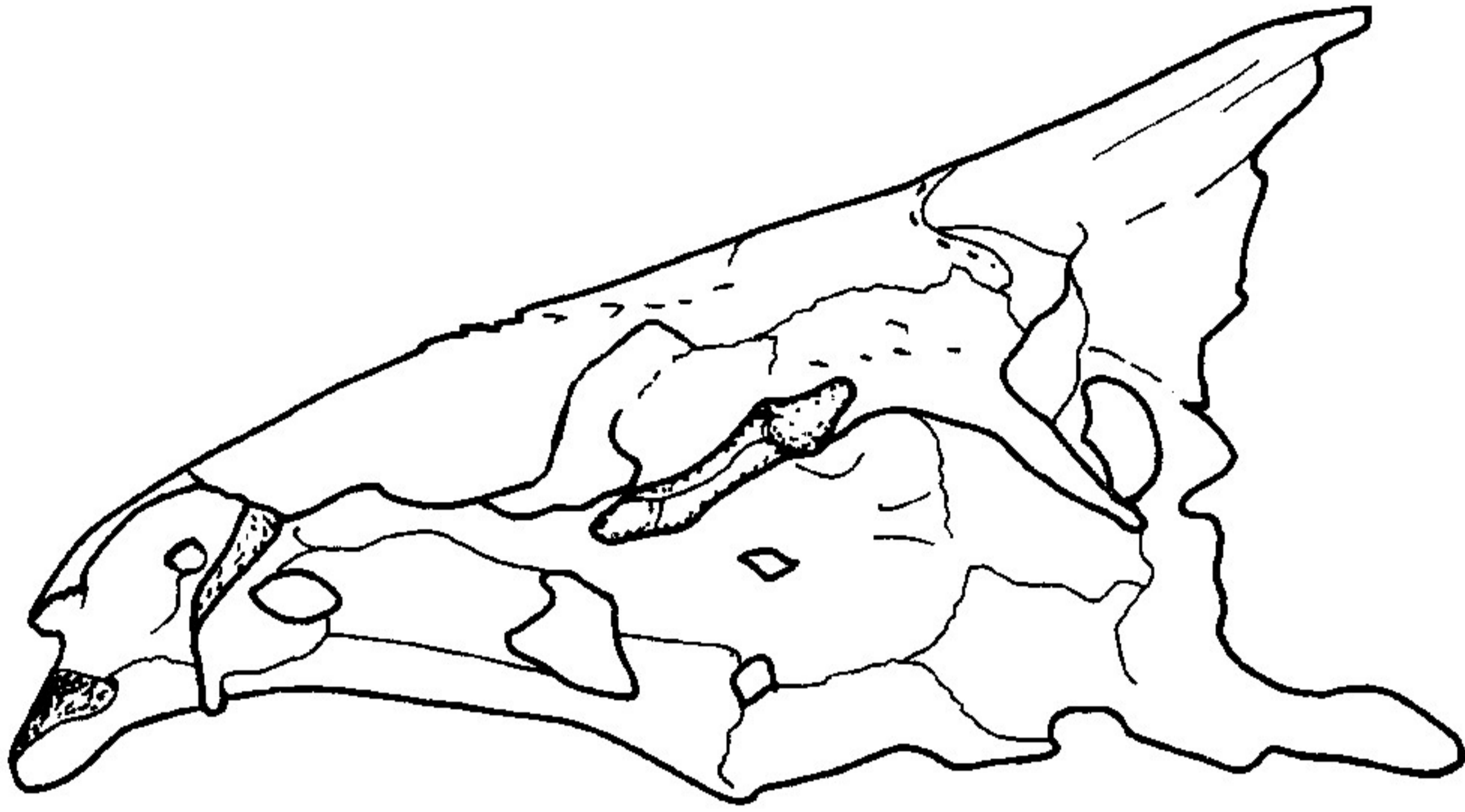


*Tinca tinca*

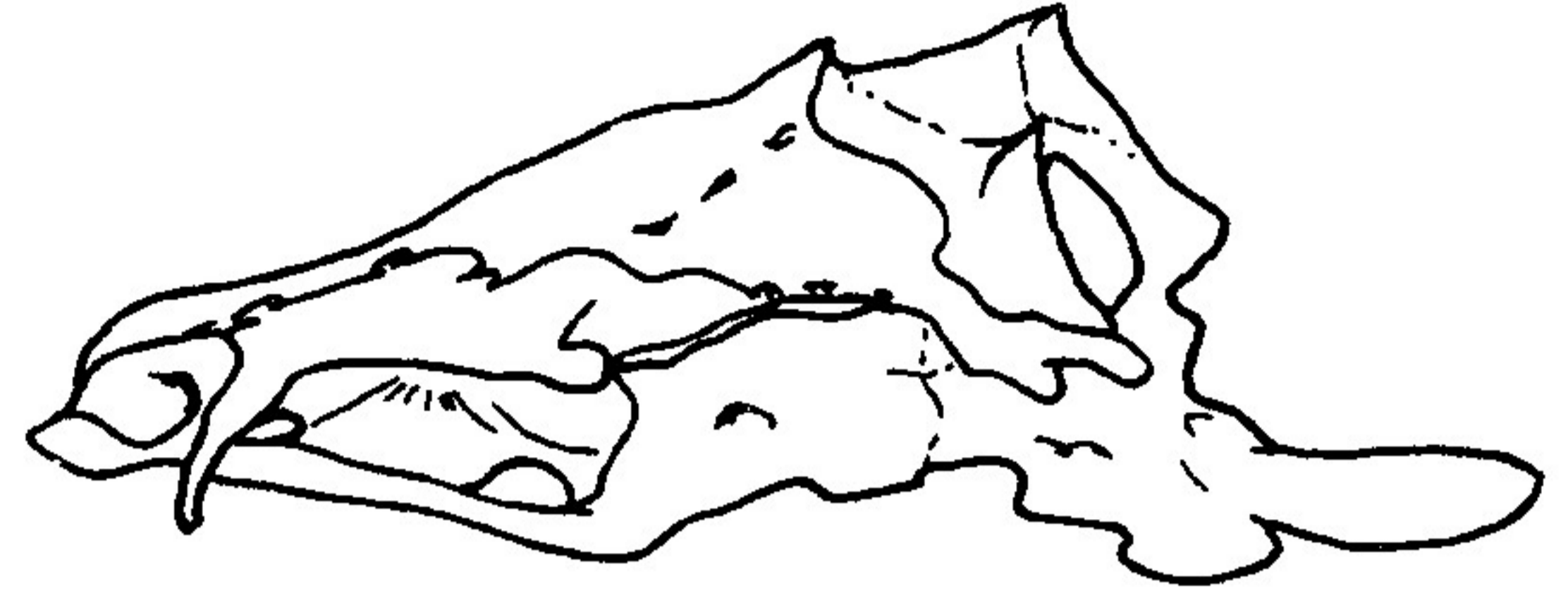


*Pelecus cultratus*

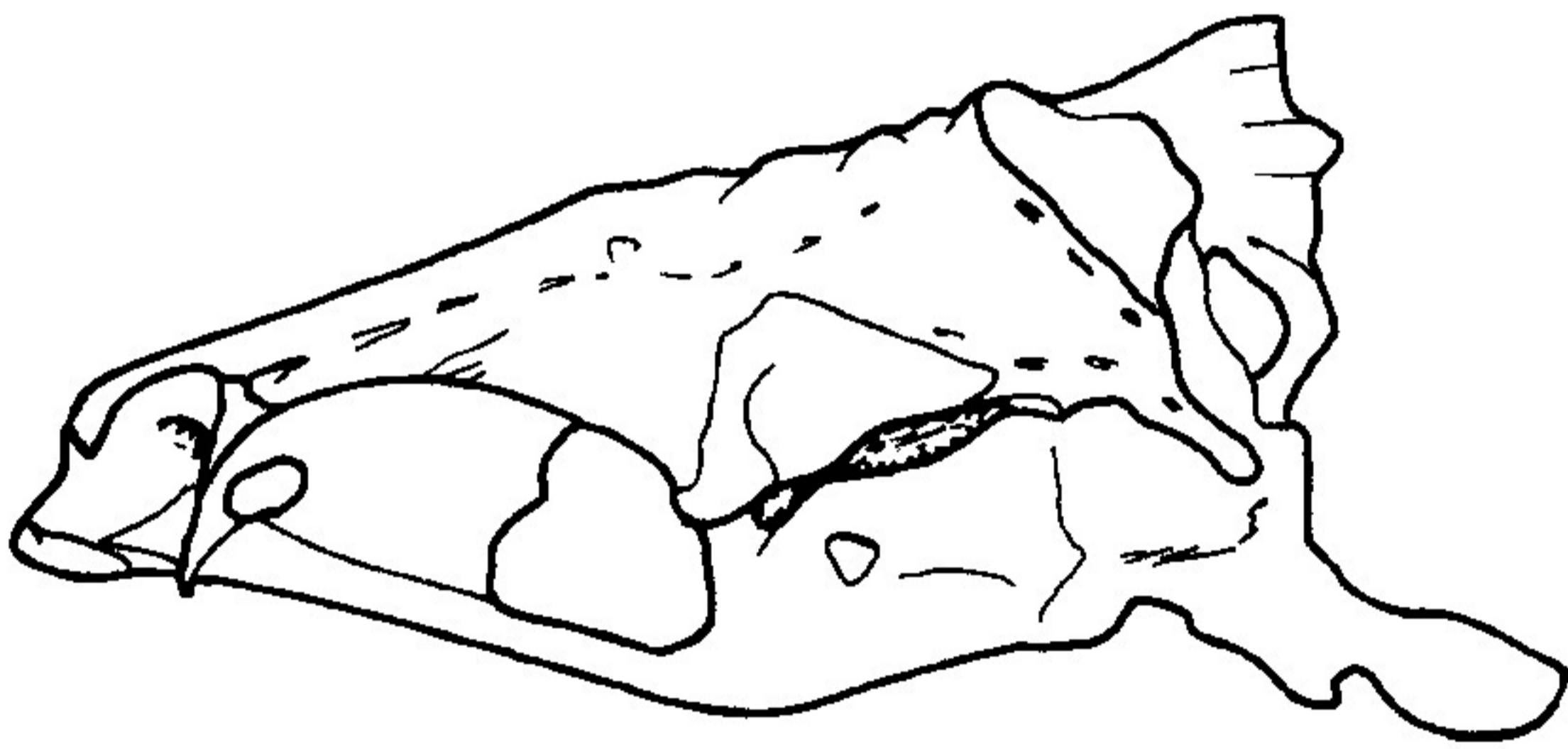
NEUROCRANIUM  
NORMA LATERALIS



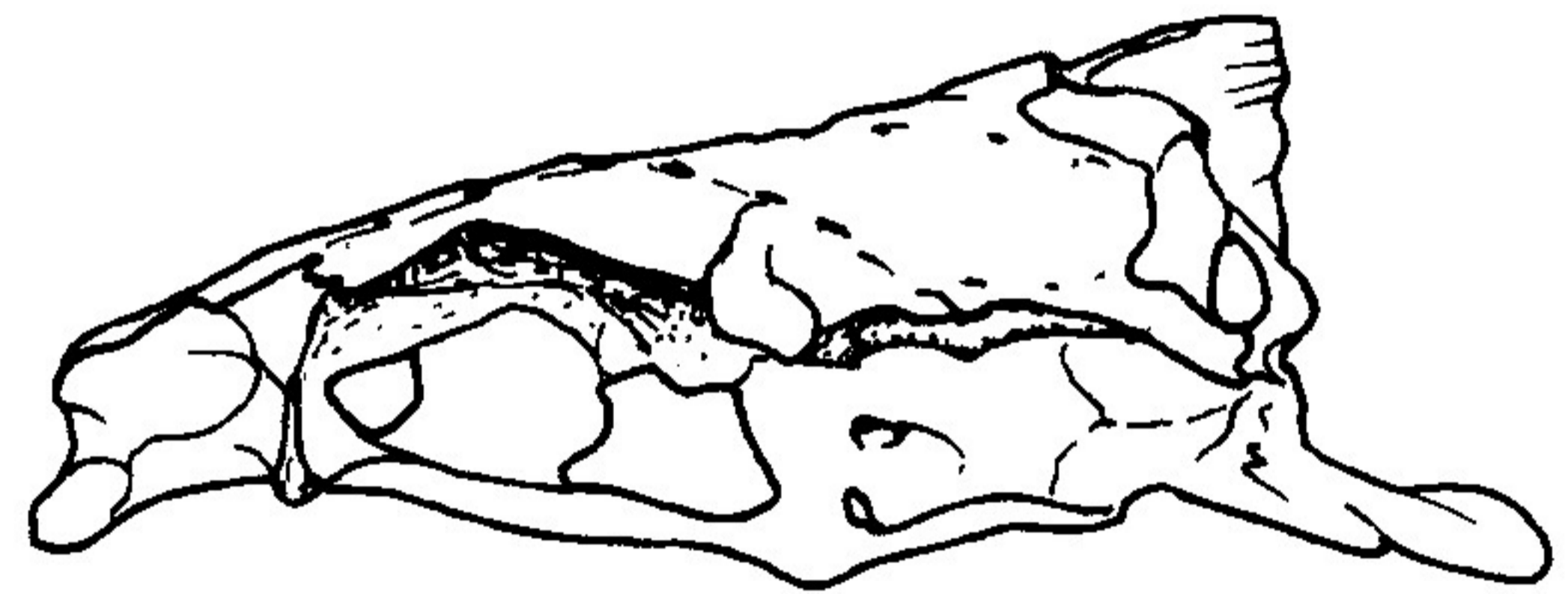
*Abramis brama*



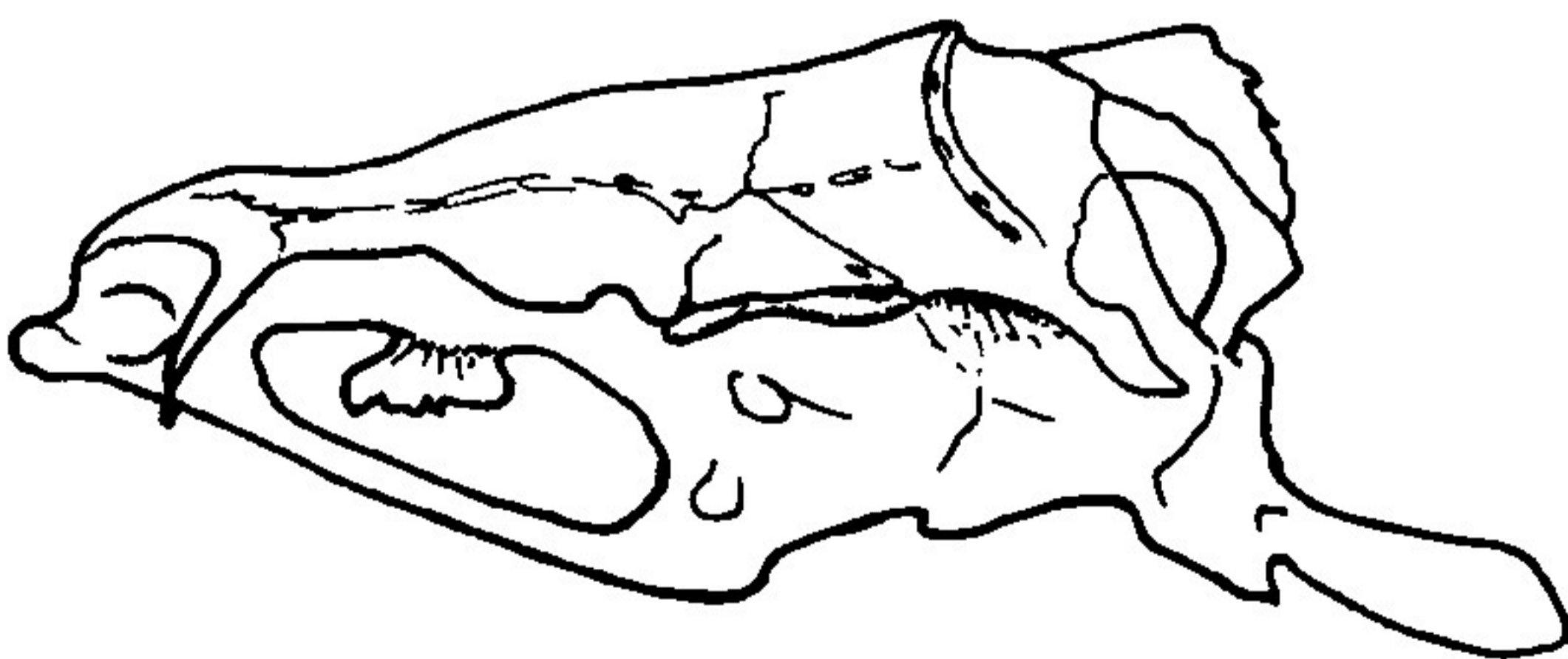
*Scardinius erythrophthalmus*



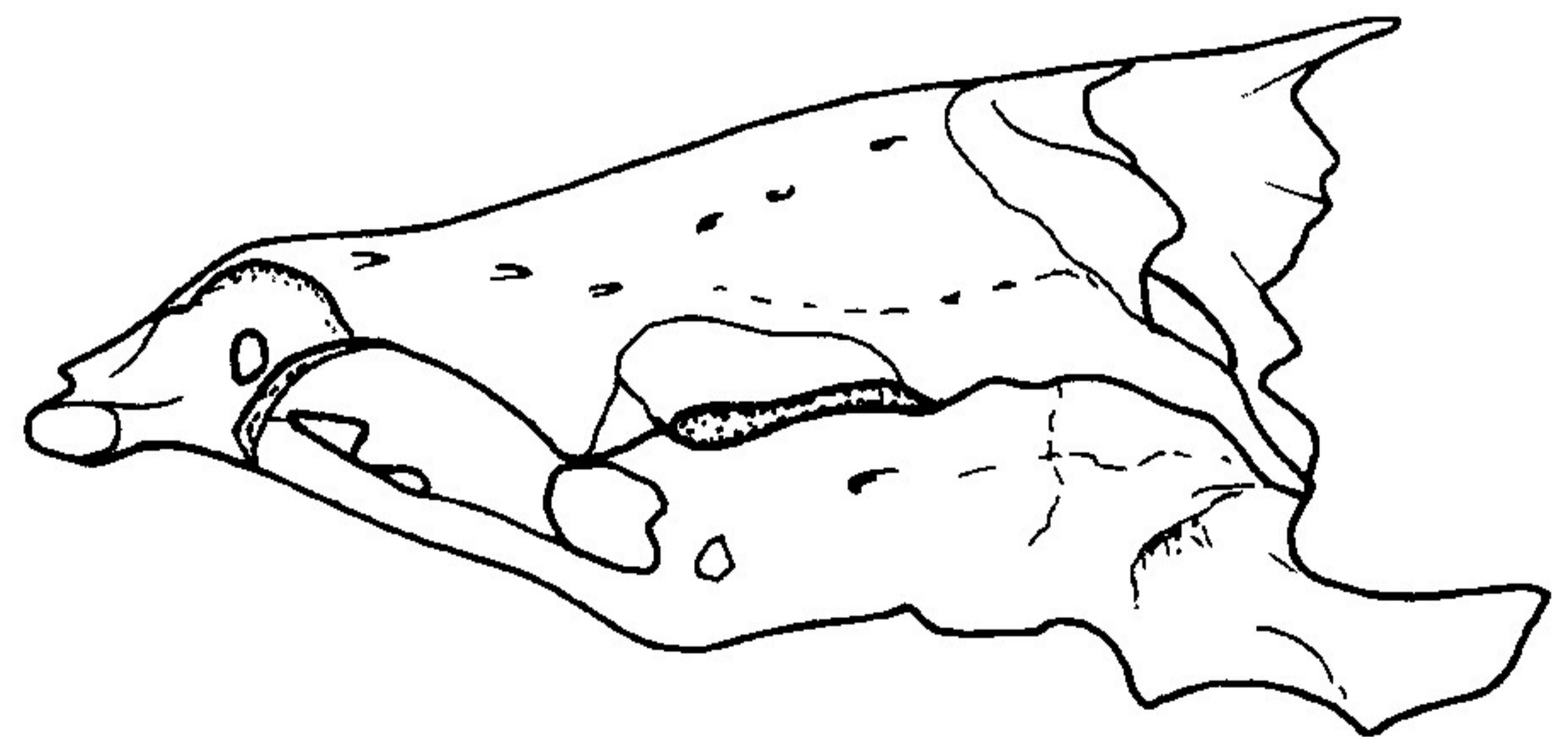
*Blicca bjoerkna*



*Vimba vimba carinata*



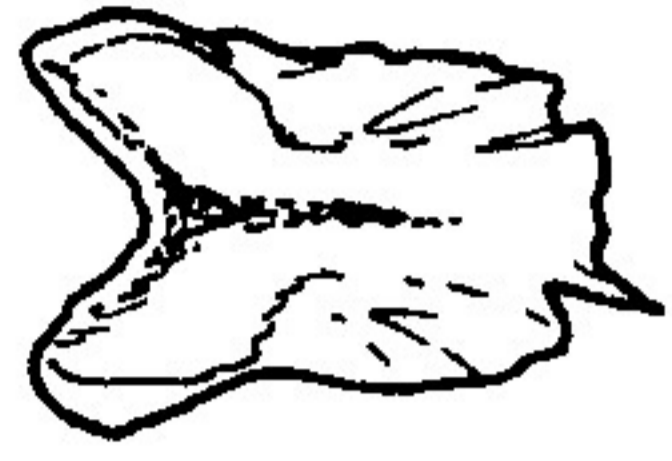
*Chalcaburnus chalcoides mento*



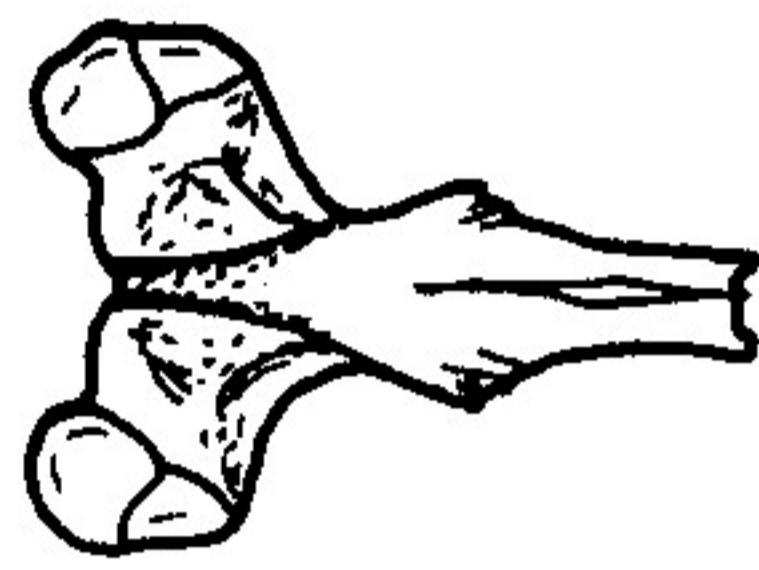
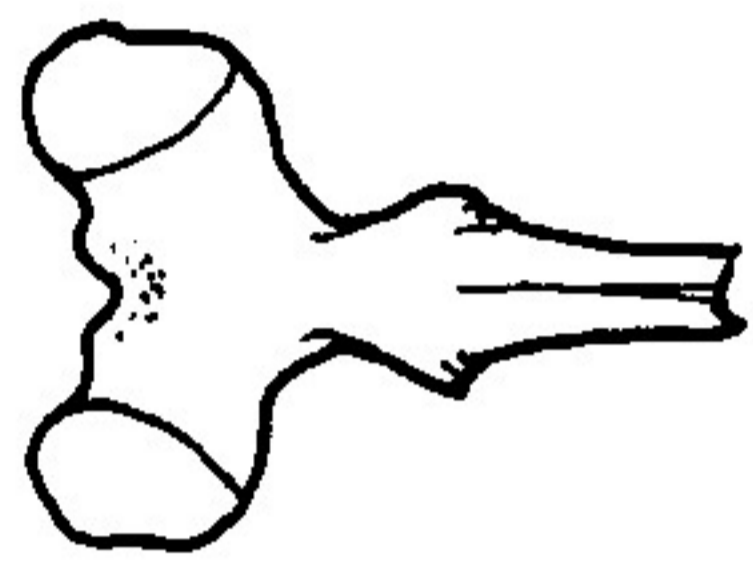
*Carassius carassius*

# PRAEVOMER

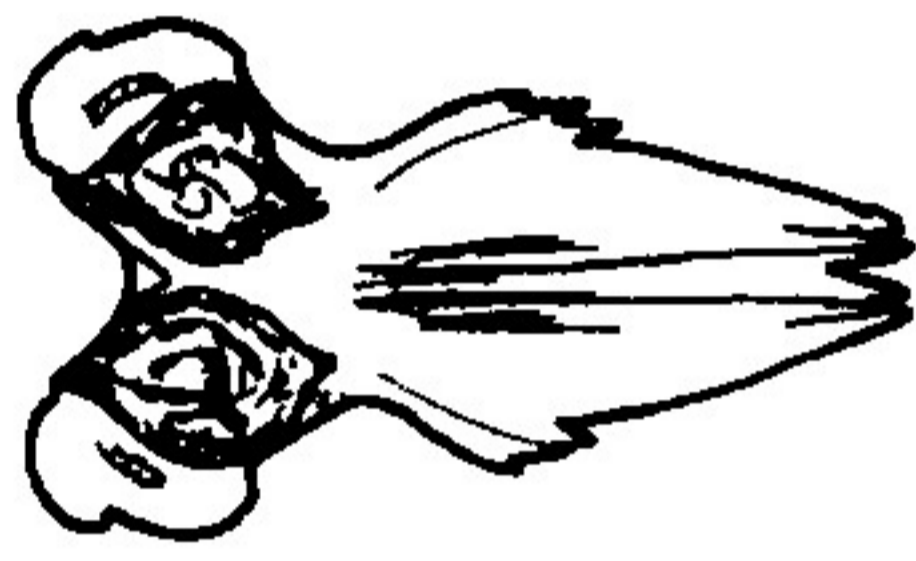
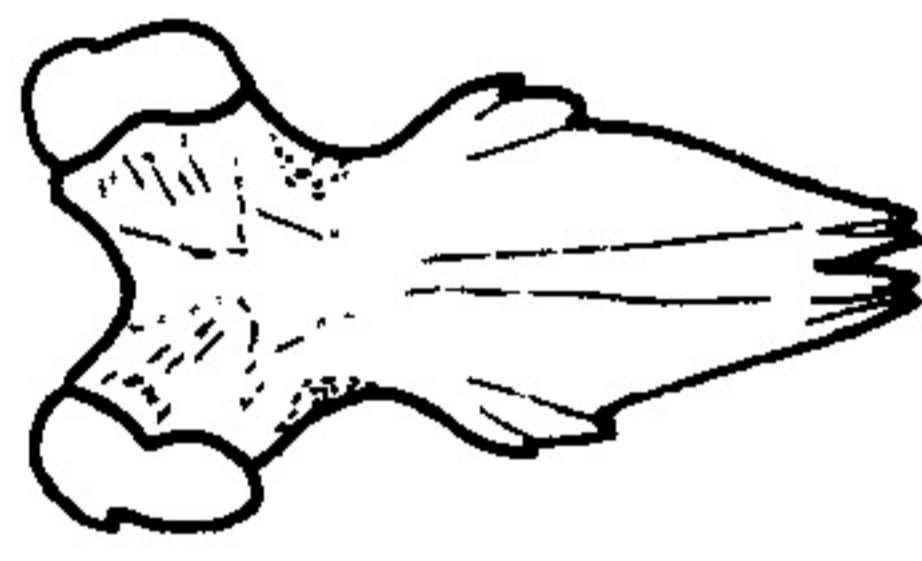
*NORMA INFERIOR*    *NORMA SUPERIOR*



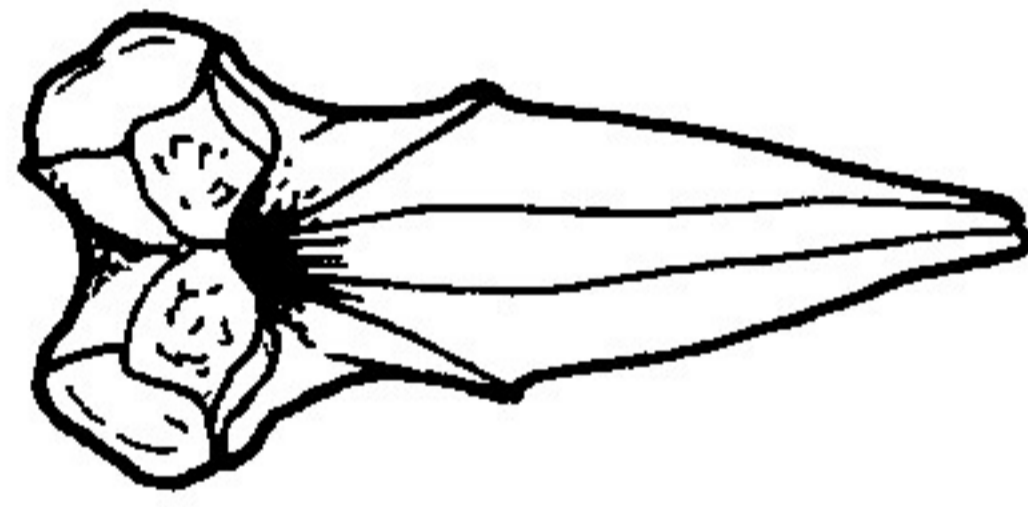
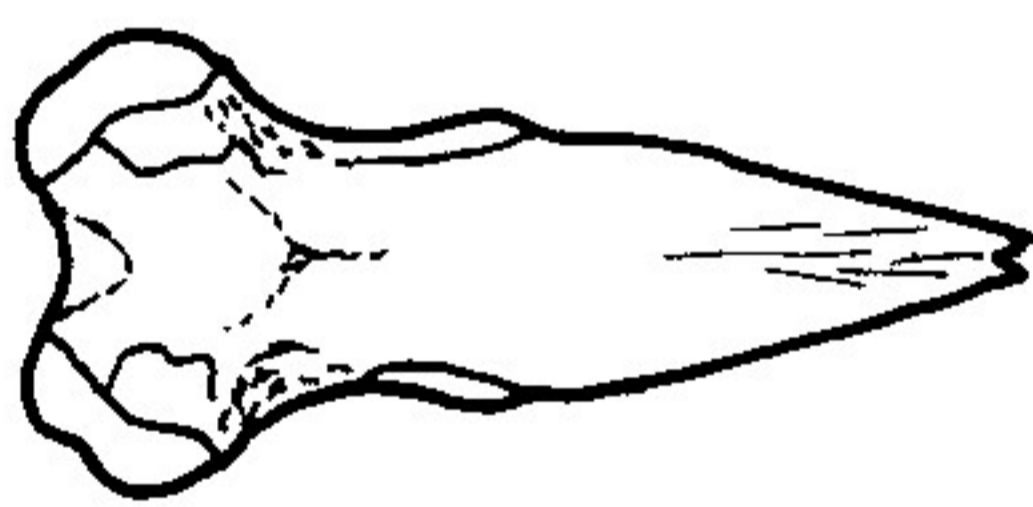
*Scardinius erythrophthalmus*



*Carassius auratus*



*Cyprinus carpio*



*Barbus barbus*

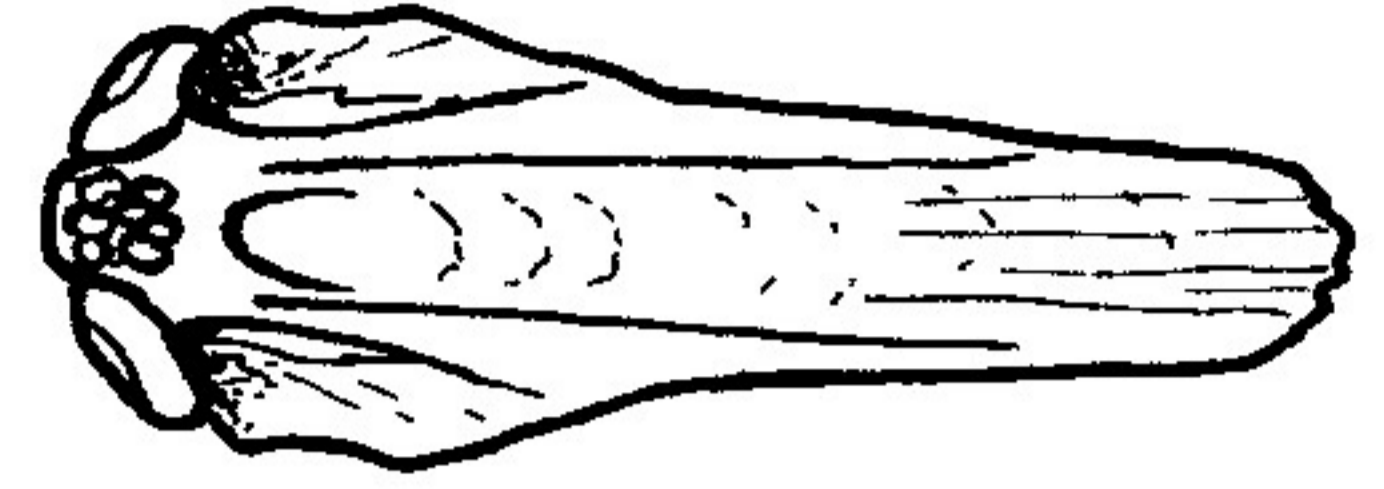


*Tinca tinca*

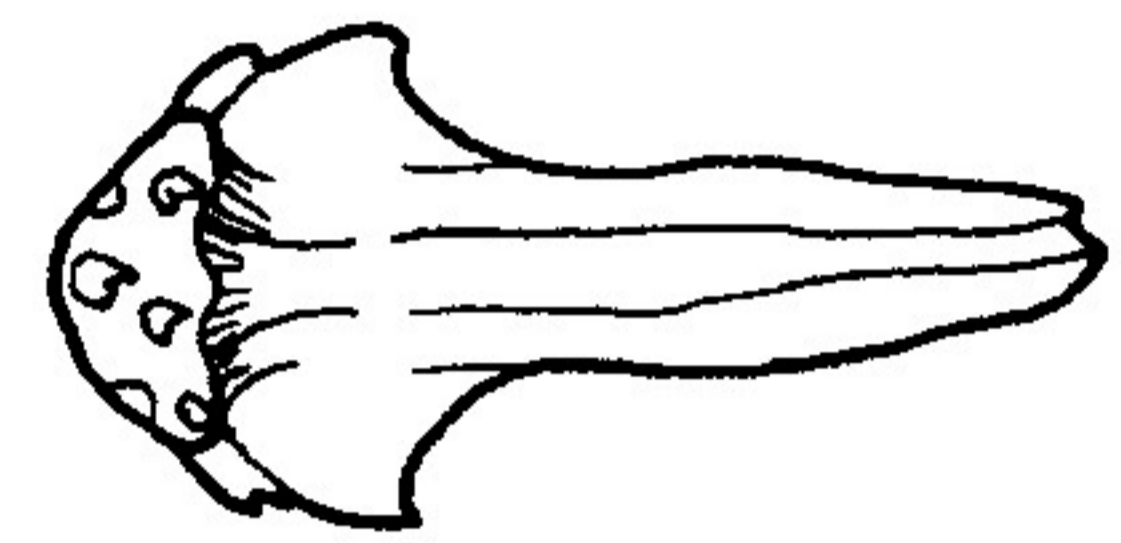


*Aspius aspius*

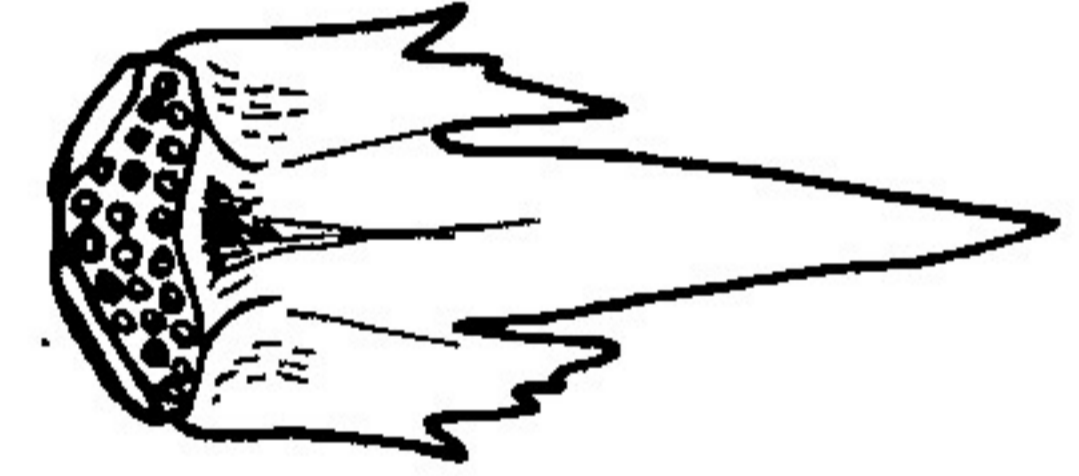
*NORMA INFERIOR*



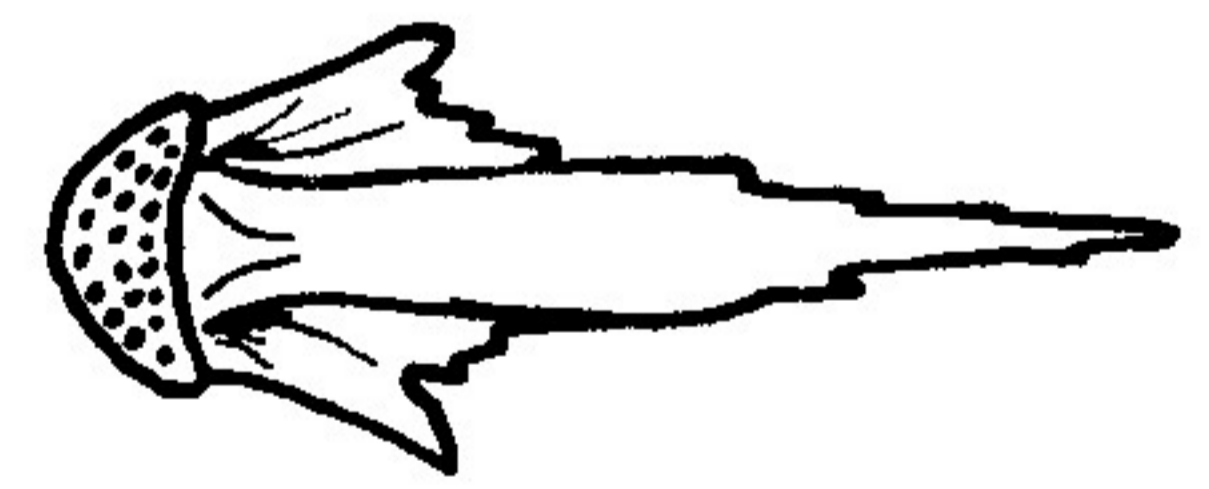
*Acerina schraetser*



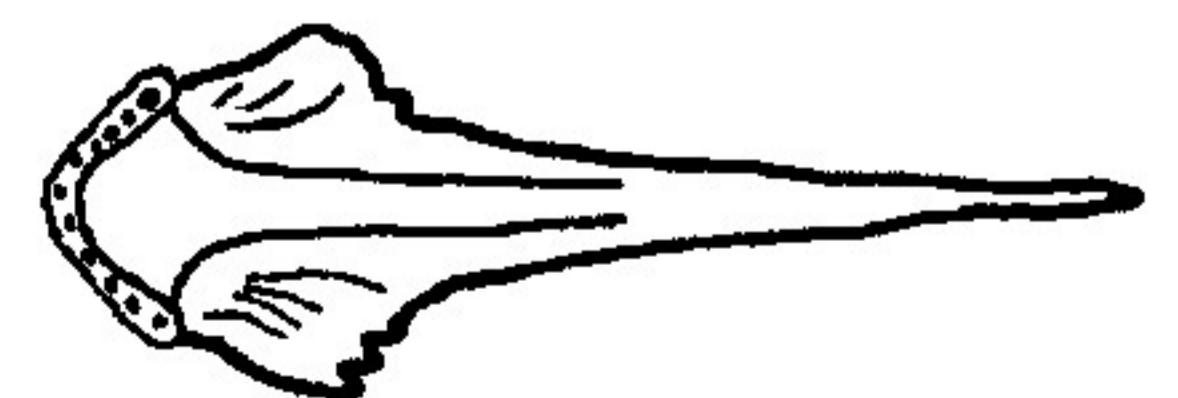
*Gymnocephalus* sp.



*Aspro zingel*



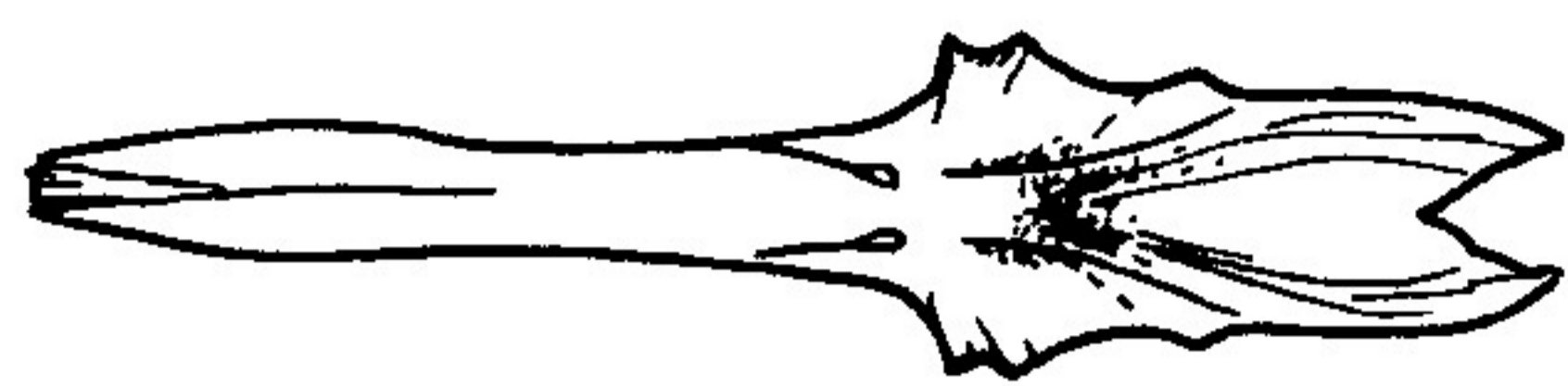
*Perca fluviatilis*



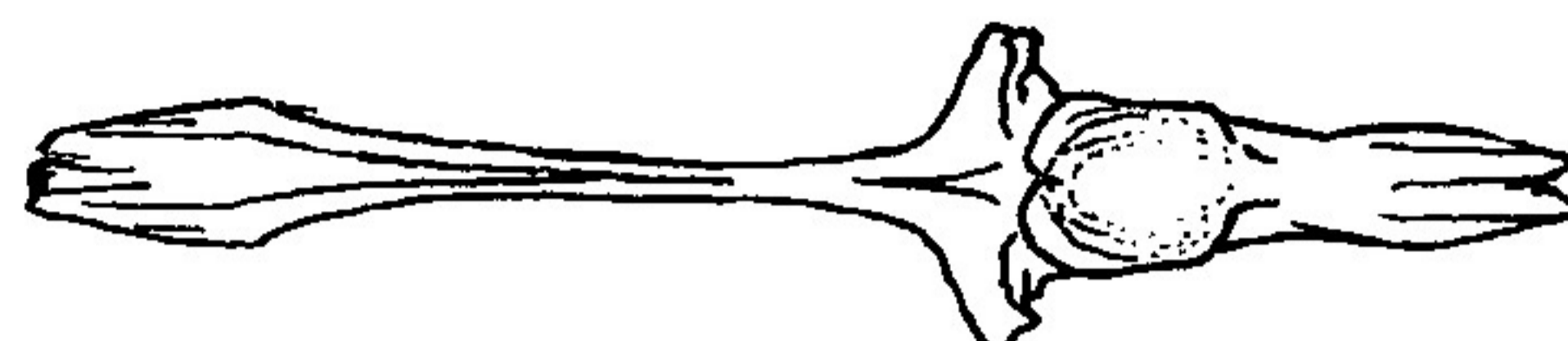
*Stizostedion lucioperca*

# PARASPHEENOIDEUM

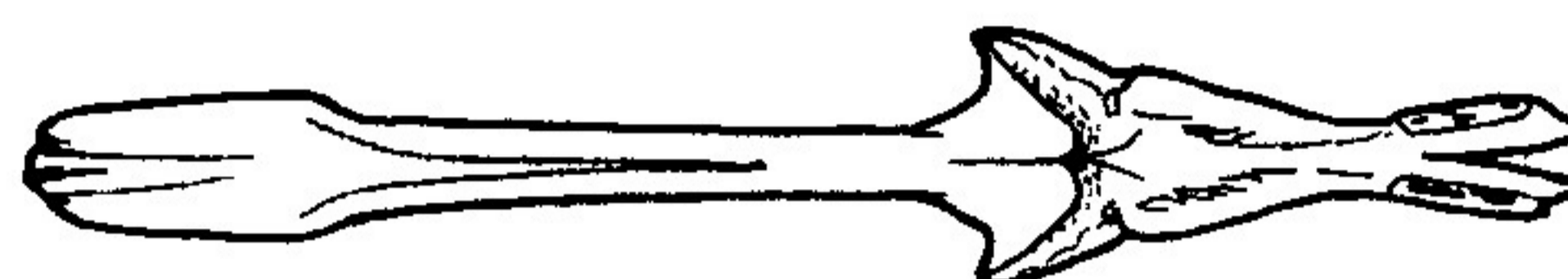
## NORMA INFERIOR



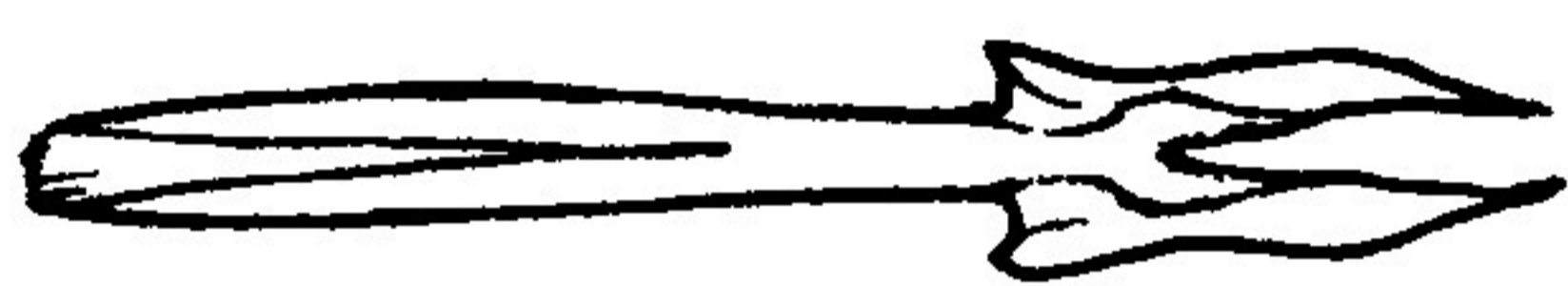
*Salmo trutta lacustris*



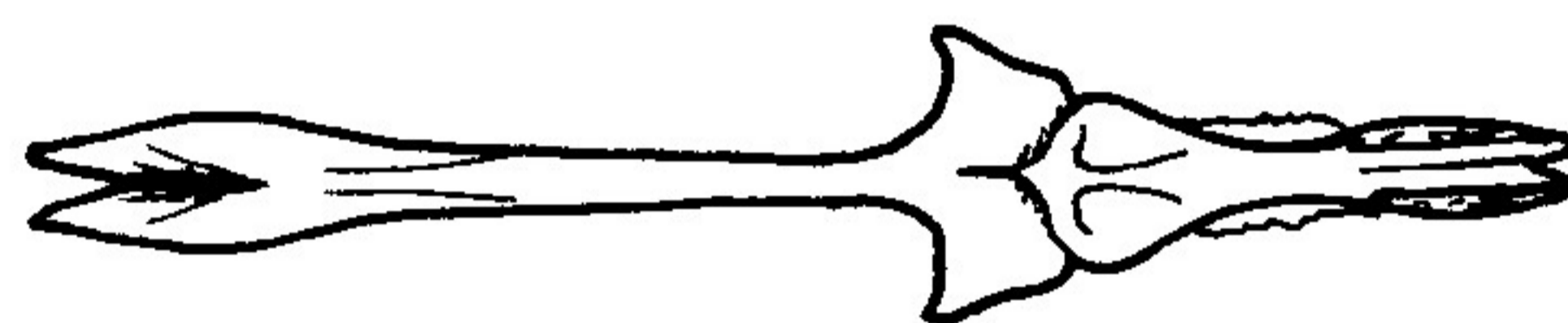
*Scardinius erythrophthalmus*



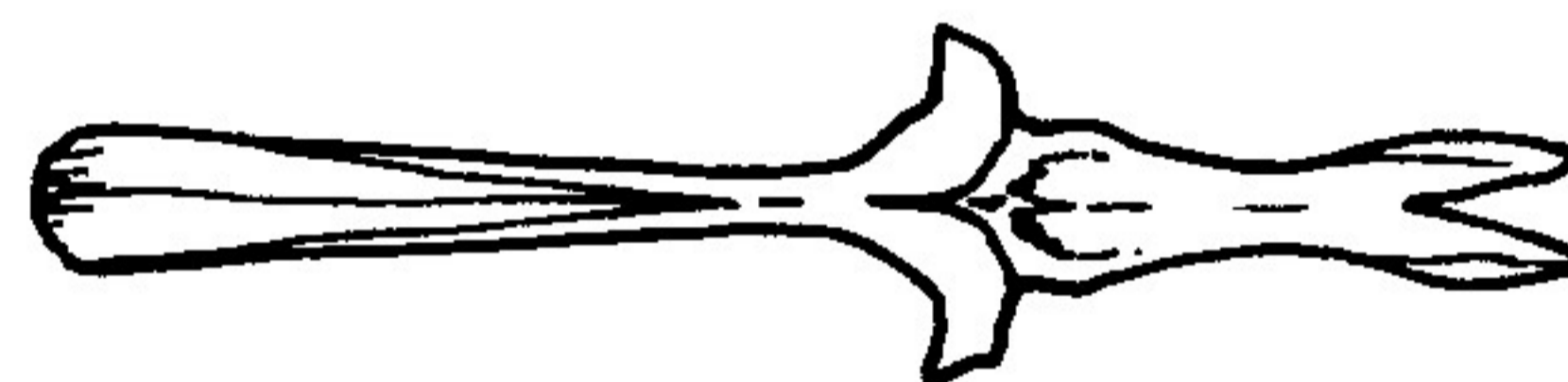
*Vimba vimba carinata*



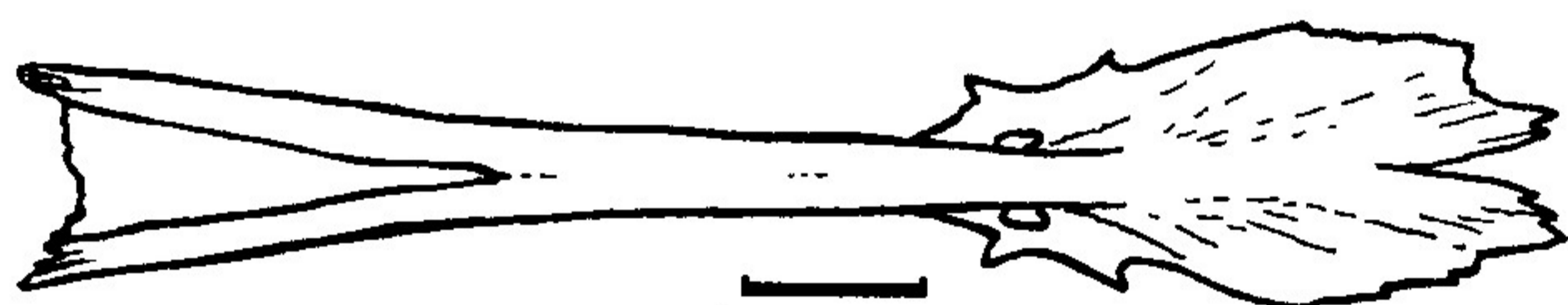
*Alosa pontica*



*Abramis brama*



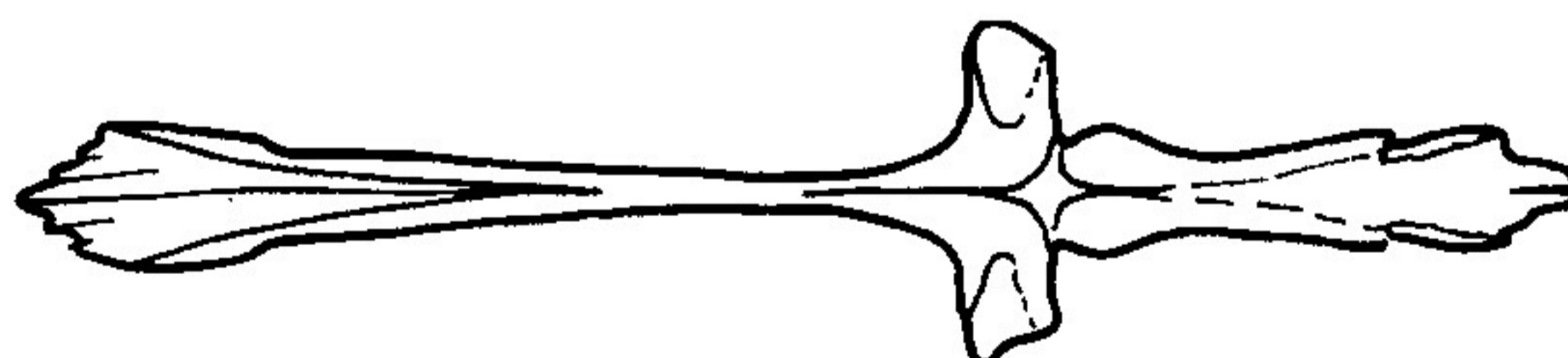
*Alburnus alburnus*



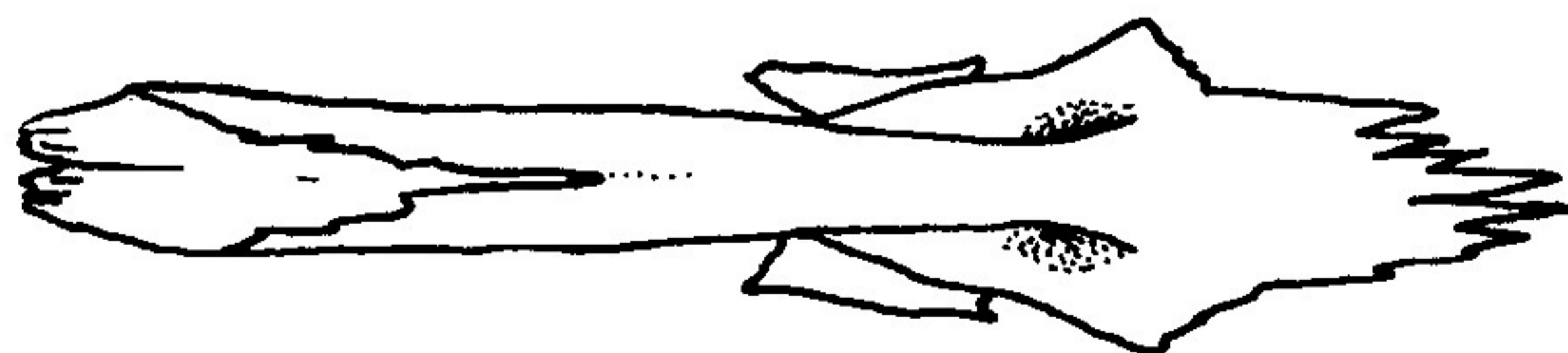
*Esox lucius*



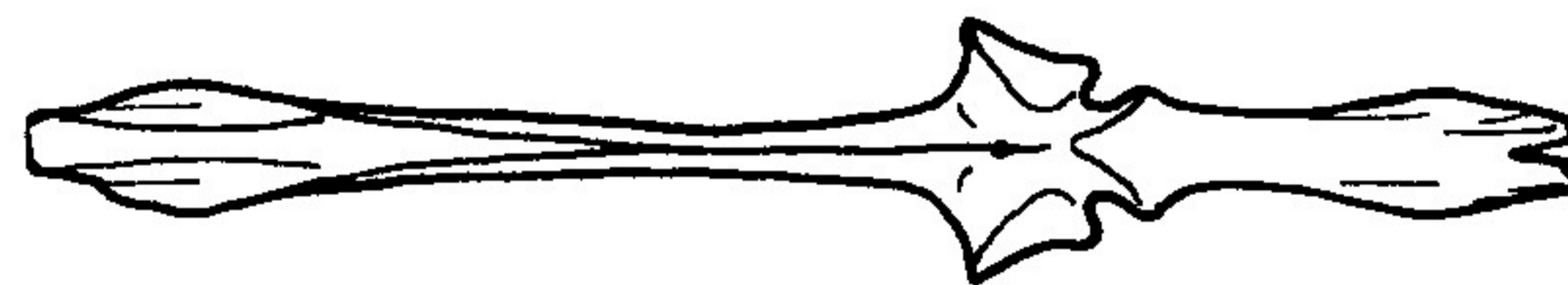
*Chalcaburnus chalcoides mento*



*Rutilus rutilus*



*Silurus glanis*



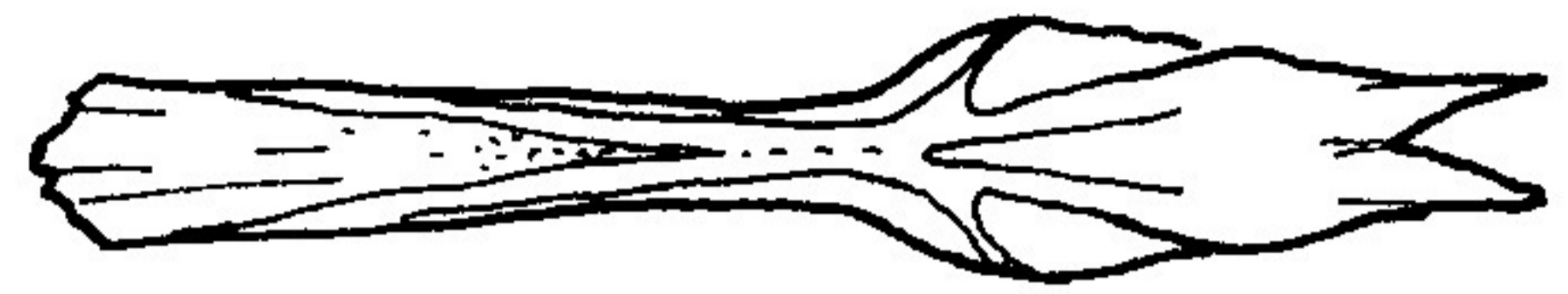
*Pelecus cultratus*

# PARASPHEENOIDEUM

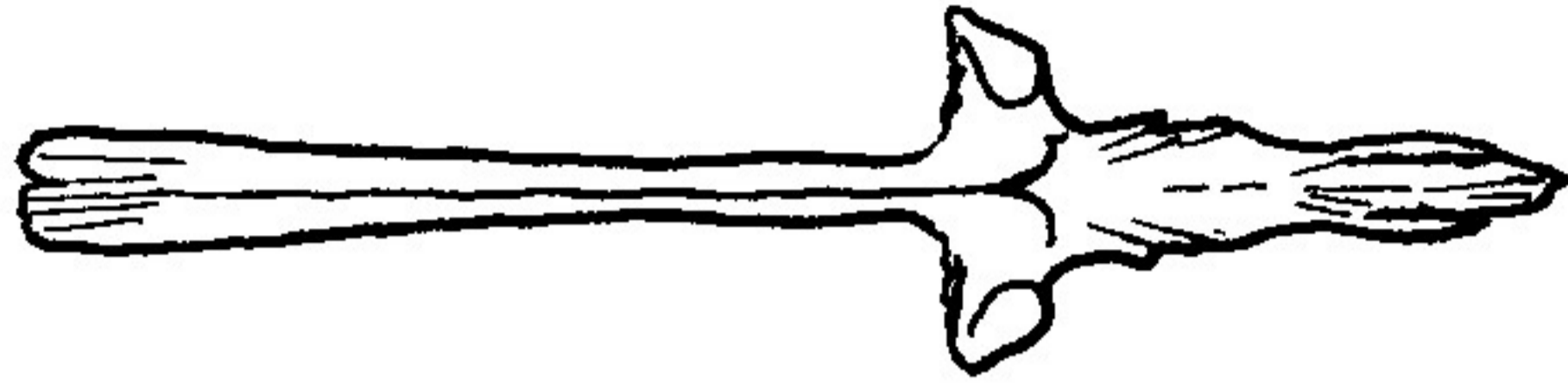
## NORMA INFERIOR



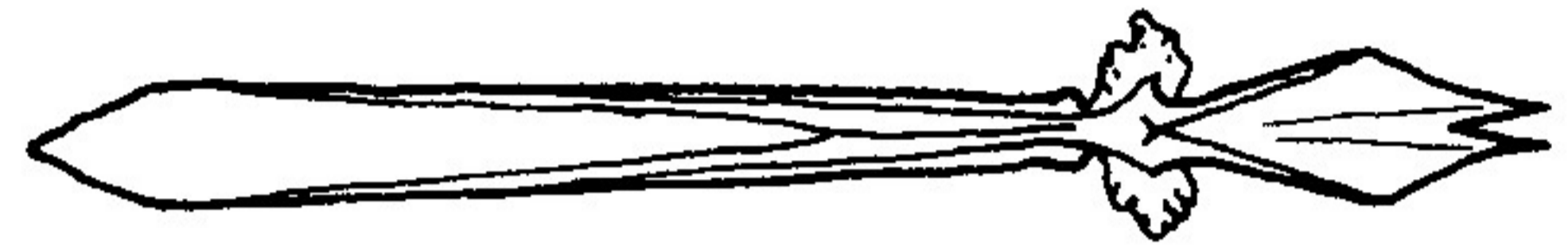
*Leuciscus idus*



*Gymnocephalus sp.*



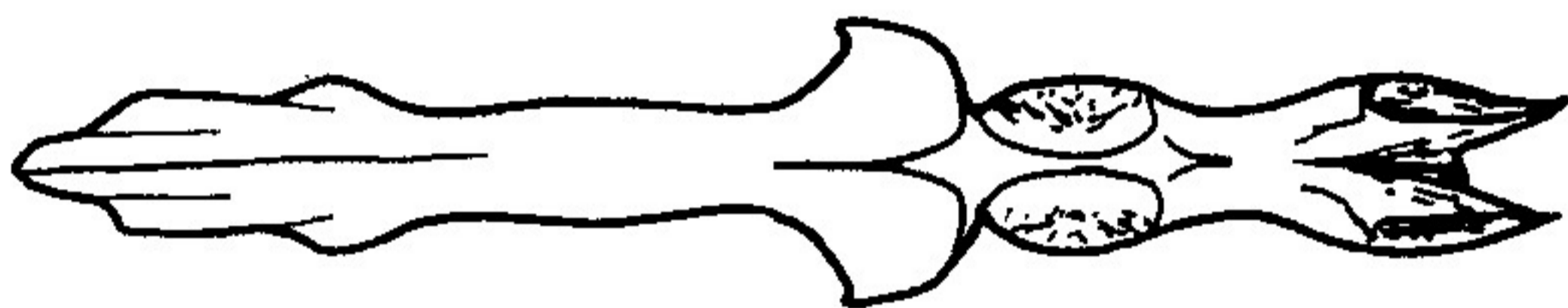
*Chondrostoma nasus*



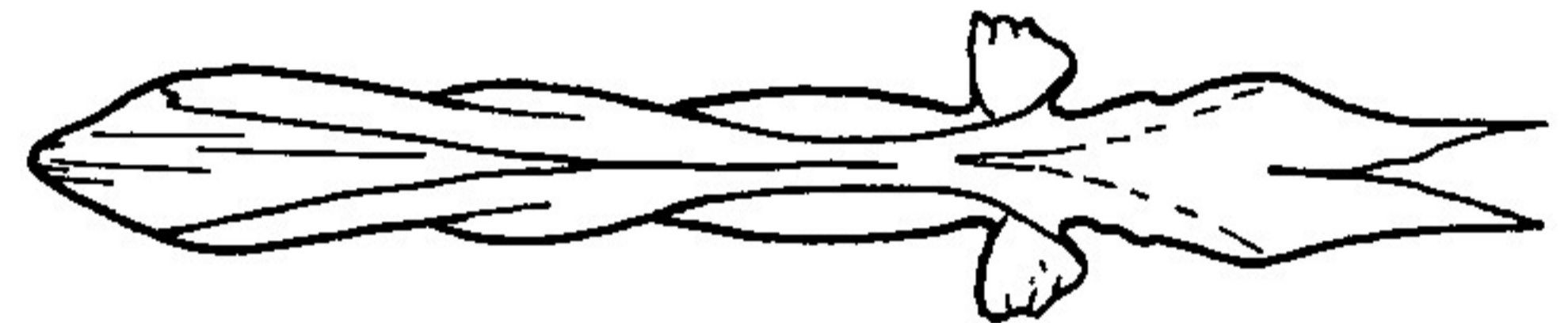
*Acerina schraetser*



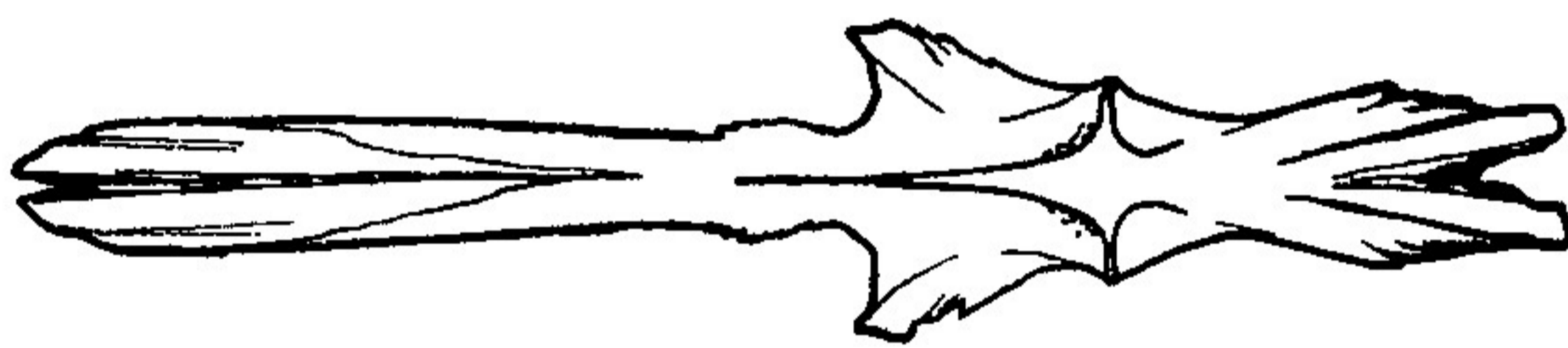
*Blicca bjoerkna*



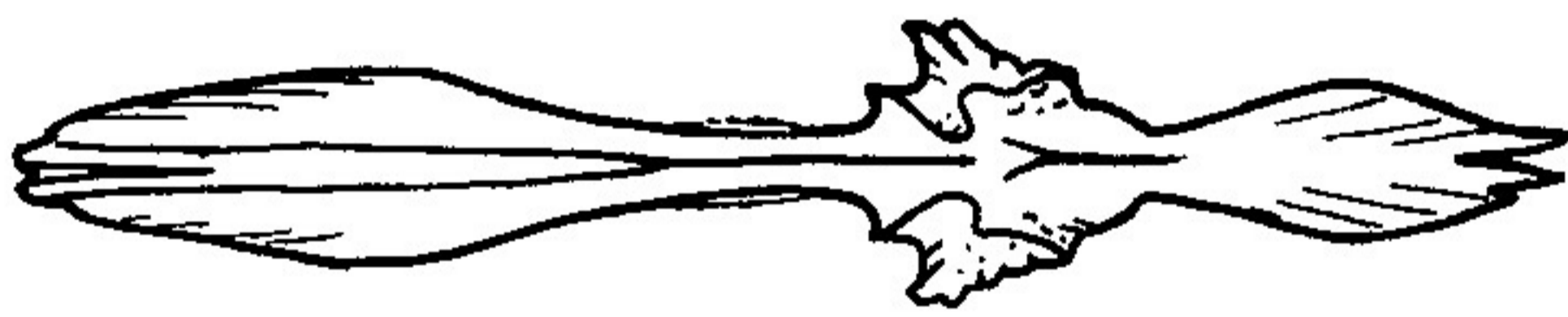
*Carassius auratus*



*Aspro zingel*



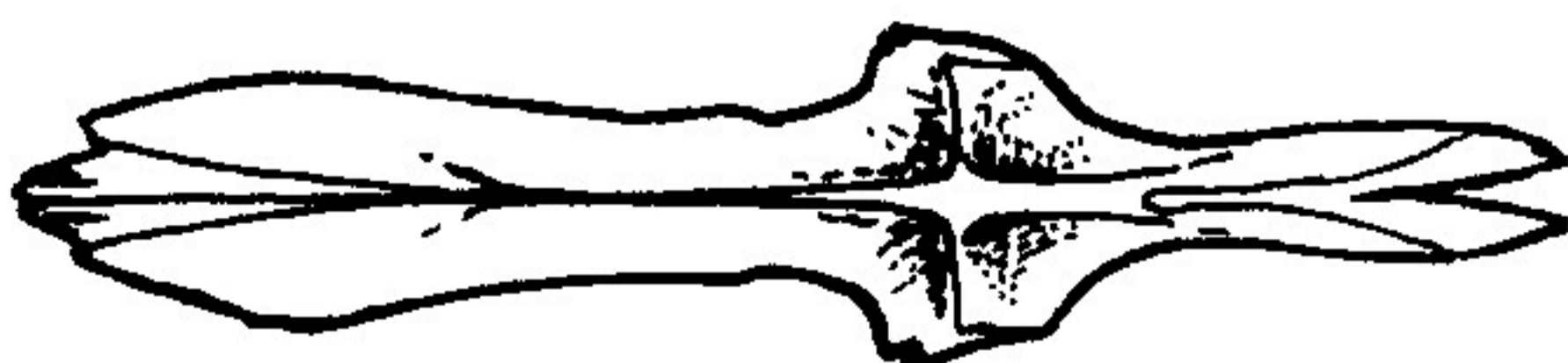
*Barbus barbus*



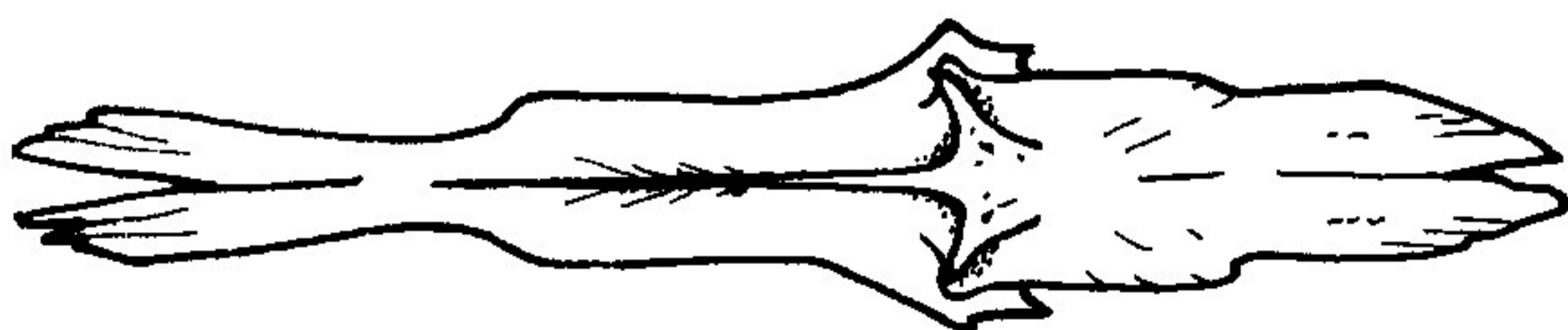
*Aspius aspius*



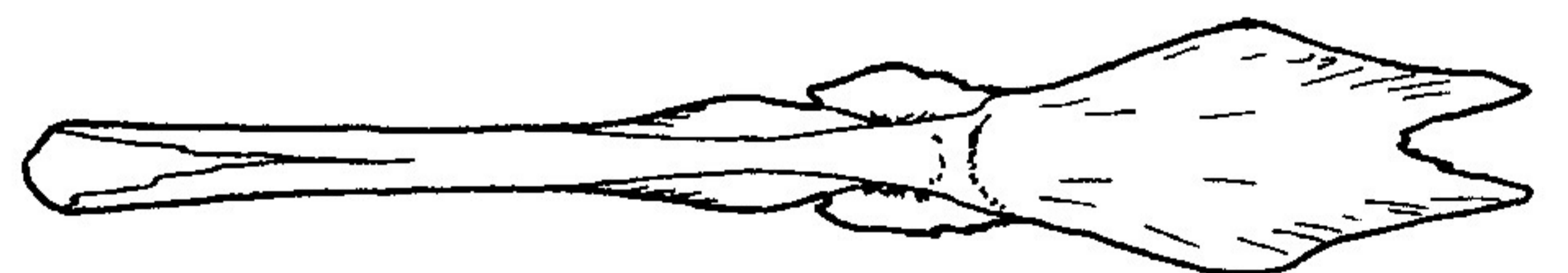
*Perca fluviatilis*



*Tinca tinca*



*Cyprinus carpio*



*Stizostedion lucioperca*

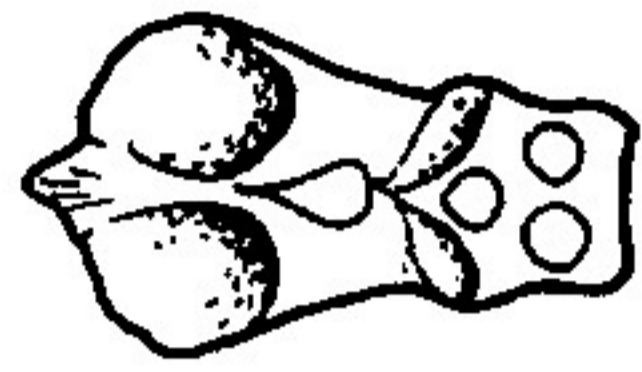
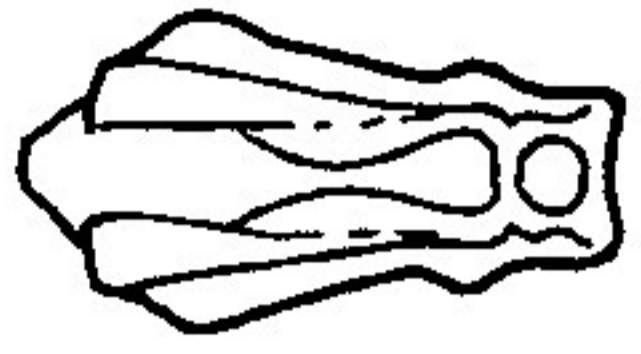
# BASIOCCIPITALE

NORMA INFERIOR

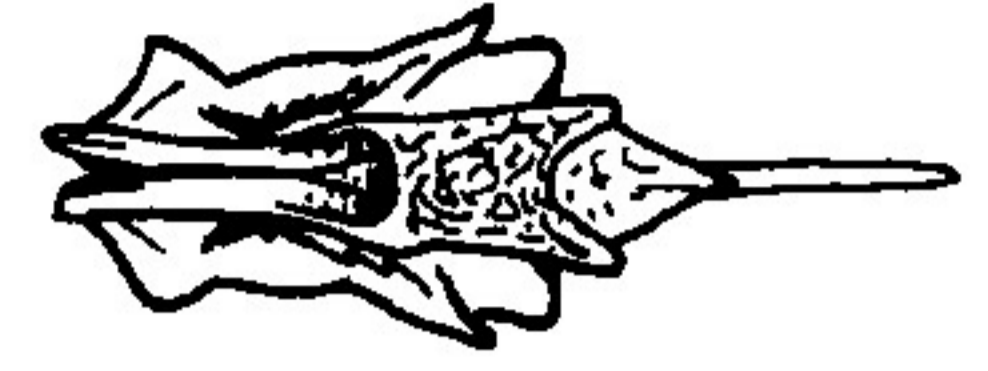
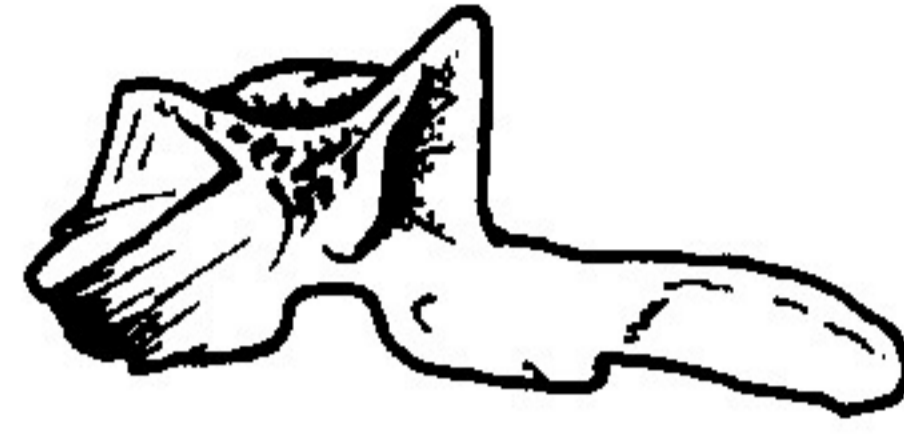
NORMA SUPERIOR

NORMA LATERALIS

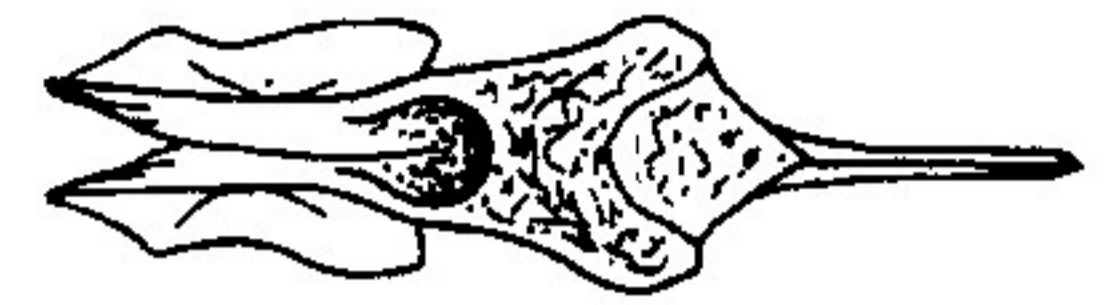
NORMA INFERIOR



*Salmo trutta lacustris*



*Abramis brama*



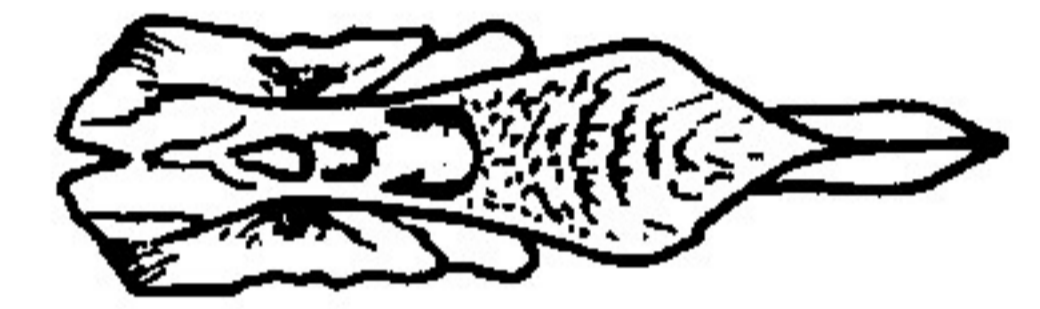
*Blicca bjoerkna*



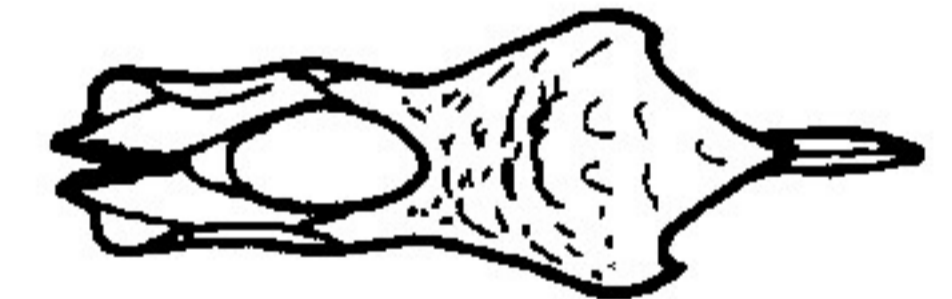
*Chalcaburnus chalcoides mento*



*Alosa pontica*



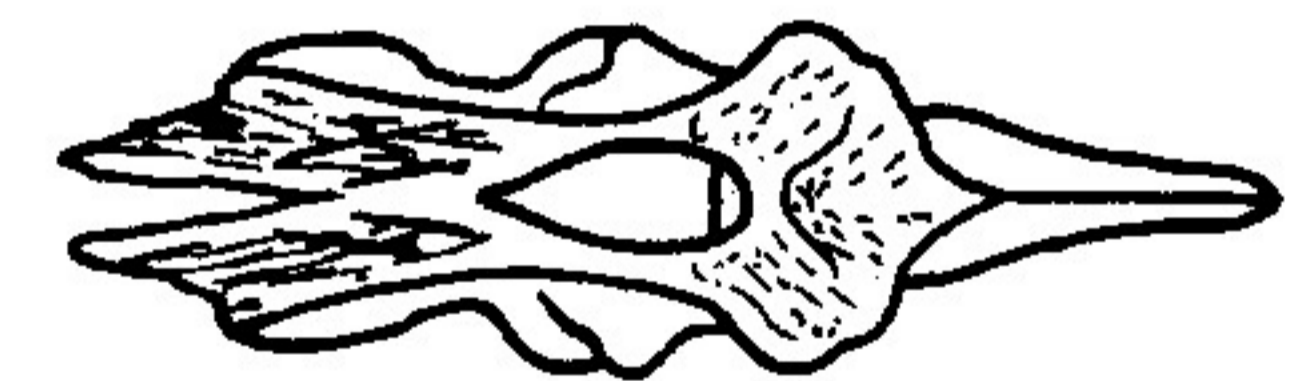
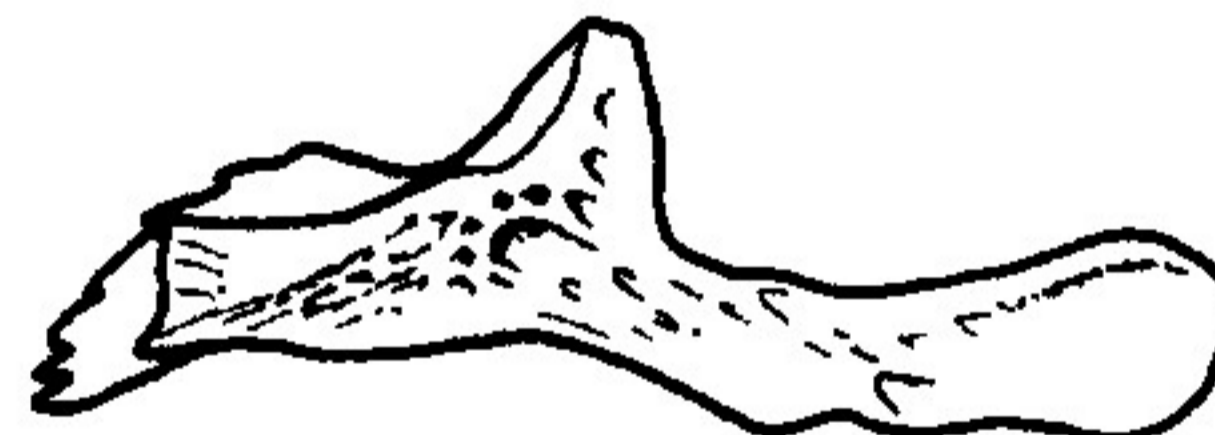
*Vimba vimba carinata*



*Leuciscus idus*



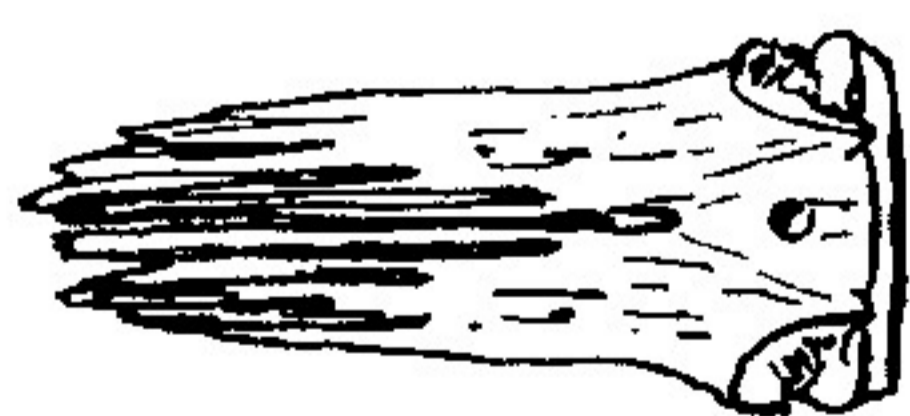
*Esox lucius*



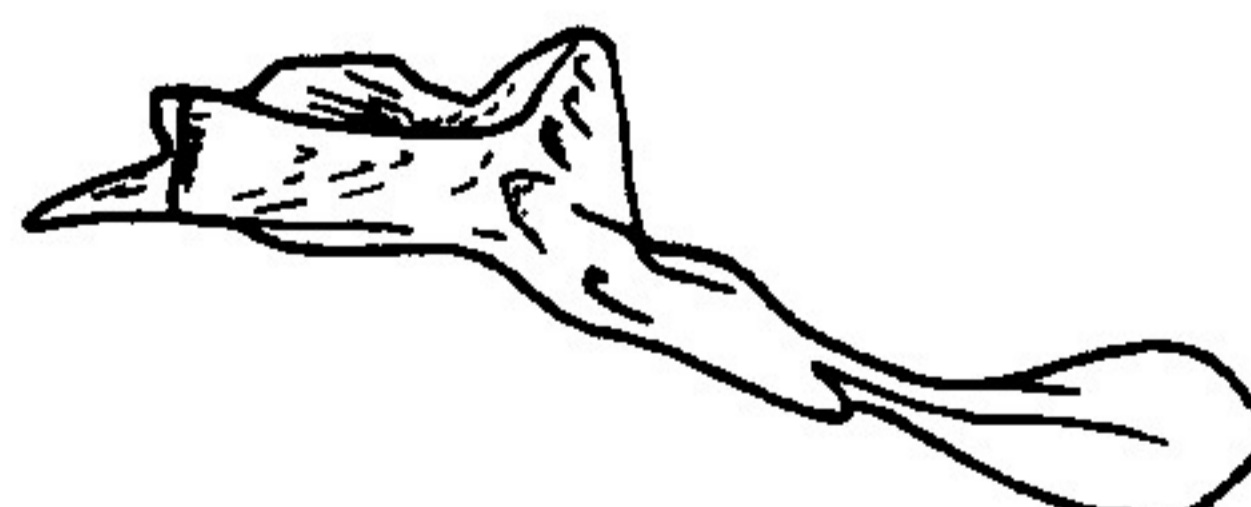
*Barbus barbus*



*Pelecus cultratus*



*Silurus glanis*



*Aspius aspius*

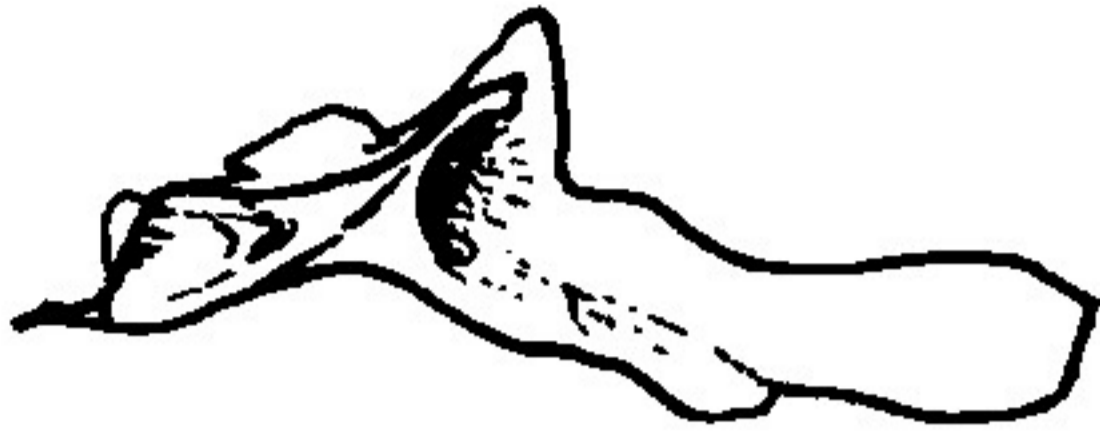
# BASIOCCIPITALE

*NORMA LATERALIS*

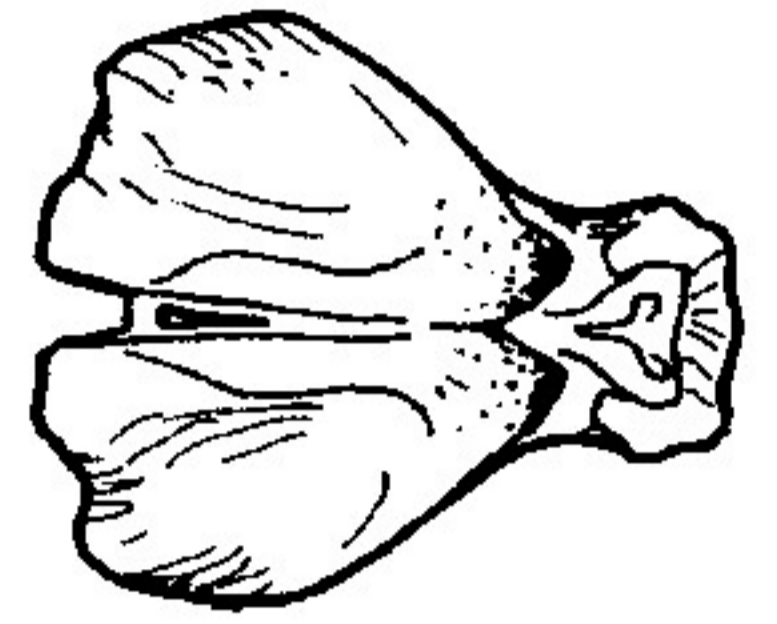
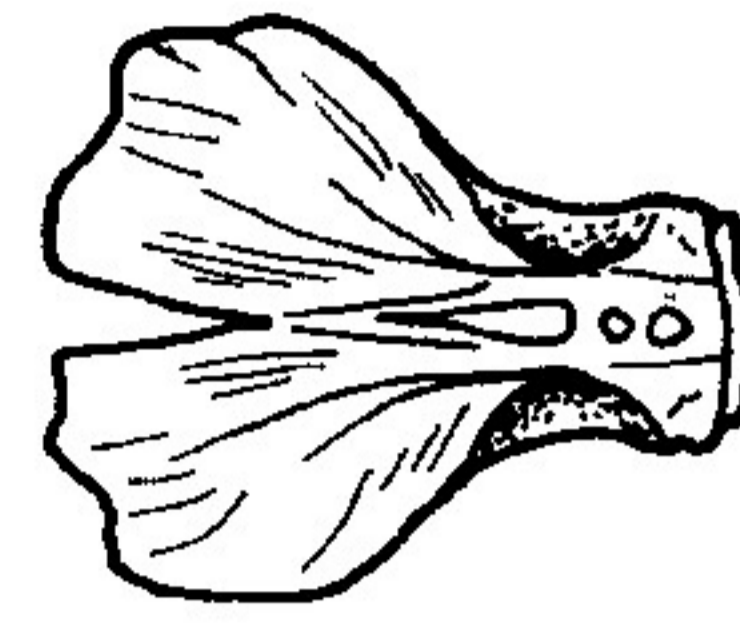
*NORMA INFERIOR*

*NORMA INFERIOR*

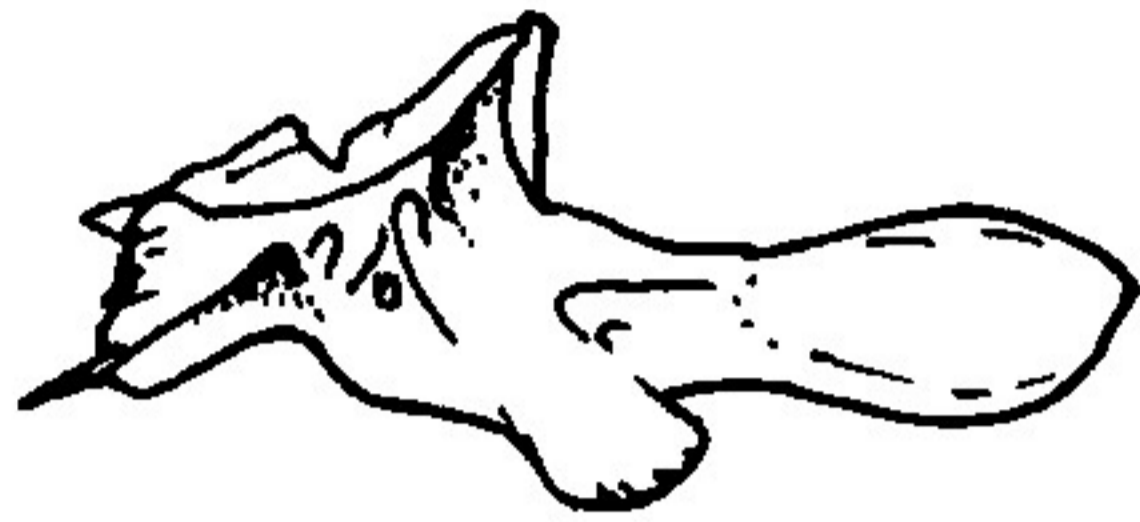
*NORMA SUPERIOR*



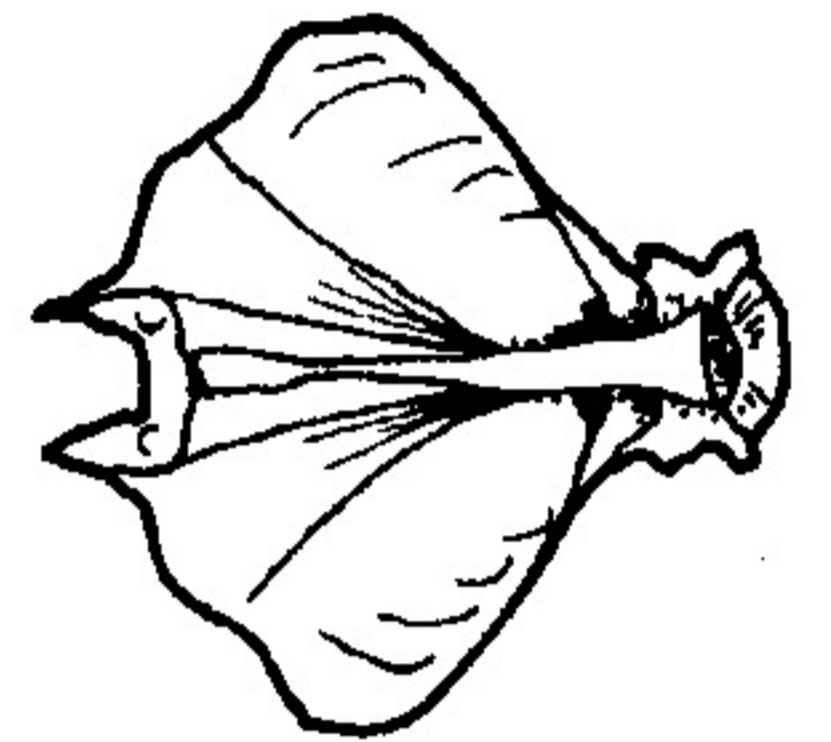
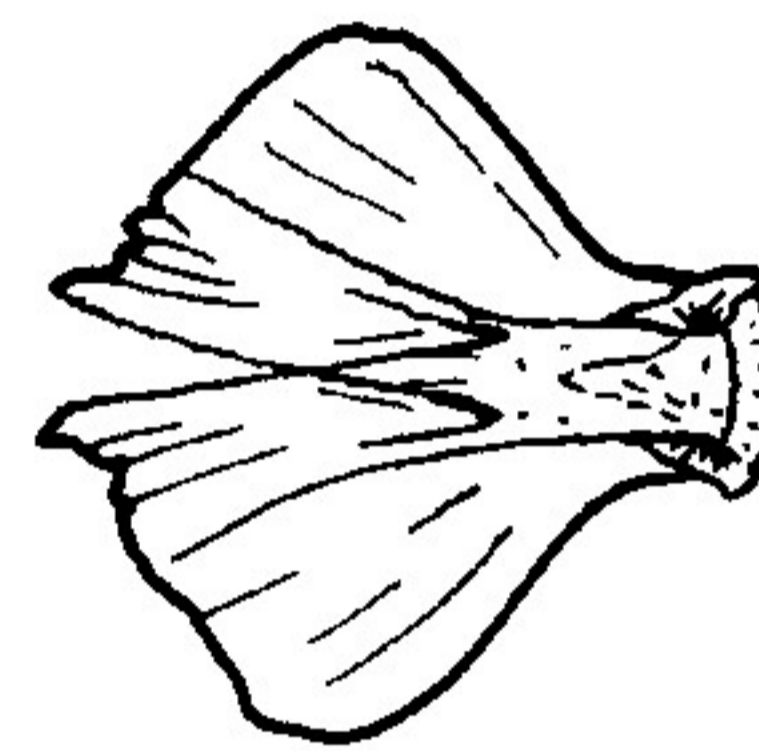
*Alburnus alburnus*



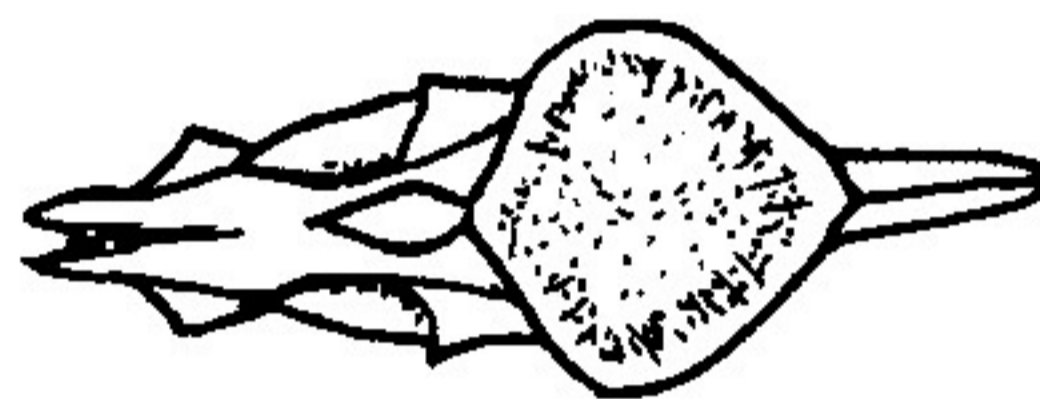
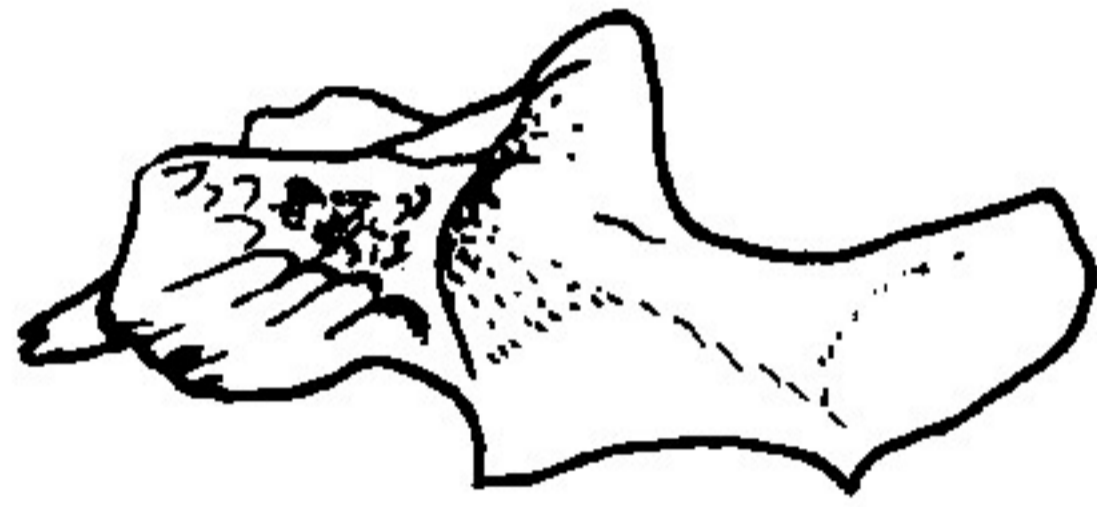
*Acerina schraetser*



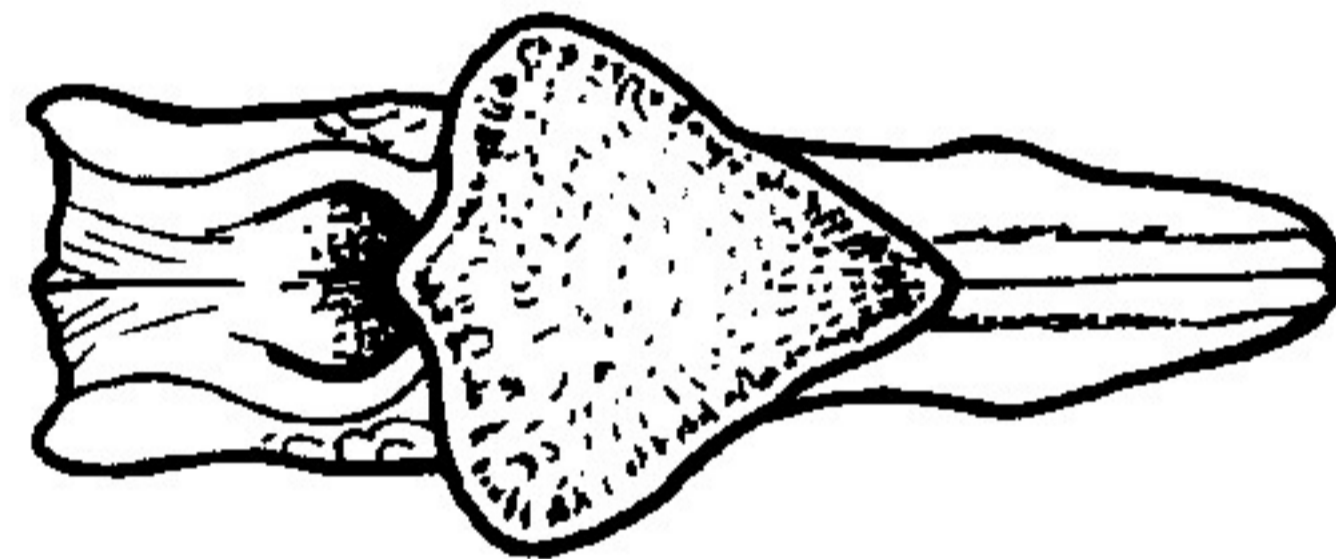
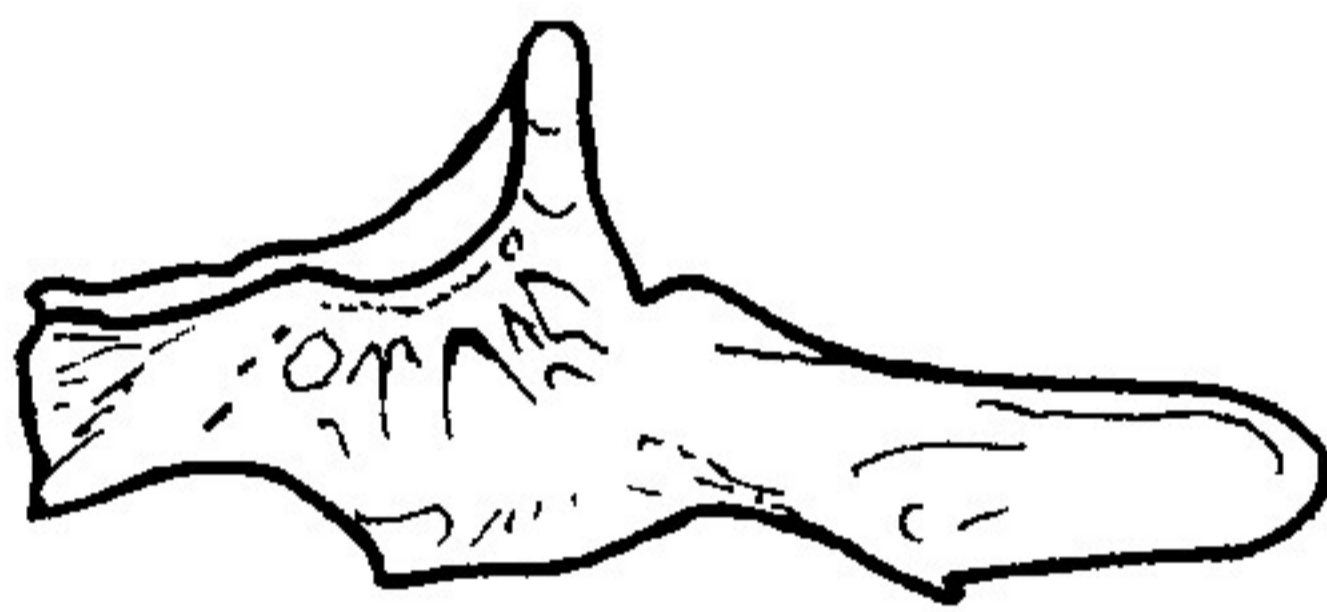
*Scardinius erythrophthalmus*



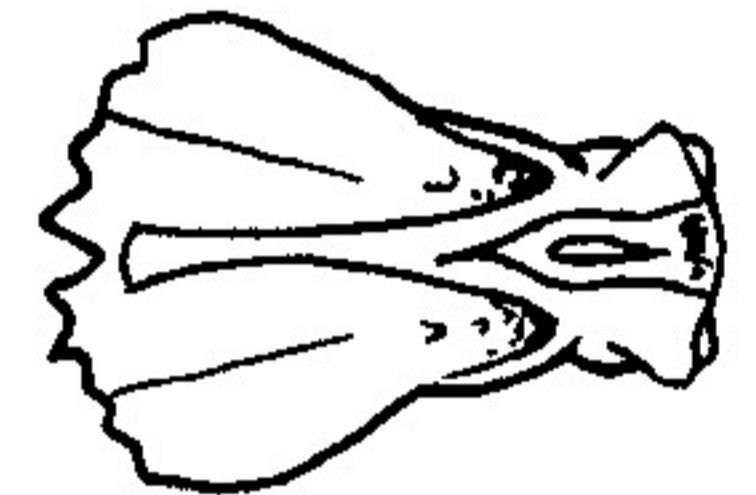
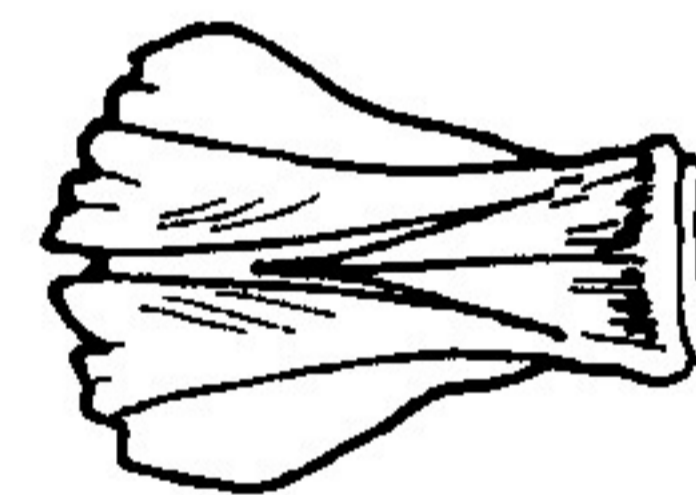
*Gymnocephalus sp.*



*Carassius auratus*



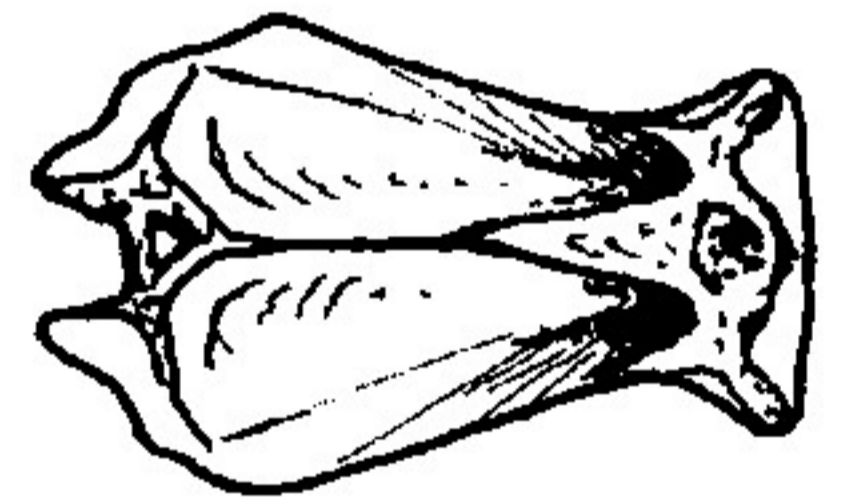
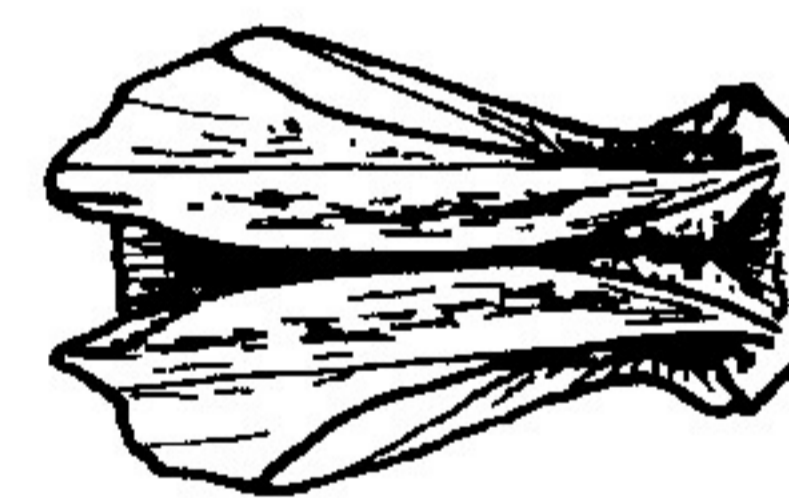
*Cyprinus carpio*



*Aspro zingel*



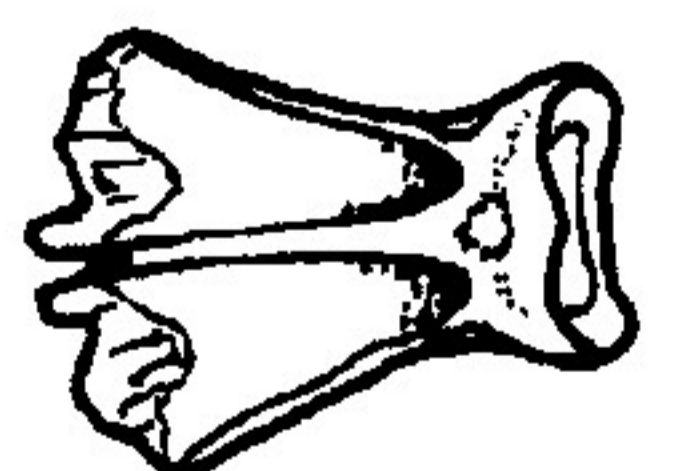
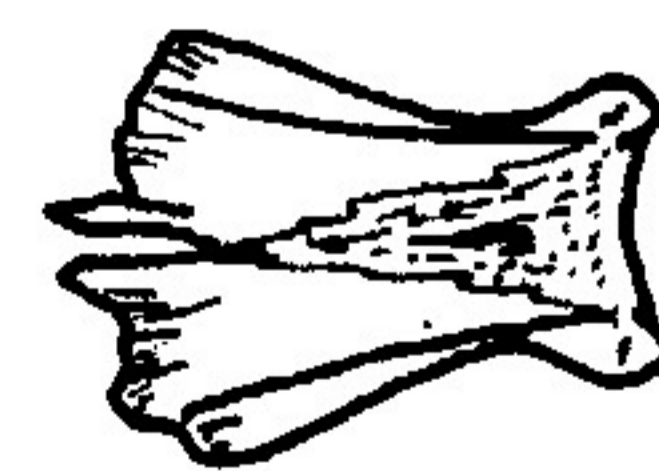
*Rutilus rutilus*



*Perca fluviatilis*



*Tinca tinca*



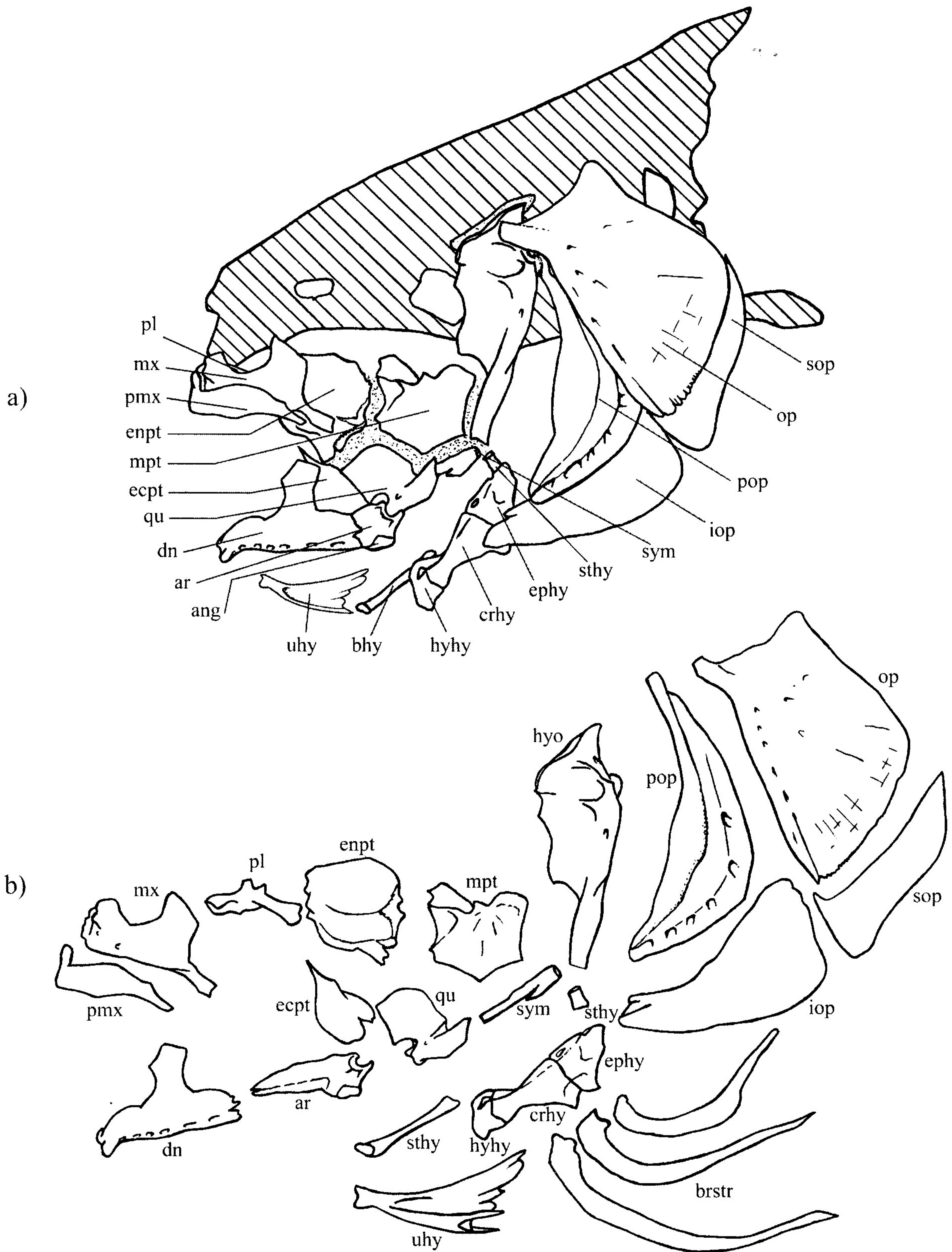
*Stizostedion lucioperca*



*Chondrostoma nasus*

**Branchiocranium** (*viscerocranium*) is the skeleton of the oromandibular region and includes also several bony arches as well as the opercular bones (figs 3 and 4).

<b>Element</b>	<b>Abbreviation</b>	<b>Names from Lepiksaar (1983)</b>
<i>Upper jaw</i>		
<b>premaxilla</b>	<b>pmx</b>	<b>praemaxillare</b>
<b>maxilla</b>	<b>mx</b>	<b>maxillare</b>
<i>Mandibular arches</i>		
<i>Palatoquadrate bones</i>		
<b>palatine</b>	<b>pl</b>	<b>palatinum</b>
<b>endopterygoid</b>	<b>enpt</b>	<b>entopterygoideum</b>
<b>ectopterygoid</b>	<b>ecpt</b>	<b>ectopterygoideum</b>
<b>metapterygoid</b>	<b>mpt</b>	<b>matapterygoideum</b>
<b>quadrate</b>	<b>qu</b>	<b>quadratum</b>
<i>Lower jaw Meckel's bones</i>		
<b>articular</b>	<b>ar</b>	<b>articulare</b>
angular	ang	angulare
<b>dentary</b>	<b>dn</b>	<b>dentale</b>
<i>Hyoid arches</i>		
<b>hyomandibular</b>	<b>hyo</b>	<b>hyomandibulare</b>
symplectic	sym	symplecticum
stylohyal	sthy	stylohyale
<b>epihyal</b>	<b>ephy</b>	<b>epihyale</b>
<b>ceratohyal</b>	<b>crhy</b>	<b>keratohyale</b>
hypohyal	hyhy	hypohyale
basihyal	bhy	basihyale
<b>urohyal</b>	<b>uhy</b>	<b>urohyale</b>
branchiostegal ray	brstr	branchiostegalia
<i>Opercular bones/gill cover</i>		
<b>preopercular</b>	<b>pop</b>	<b>praeoperculare</b>
<b>opercular</b>	<b>op</b>	<b>operculare</b>
<b>interopercular</b>	<b>iop</b>	<b>interoperculare</b>
<b>subopercular</b>	<b>sop</b>	<b>suboperculare</b>



**Fig. 3.** Bream, *Abramis brama* (lateral view). Head bones.  
 a) Elements of the left side of head in connection. b) Exploded view of the head.

# PRAEMAXILLARE

## NORMA MEDIALIS



*Salmo trutta lacustris*

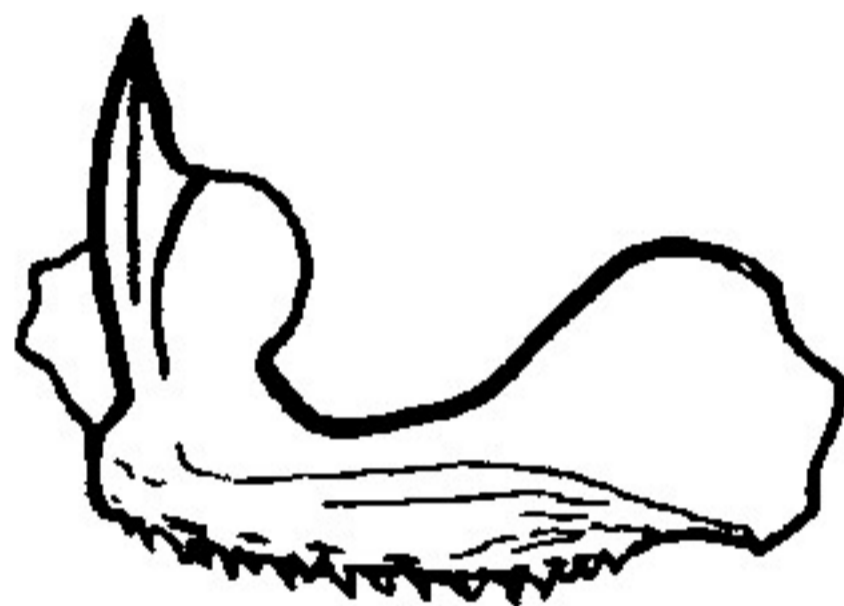


*Esox lucius*

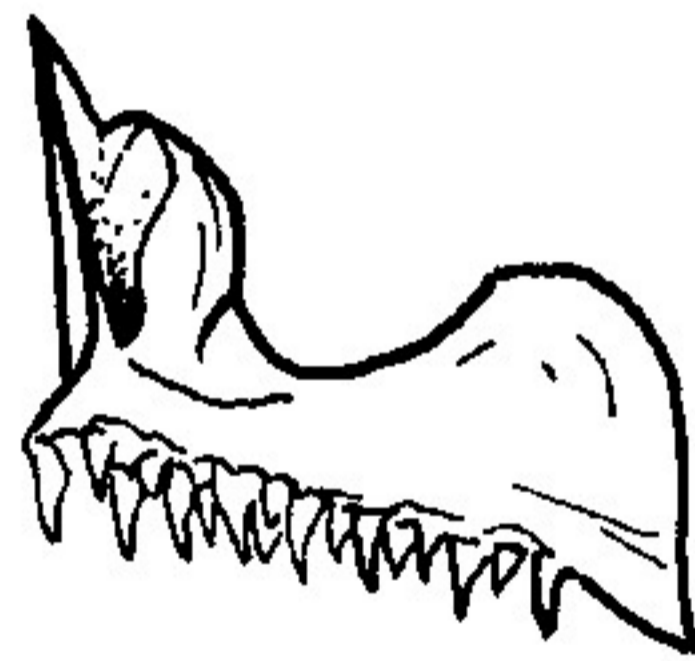
## NORMA LATERALIS



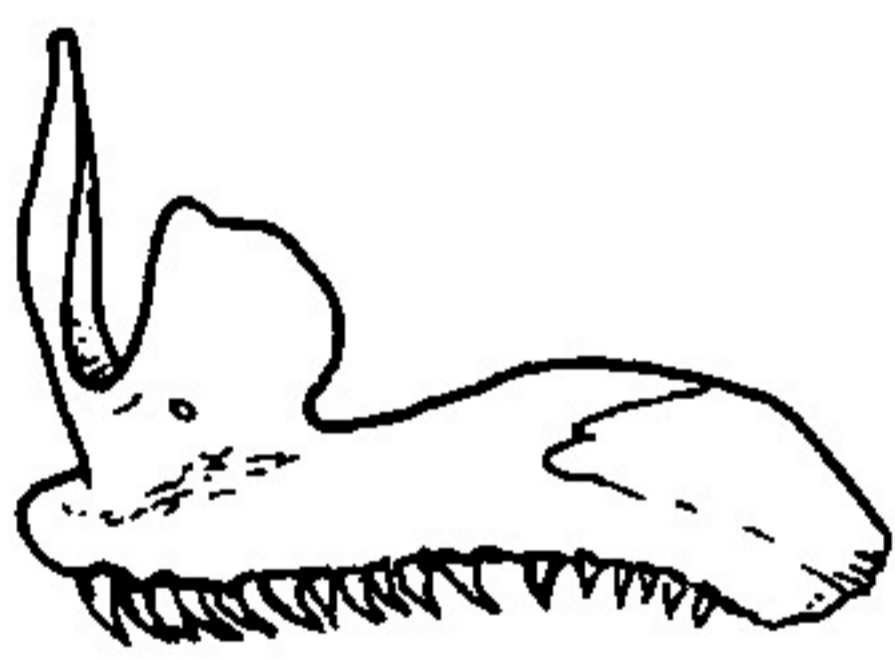
*Alosa pontica*



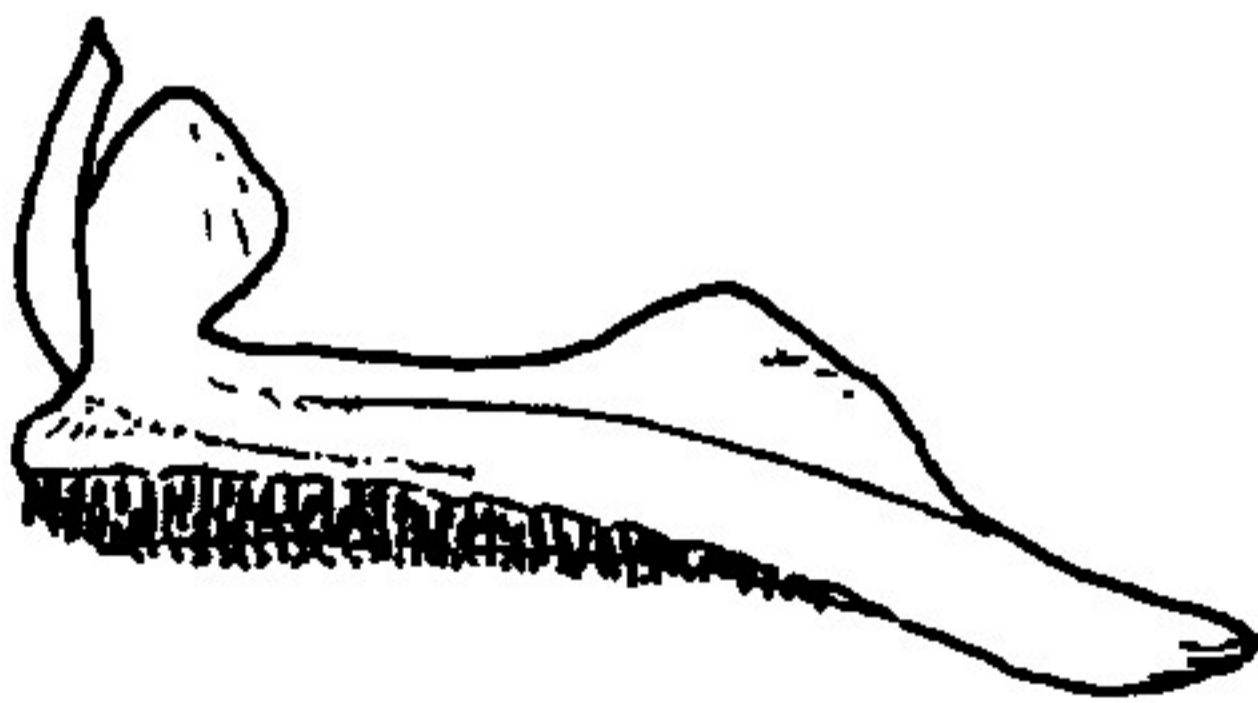
*Acerina schraetser*



*Gymnocephalus sp.*



*Aspro zingel*



*Perca fluviatilis*



*Stizostedion lucioperca*

## NORMA LATERALIS



*Abramis brama*



*Carassius auratus*



*Cyprinus carpio*



*Barbus barbus*



*Leuciscus idus*



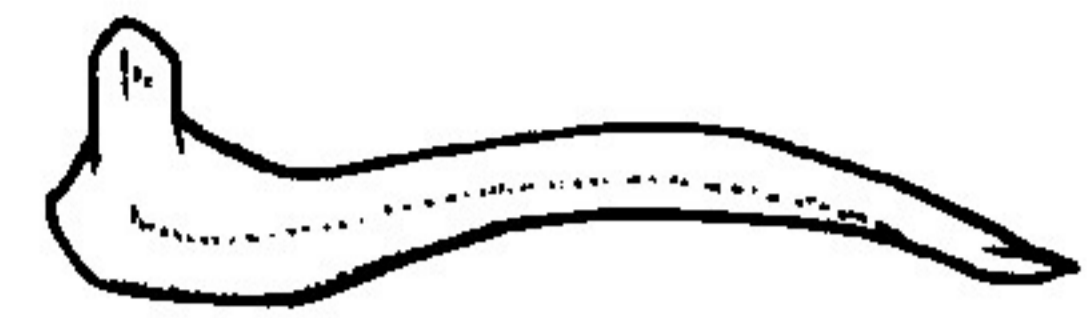
*Pelecus cultratus*



*Scardinius erythrophthalmus*



*Alburnus alburnus*



*Aspius aspius*



*Vimba vimba carinata*



*Blicca bjoerkna*



*Tinca tinca*



*Rutilus rutilus*



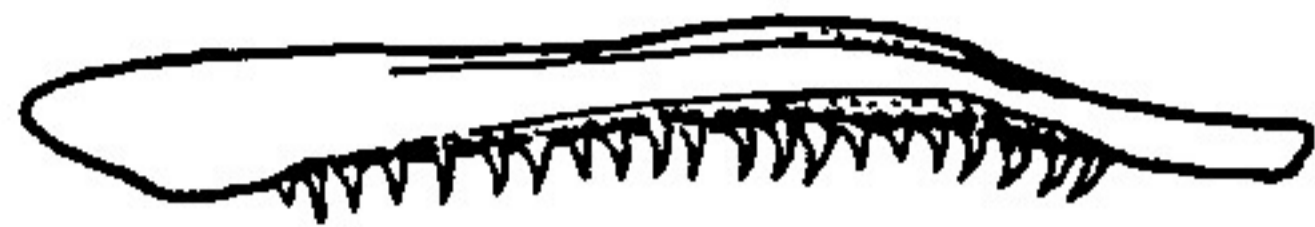
*Chalcaburnus chalcoides mento*



*Chondrostoma nasus*

# MAXILLARE

## NORMA MEDIALIS



*Salmo trutta lacustris*

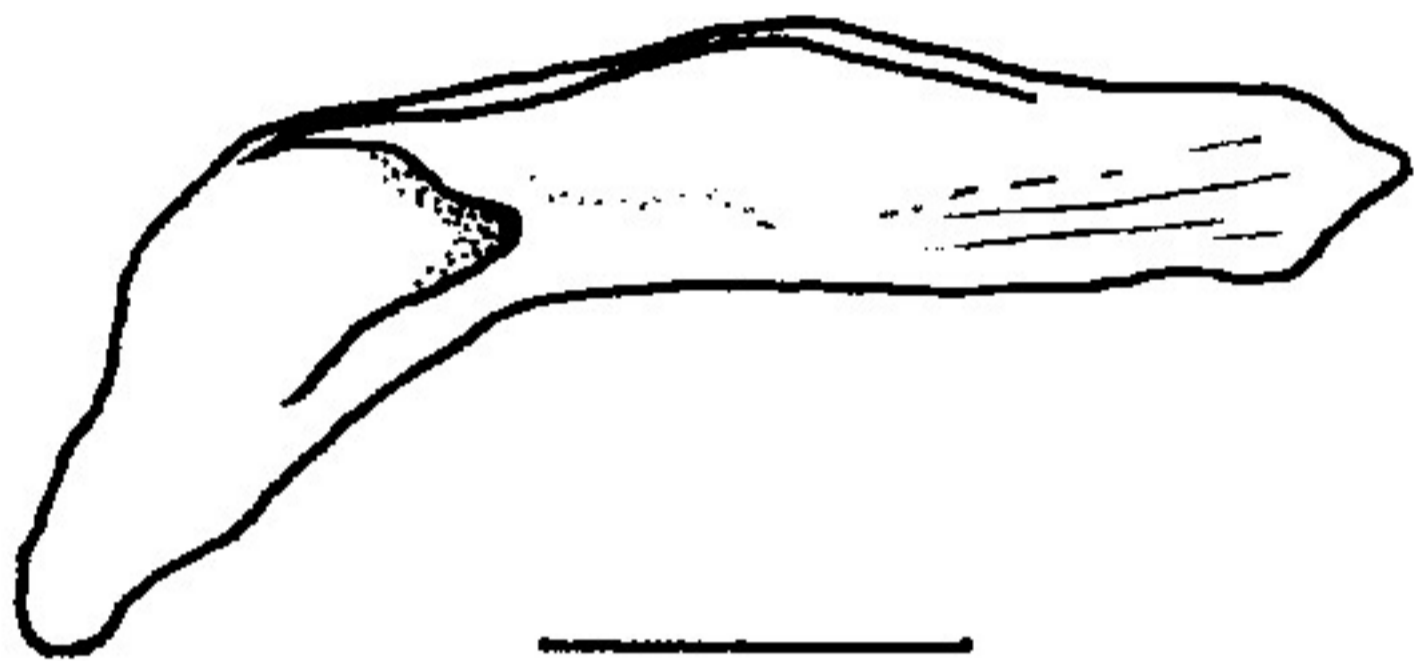


*Alosa pontica*



*Esox lucius*

## NORMA SUPERIOR



*Silurus glanis*

## NORMA LATERALIS



*Acerina schraetser*



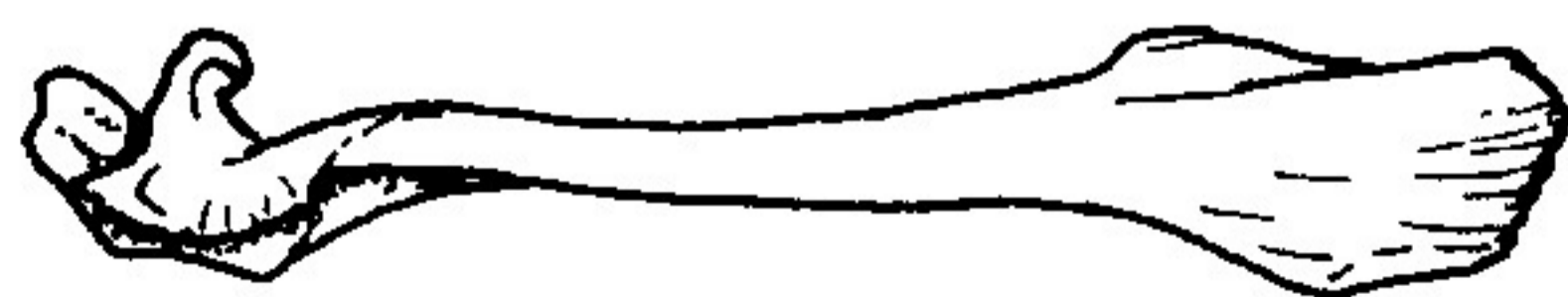
*Gymnocephalus sp.*



*Aspro zingel*



*Perca fluviatilis*



*Stizostedion lucioperca*

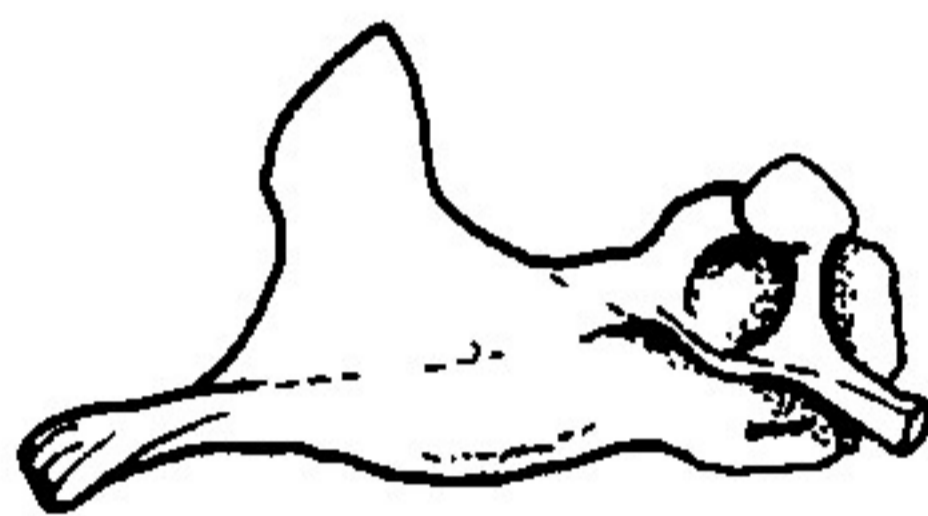
## NORMA MEDIALIS



*Abramis brama*



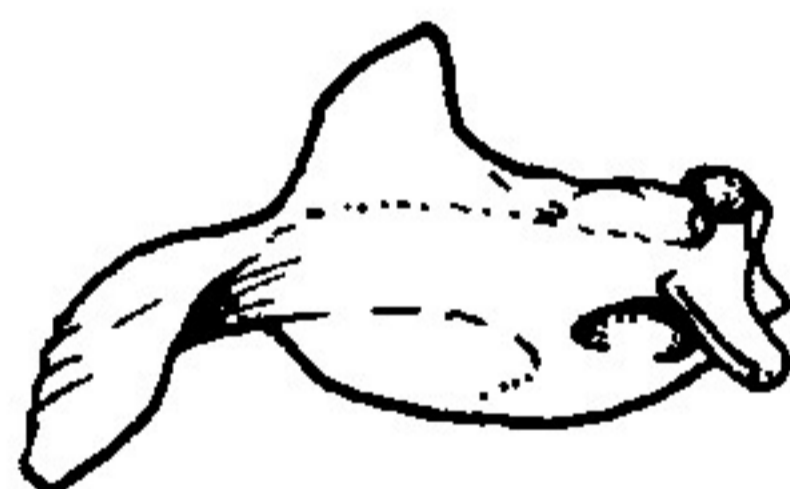
*Blicca bjoerkna*



*Rutilus rutilus*



*Vimba vimba carinata*



*Cyprinus carpio*



*Carassius auratus*



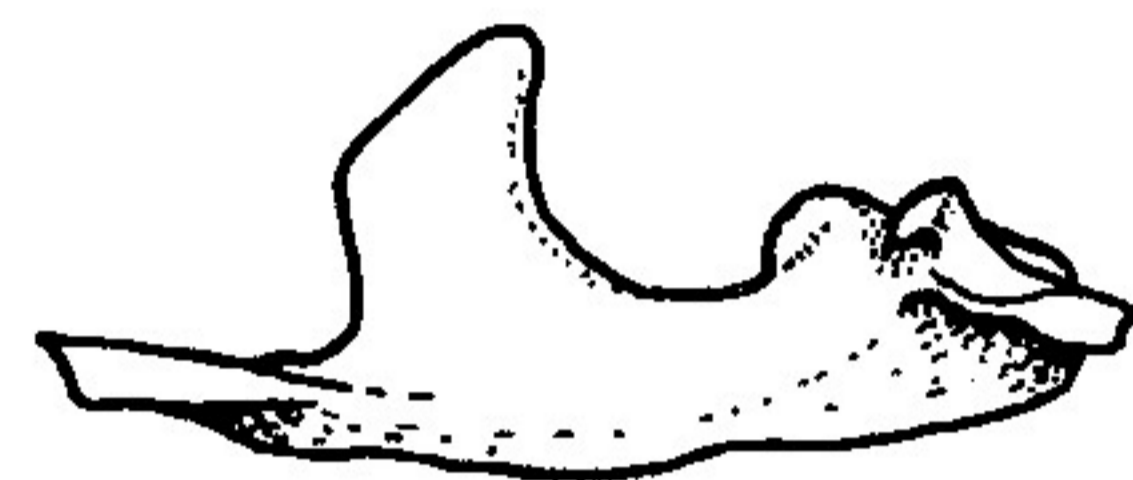
*Tinca tinca*



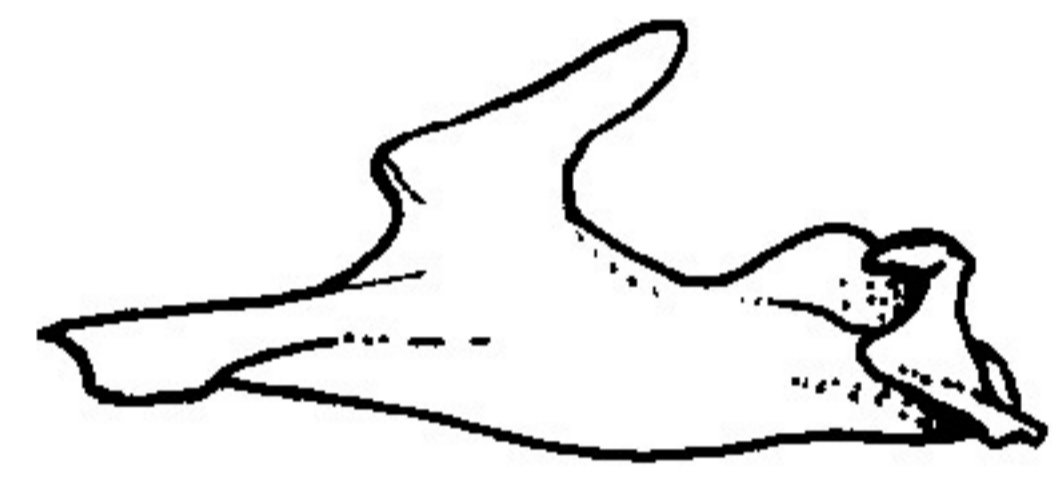
*Barbus barbus*



*Pelecus cultratus*



*Chalcaburnus chalcoides mento*



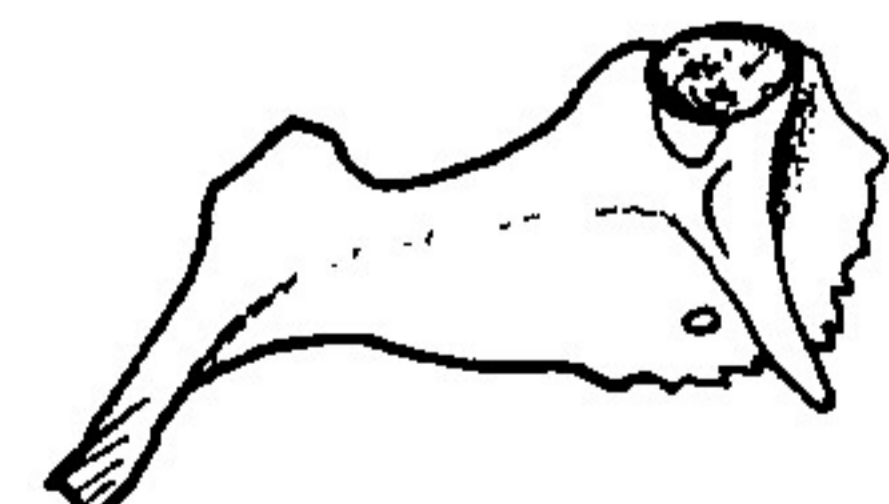
*Scardinius erythrophthalmus*



*Leuciscus idus*



*Alburnus alburnus*



*Chondrostoma nasus*



*Aspius aspius*

# PALATINUM

## NORMA LATERALIS

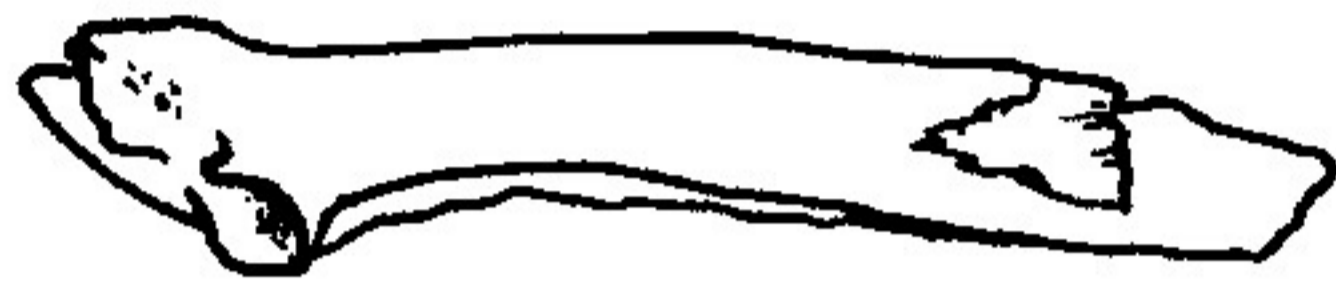


*Salmo trutta lacustris*



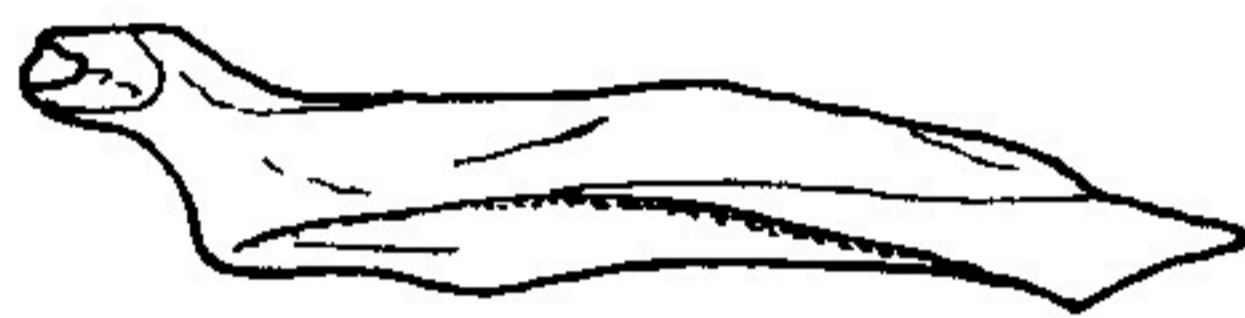
*Alosa pontica*

## NORMA SUPERIOR



*Esox lucius*

## NORMA LATERALIS



*Acerina schraetser*



*Gymnocephalus sp.*



*Aspro zingel*



*Perca fluviatilis*



*Stizostedion lucioperca*

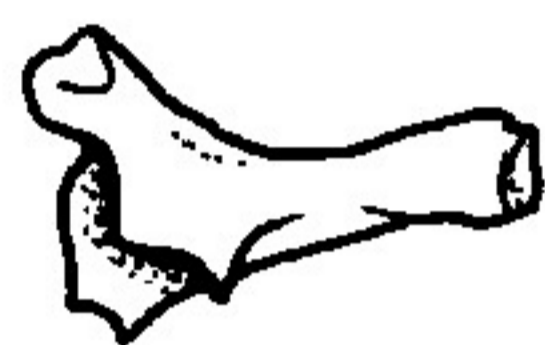
## NORMA LATERALIS



*Abramis brama*



*Blicca bjoerkna*



*Rutilus rutilus*



*Cyprinus carpio*



*Carassius auratus*



*Scardinius erythrophthalmus*



*Tinca tinca*



*Barbus barbus*



*Vimba vimba carinata*



*Leuciscus idus*



*Chalcaburnus chalcoides mento*



*Chondrostoma nasus*



*Aspius aspius*



*Pelecus cultratus*



*Alburnus alburnus*

# ENTOPTERYGOIDEUM

## NORMA LATERALIS



*Salmo trutta lacustris*



*Alosa pontica*



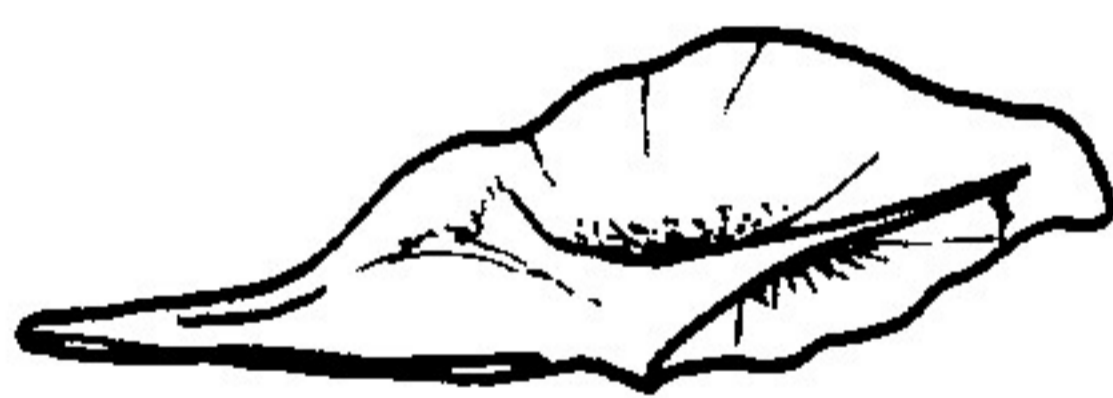
*Esox lucius*



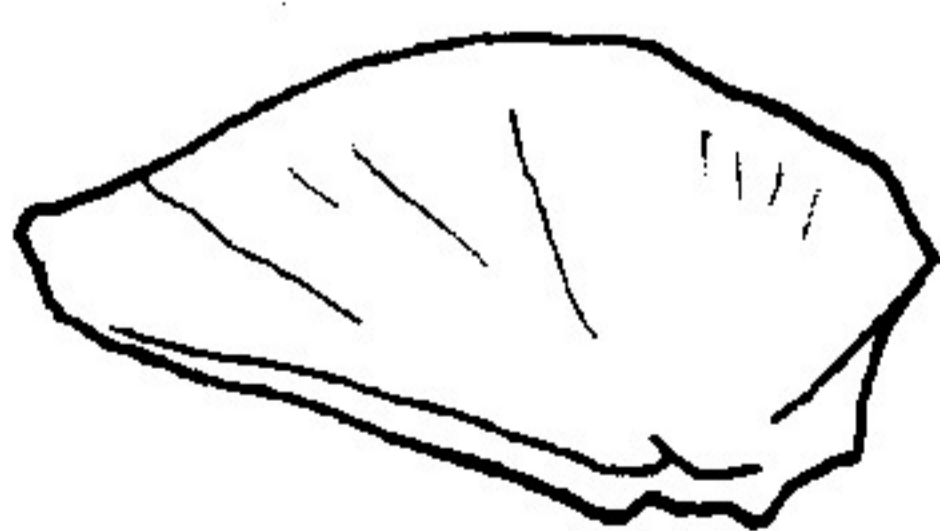
*Acerina schraetser*



*Gymnocephalus sp.*



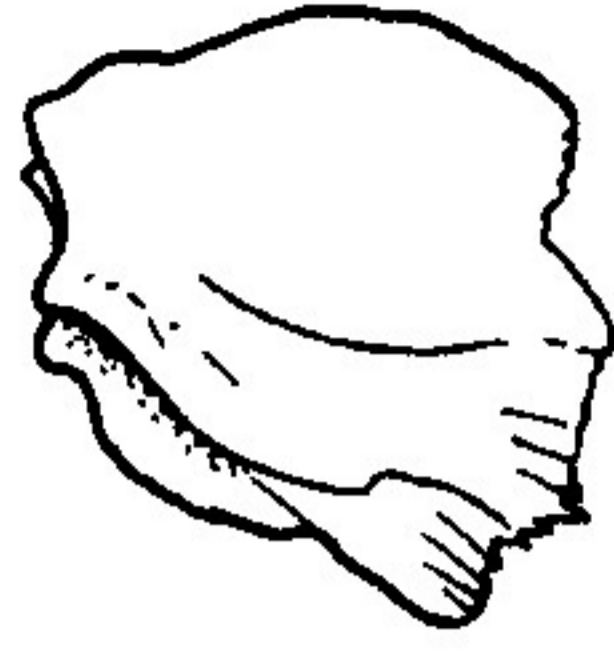
*Aspro zingel*



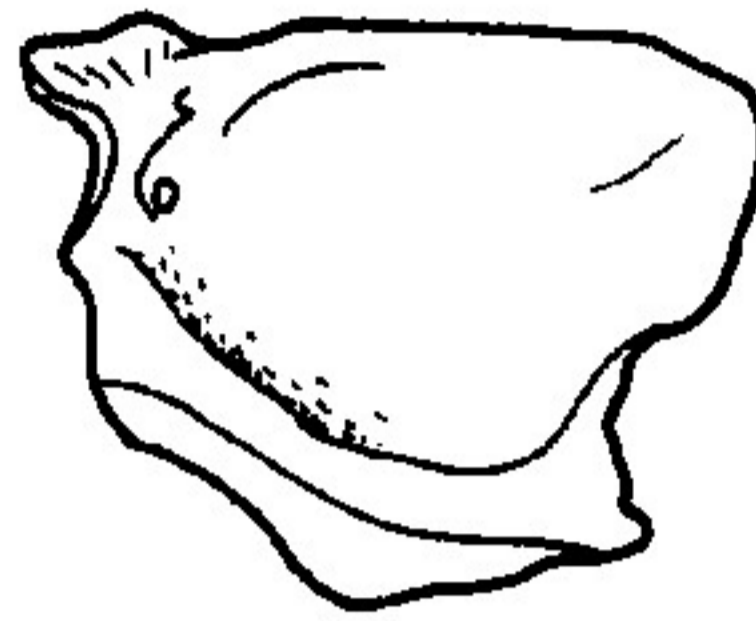
*Perca fluviatilis*



*Stizostedion lucioperca*



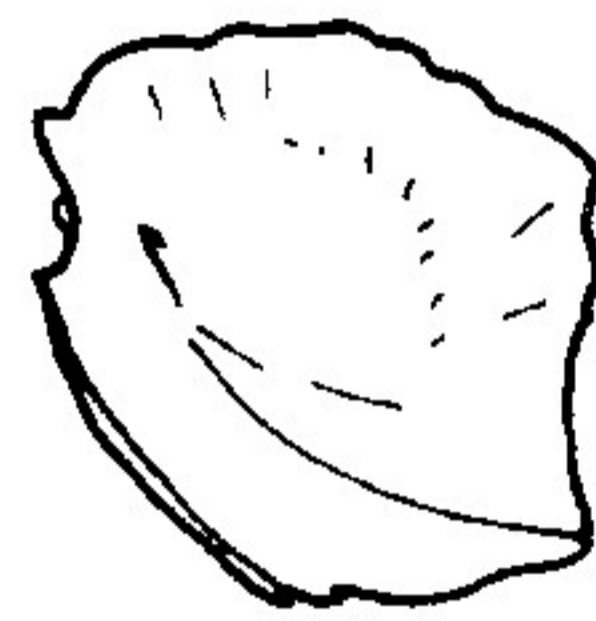
*Abramis brama*



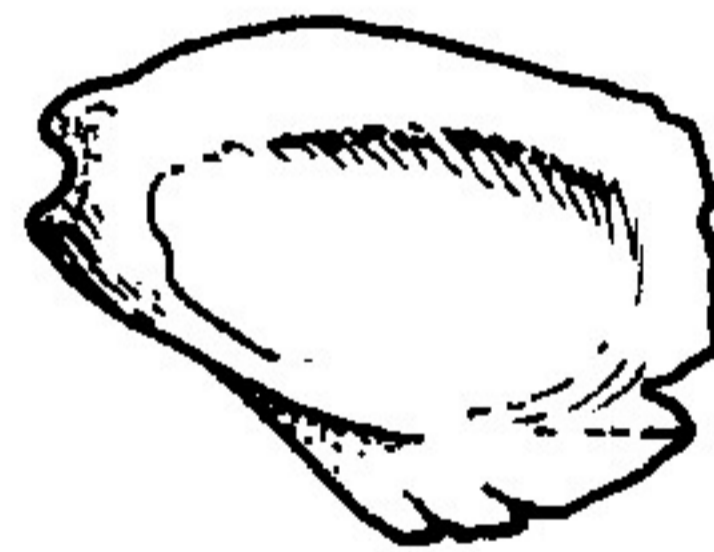
*Pelecus cultratus*



*Scardinius erythrophthalmus*



*Aspius aspius*



*Alburnus alburnus*



*Rutilus rutilus*



*Chondrostoma nasus*



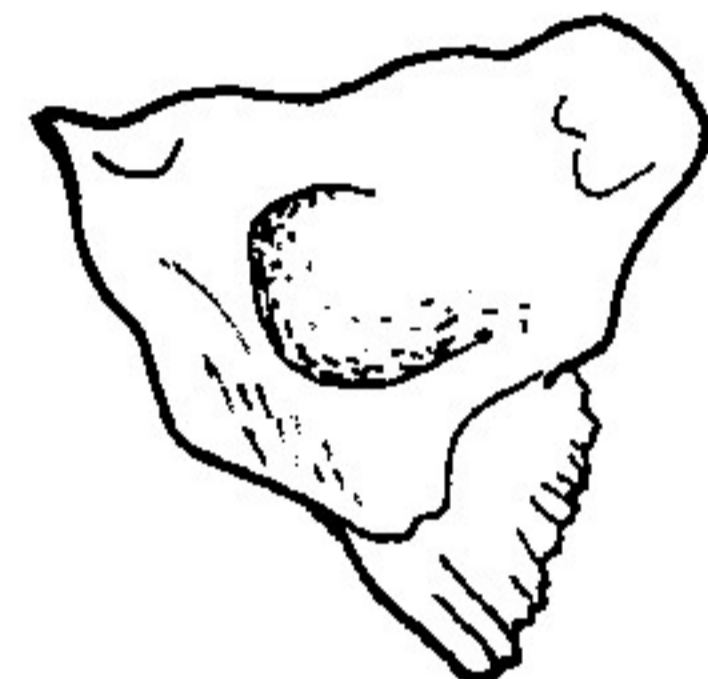
*Blicca bjoerkna*



*Leuciscus idus*



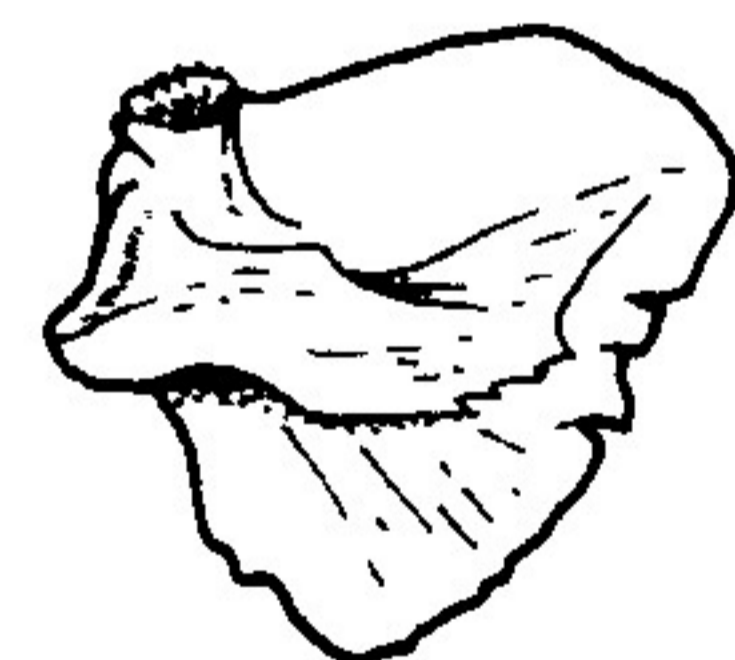
*Vimba vimba carinata*



*Carassius auratus*



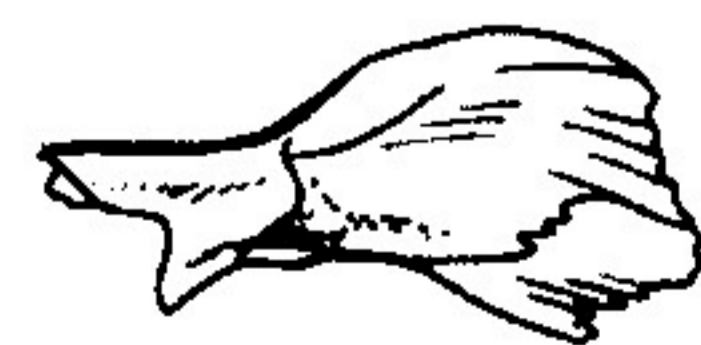
*Tinca tinca*



*Cyprinus carpio*



*Chalcaburnus chalcoides mento*

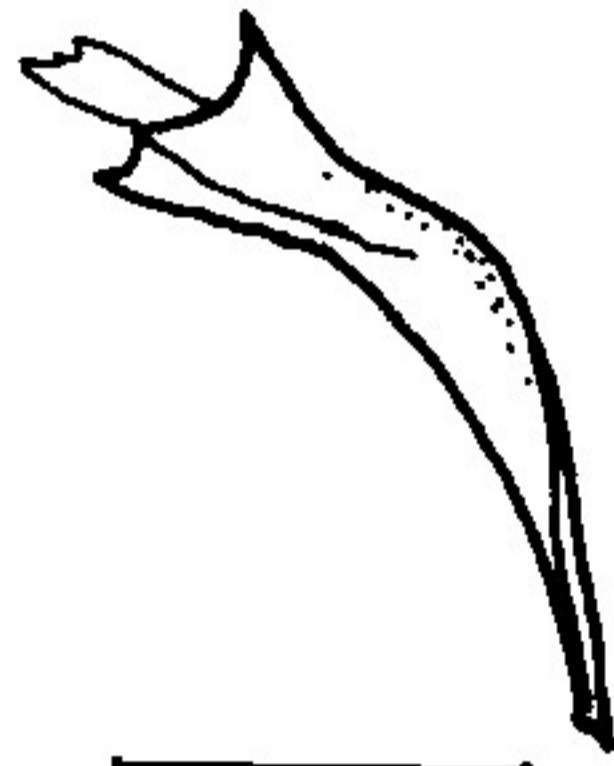


*Barbus barbus*

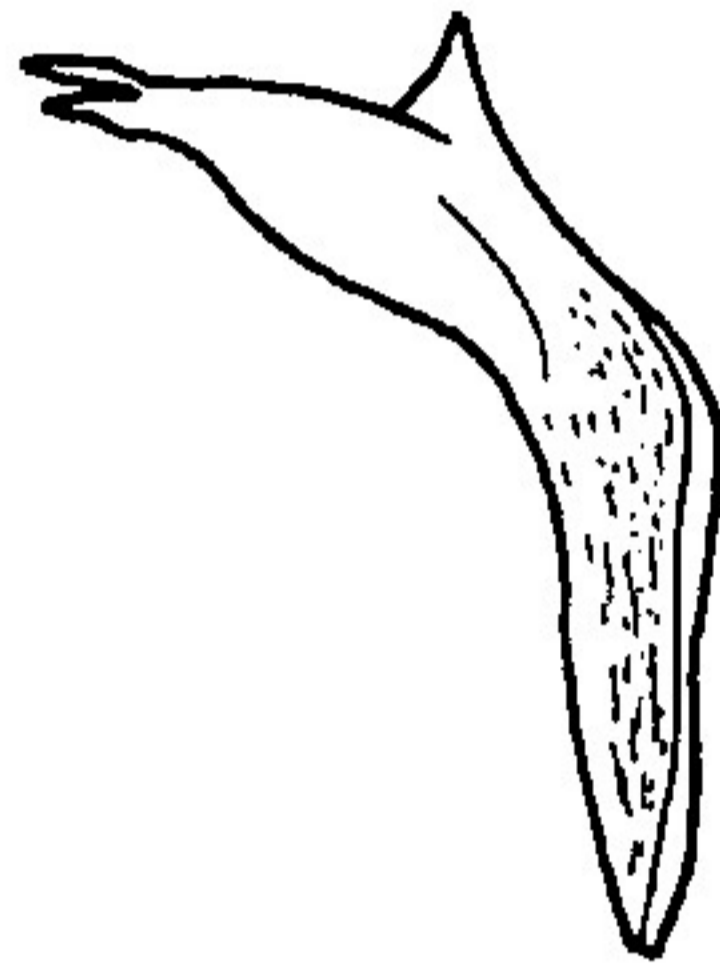
ECTOPTERYGOIDEUM  
NORMA LATERALIS



*Salmo trutta lacustris*



*Alosa pontica*



*Esox lucius*



*Abramis brama*



*Carassius auratus*



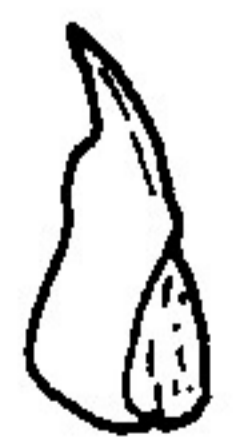
*Aspius aspius*



*Blicca bjoerkna*



*Chalcaburnus chalcoides mento*



*Leuciscus idus*



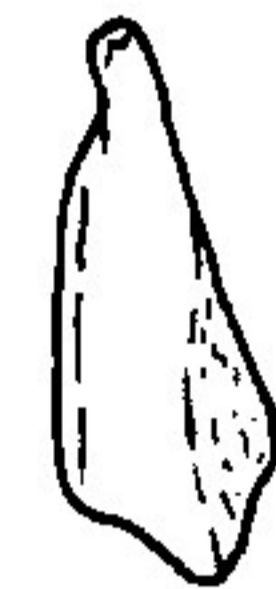
*Rutilus rutilus*



*Tinca tinca*



*Vimba vimba carinata*



*Chondrostoma nasus*



*Alburnus alburnus*



*Scardinius erythrophthalmus*



*Pelecus cultratus*



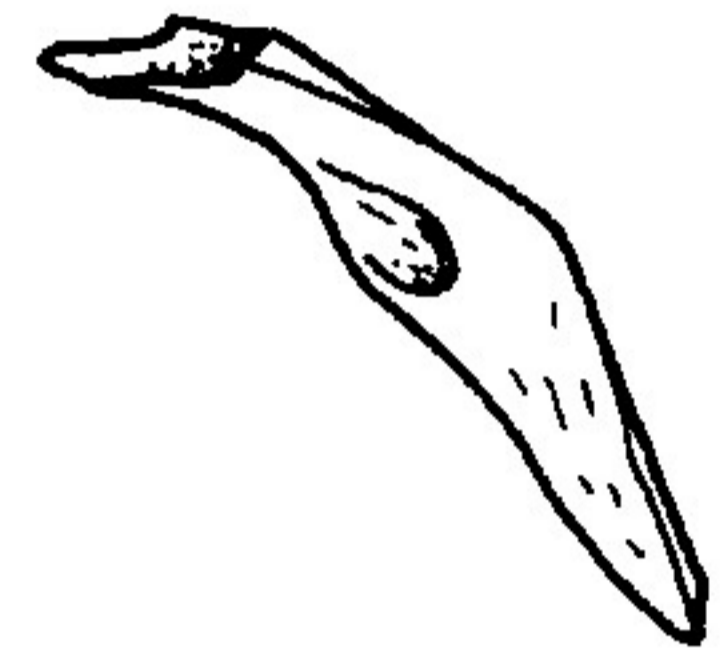
*Cyprinus carpio*



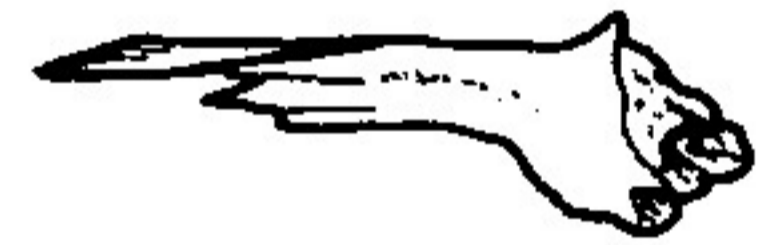
*Barbus barbus*



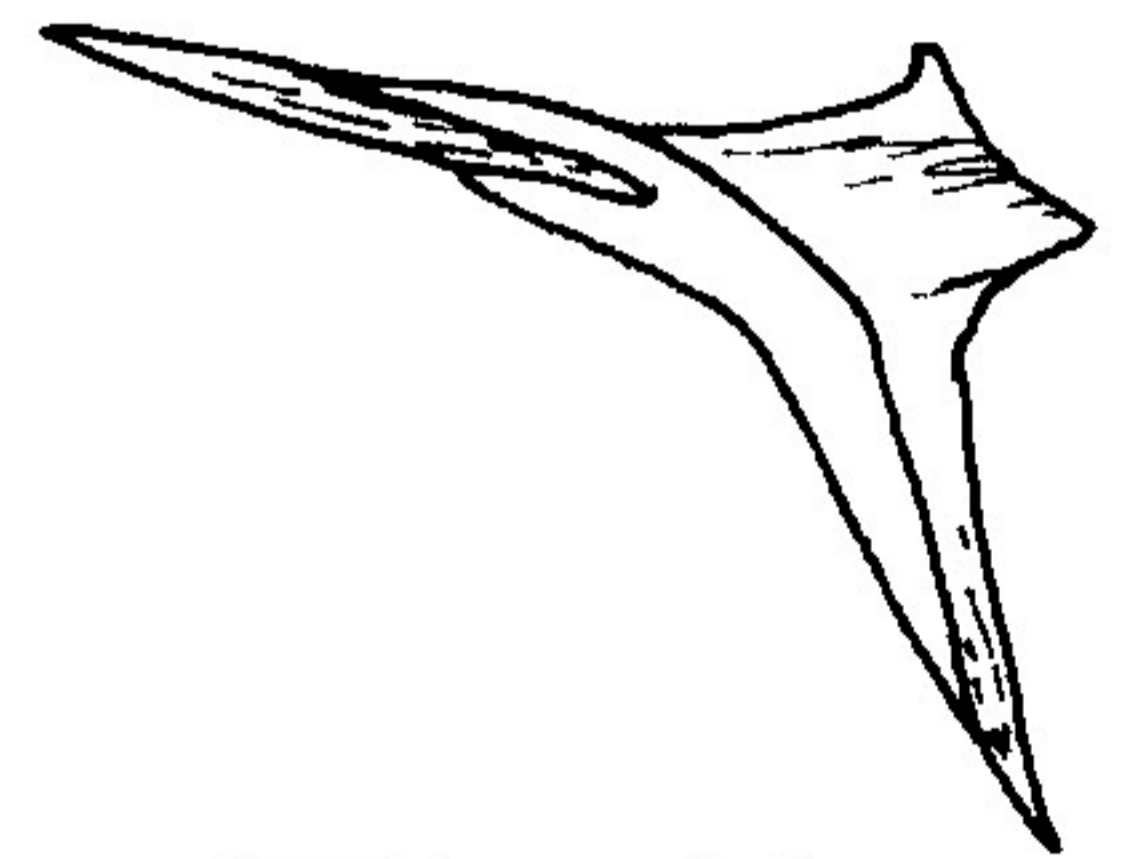
*Acerina schraetser*



*Gymnocephalus sp.*



*Aspro zingel*

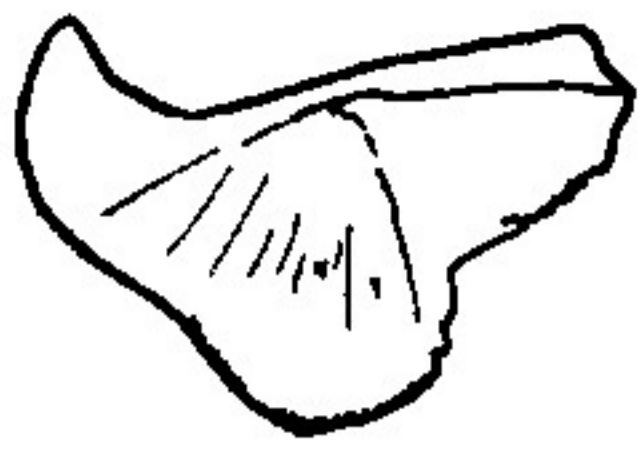


*Perca fluviatilis*

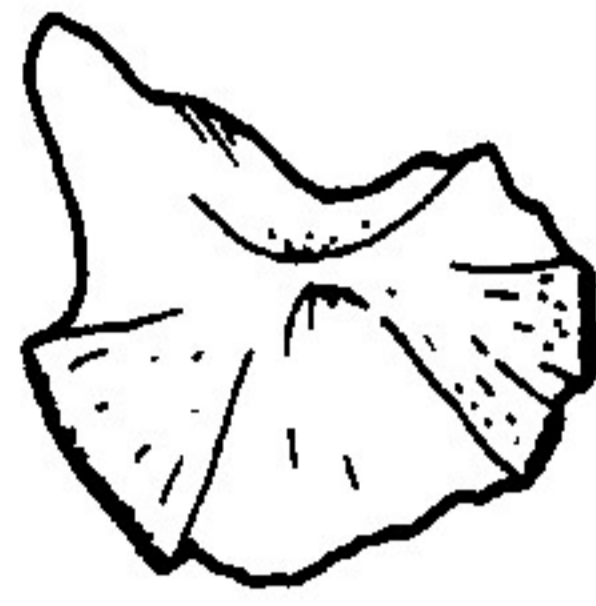


*Stizostedion lucioperca*

**METAPTERYGOIDEUM**  
**NORMA LATERALIS**



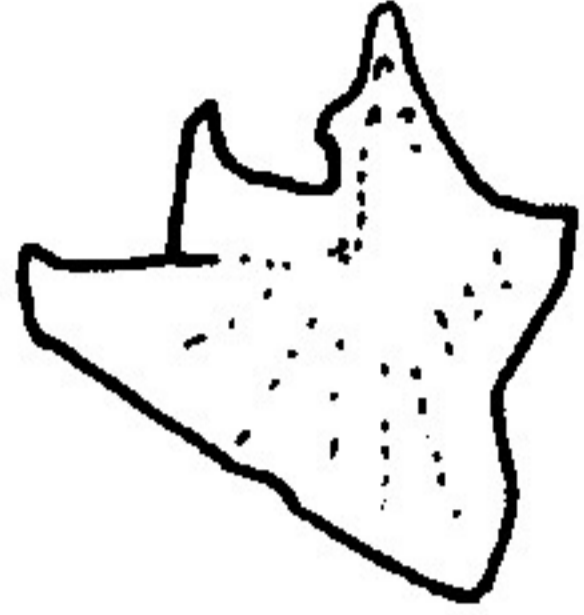
*Salmo trutta lacustris*



*Alburnus alburnus*



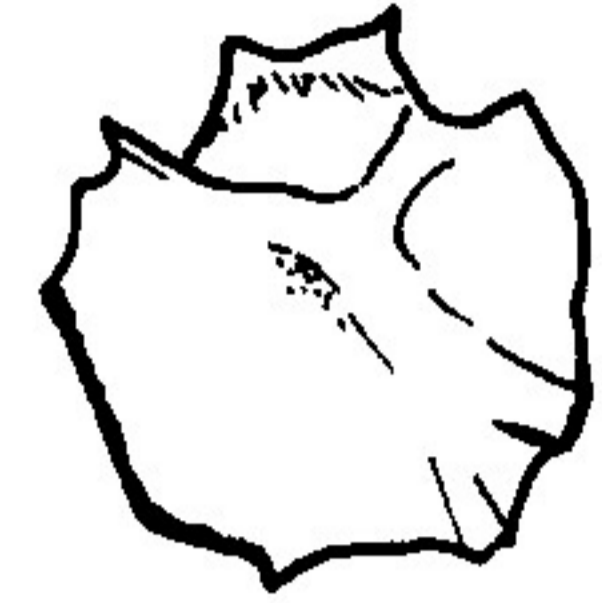
*Vimba vimba carinata*



*Alosa pontica*



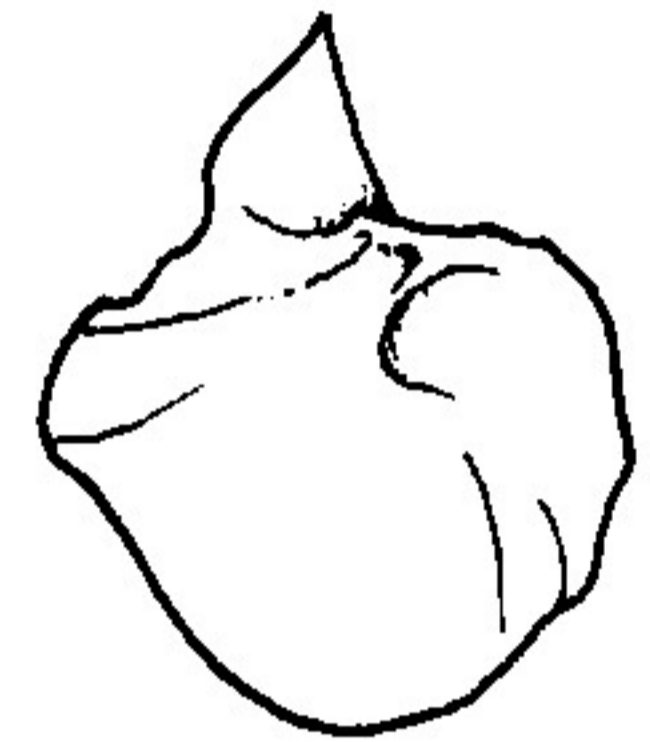
*Blicca bjoerkna*



*Tinca tinca*



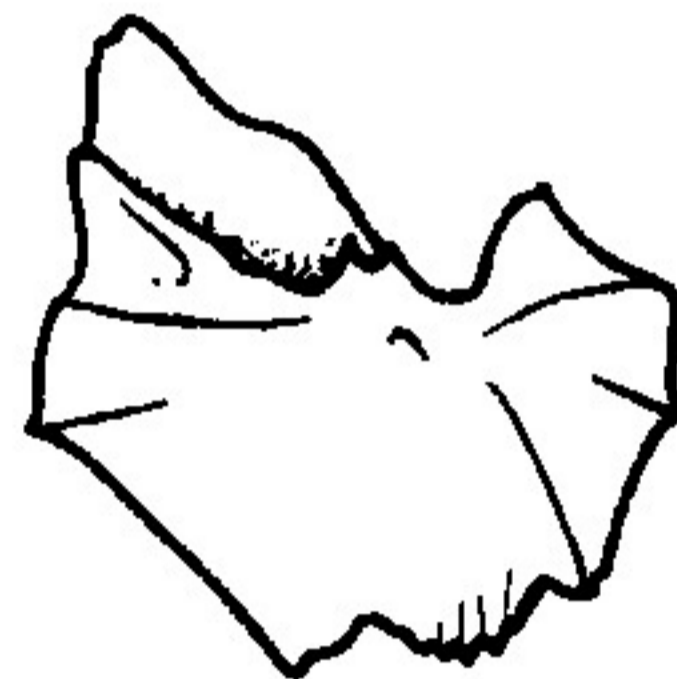
*Esox lucius*



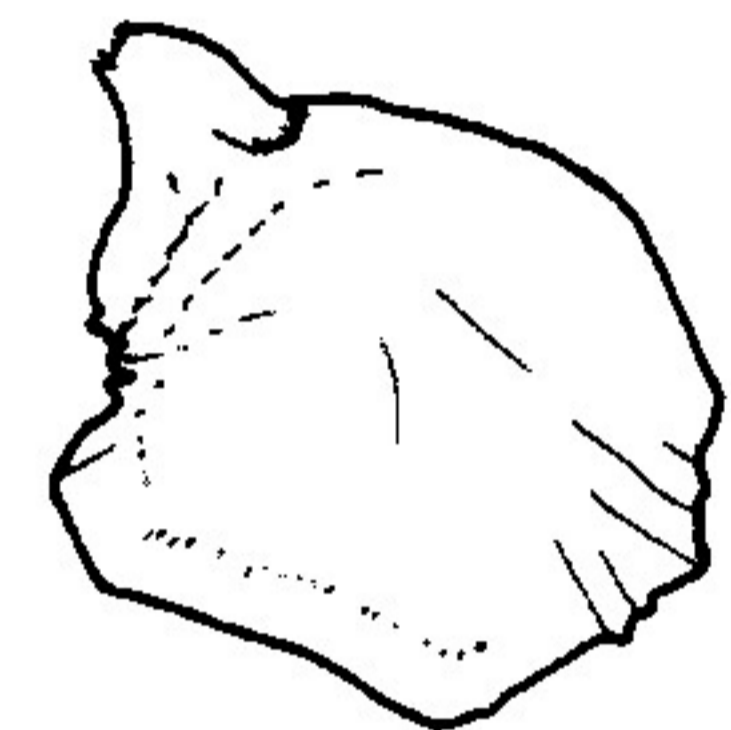
*Carassius auratus*



*Silurus glanis*



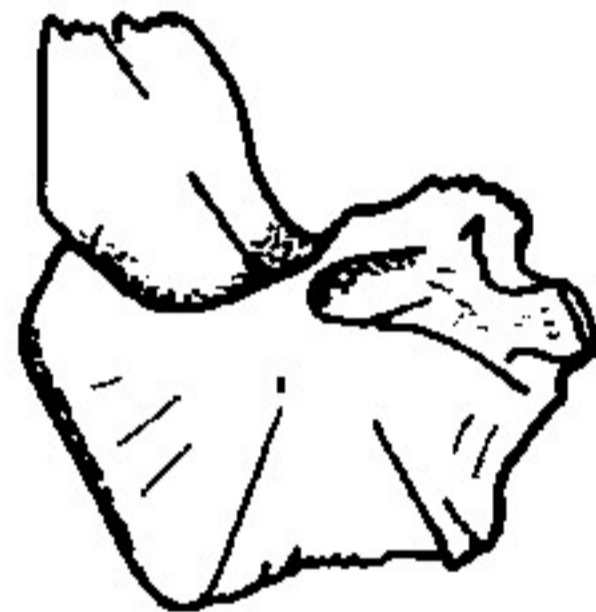
*Abramis brama*



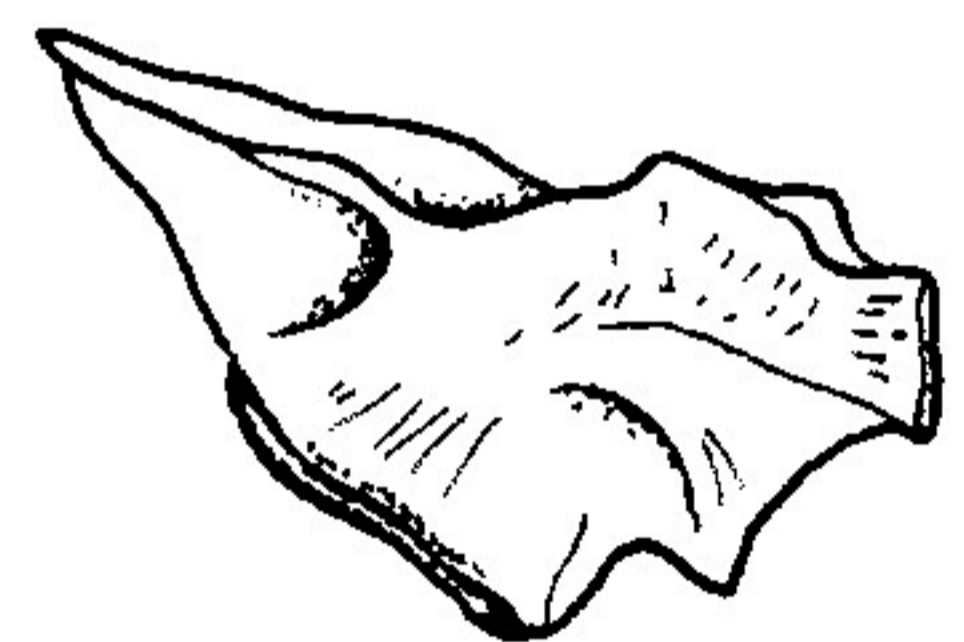
*Cyprinus carpio*



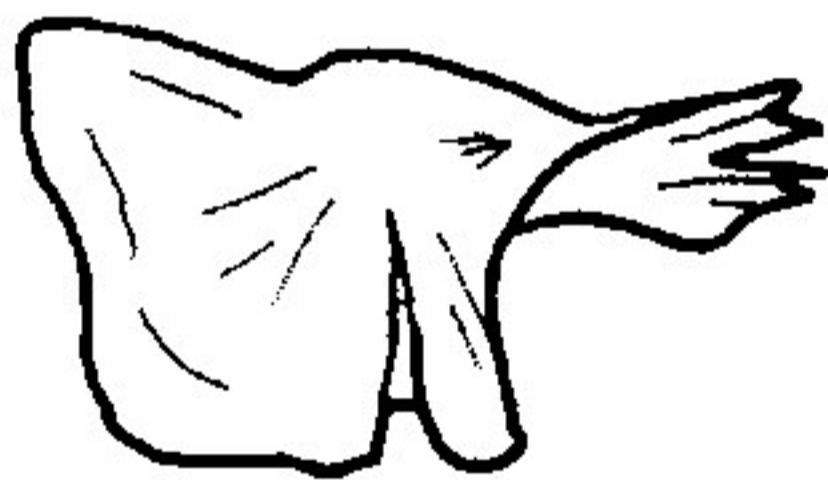
*Acerina schraetser*



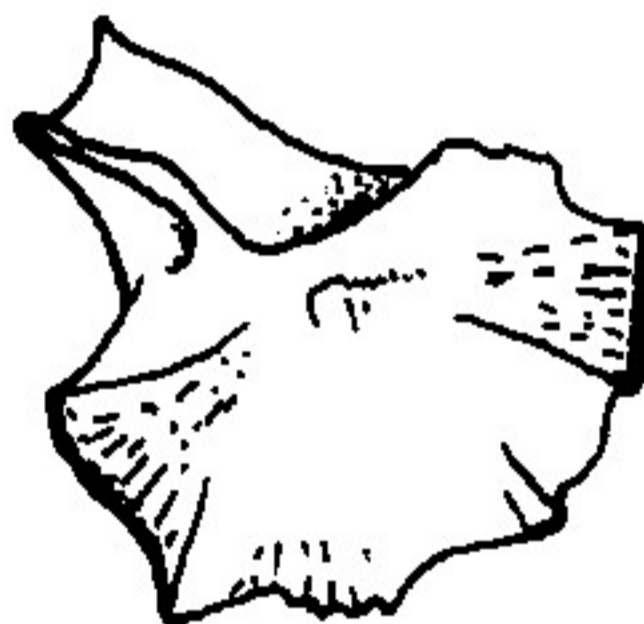
*Aspius aspius*



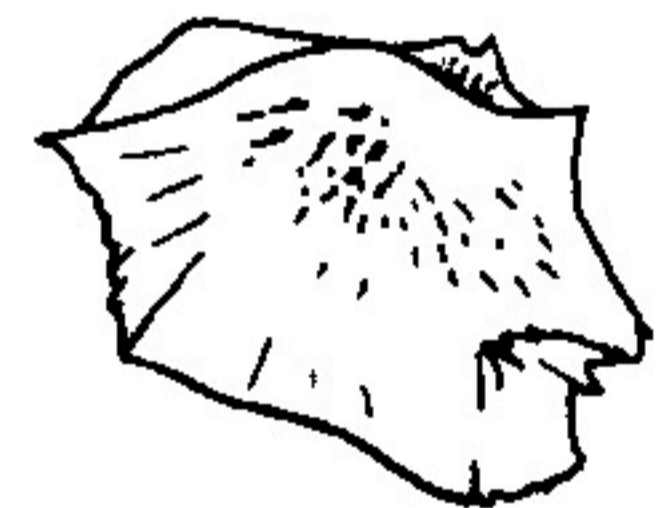
*Chondrostoma nasus*



*Gymnocephalus sp.*



*Scardinius erythrophthalmus*



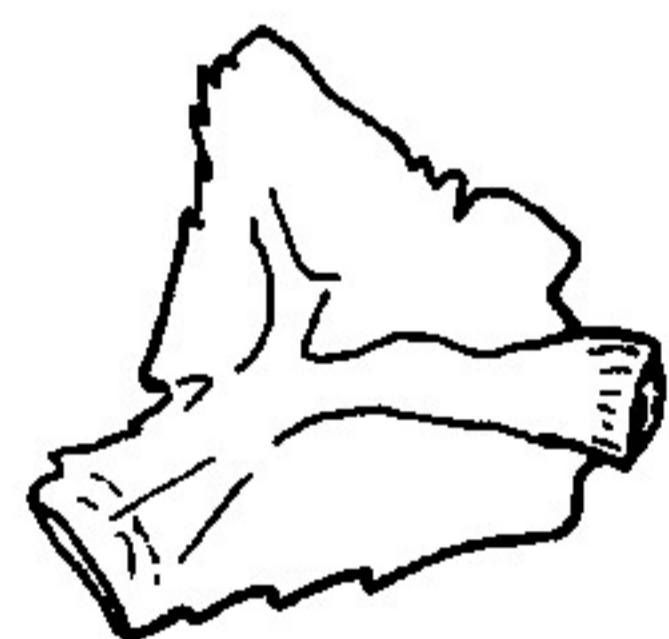
*Barbus barbus*



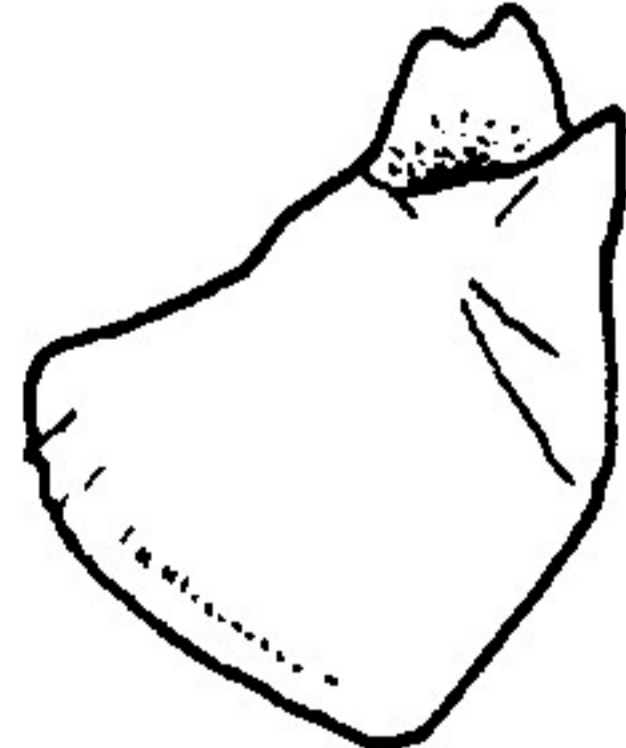
*Aspro zingel*



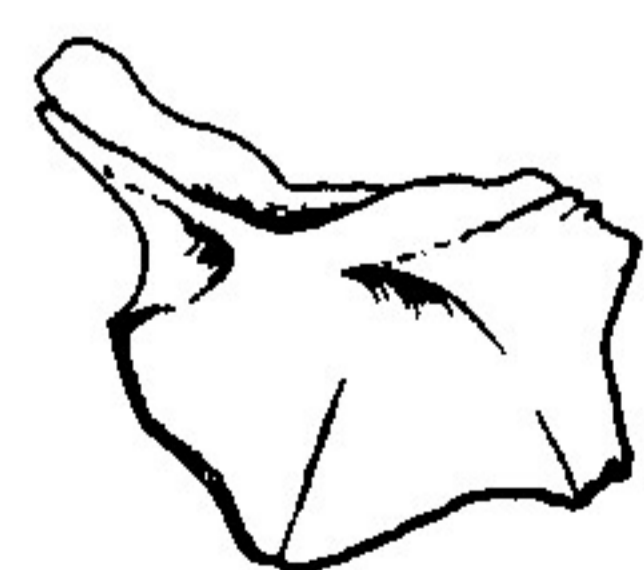
*Leuciscus idus*



*Pelecus cultratus*



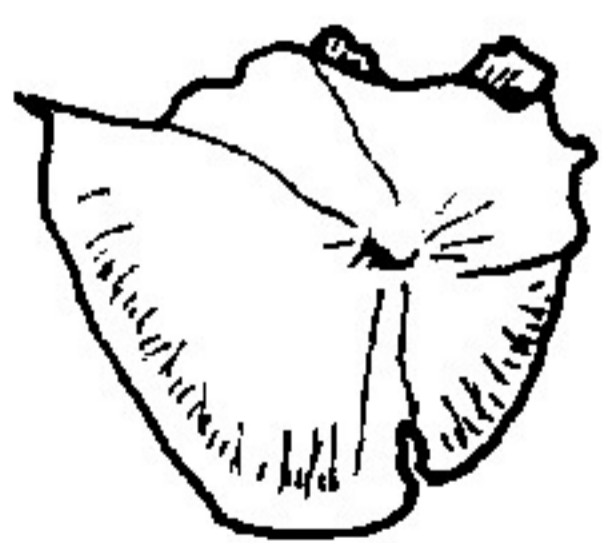
*Perca fluviatilis*



*Rutilus rutilus*



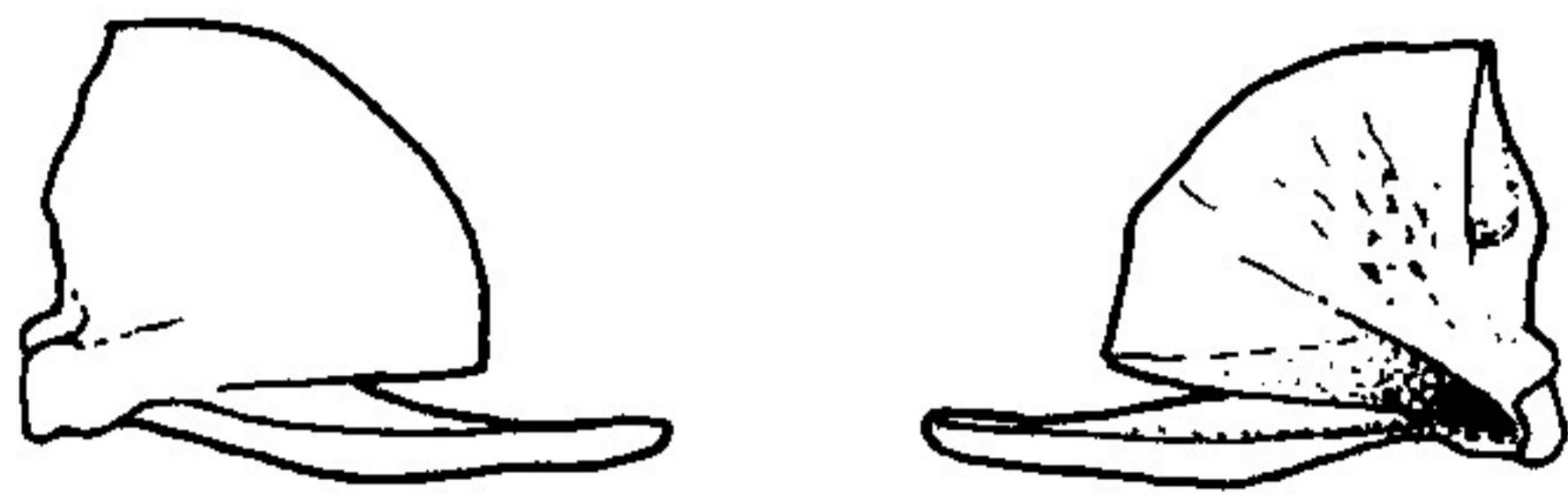
*Chalcaburnus chalcoides mento*



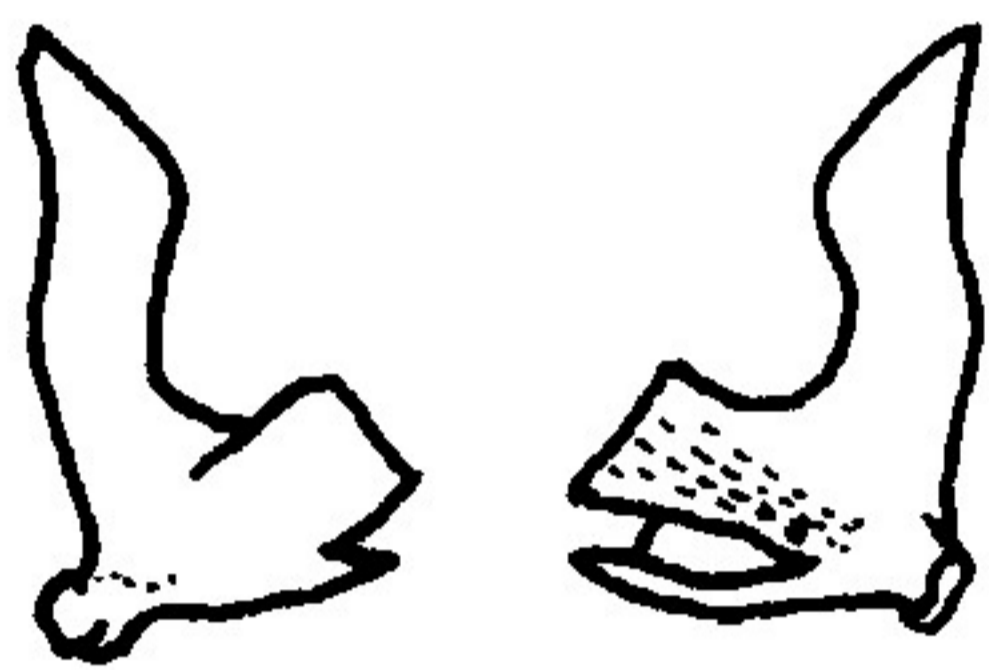
*Stizostedion lucioperca*

# QUADRATUM

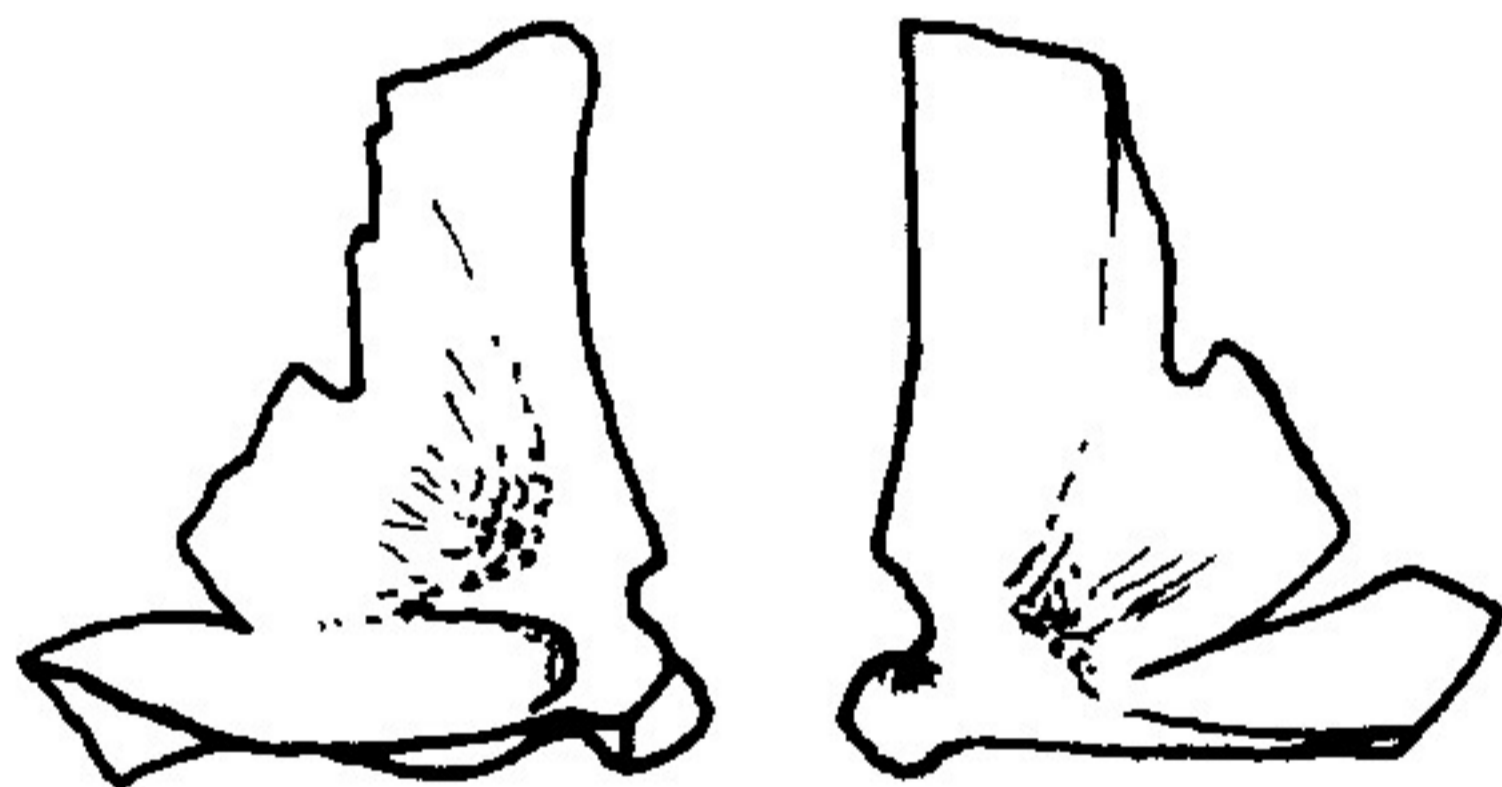
*NORMA LATERALIS*   *NORMA MEDIALIS*



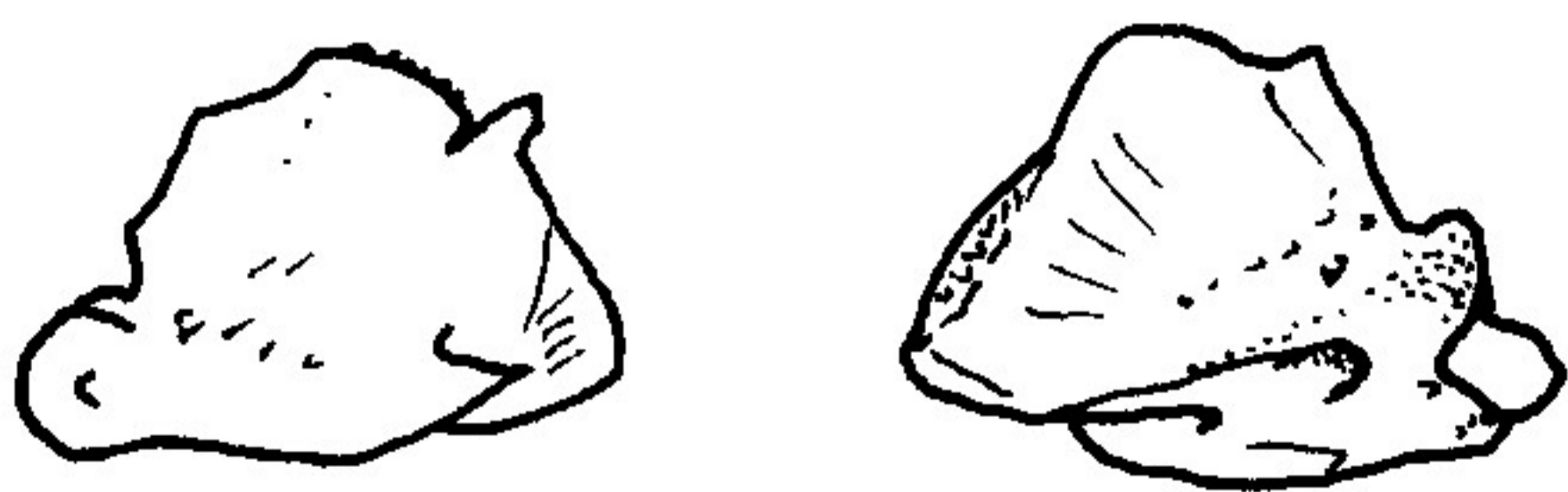
*Salmo trutta lacustris*



*Alosa pontica*

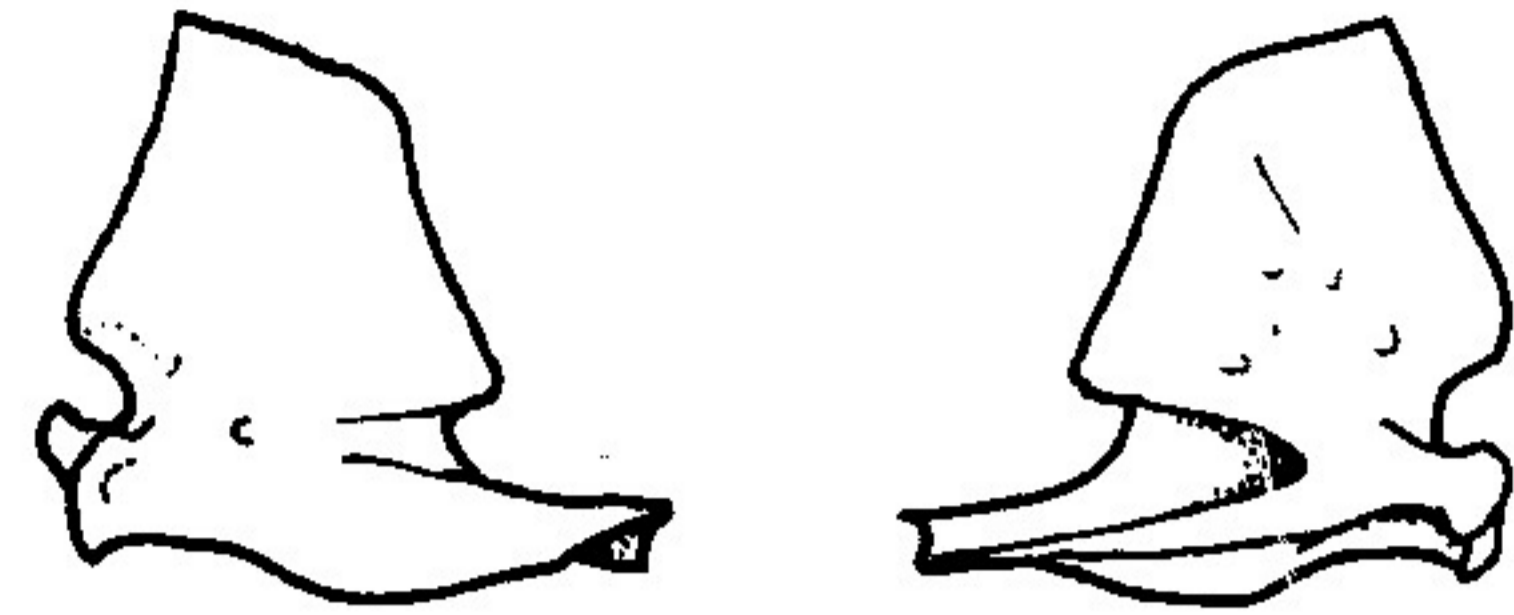


*Esox lucius*

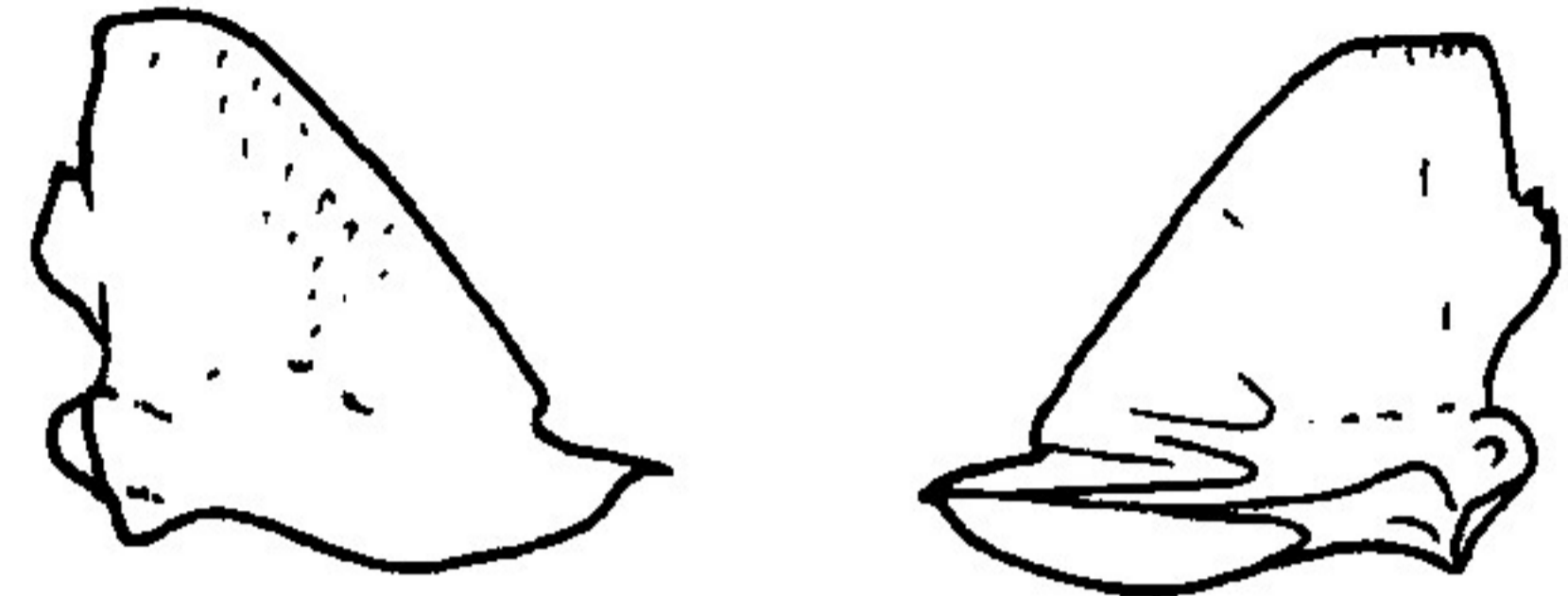


*Silurus glanis*

*NORMA LATERALIS*   *NORMA MEDIALIS*



*Abramis brama*



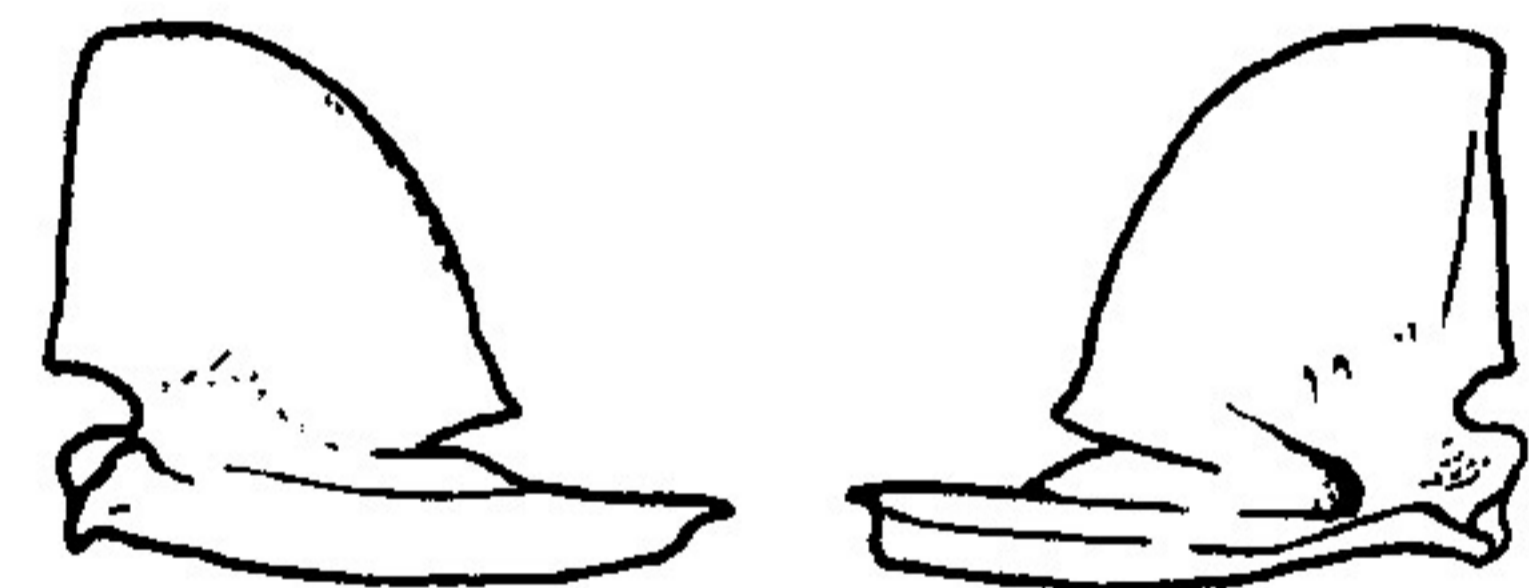
*Barbus barbus*



*Tinca tinca*



*Cyprinus carpio*



*Chondrostoma nasus*



*Carassius auratus*



*Chalcaburnus chalcoides mento*

# QUADRATUM

NORMA LATERALIS    NORMA MEDIALIS



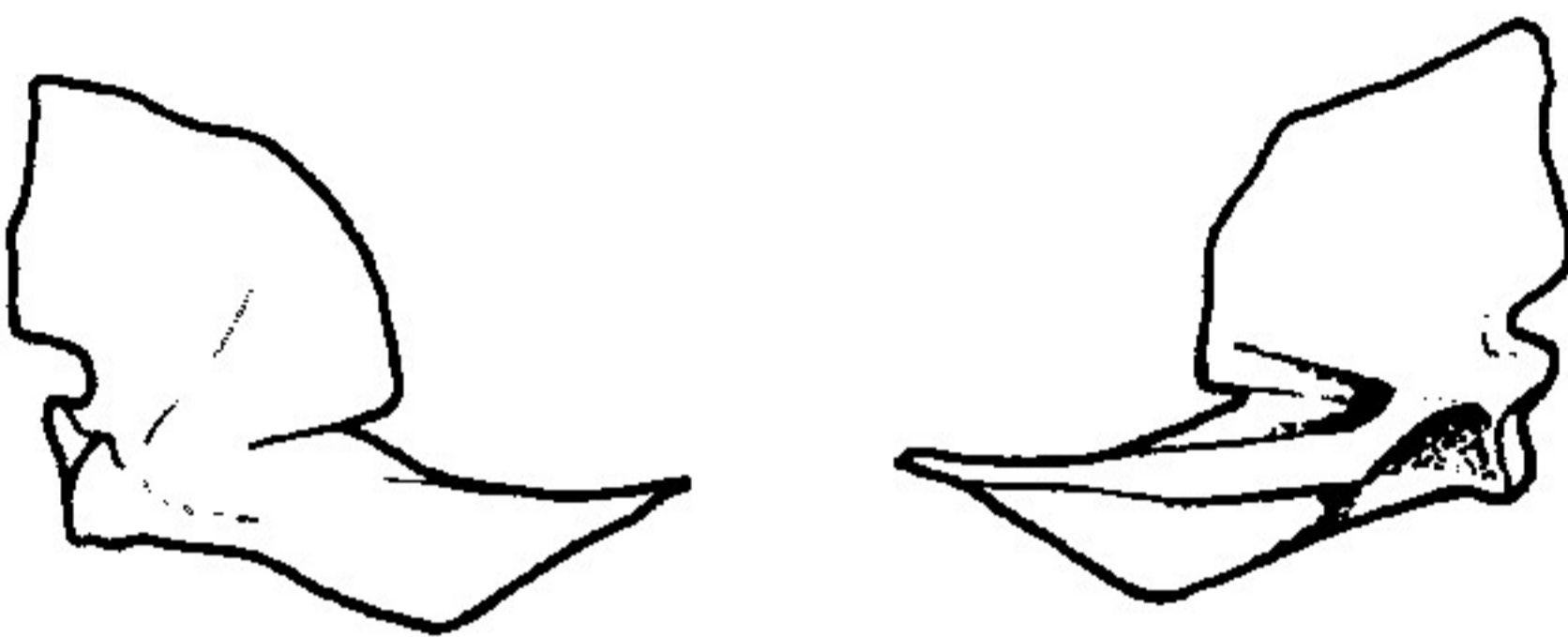
*Vimba vimba carinata*



*Leuciscus idus*



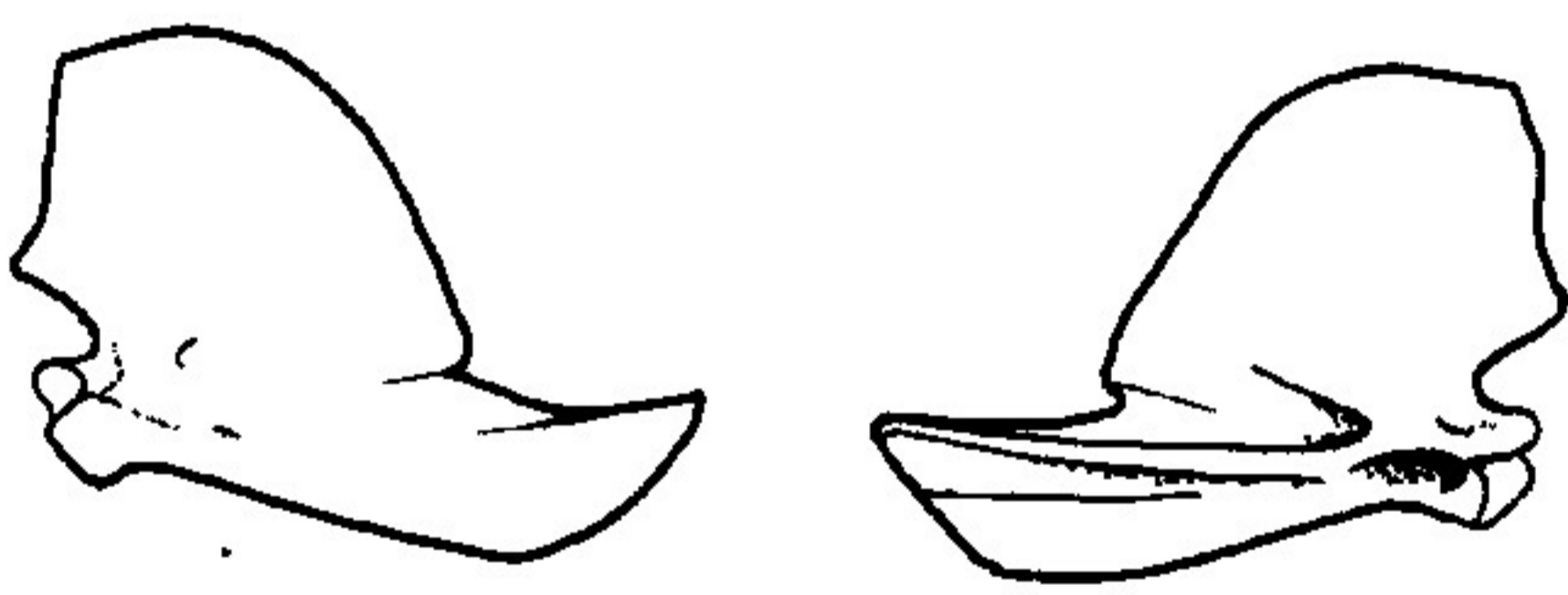
*Pelecus cultratus*



*Rutilus rutilus*



*Scardinius erythrophthalmus*



*Blicca bjoerkna*



*Aspius aspius*



*Alburnus alburnus*

NORMA LATERALIS    NORMA MEDIALIS



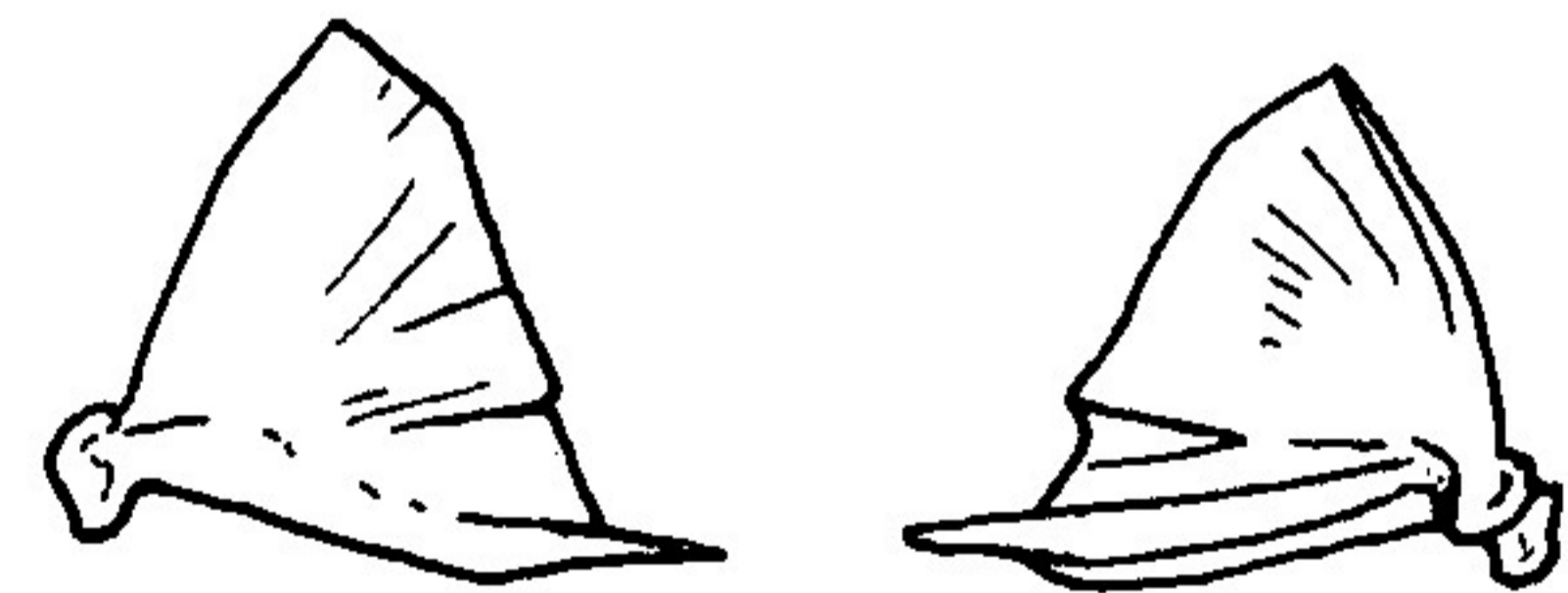
*Acerina schraetser*



*Gymnocephalus sp.*



*Aspro zingel*



*Perca fluviatilis*



*Stizostedion lucioperca*

ARTICULARE  
NORMA LATERALIS



*Salmo trutta lacustris*



*Cyprinus carpio*



*Abramis brama*



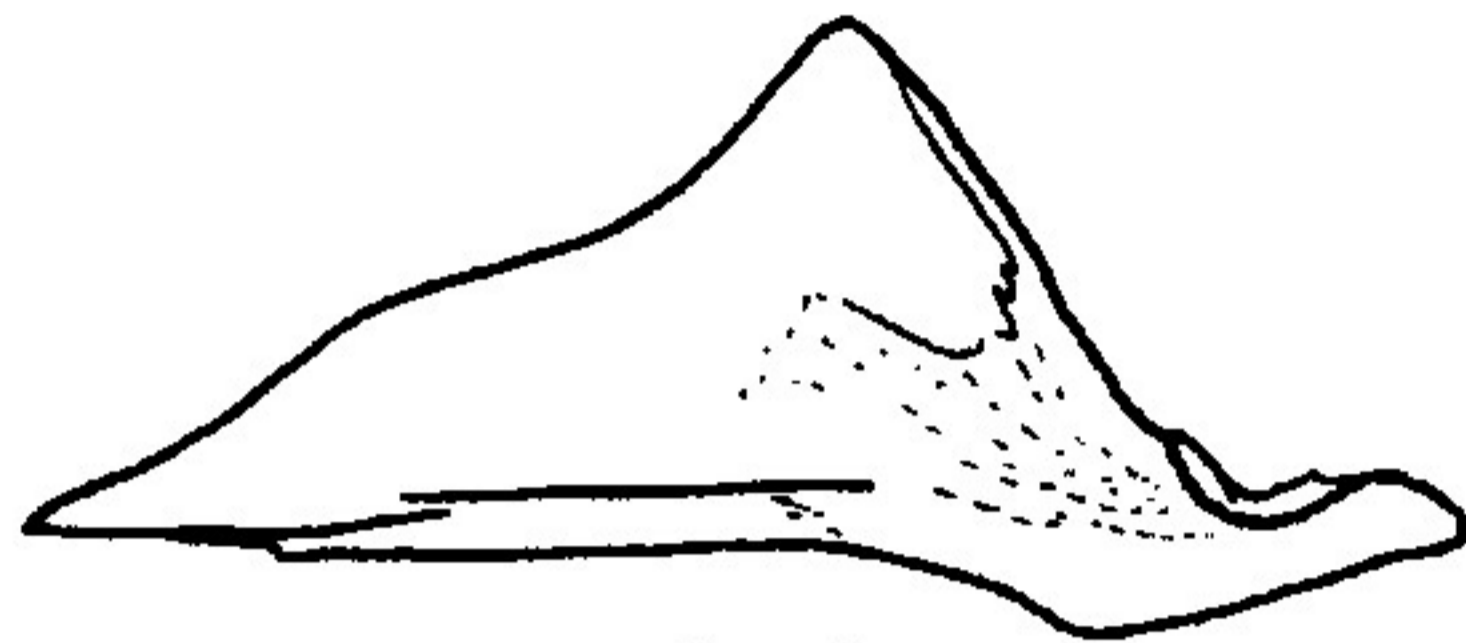
*Alosa pontica*



*Leuciscus idus*



*Scardinius erythrophthalmus*



*Esox lucius*



*Aspius aspius*



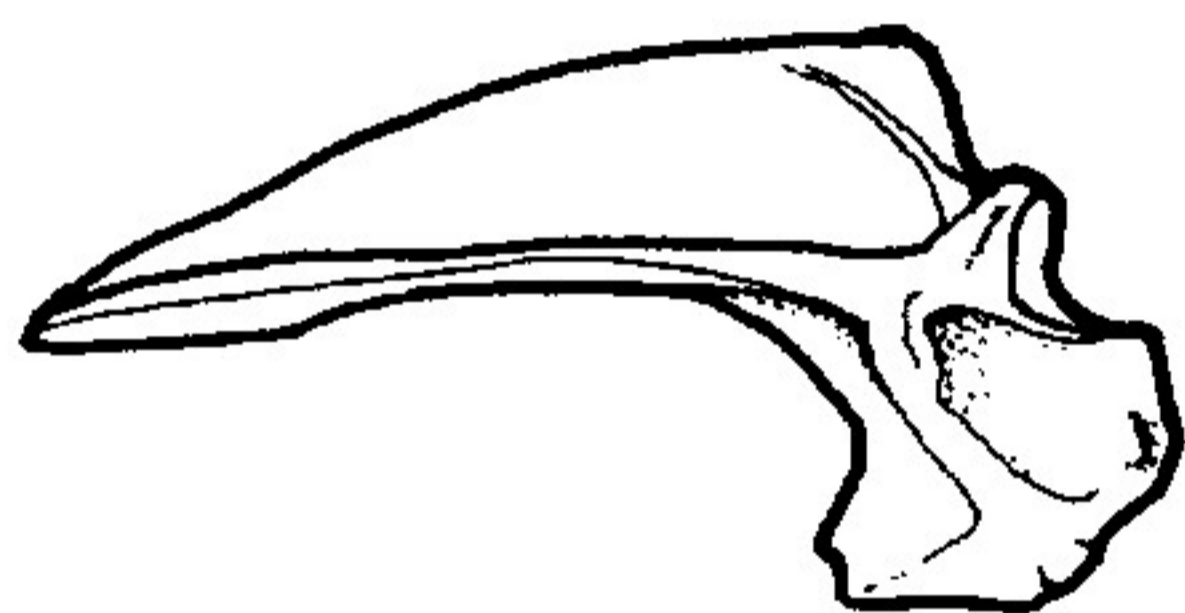
*Blicca bjoerkna*



*Silurus glanis*



*Alburnus alburnus*



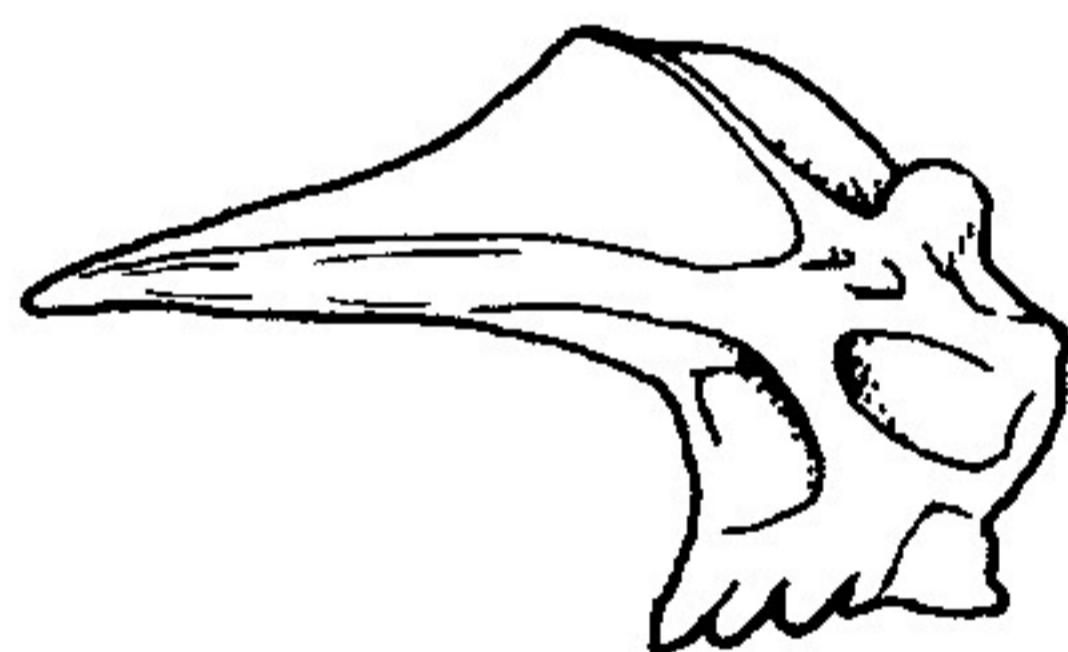
*Acerina schraetser*



*Barbus barbus*



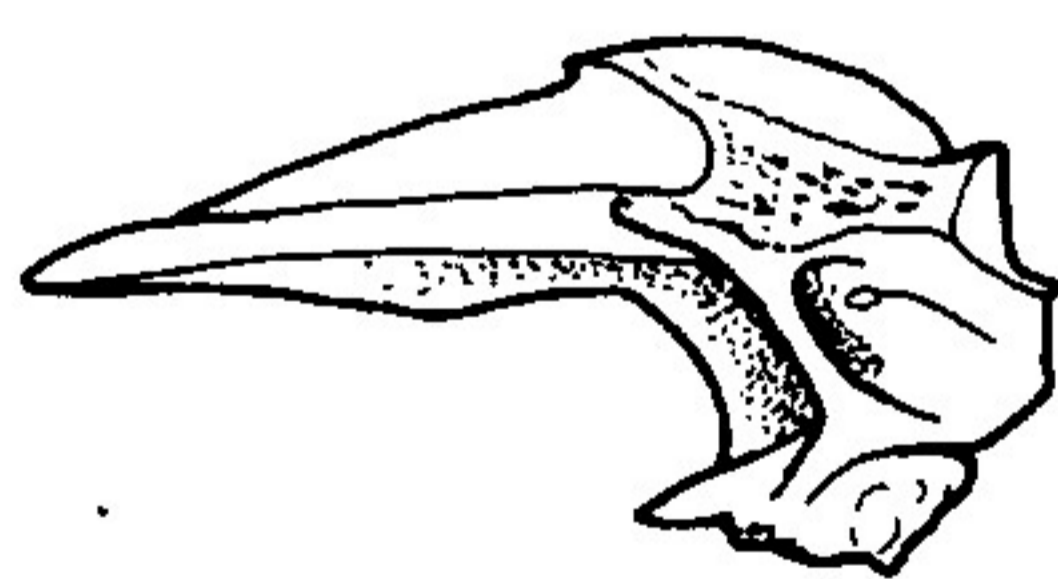
*Chalcaburnus chalcoides mento*



*Gymnocephalus sp.*



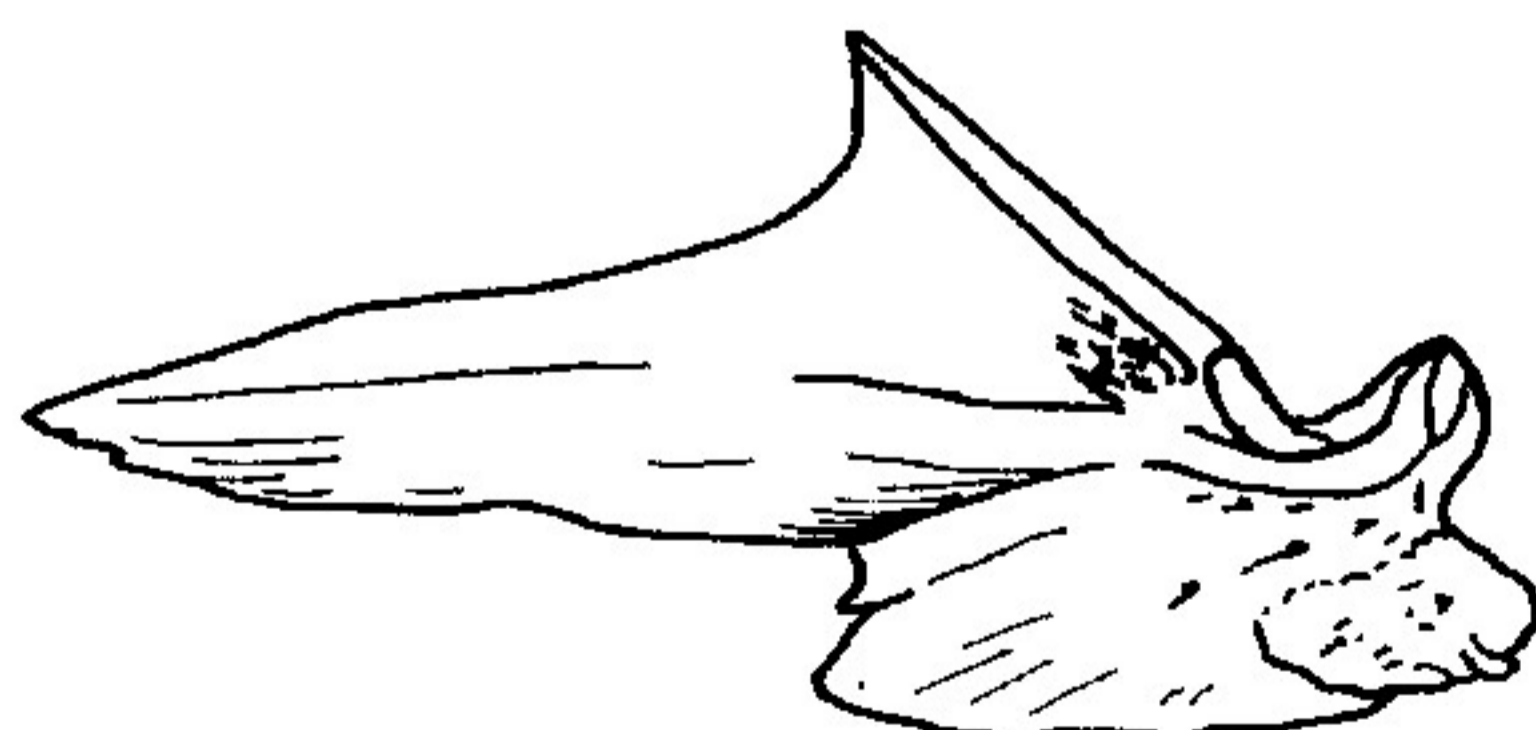
*Carassius auratus*



*Aspro zingel*



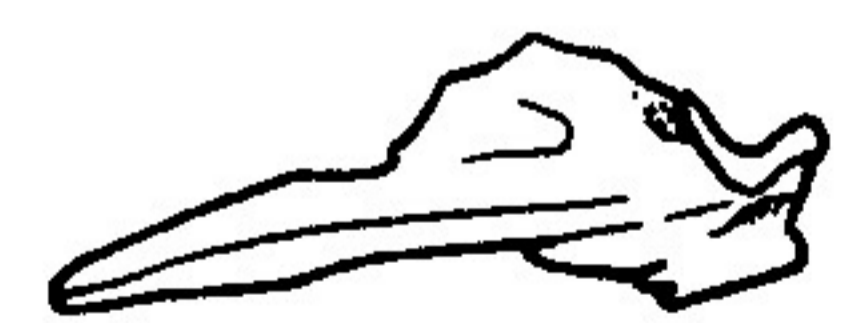
*Vimba vimba carinata*



*Perca fluviatilis*



*Rutilus rutilus*



*Pelecus cultratus*



*Stizostedion lucioperca*

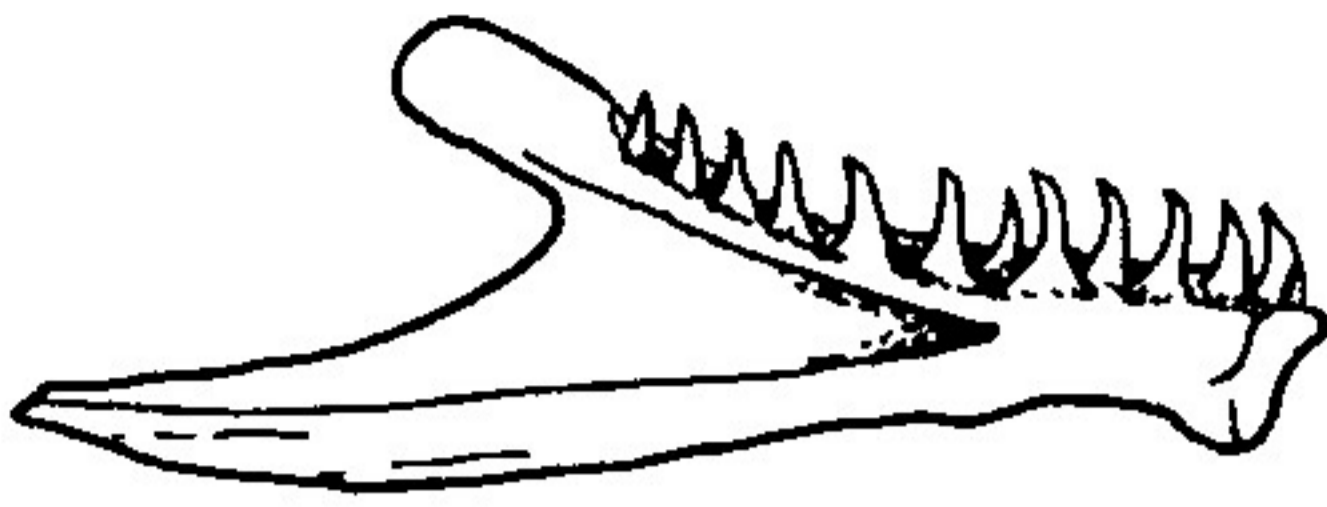


*Tinca tinca*

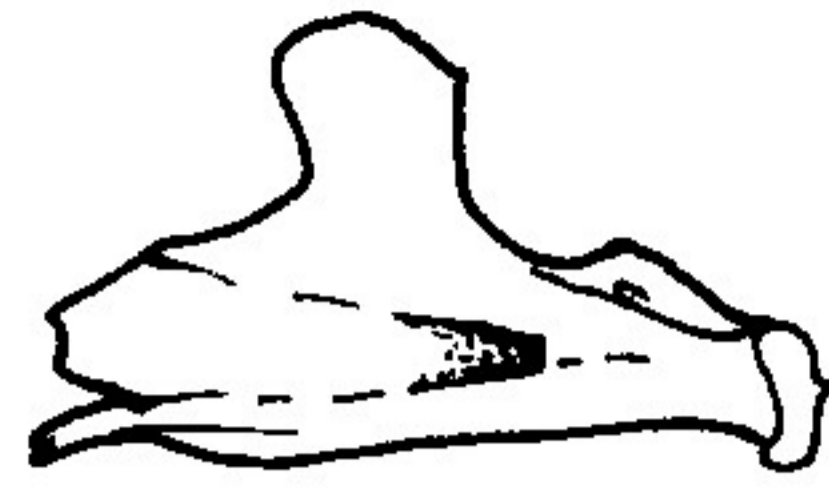


*Chondrostoma nasus*

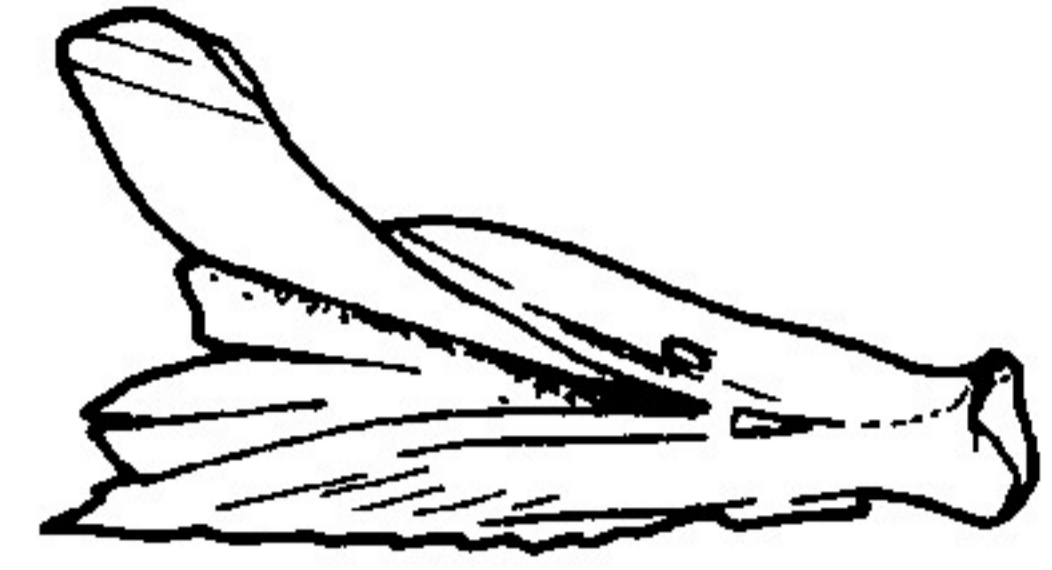
**DENTALE**  
**NORMA MEDIALIS**



*Salmo trutta lacustris*



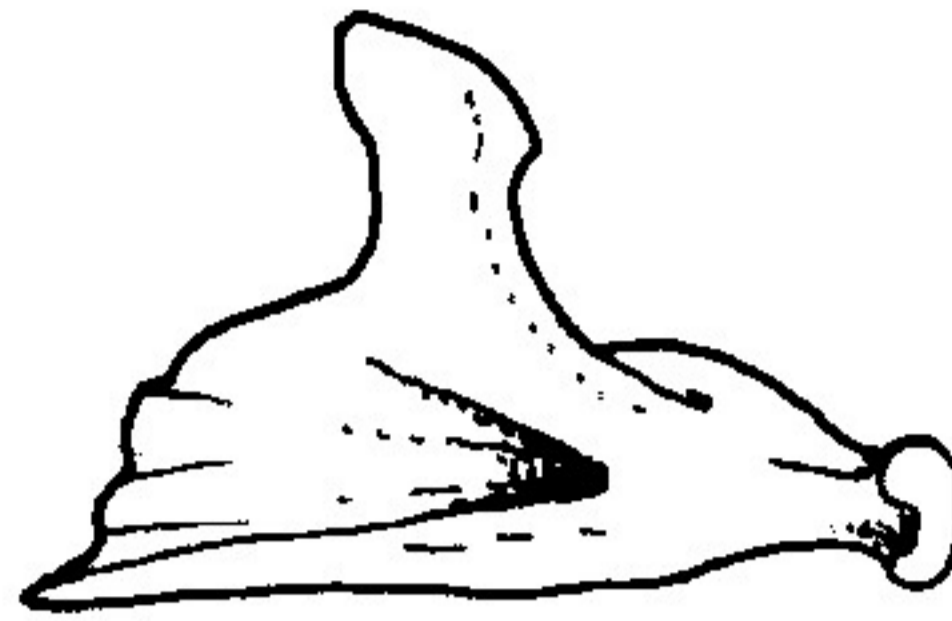
*Abramis brama*



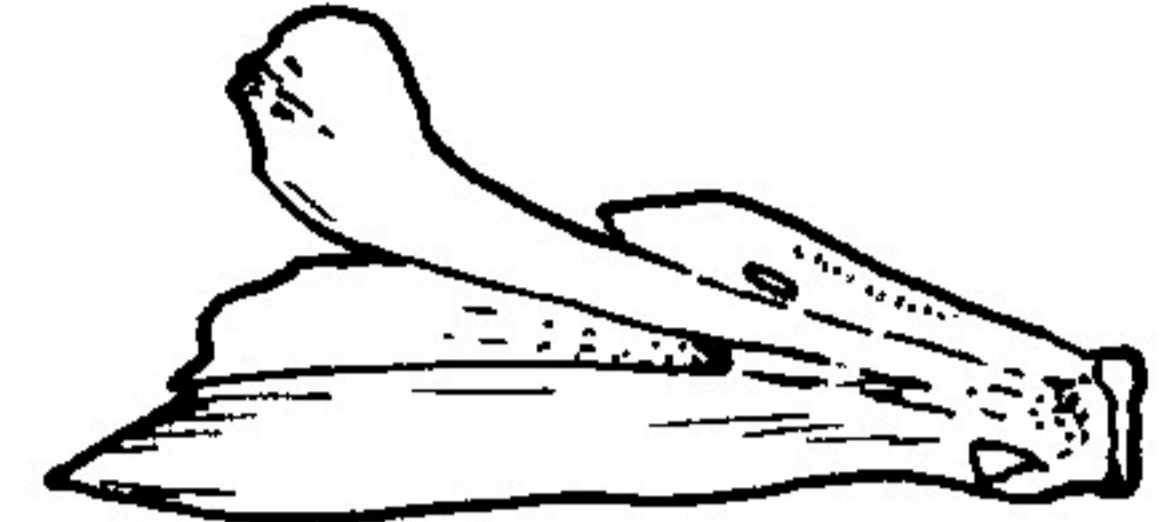
*Aspius aspius*



*Alosa pontica*



*Carassius auratus*



*Chalcaburnus chalcoides mento*



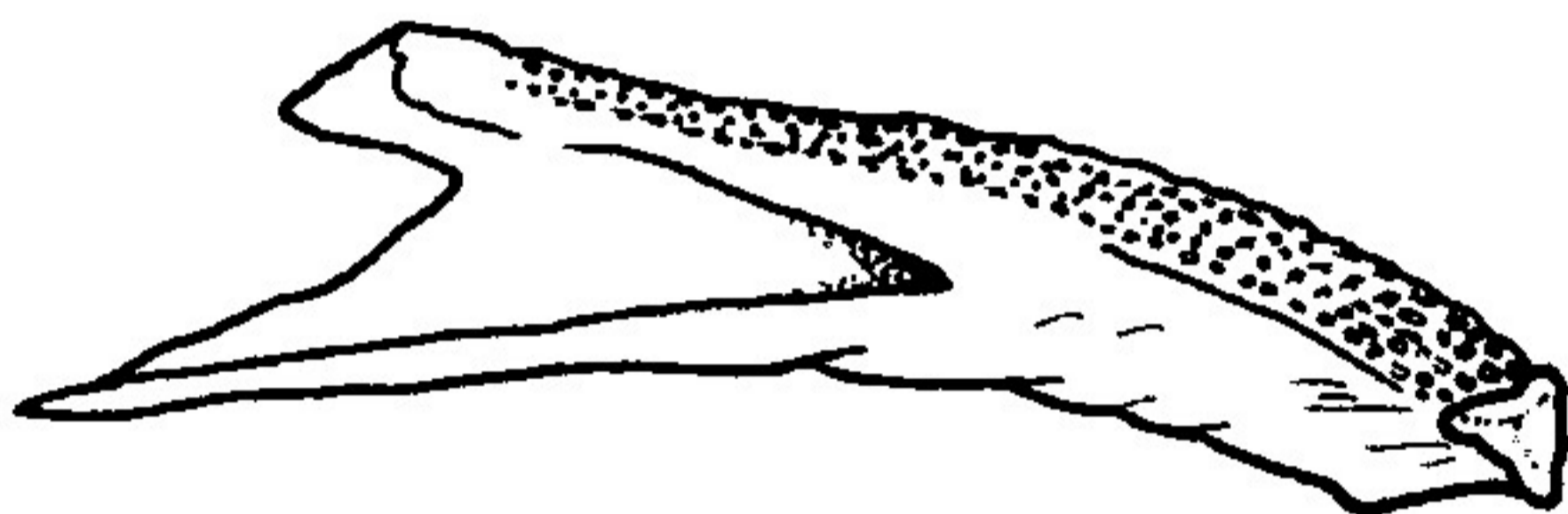
*Esox lucius*



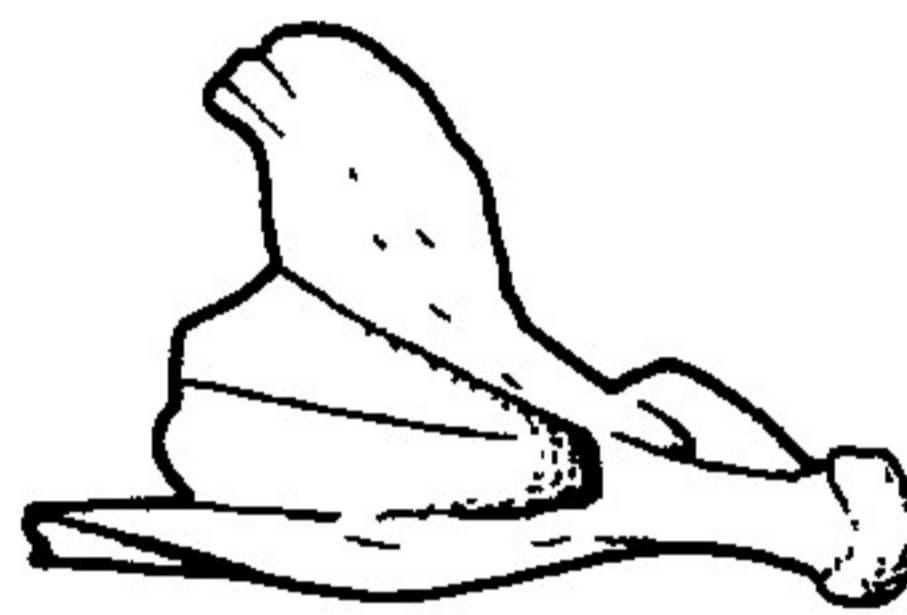
*Vimba vimba carinata*



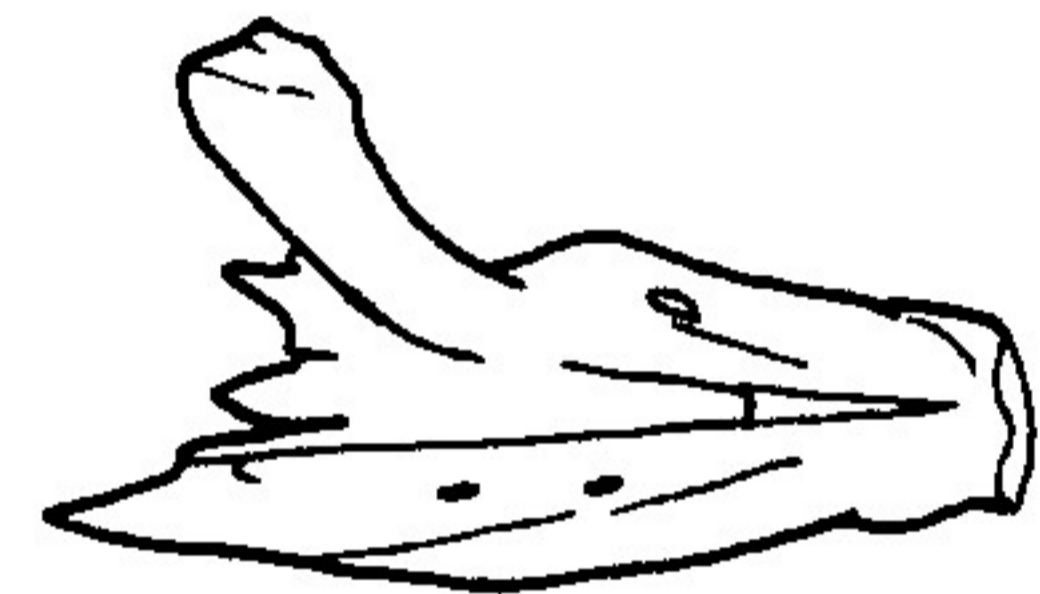
*Alburnus alburnus*



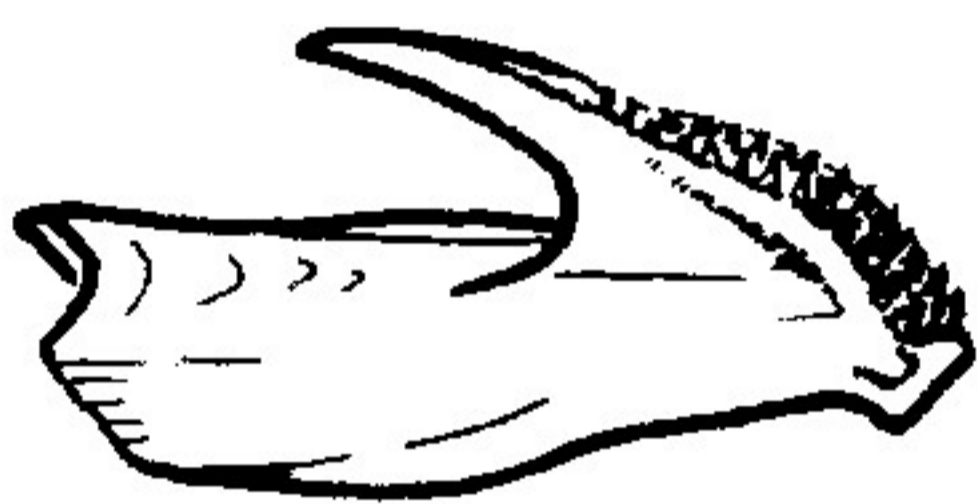
*Silurus glanis*



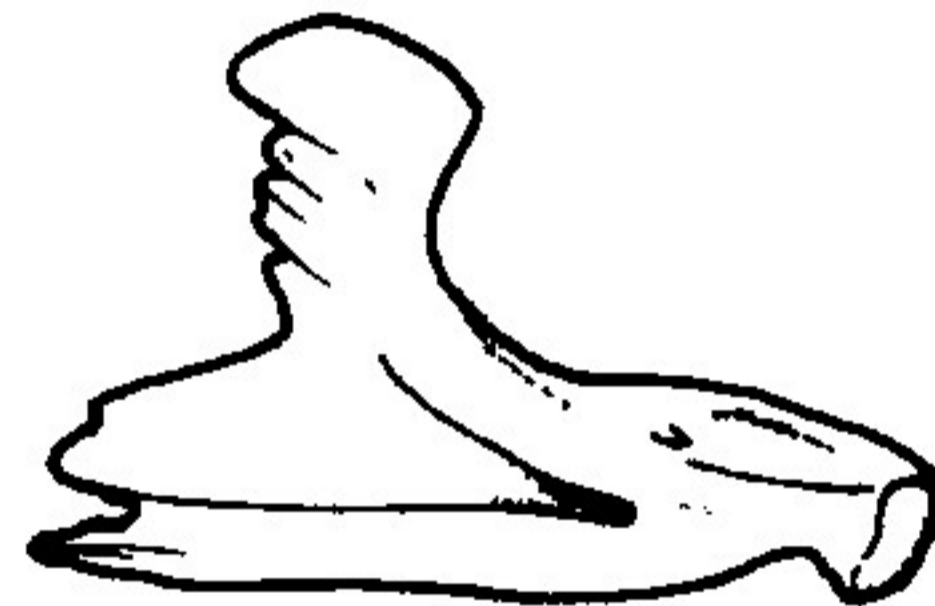
*Cyprinus carpio*



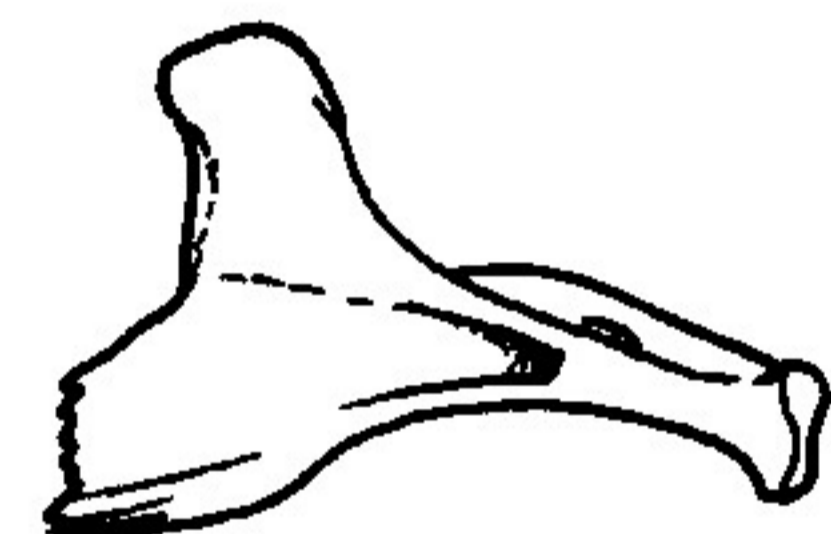
*Pelecus cultratus*



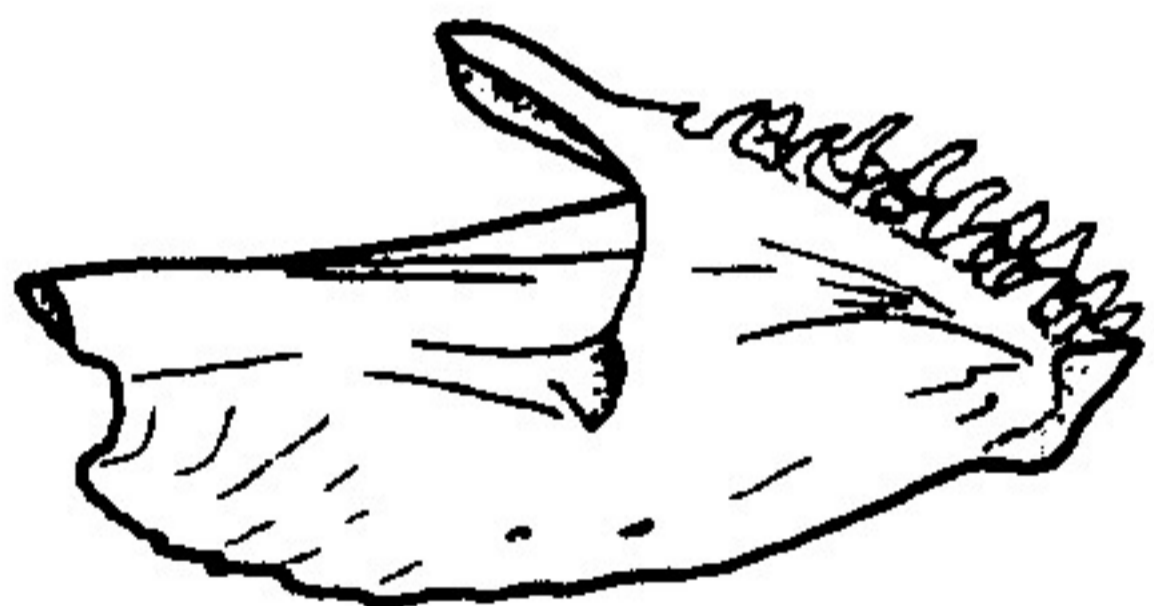
*Acerina schraetser*



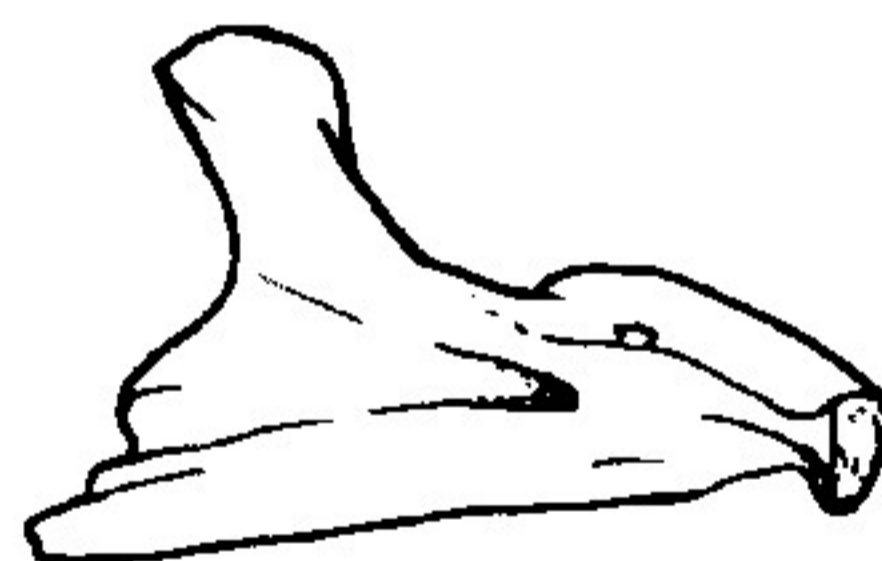
*Blicca bjoerkna*



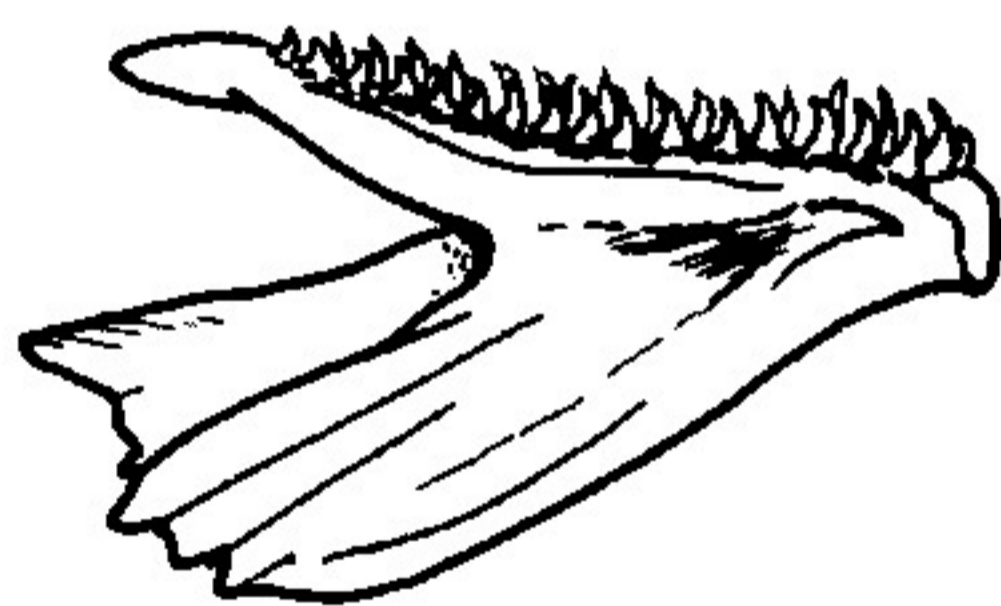
*Tinca tinca*



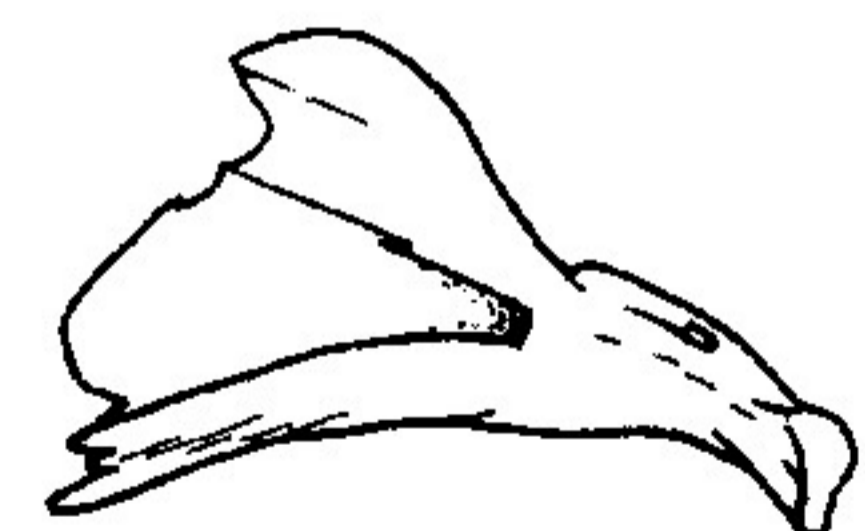
*Gymnocephalus sp.*



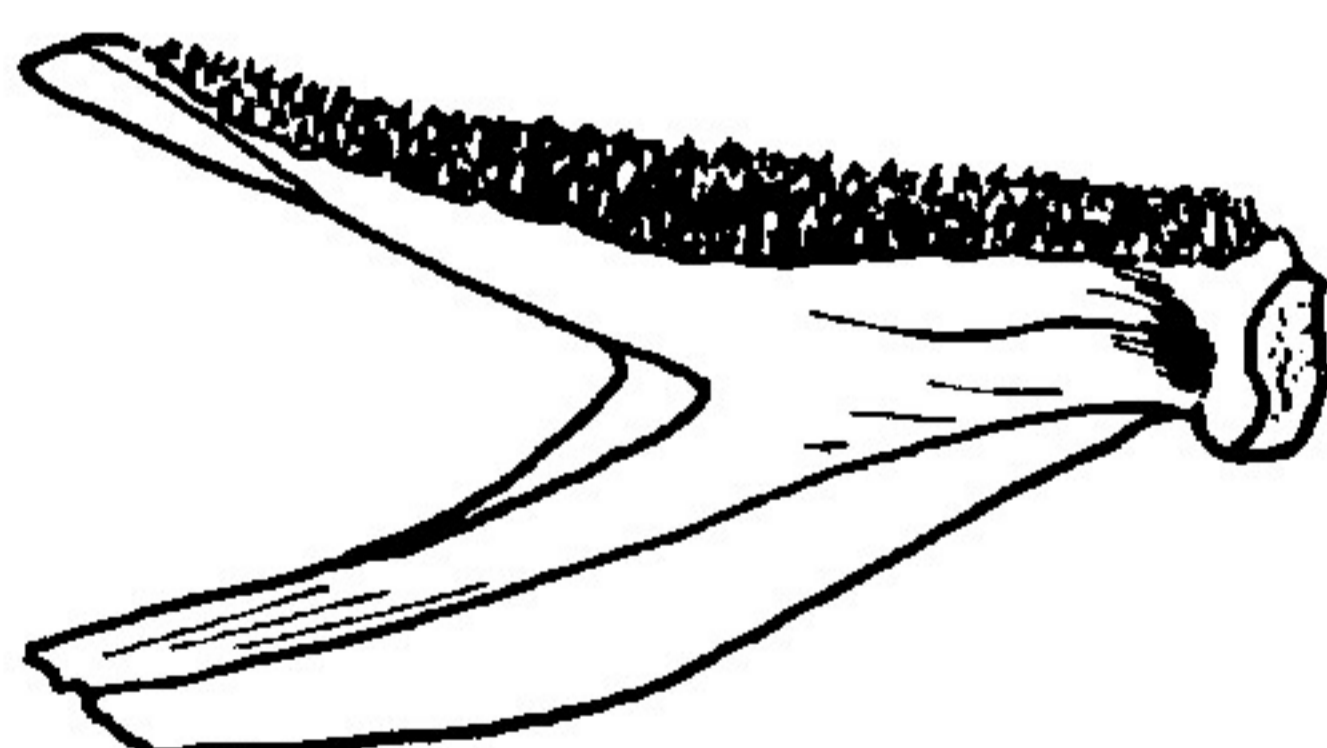
*Rutilus rutilus*



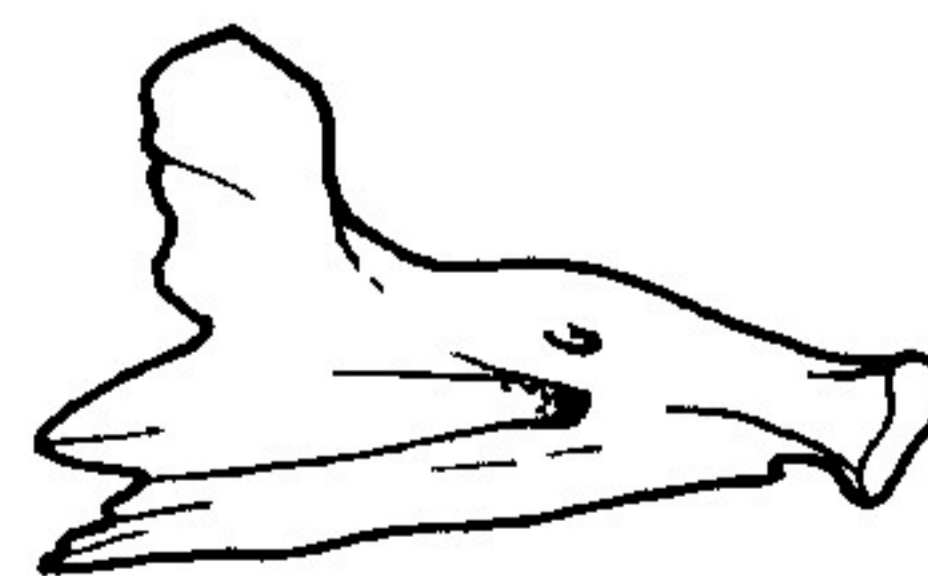
*Aspro zingel*



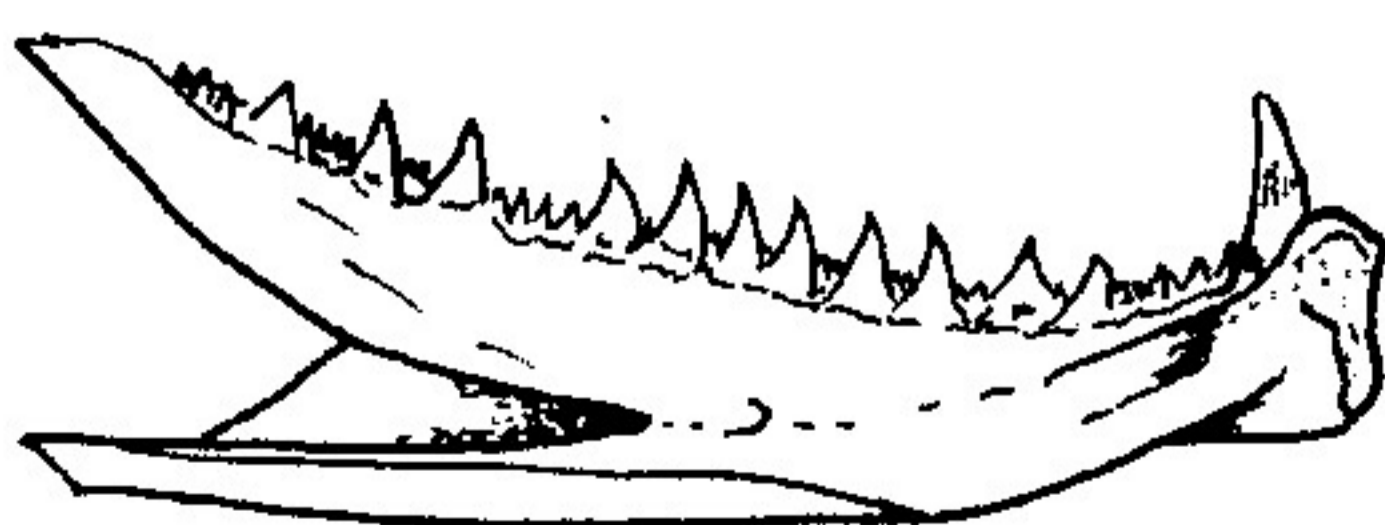
*Barbus barbus*



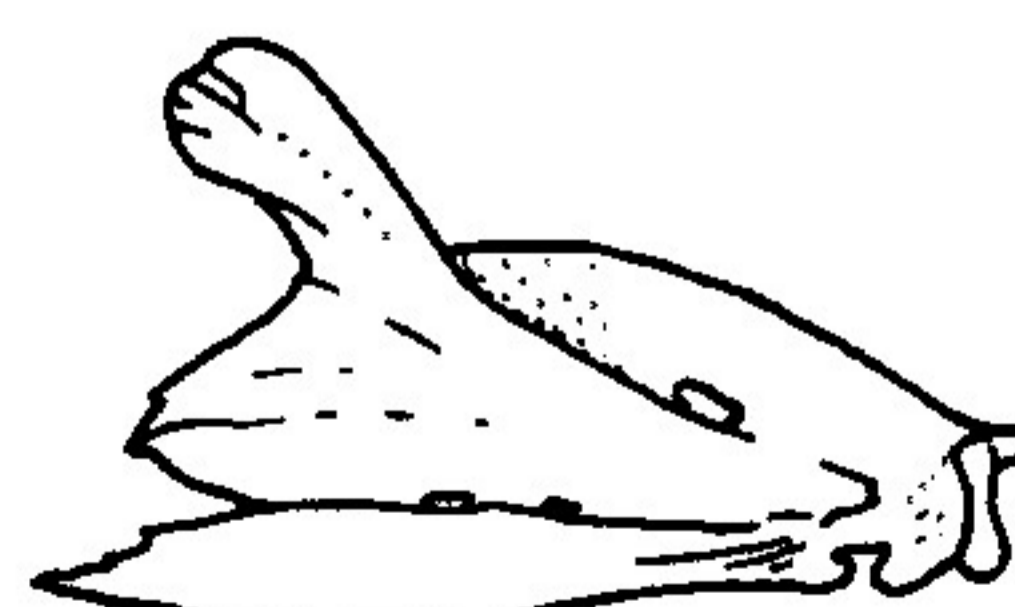
*Perca fluviatilis*



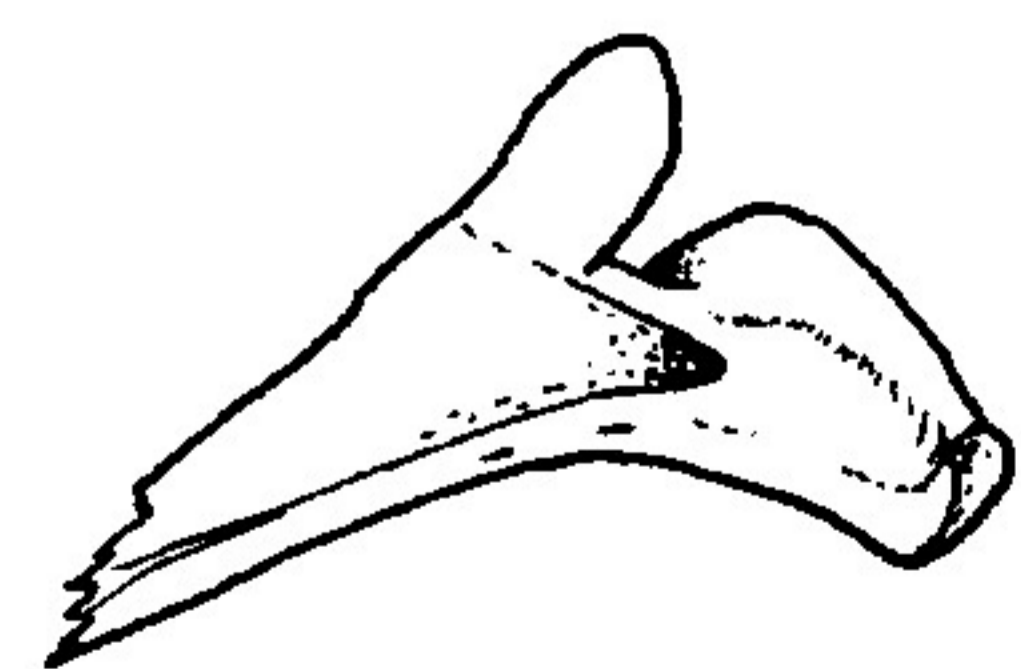
*Leuciscus idus*



*Stizostedion lucioperca*



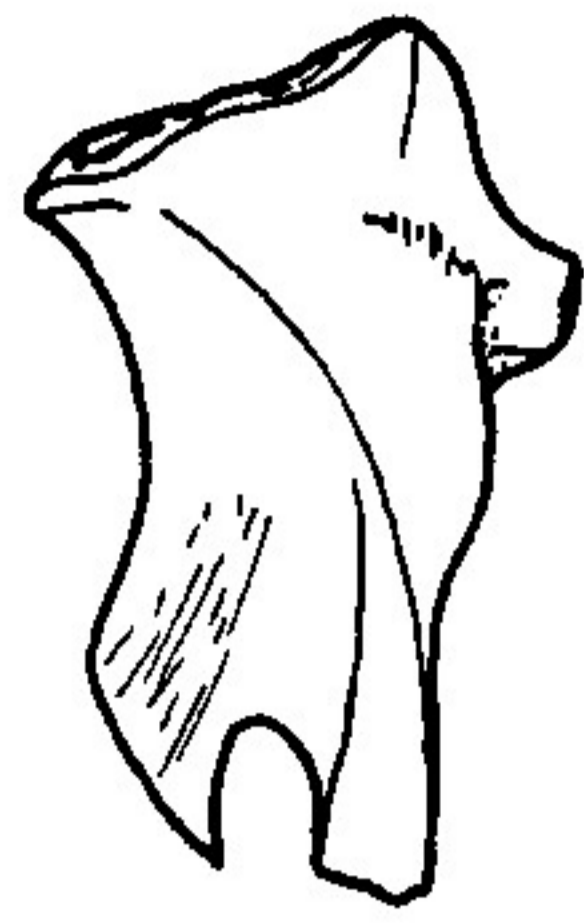
*Scardinius erythrophthalmus*



*Chondrostoma nasus*

# HYOMANDIBULARE

## NORMA LATERALIS



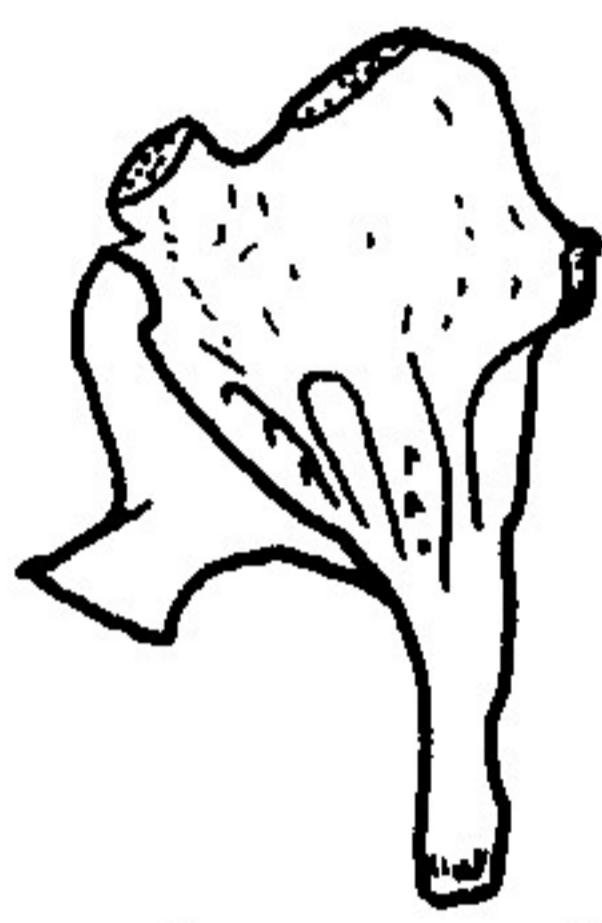
*Salmo trutta lacustris*



*Abramis brama*



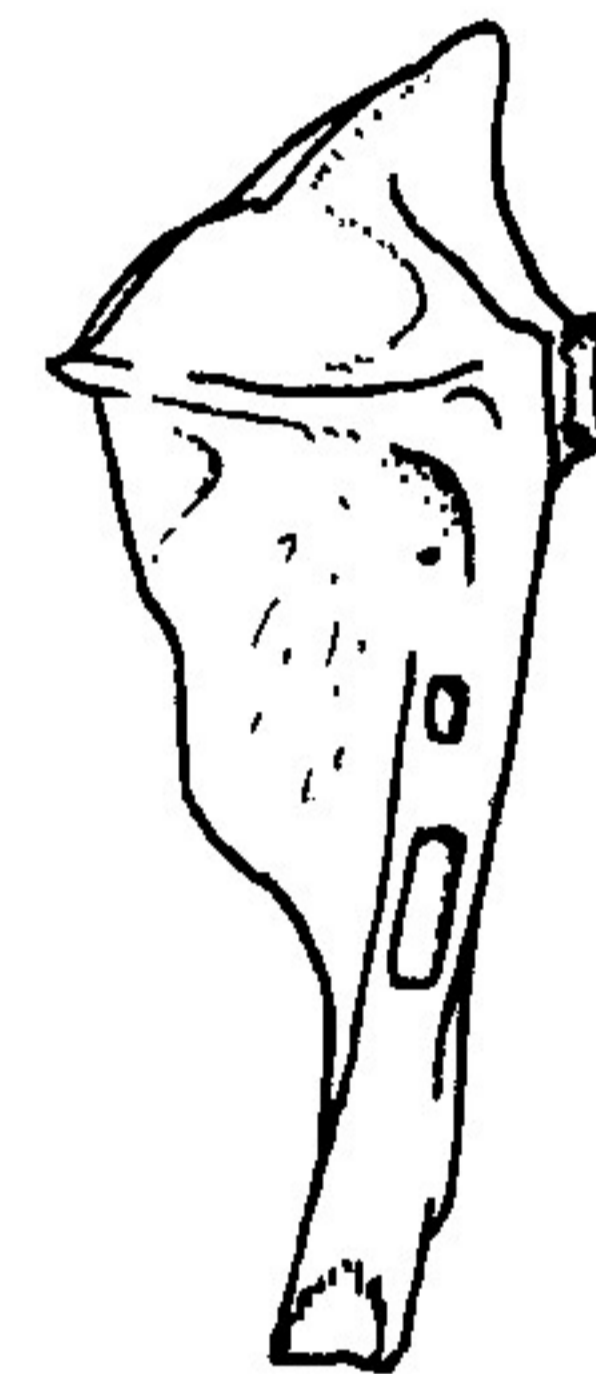
*Blicca bjoerkna*



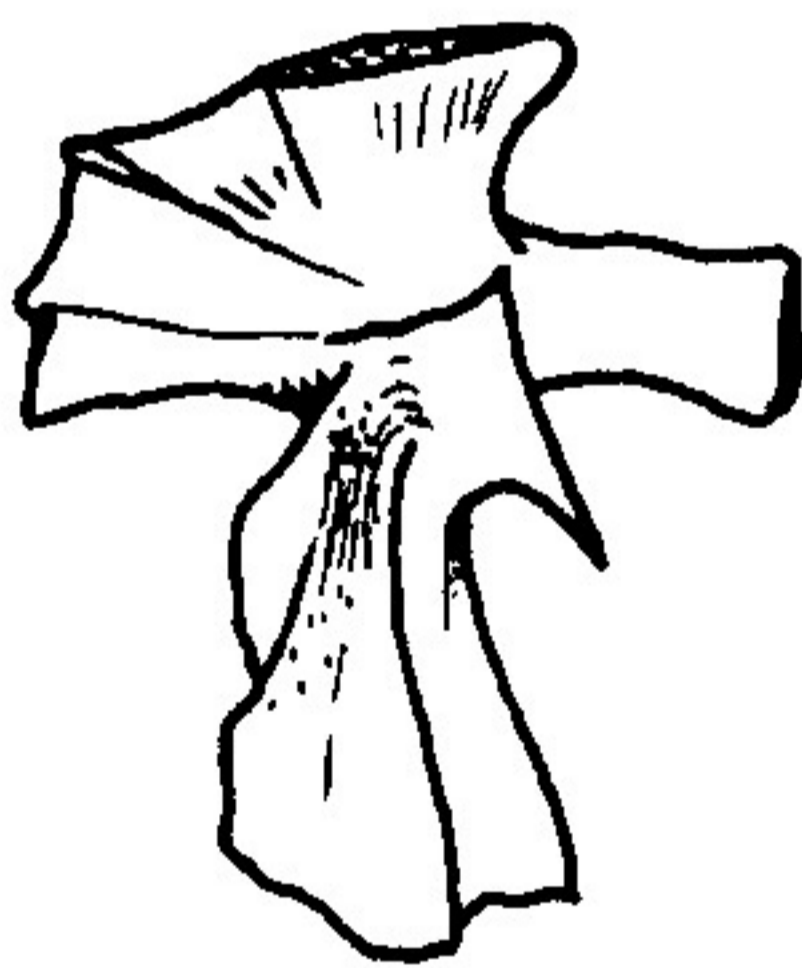
*Alosa pontica*



*Vimba vimba carinata*



*Scardinius erythrophthalmus*



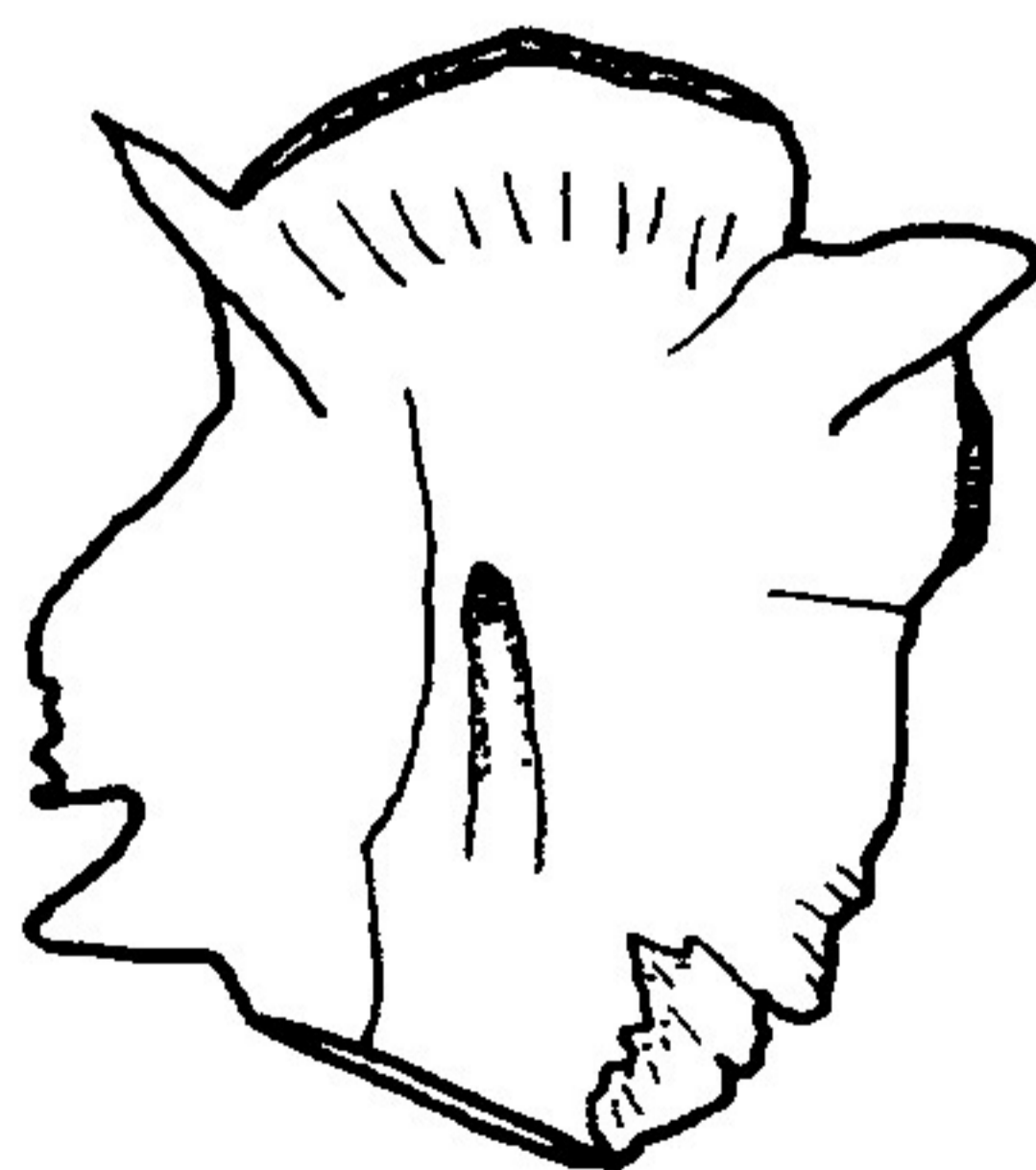
*Esox lucius*



*Rutilus rutilus*



*Carassius auratus*



*Silurus glanis*



*Barbus barbus*

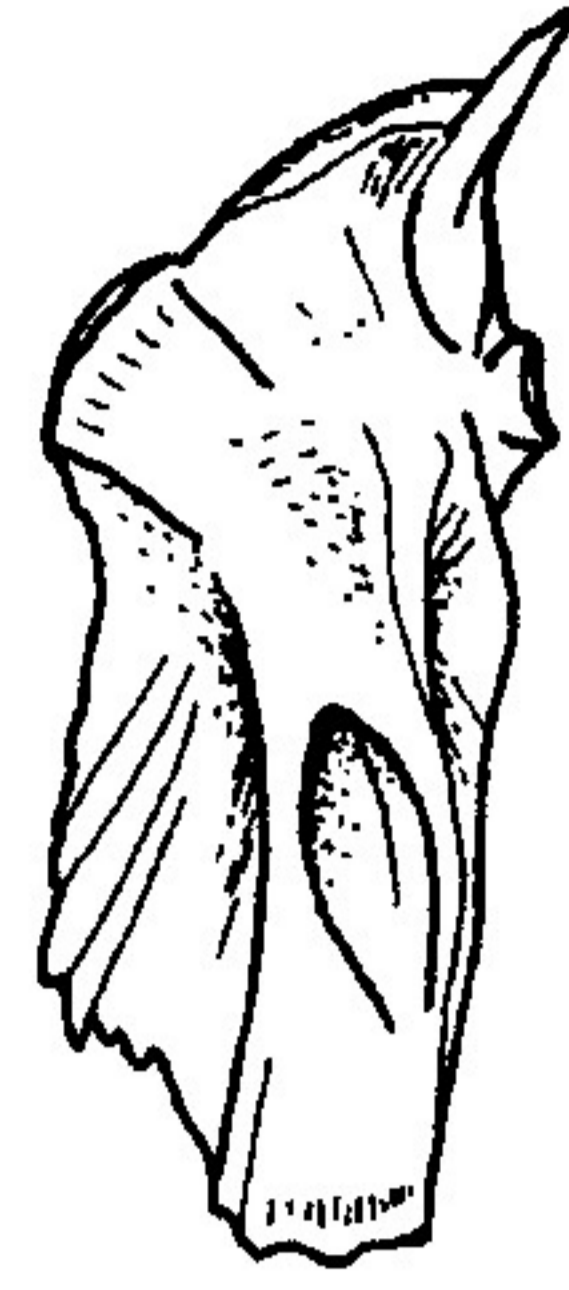
**HYOMANDIBULARE**  
*NORMA LATERALIS*



*Alburnus alburnus*



*Leuciscus idus*



*Acerina schraetser*



*Chalcaburnus chalcoides mento*



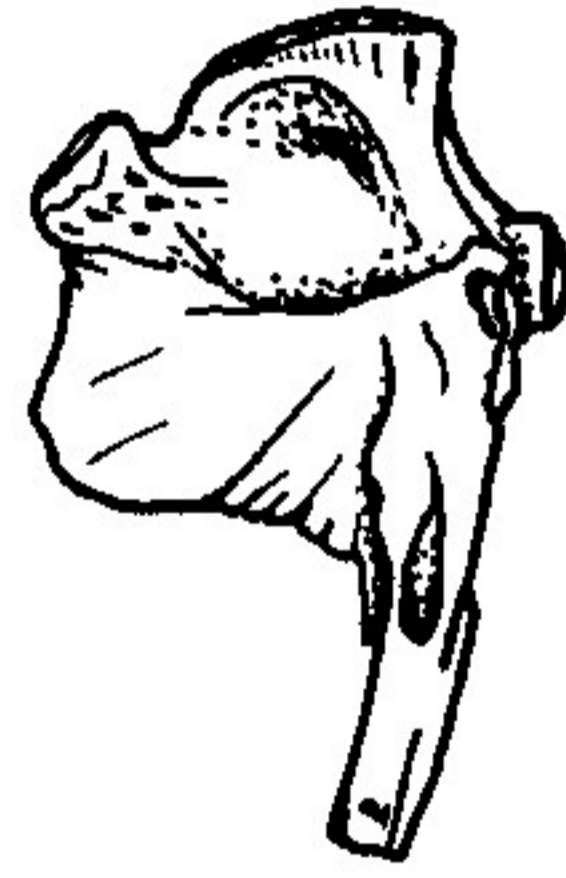
*Chondrostoma nasus*



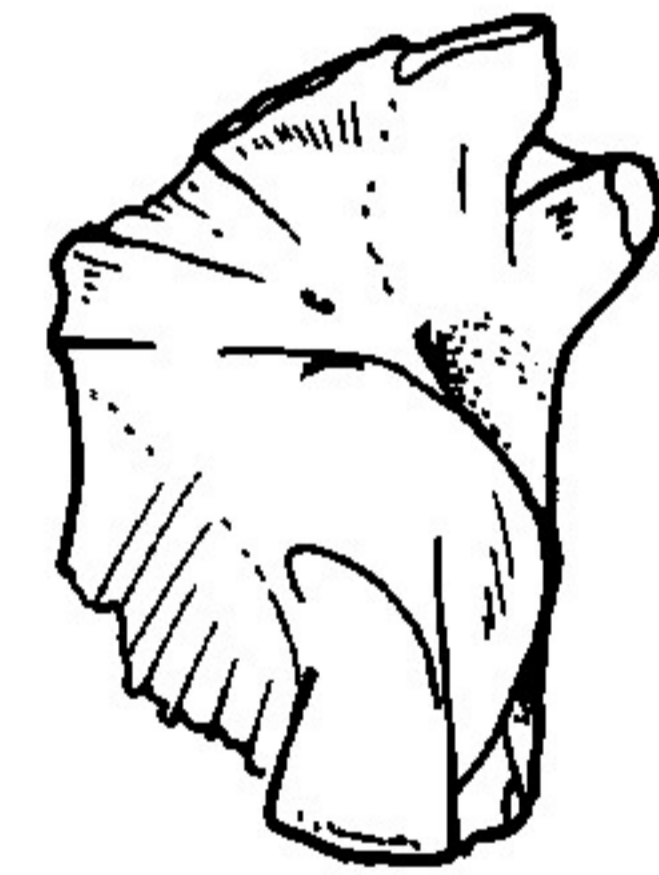
*Gymnocephalus sp.*



*Cyprinus carpio*



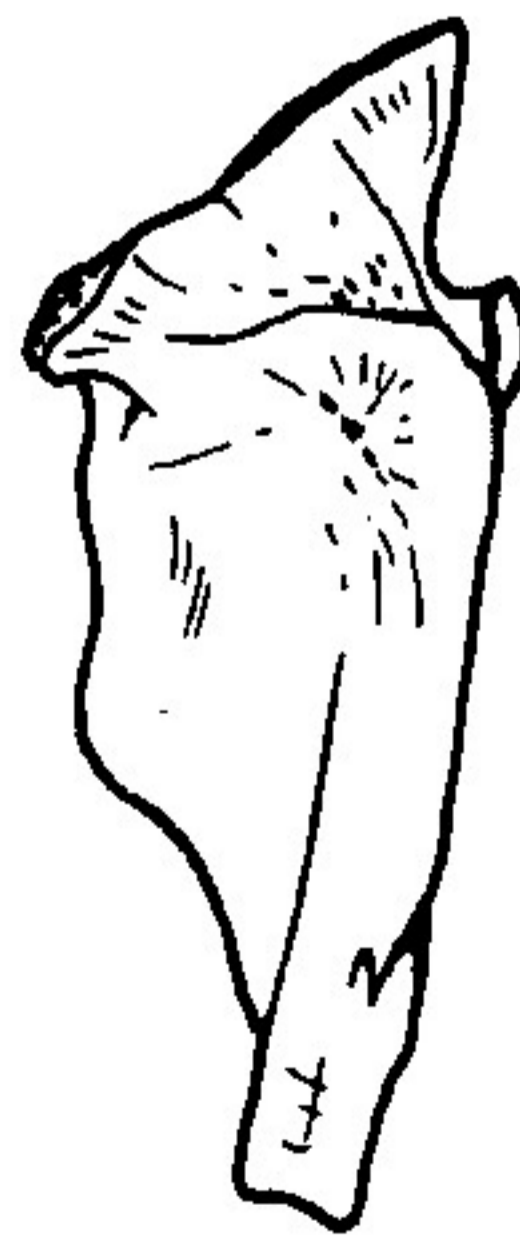
*Aspius aspius*



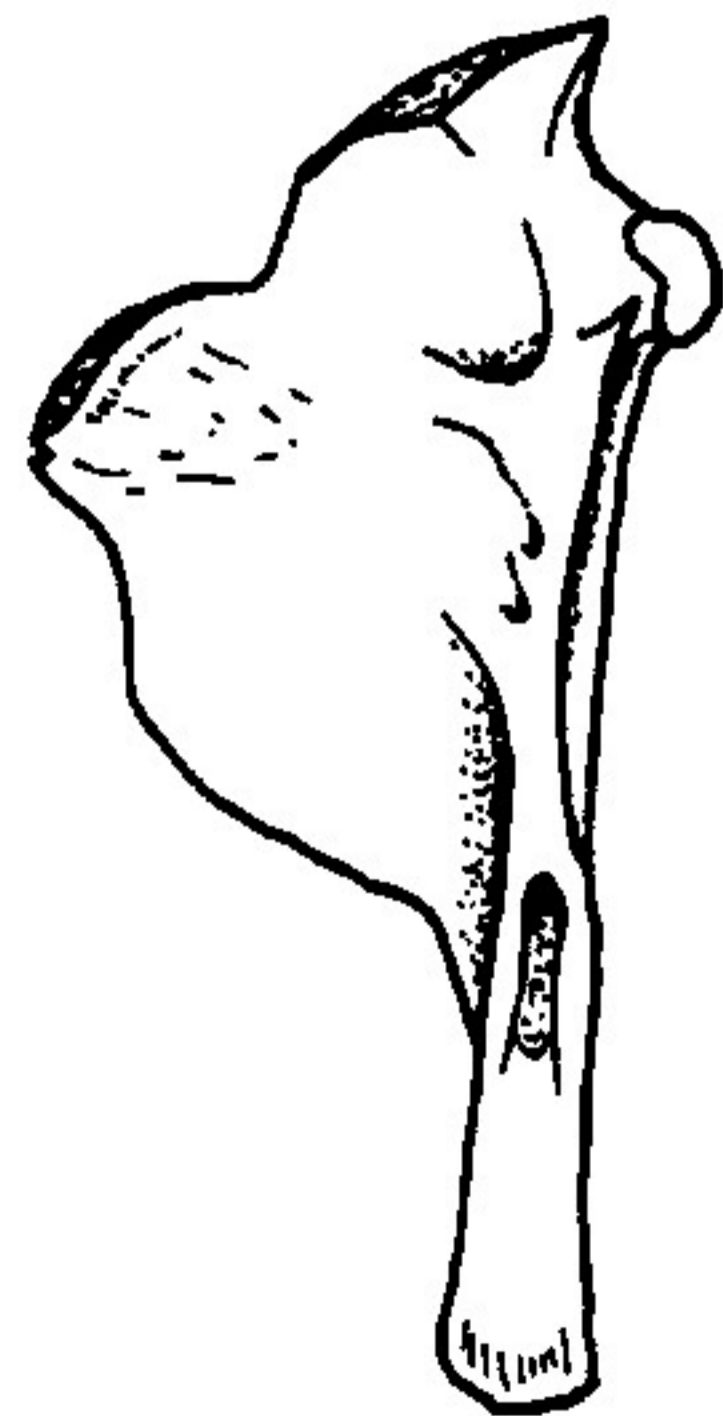
*Aspro zingel*



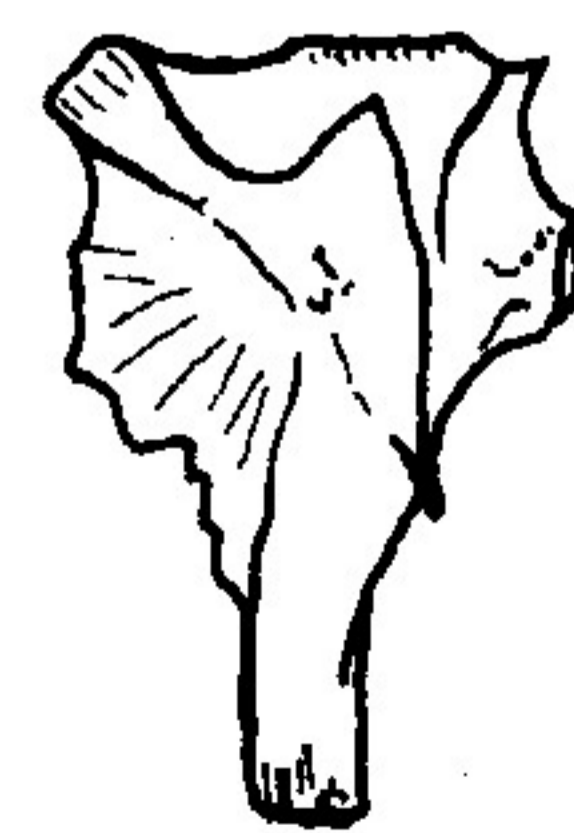
*Perca fluviatilis*



*Tinca tinca*



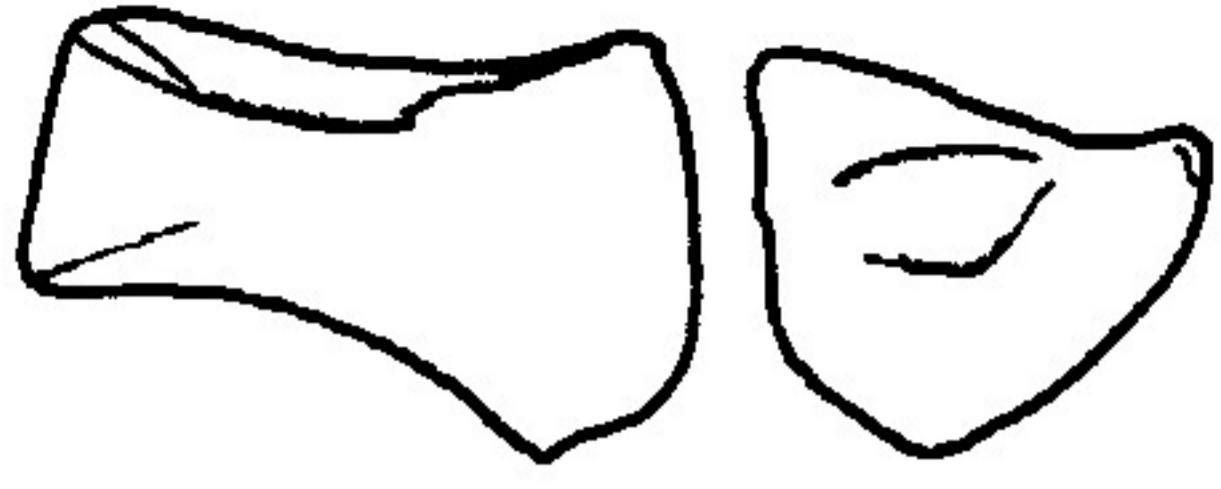
*Pelecus cultratus*



*Stizostedion lucioperca*

EPIHYALE KERATOHYALE

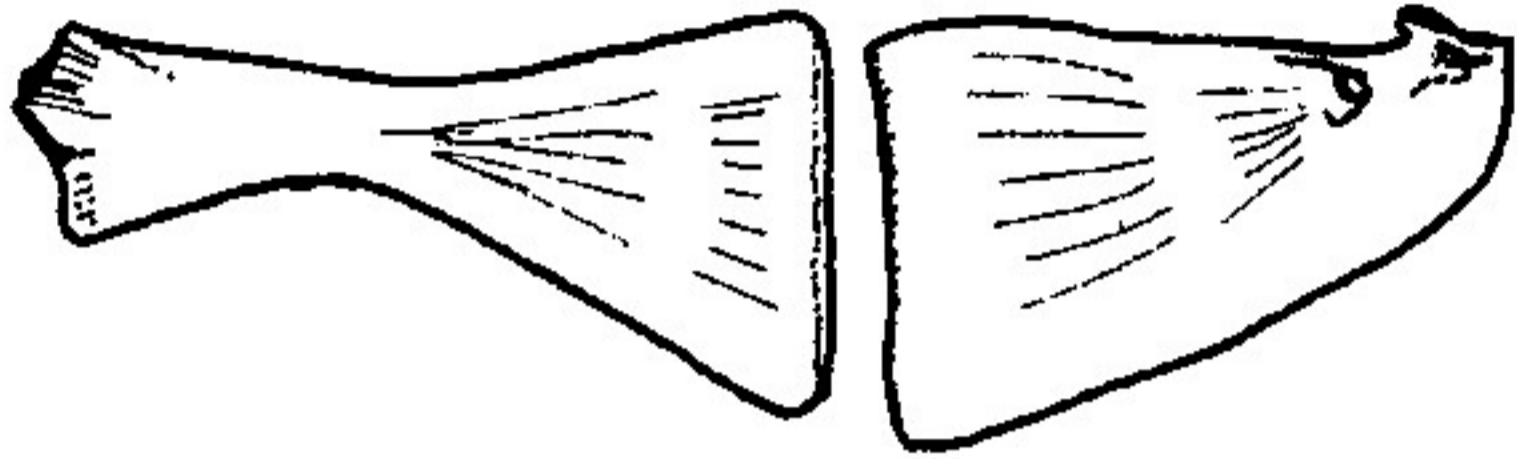
NORMA LATERALIS



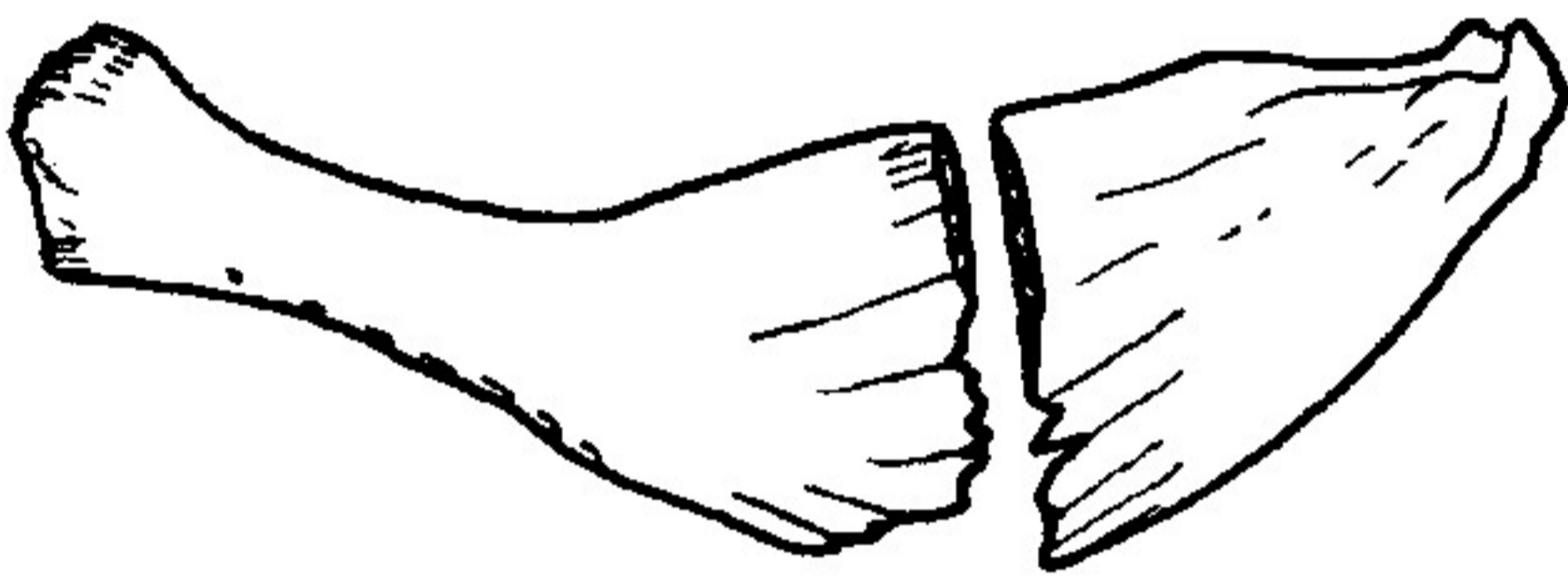
*Salmo trutta lacustris*



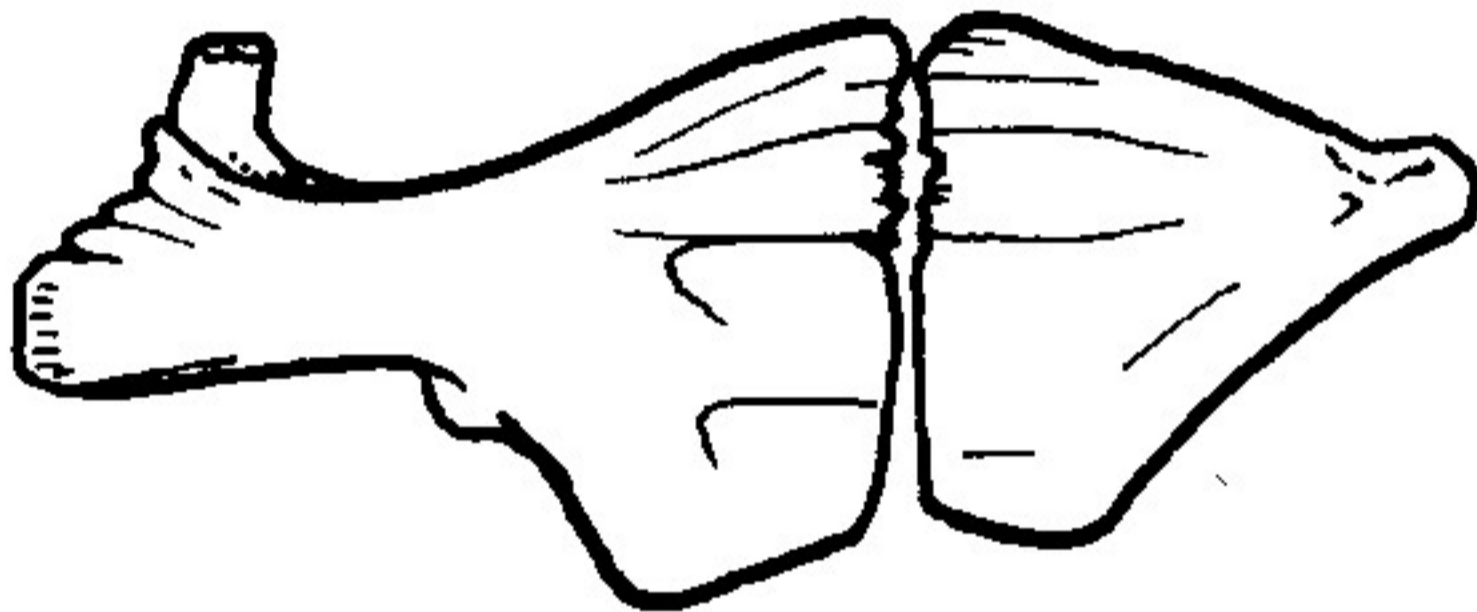
*Alosa pontica*



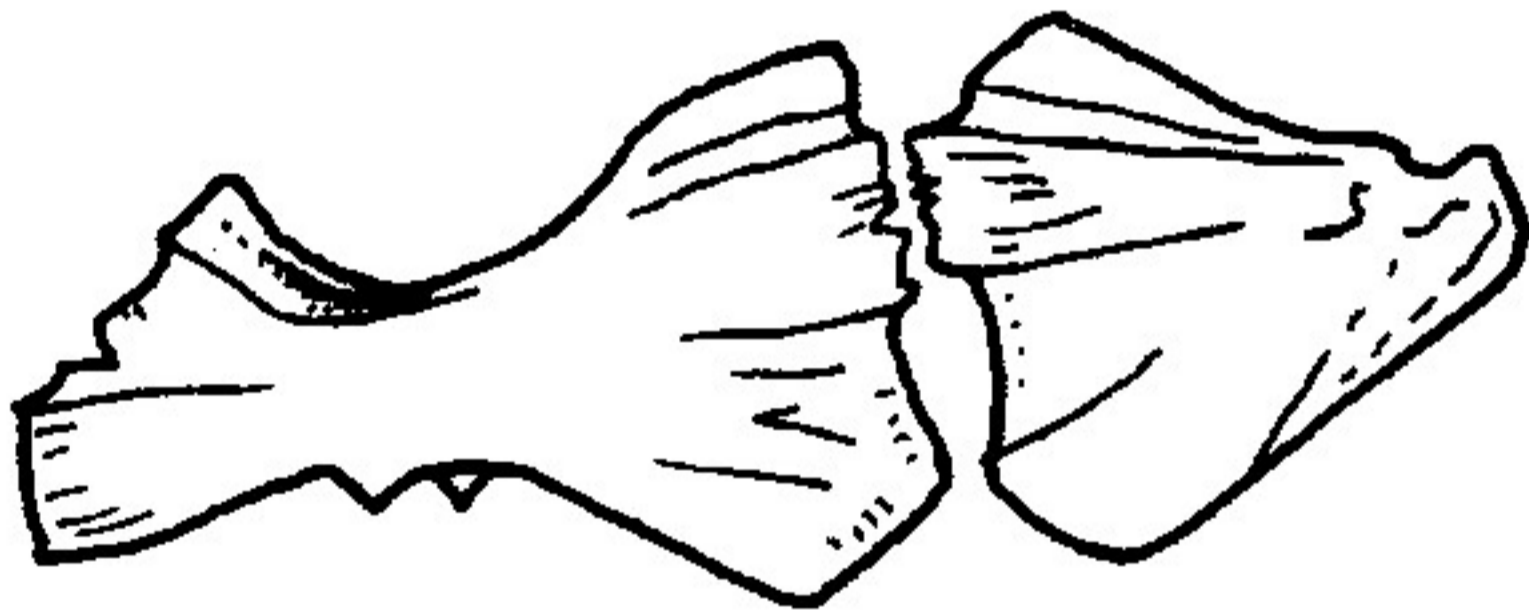
*Esox lucius*



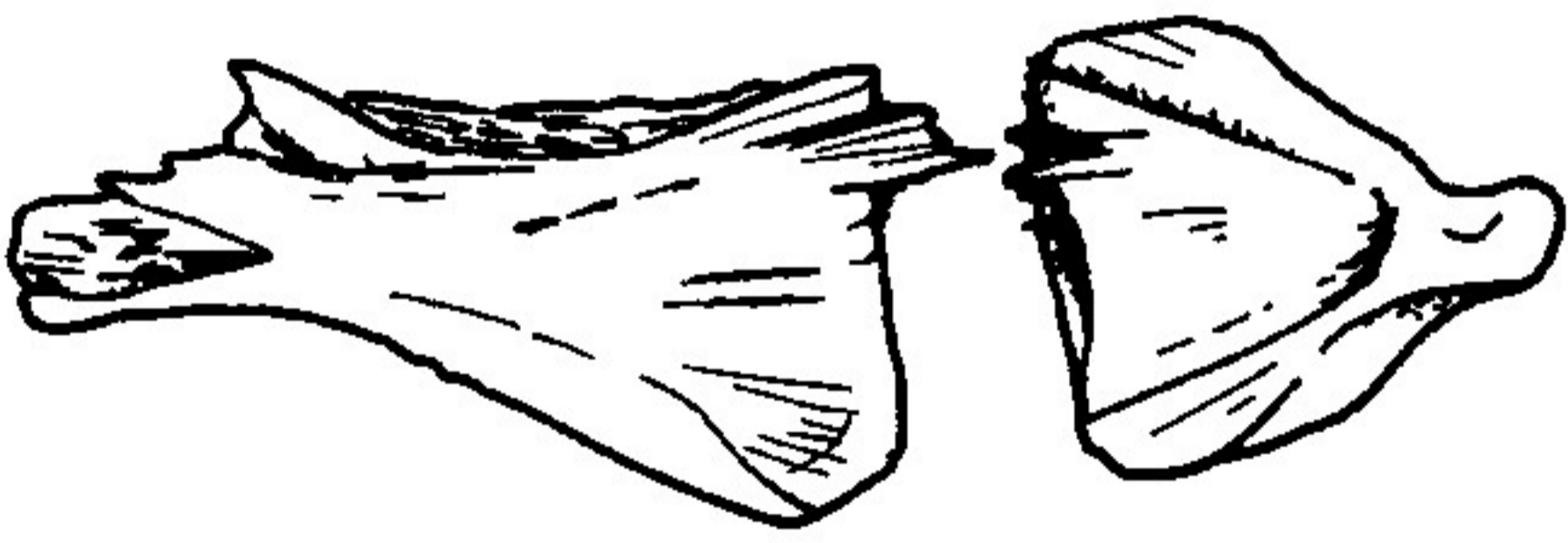
*Silurus glanis*



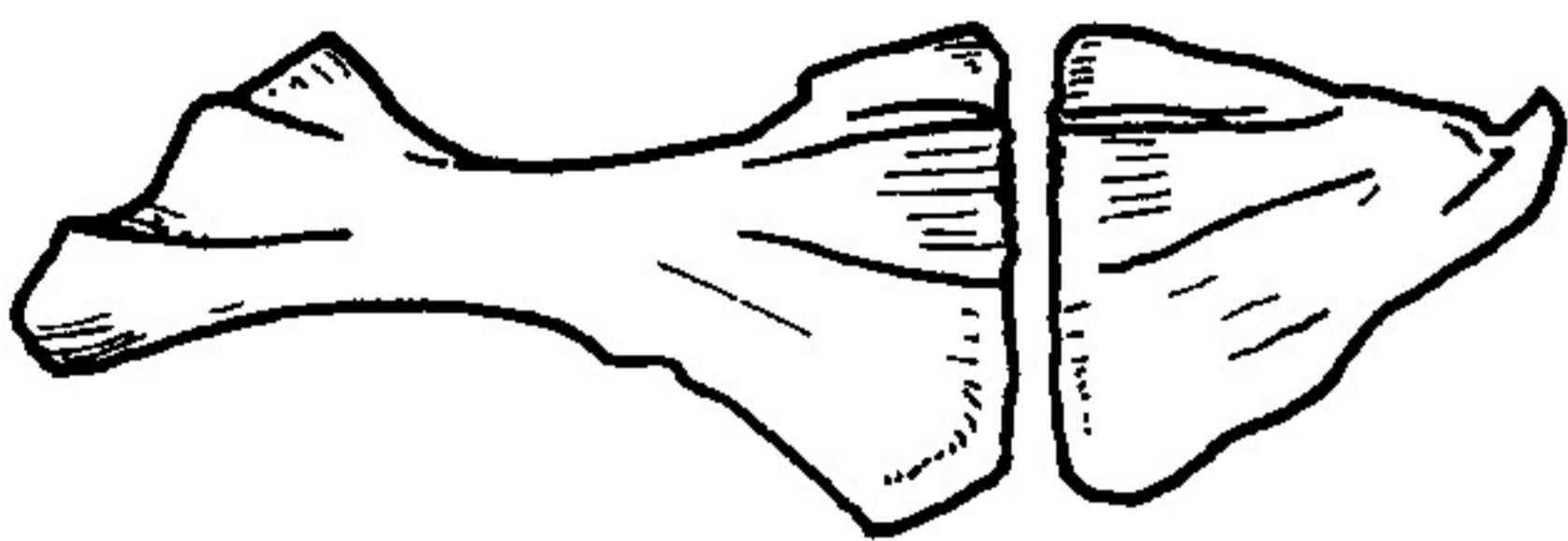
*Acerina schraetser*



*Gymnocephalus sp.*



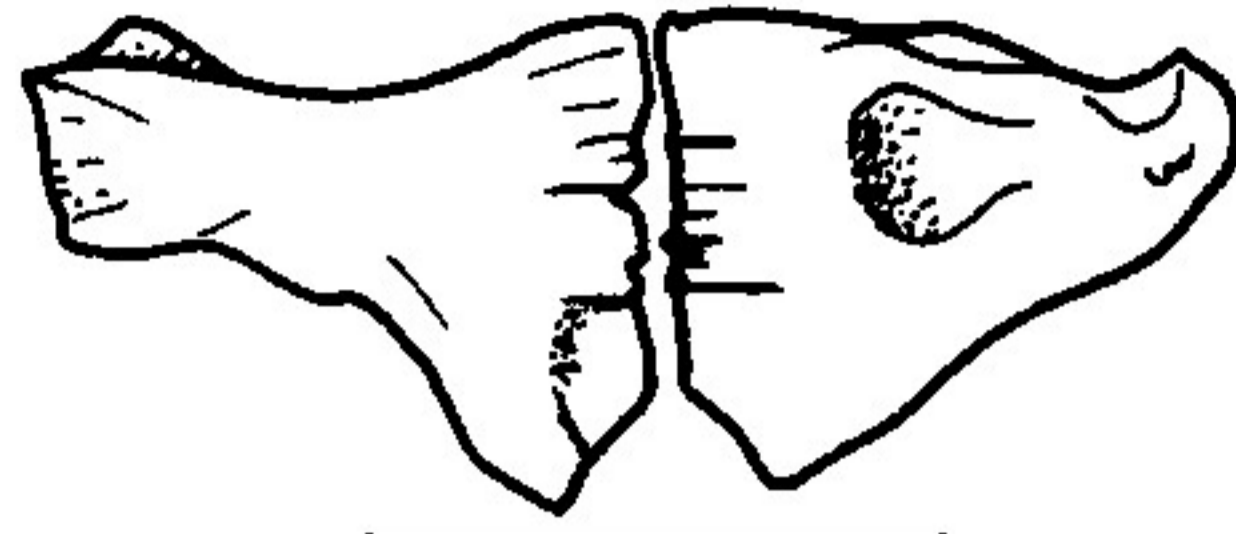
*Aspro zingel*



*Perca fluviatilis*



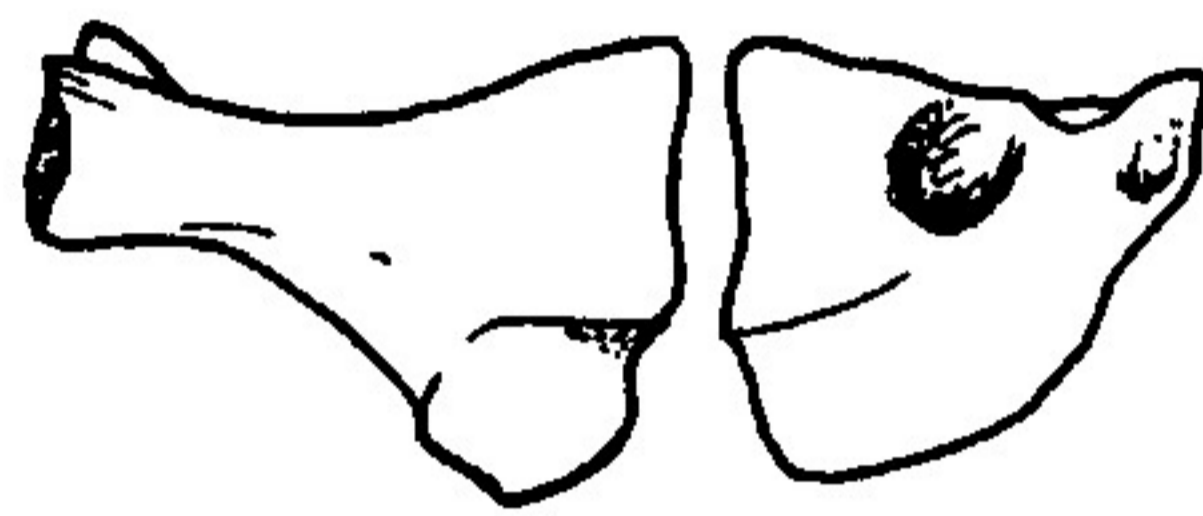
*Stizostedion lucioperca*



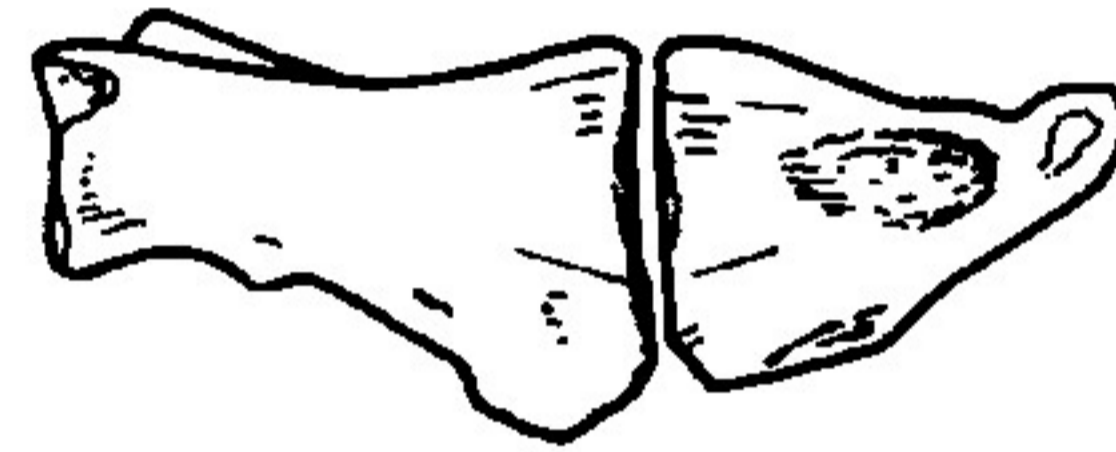
*Abramis brama*



*Cyprinus carpio*



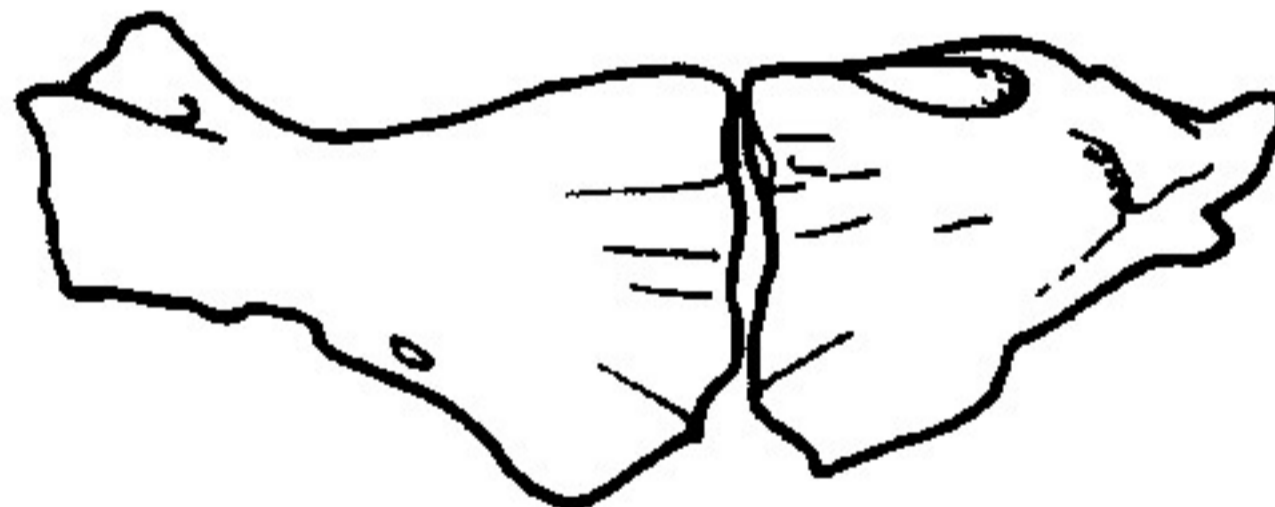
*Carassius auratus*



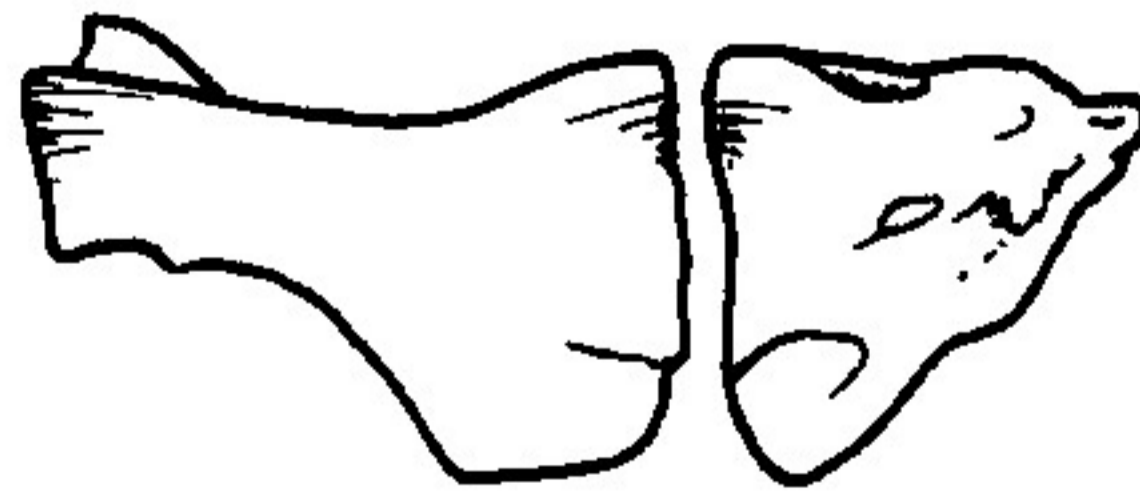
*Barbus barbus*



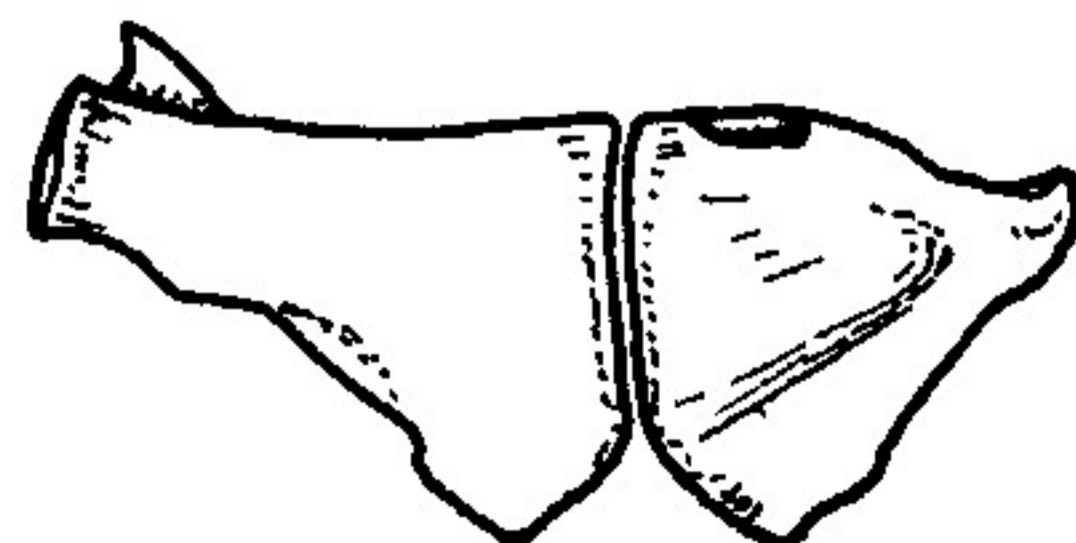
*Scardinius erythrophthalmus*



*Leuciscus idus*



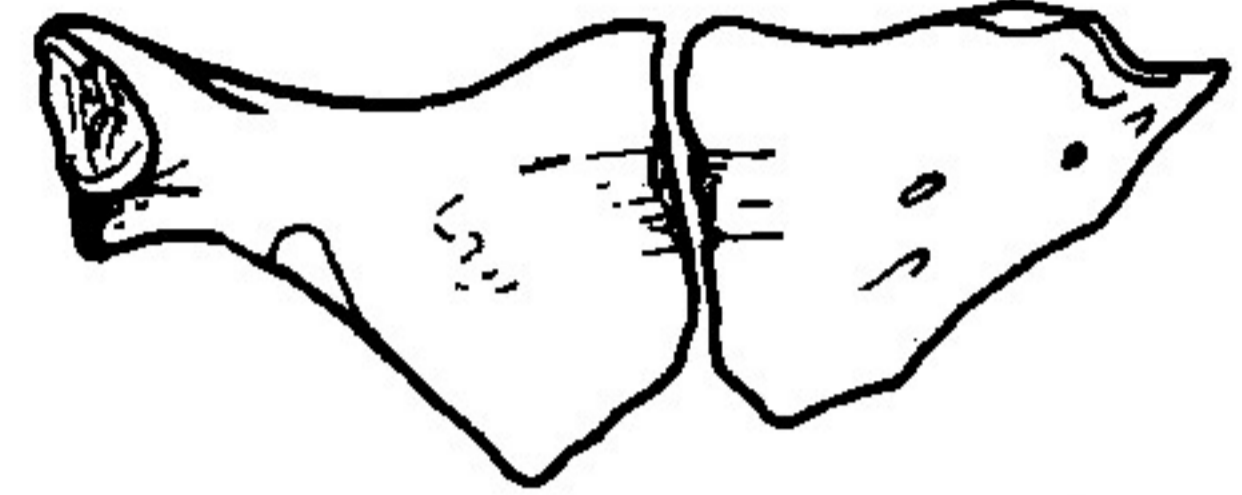
*Rutilus rutilus*



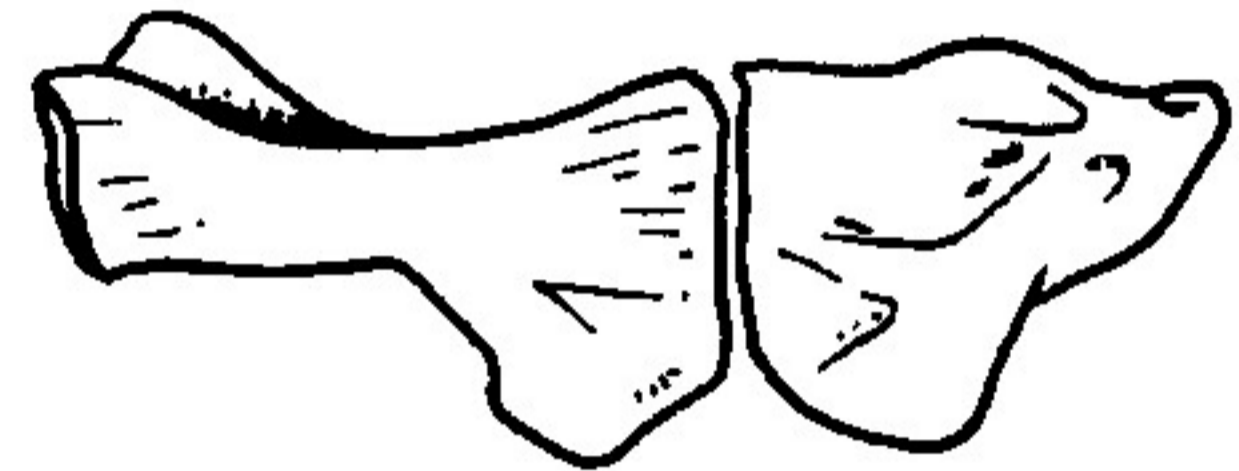
*Chondrostoma nasus*



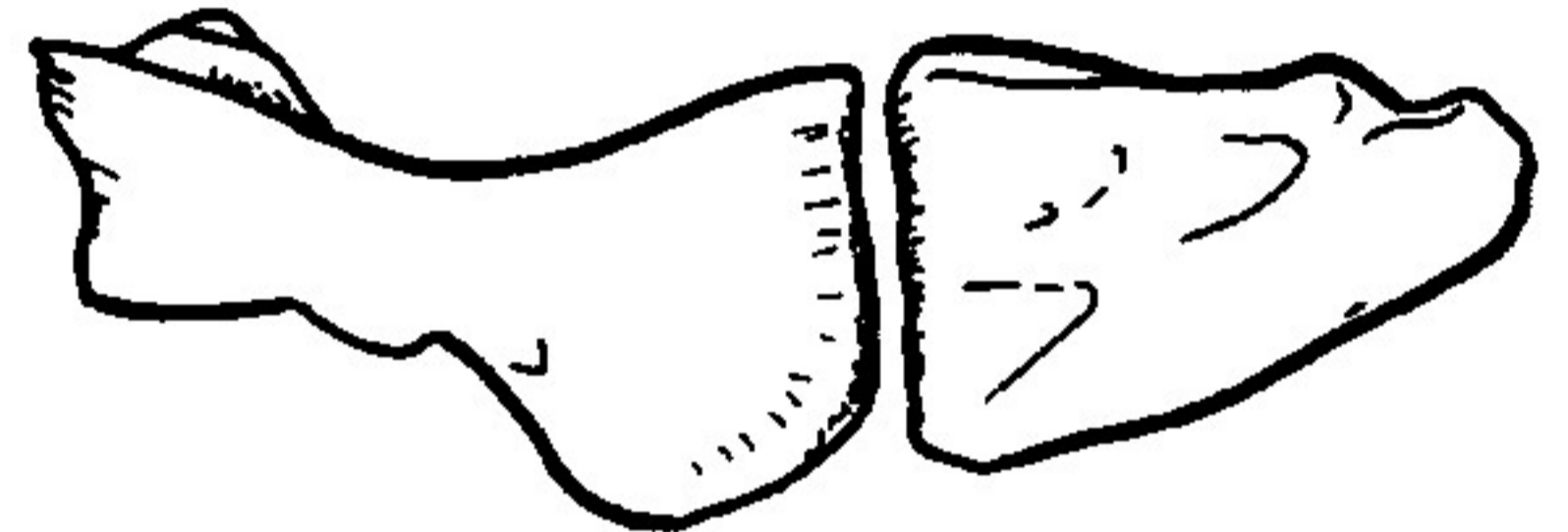
*Blicca bjoerkna*



*Vimba vimba carinata*



*Tinca tinca*



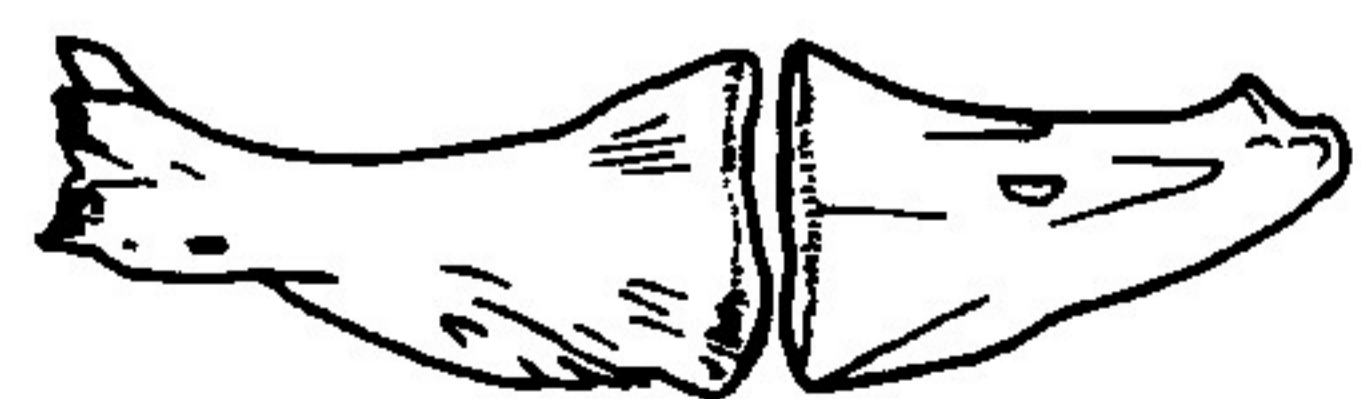
*Pelecus cultratus*



*Alburnus alburnus*



*Chalcaburnus chalcoides mento*



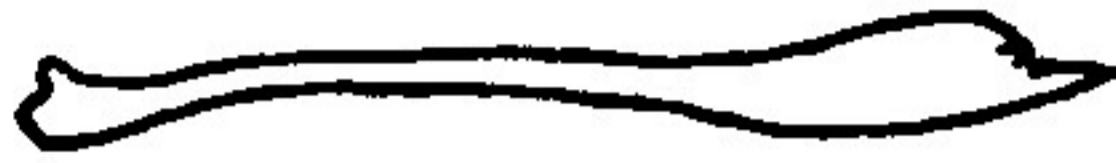
*Aspius aspius*

# UROHYALE

## NORMA LATERALIS

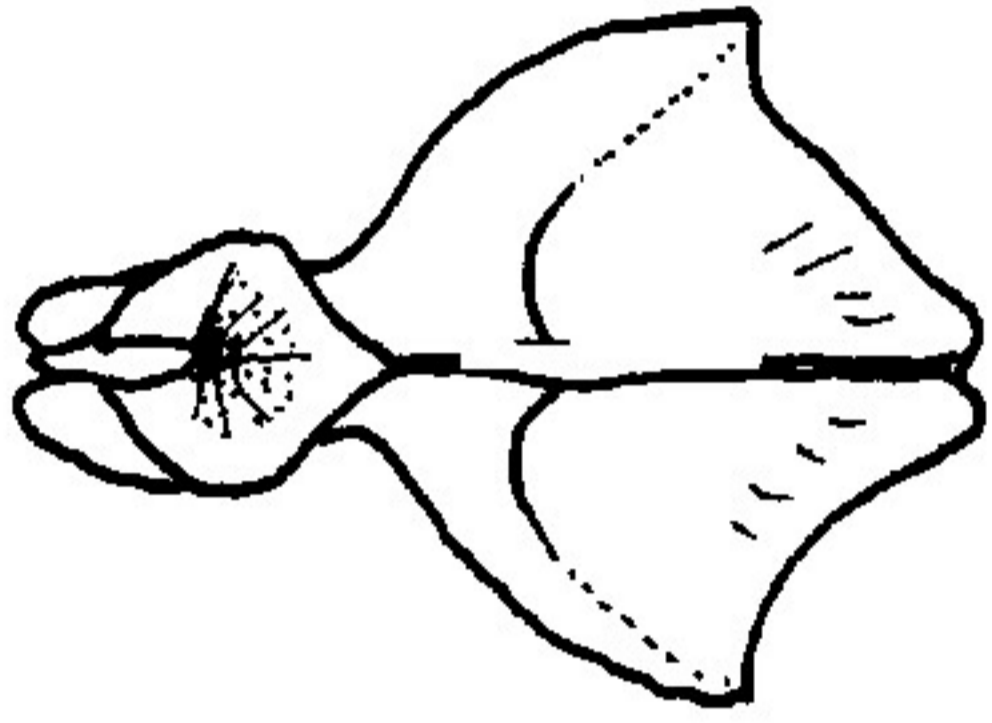


*Alosa pontica*



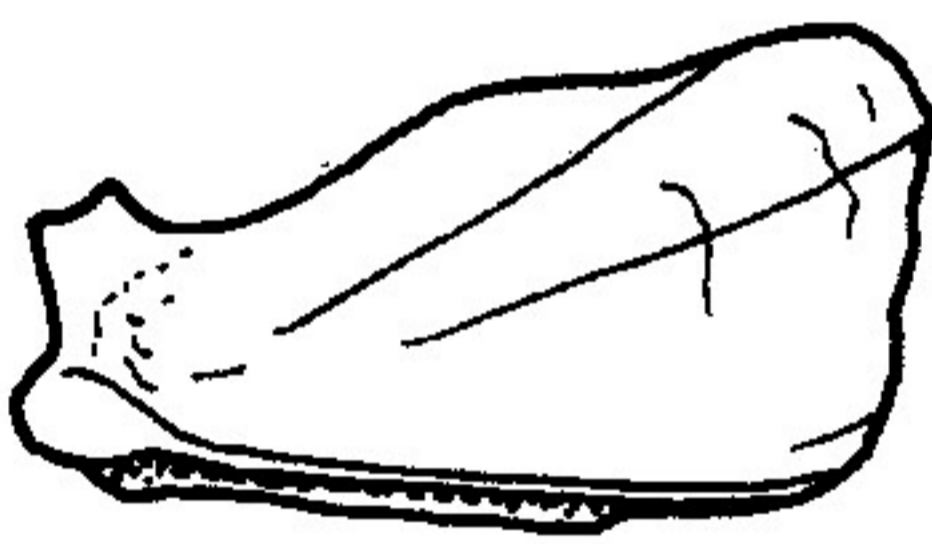
*Esox lucius*

## NORMA SUPERIOR



*Silurus glanis*

## NORMA LATERALIS



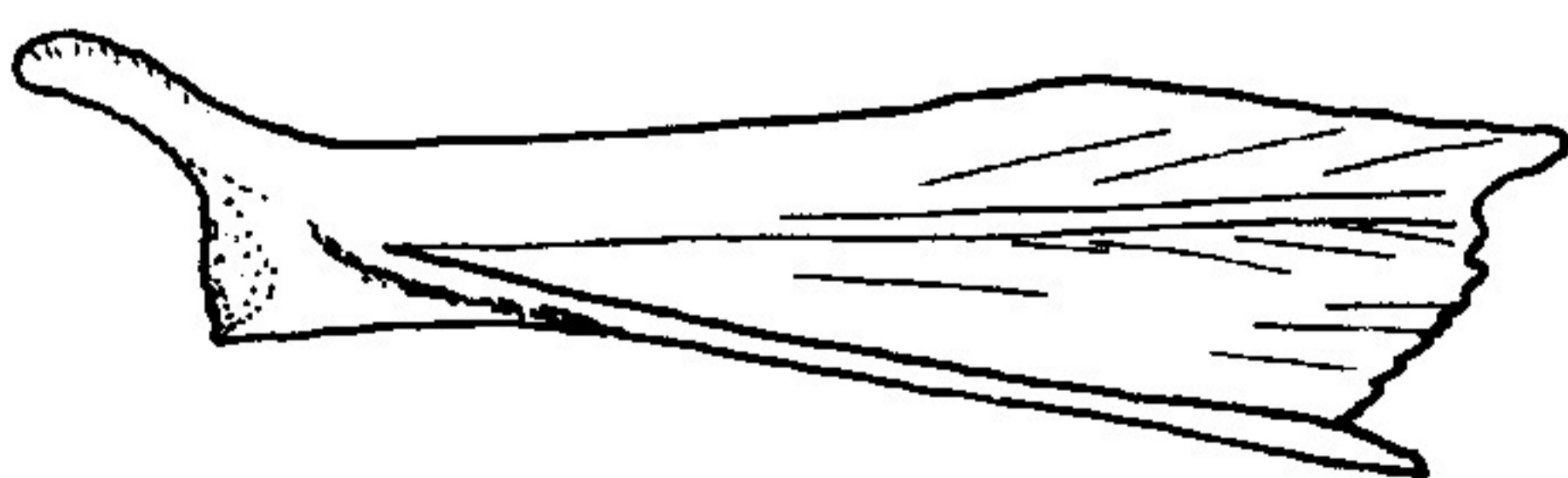
*Gymnocephalus* sp.



*Aspro zingel*

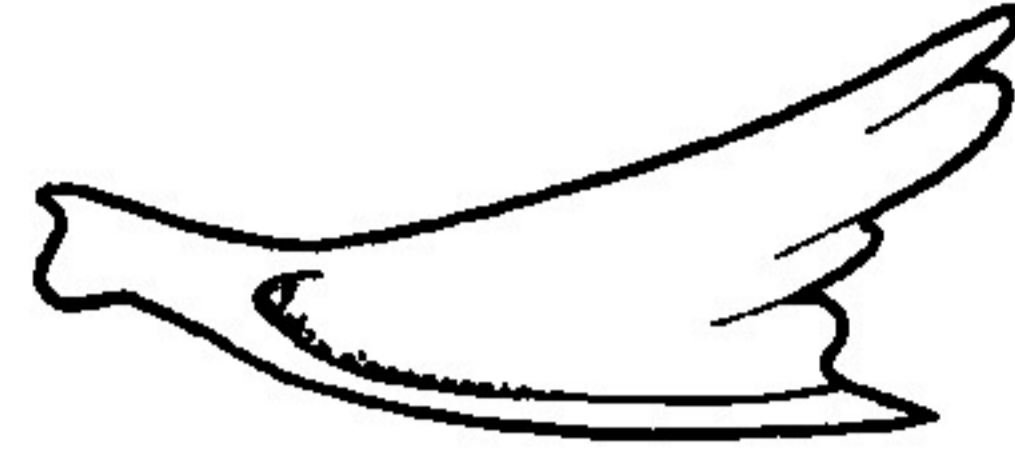


*Perca fluviatilis*



*Stizostedion lucioperca*

## NORMA LATERALIS



*Abramis brama*



*Aspius aspius*



*Chondrostoma nasus*



*Scardinius erythrophthalmus*



*Alburnus alburnus*



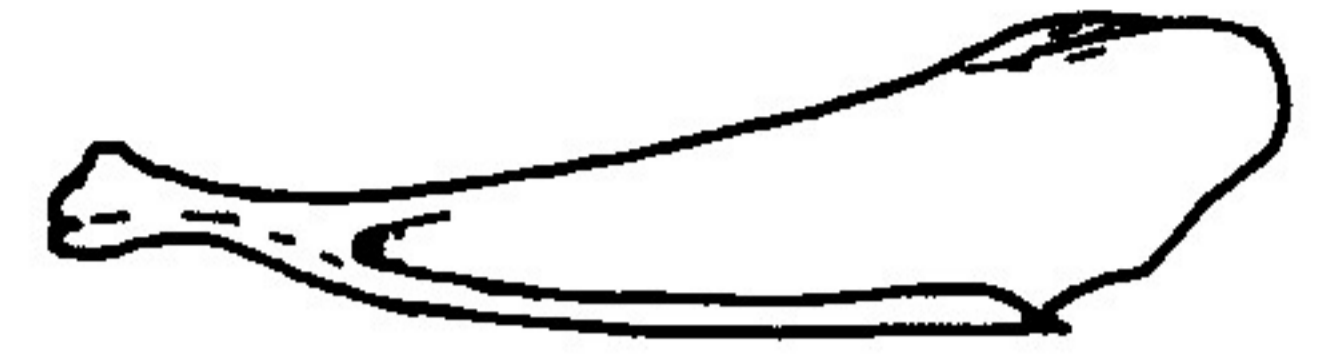
*Leuciscus idus*



*Rutilus rutilus*



*Chalcaburnus chalcoides mento*



*Cyprinus carpio*



*Carassius auratus*



*Blicca bjoerkna*



*Vimba vimba carinata*



*Pelecus cultratus*



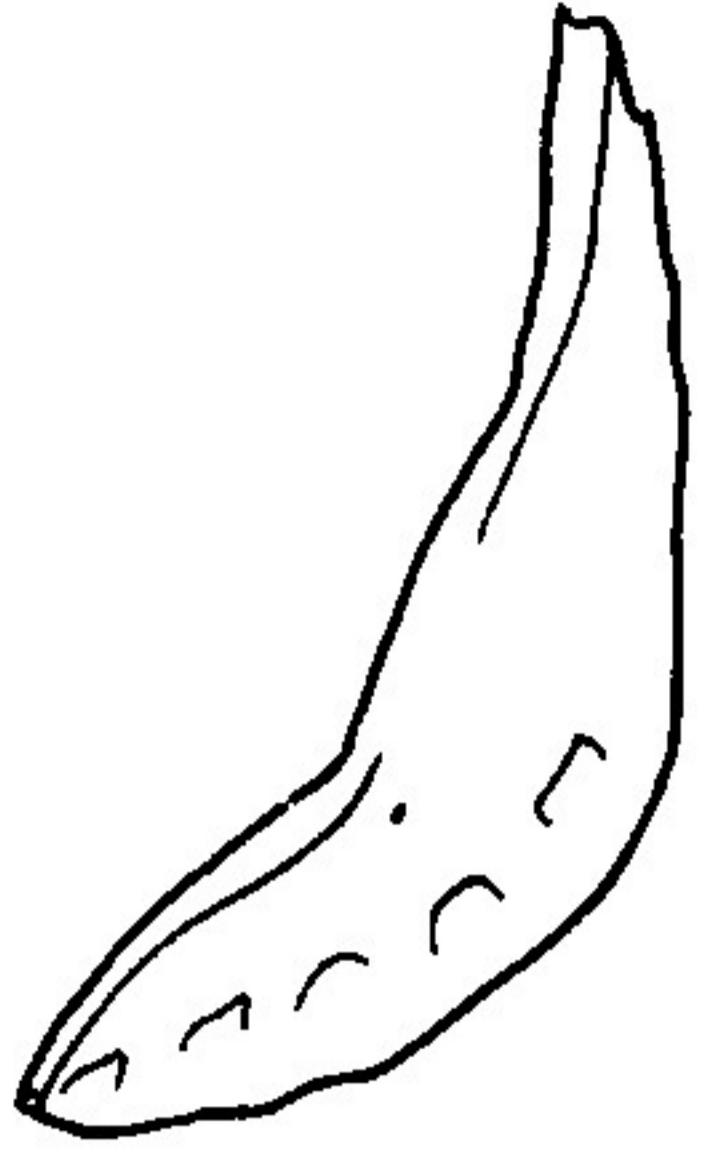
*Tinca tinca*



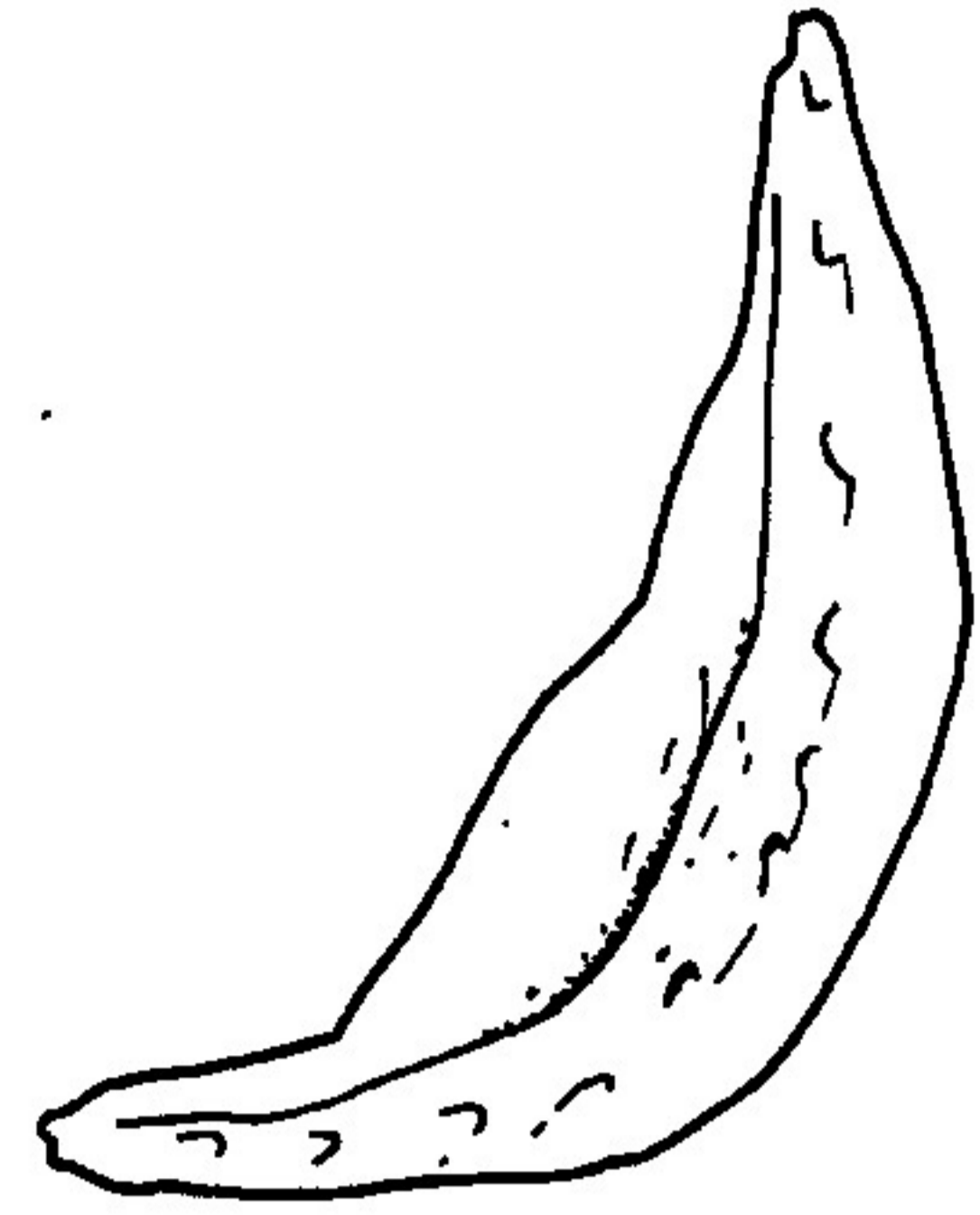
*Barbus barbus*

# PRAEOPERCULARE

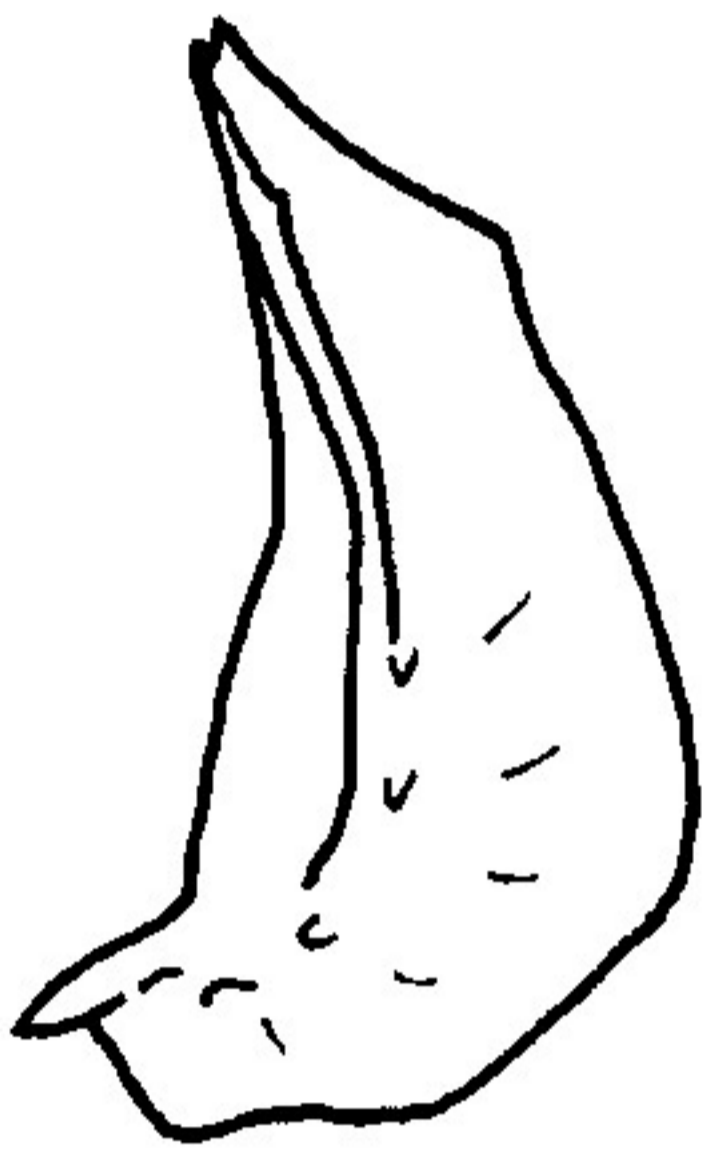
## NORMA LATERALIS



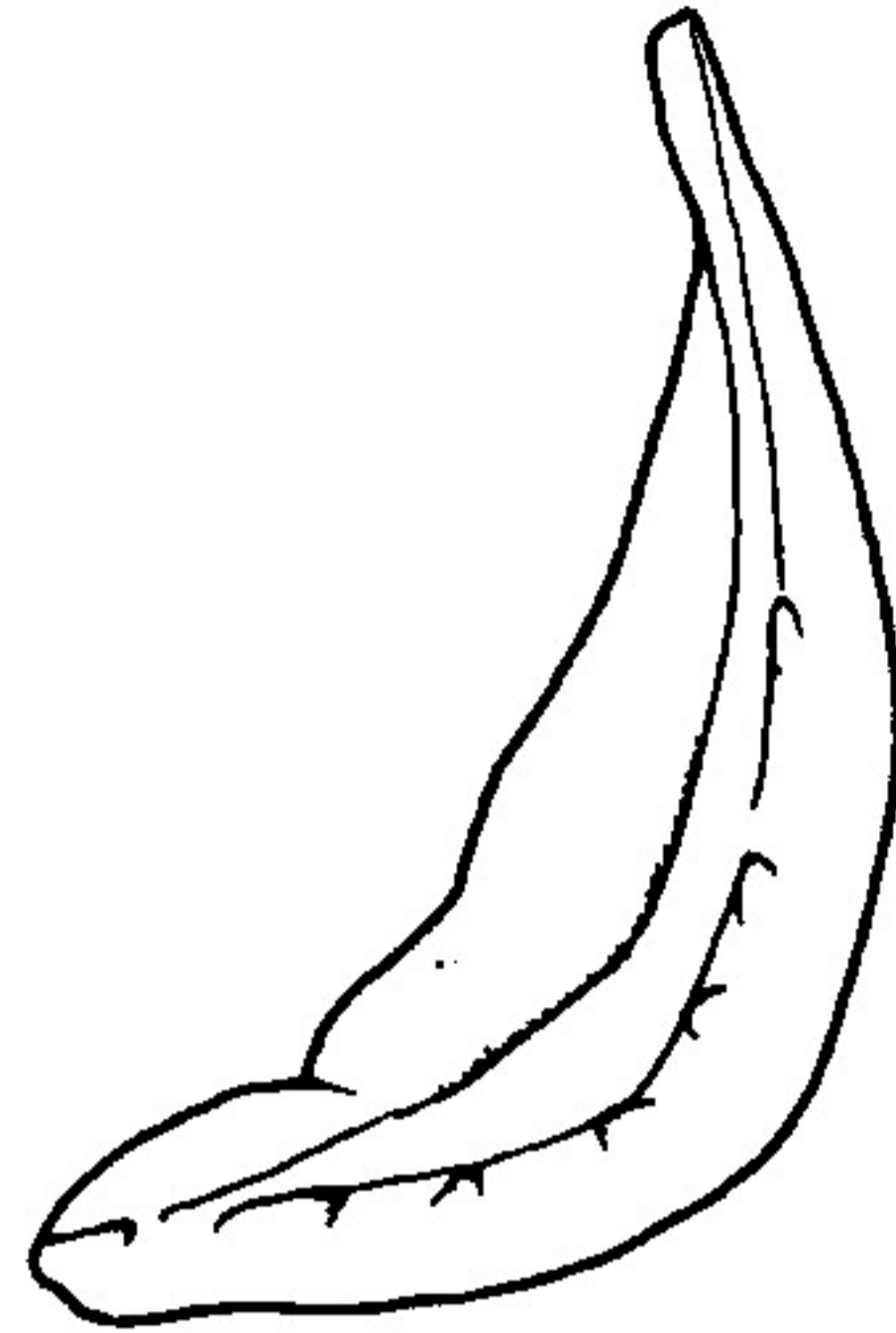
*Salmo trutta lacustris*



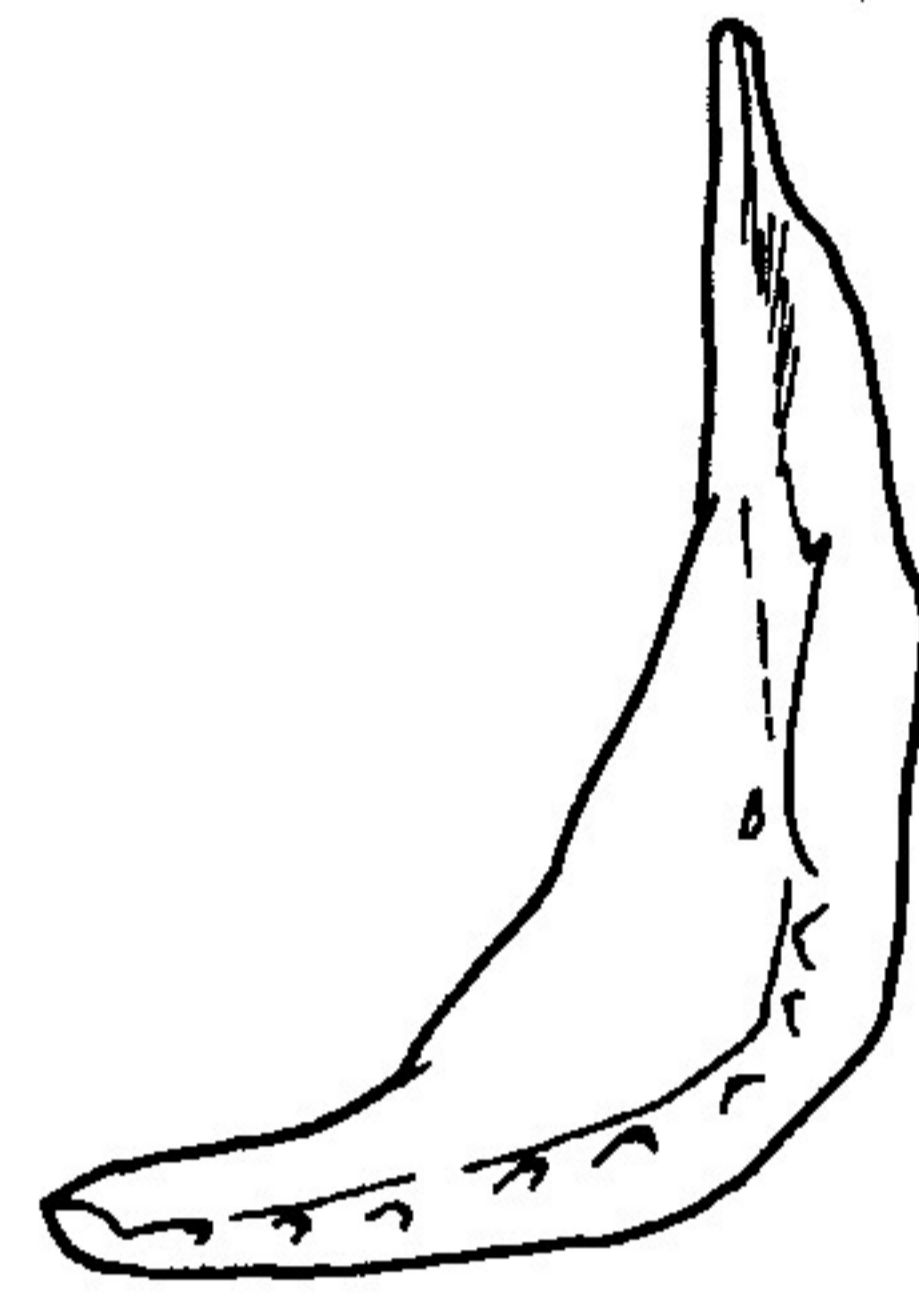
*Cyprinus carpio*



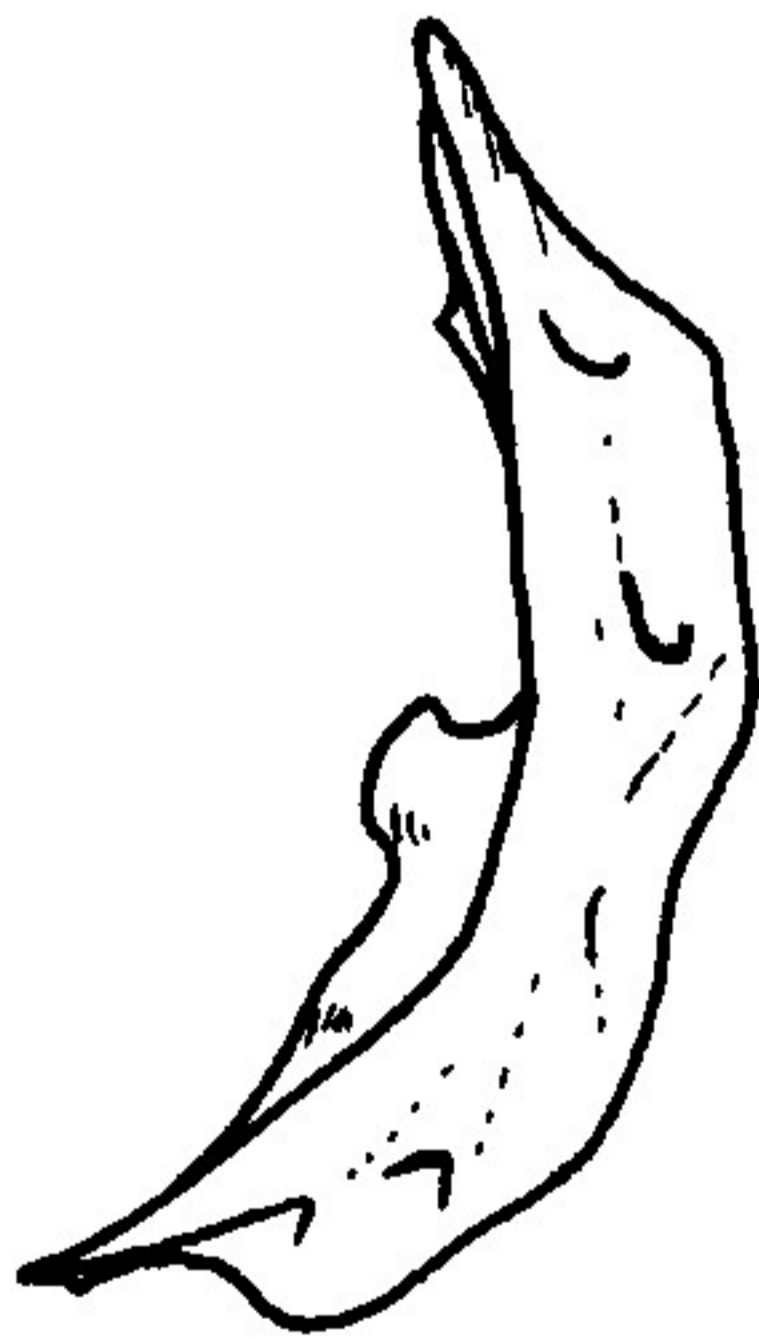
*Alosa pontica*



*Abramis brama*



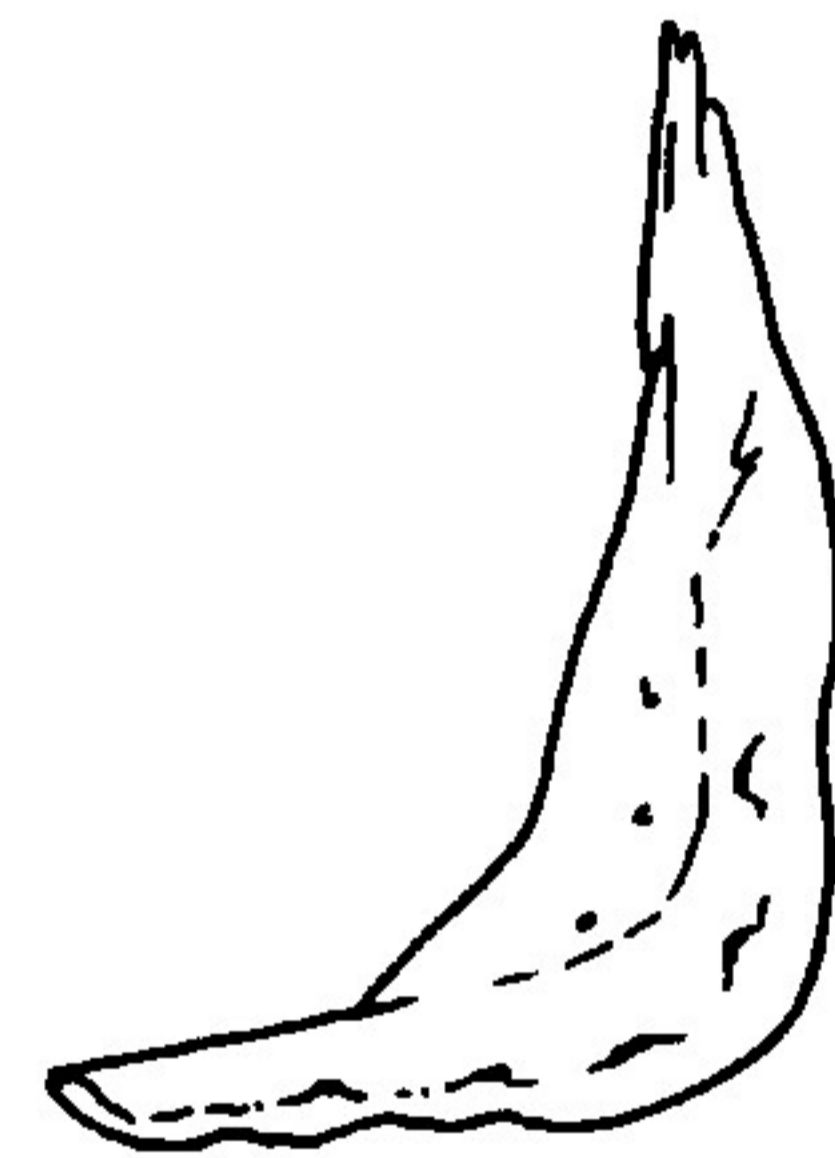
*Blicca bjoerkna*



*Esox lucius*



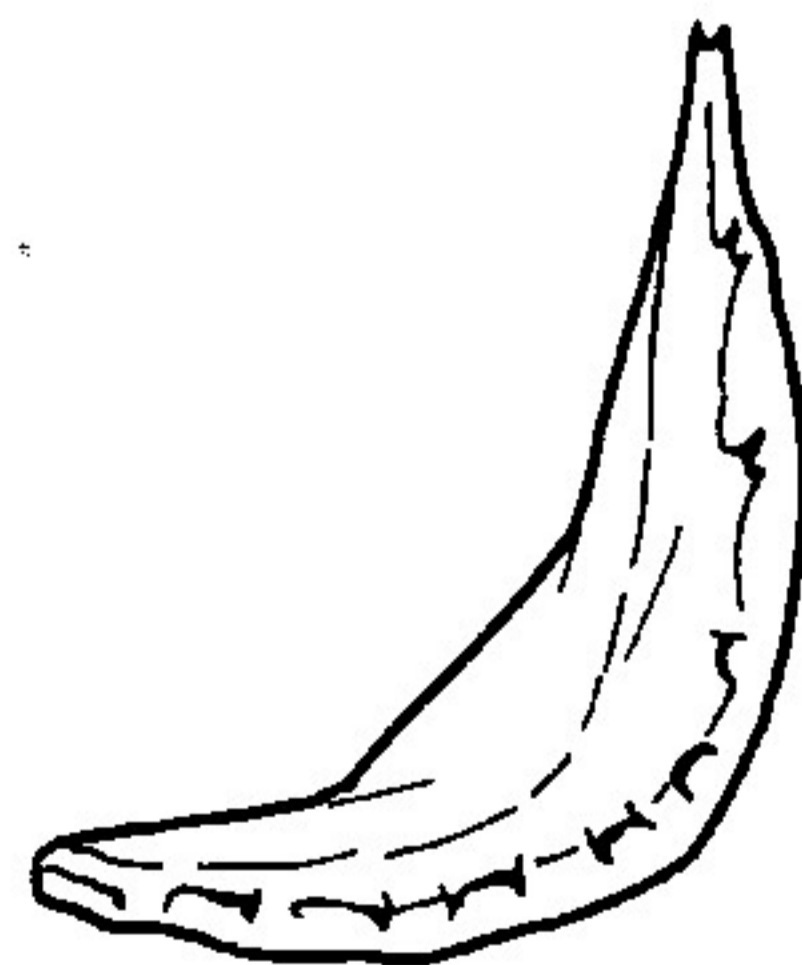
*Vimba vimba carinata*



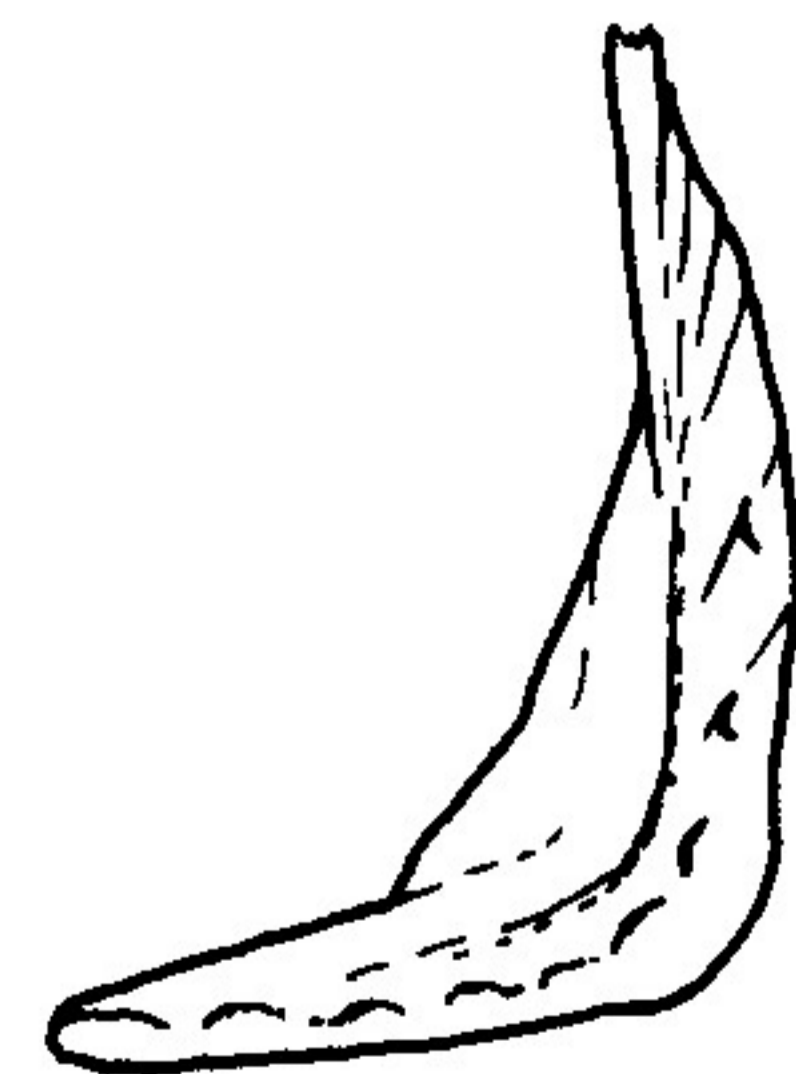
*Scardinius erythrophthalmus*



*Silurus glanis*



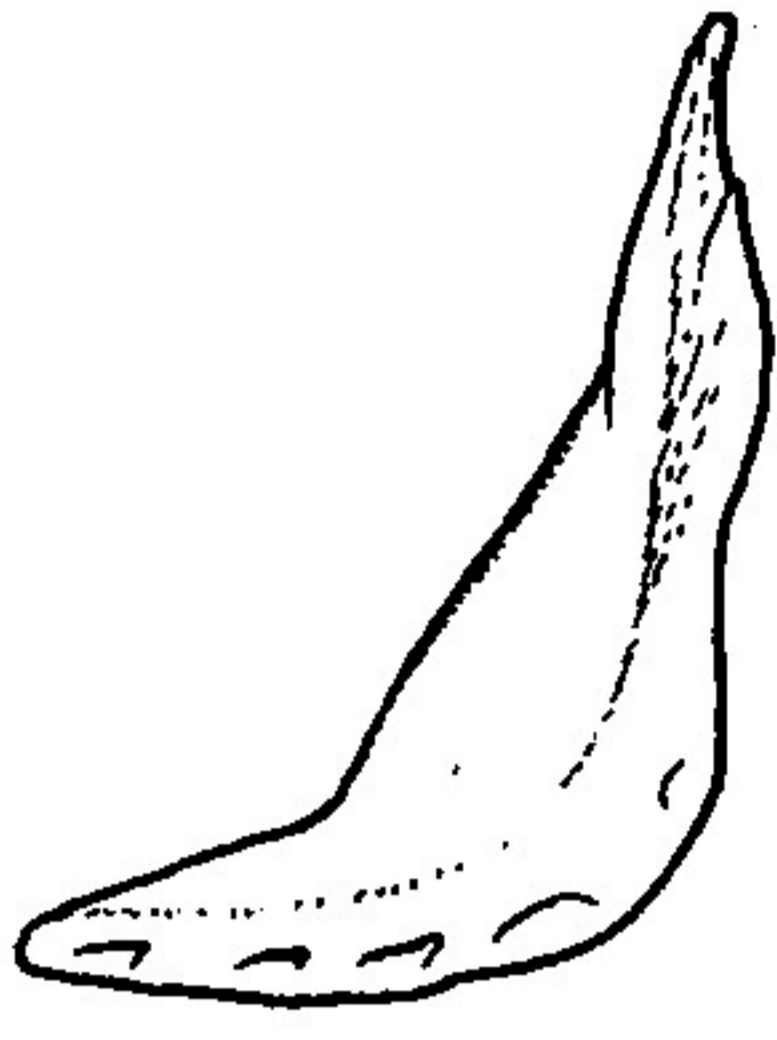
*Rutilus rutilus*



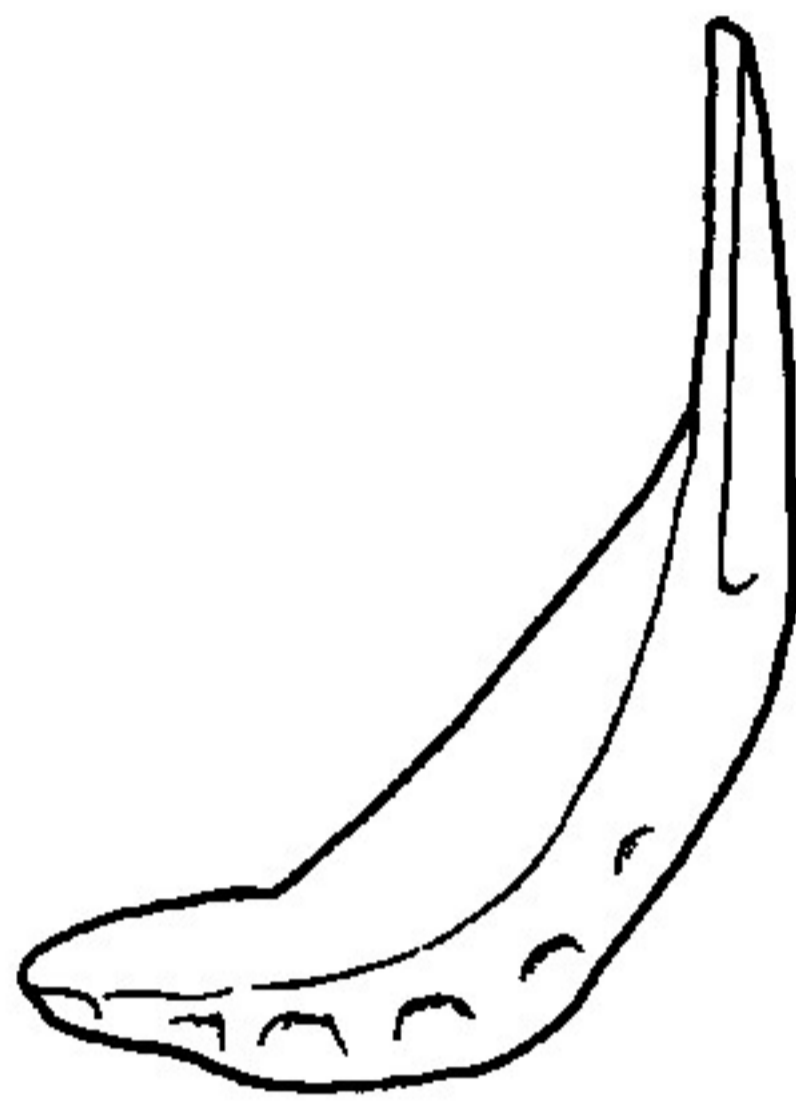
*Alburnus alburnus*

# PRAEOPERCULARE

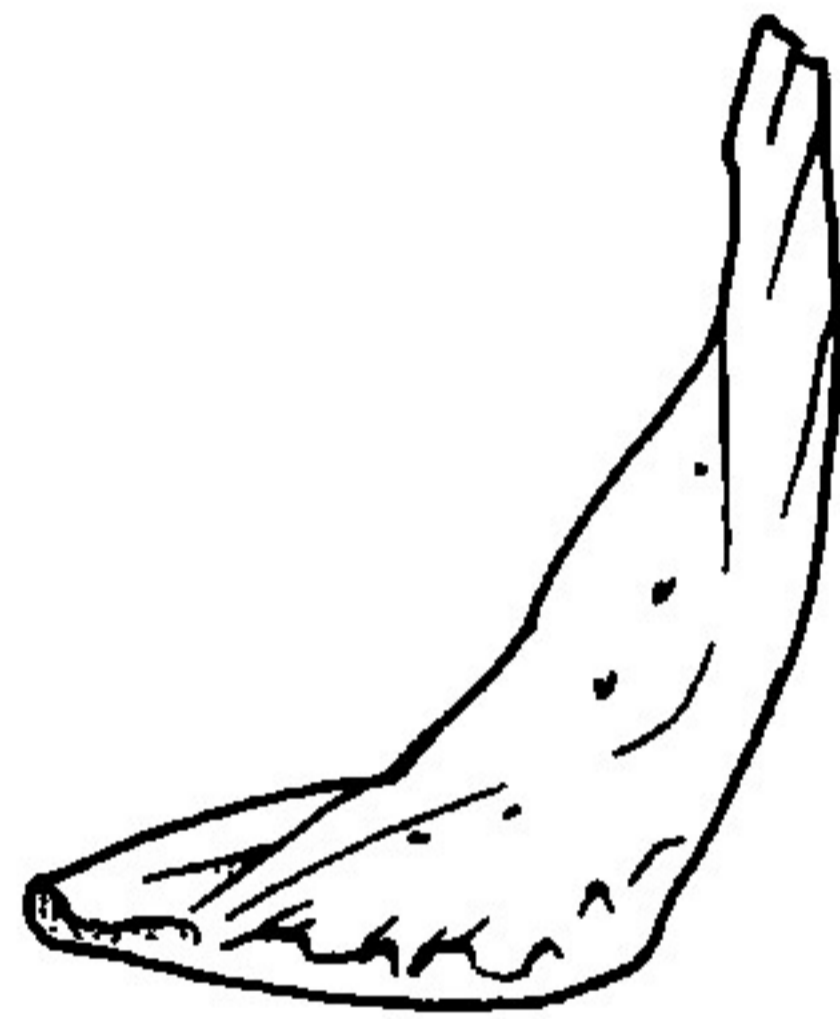
## NORMA LATERALIS



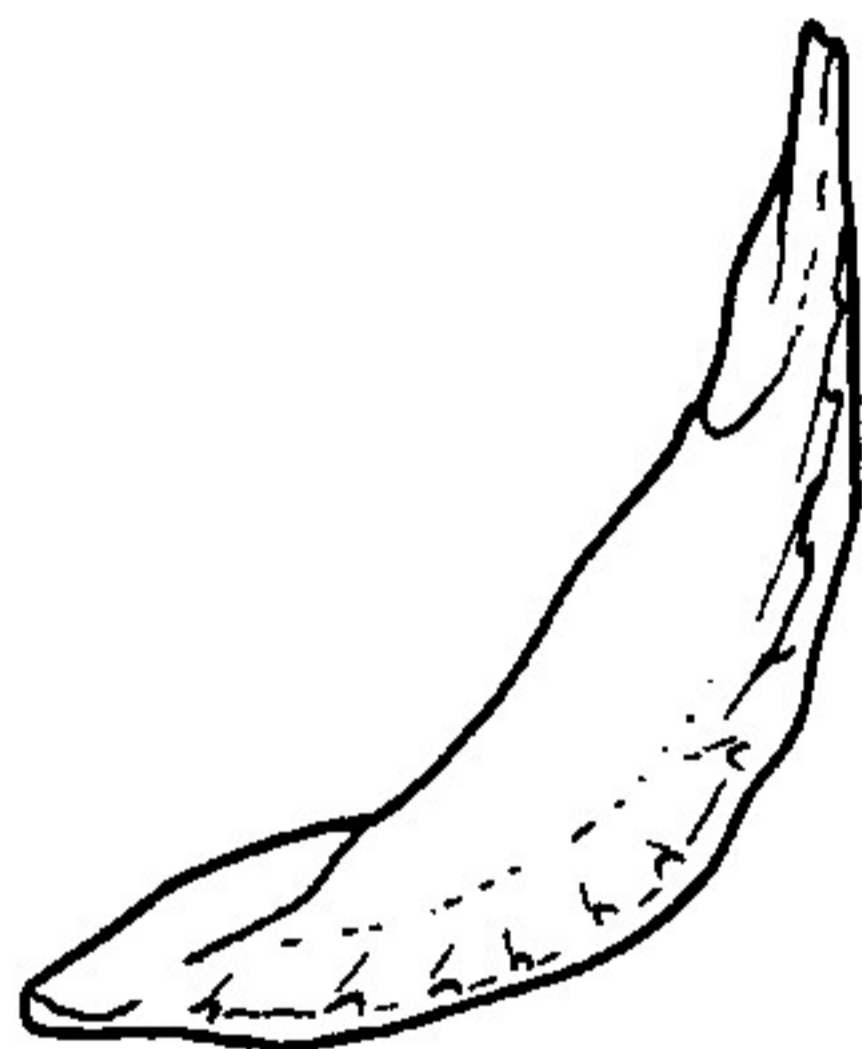
*Chondrostoma nasus*



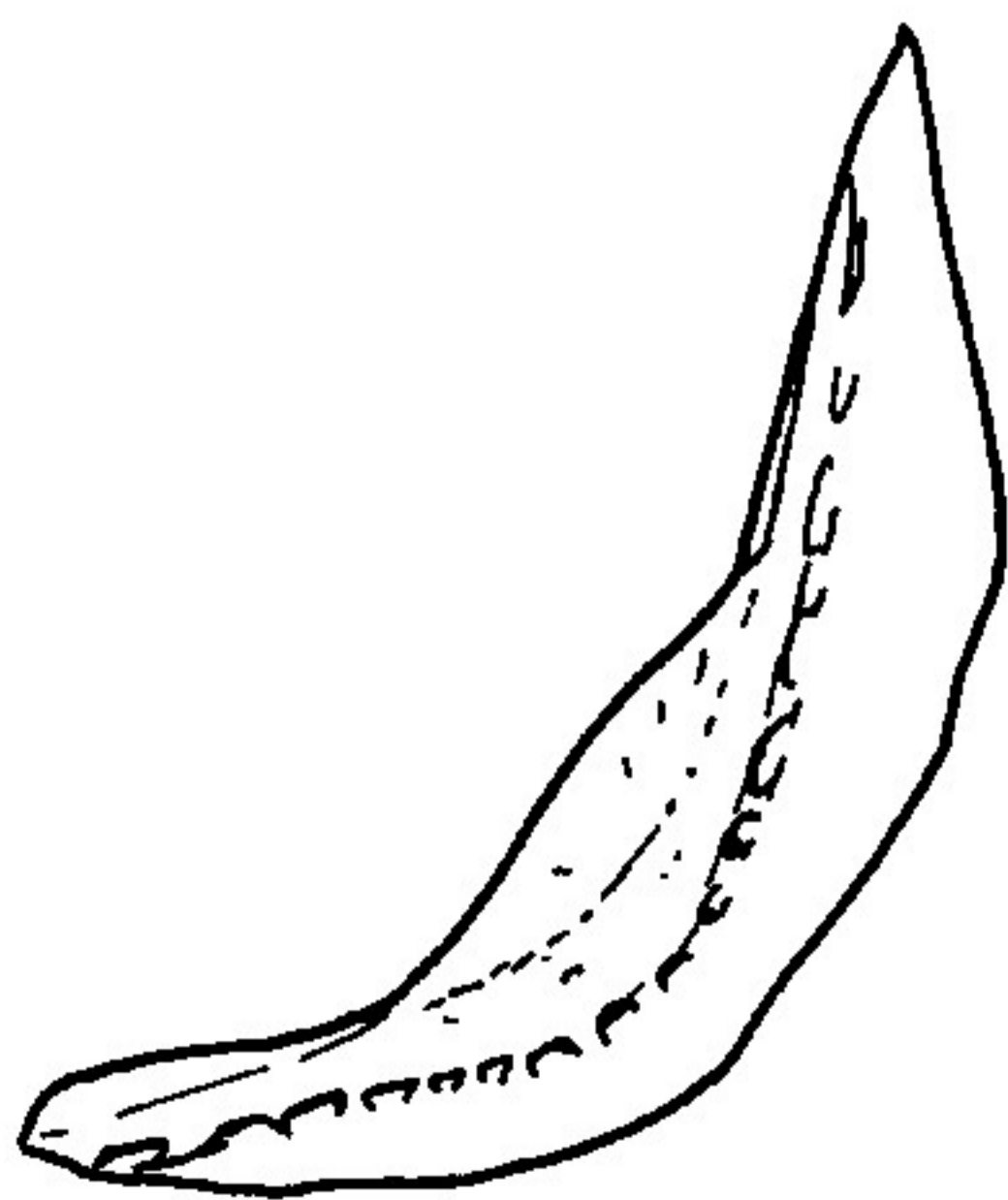
*Carassius auratus*



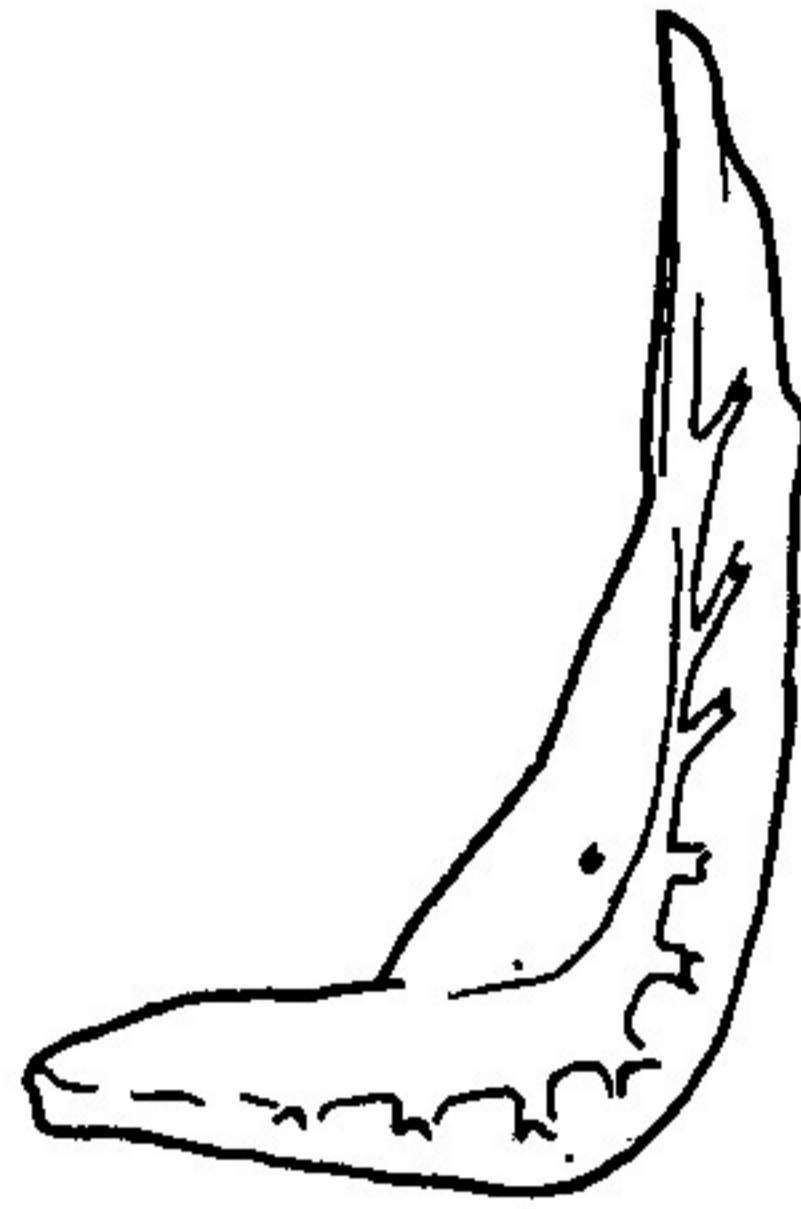
*Aspius aspius*



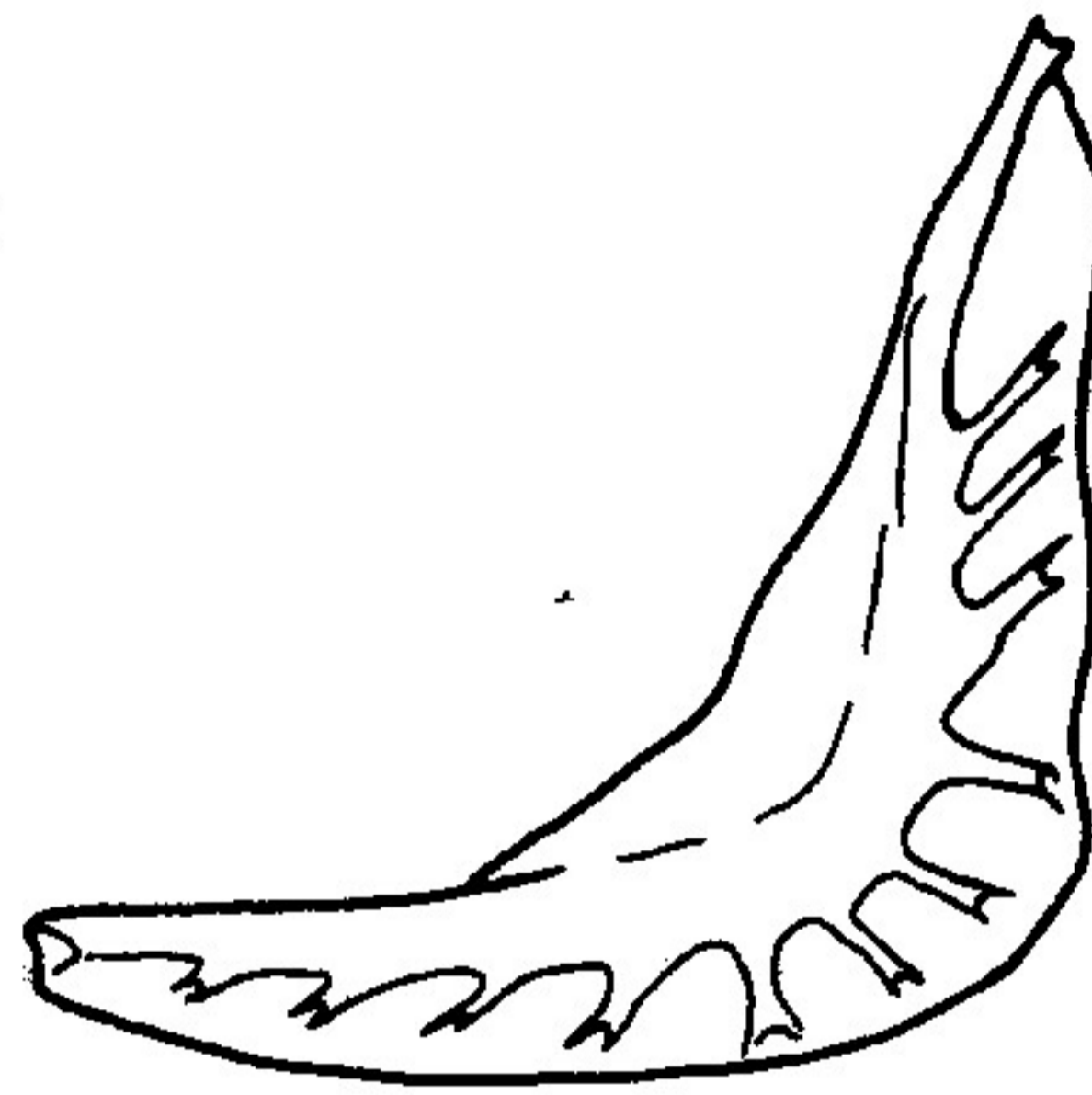
*Barbus barbus*



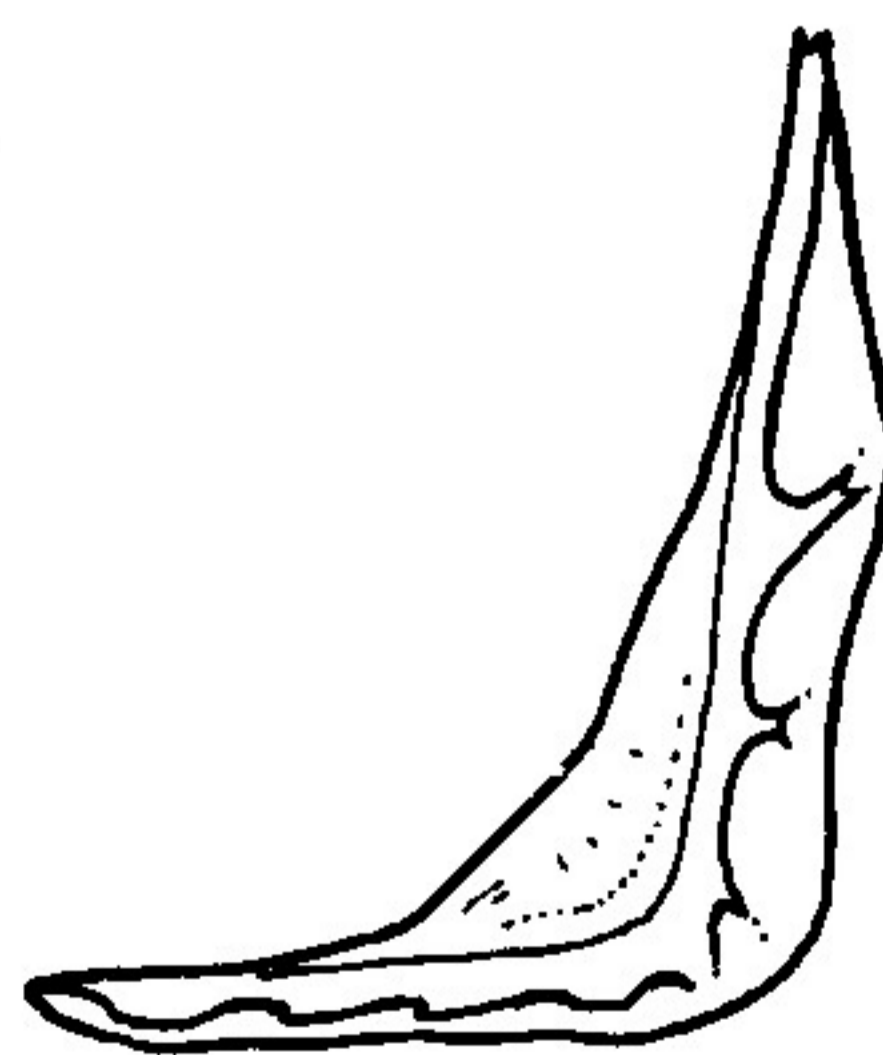
*Tinca tinca*



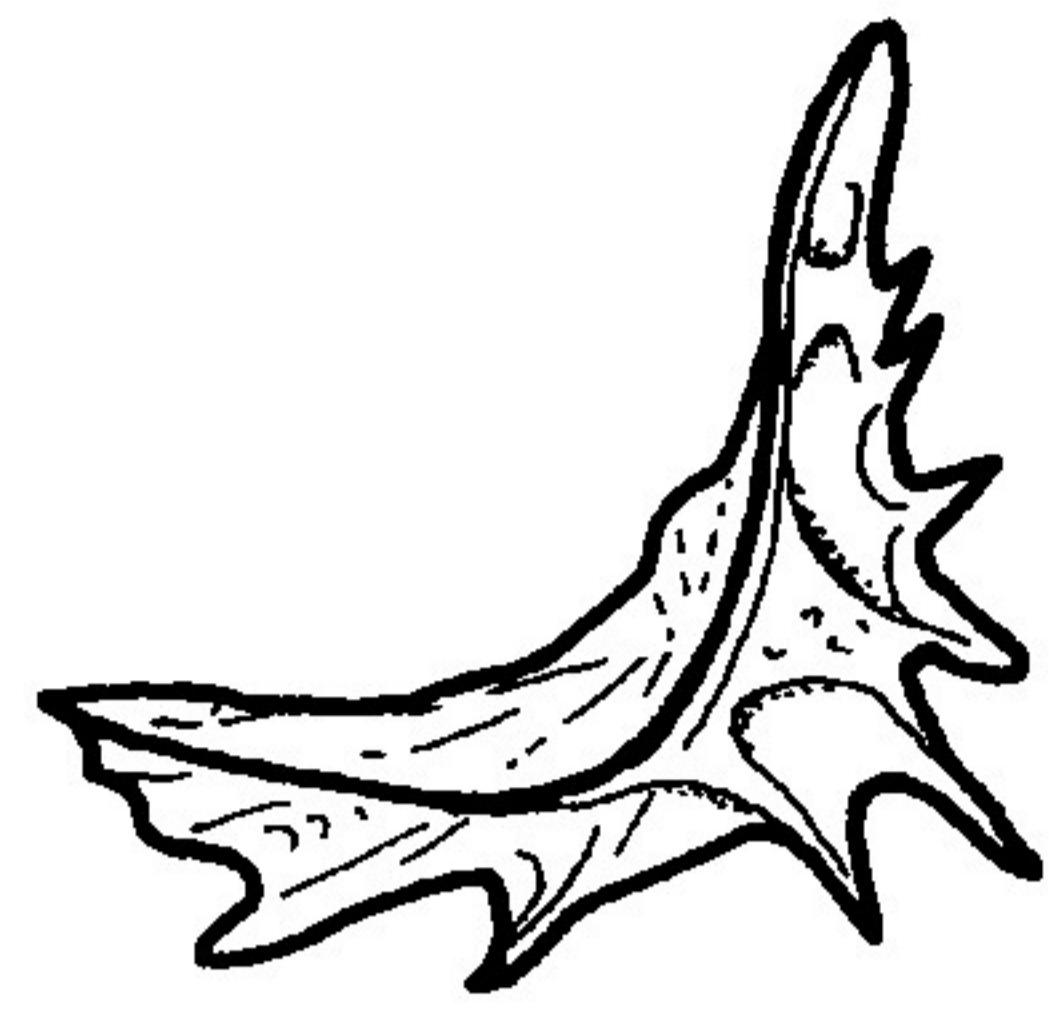
*Leuciscus idus*



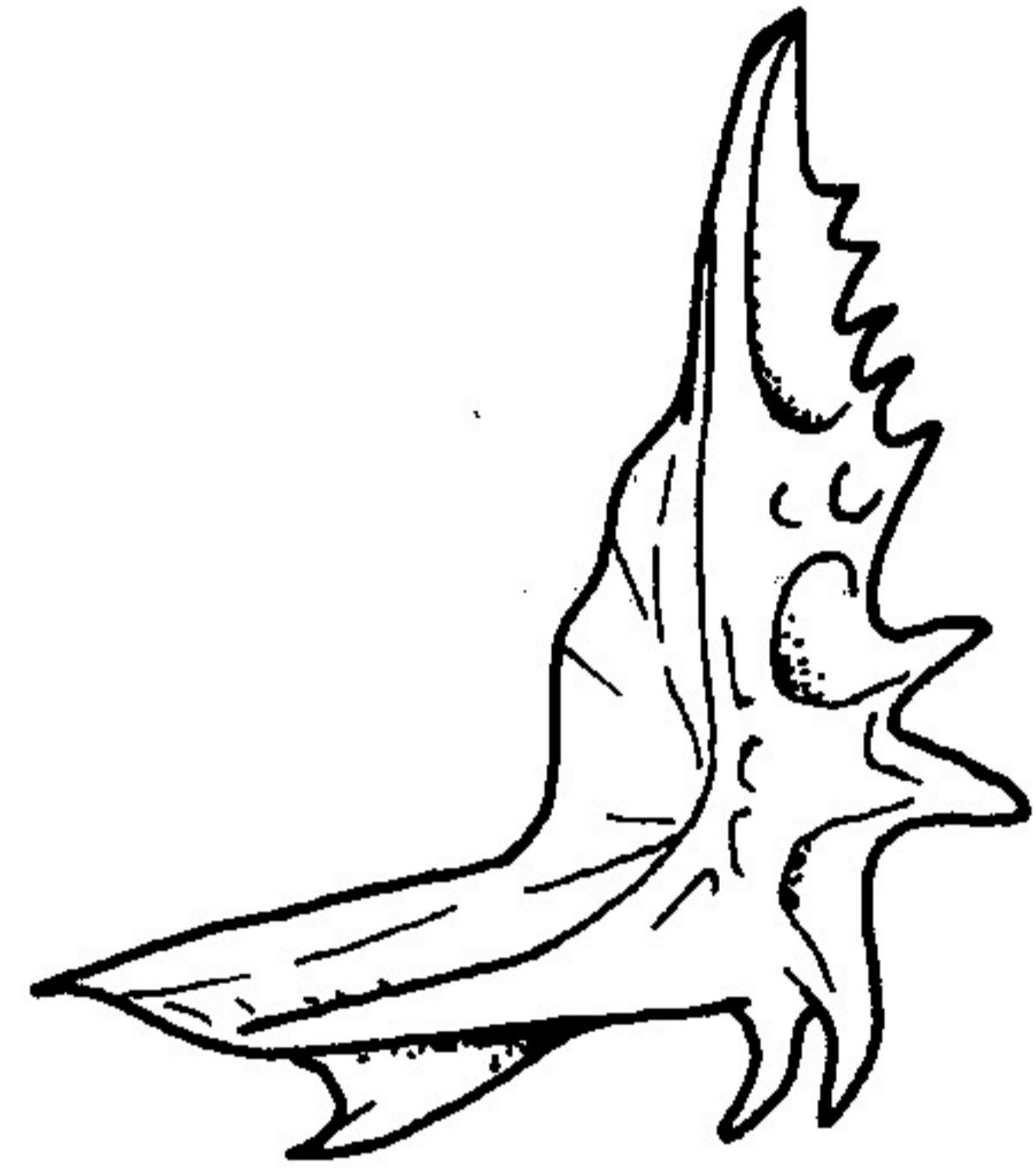
*Pelecus cultratus*



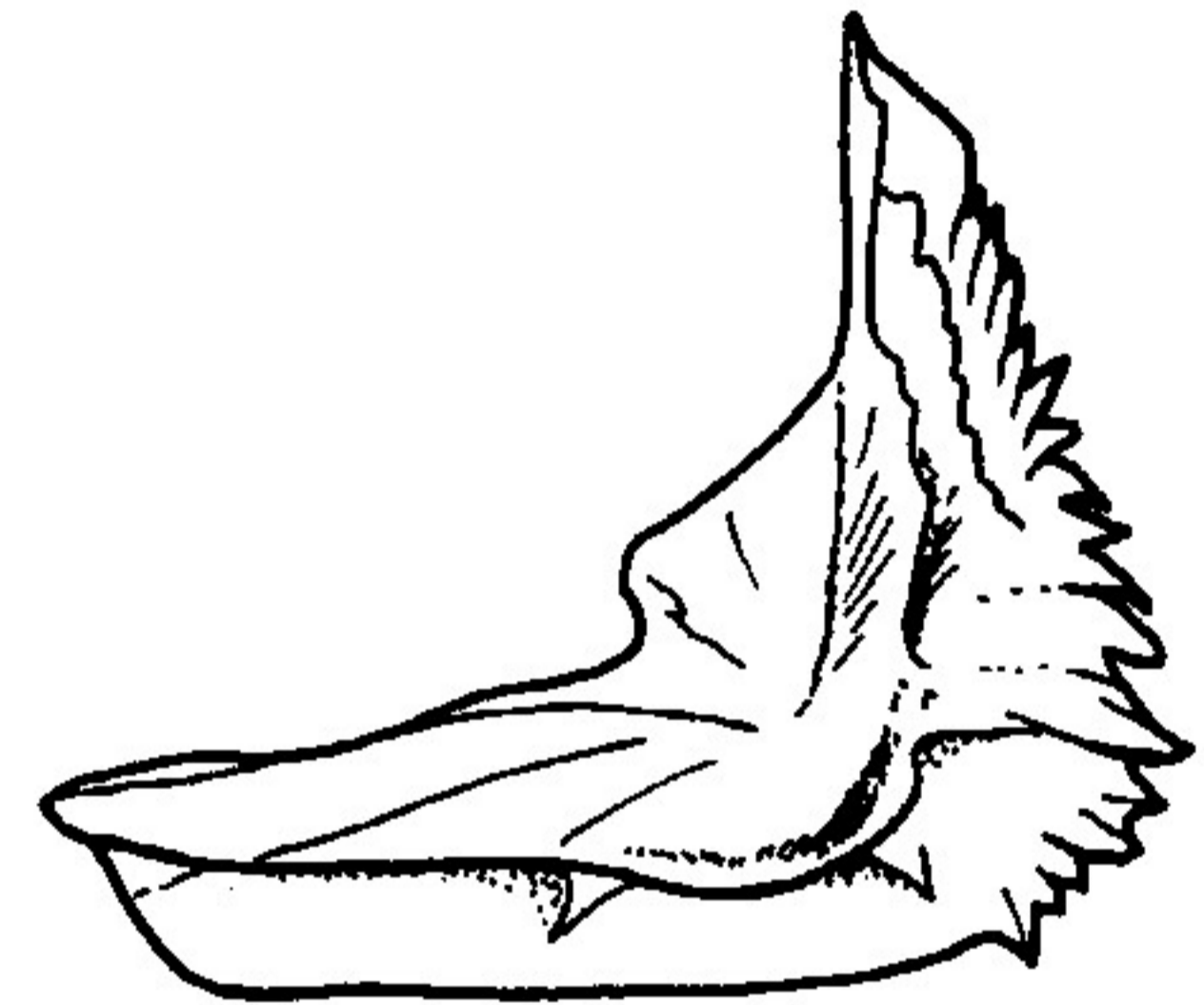
*Chalcaburnus chalcoides mento*



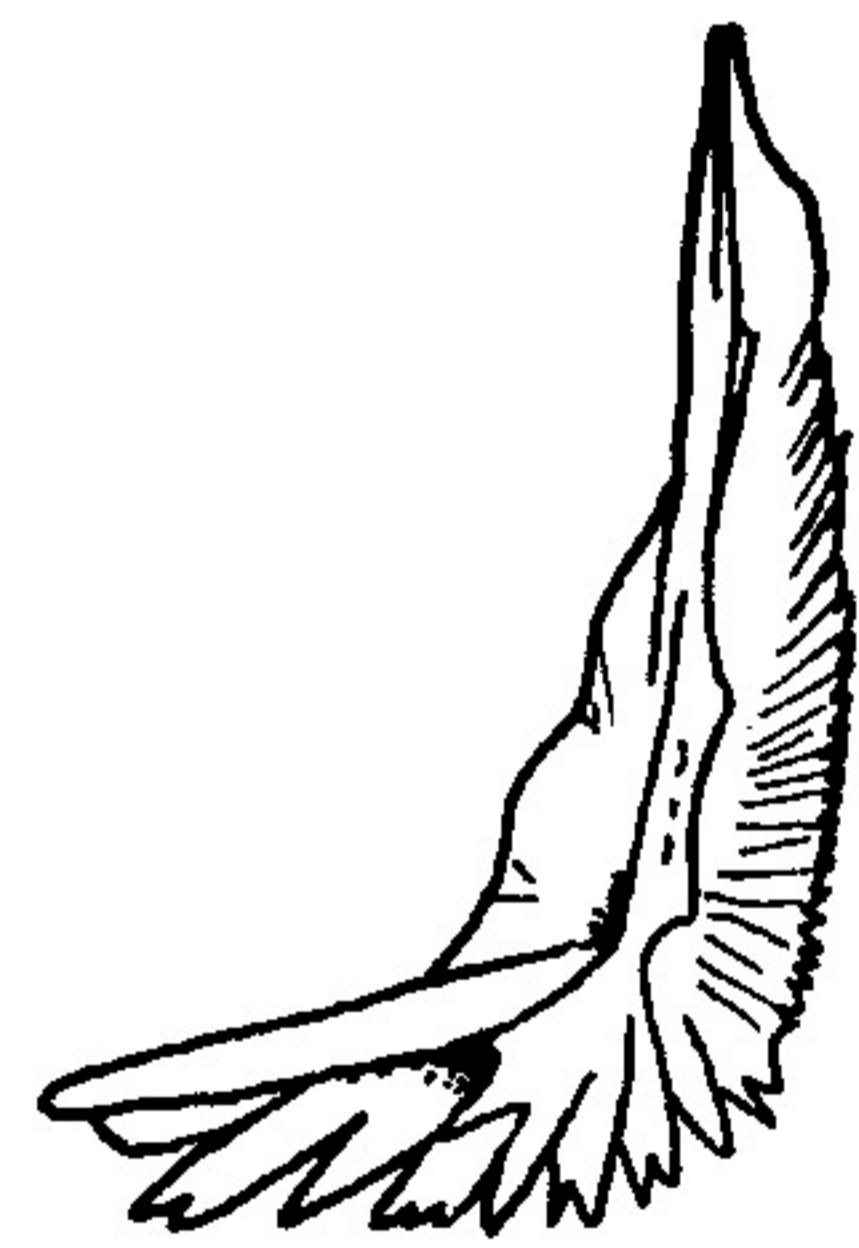
*Acerina schraetser*



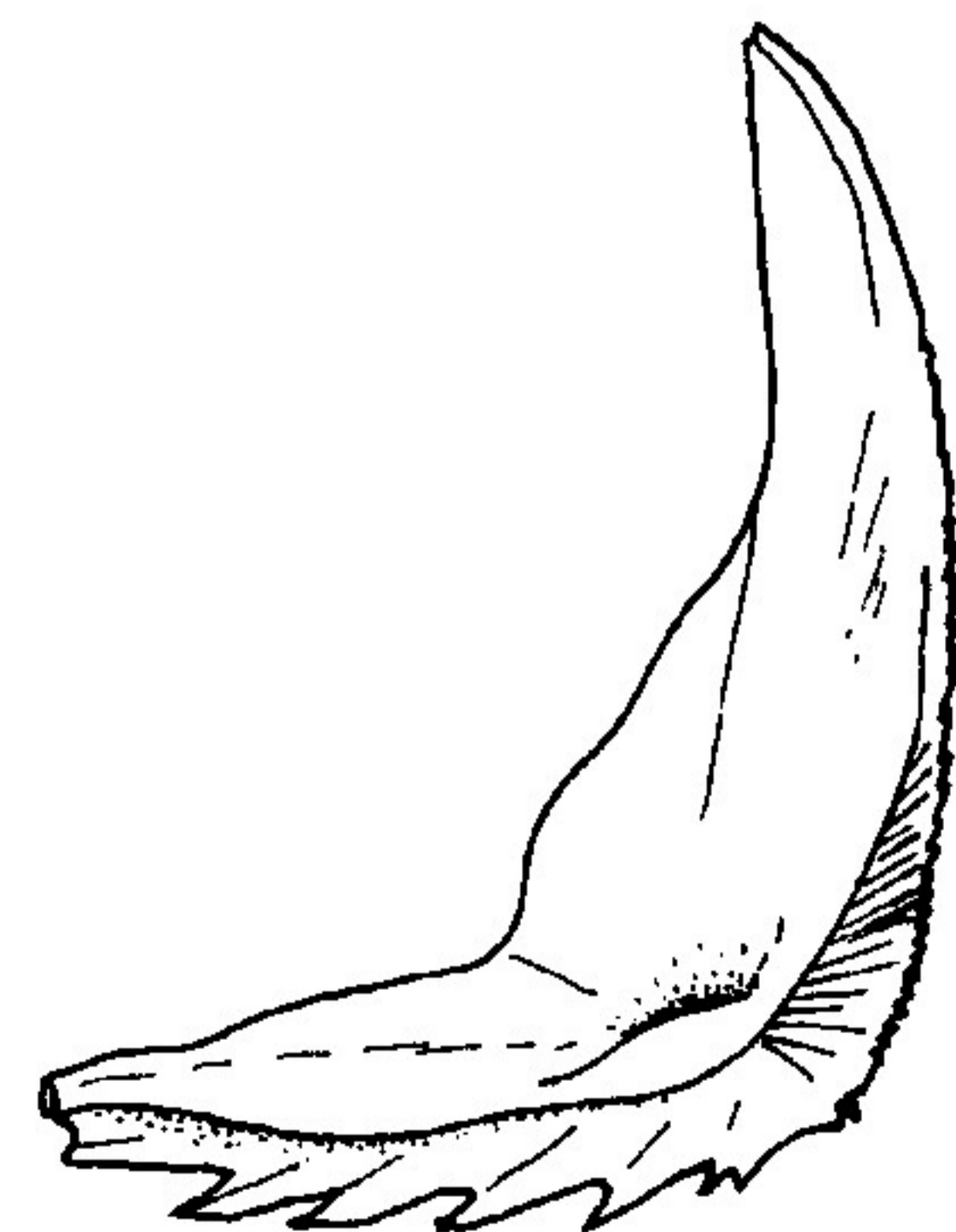
*Gymnocephalus sp.*



*Aspro zingel*

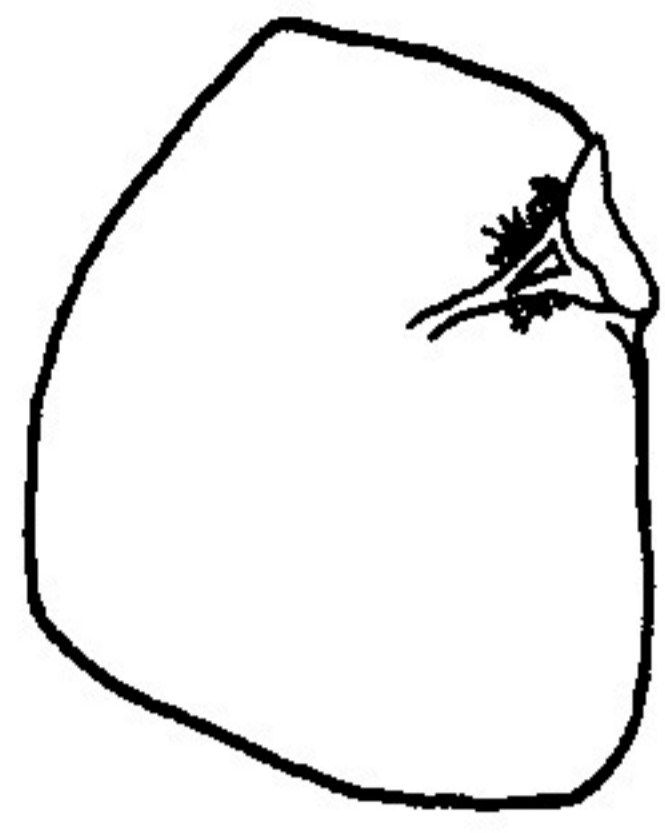


*Perca fluviatilis*

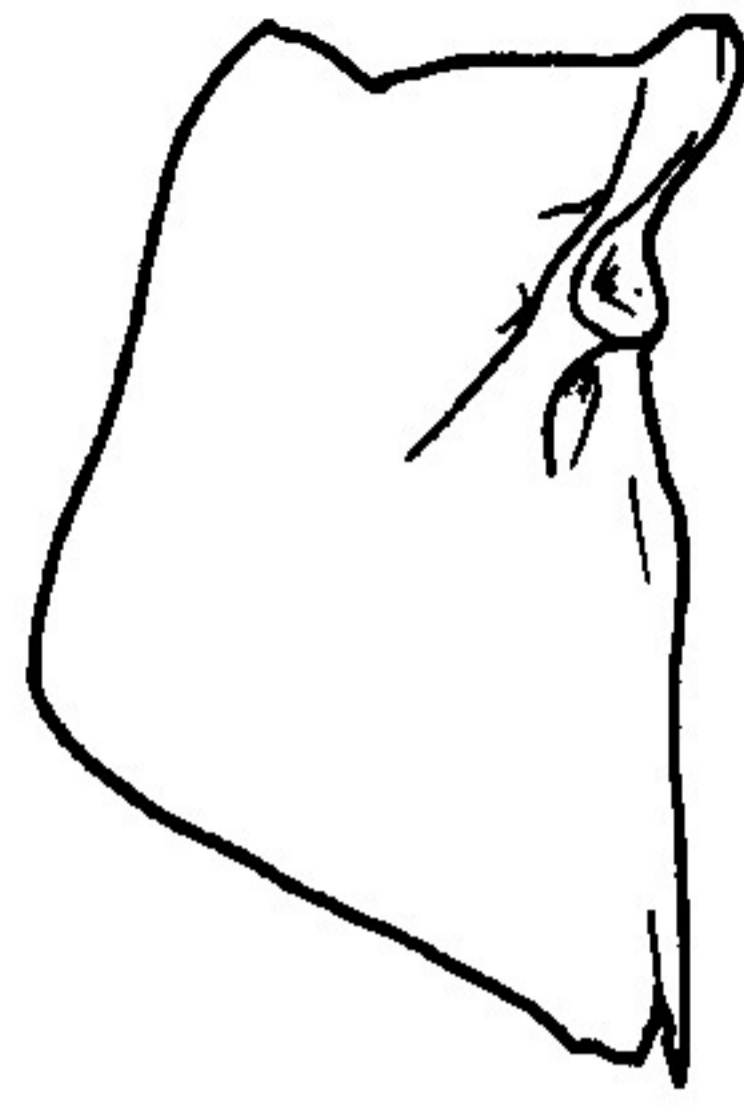


*Stizostedion lucioperca*

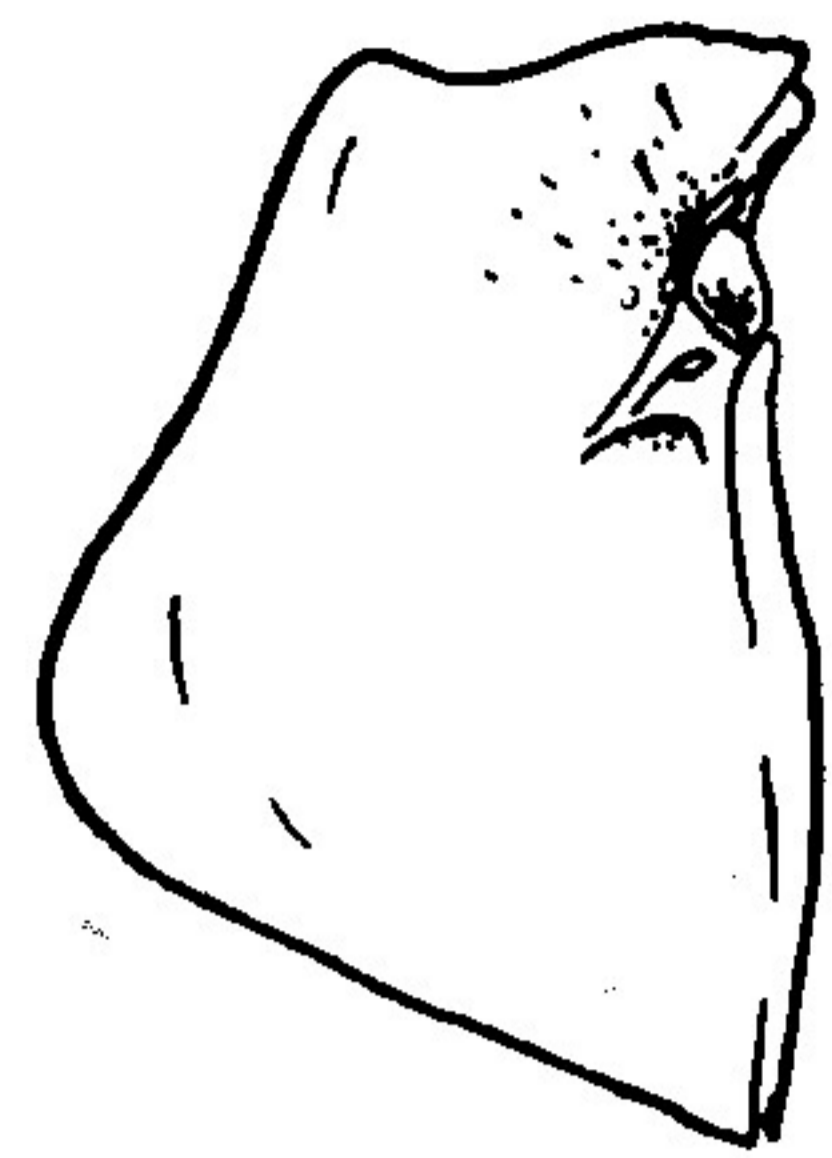
**OPERCULARE**  
**NORMA MEDIALIS**



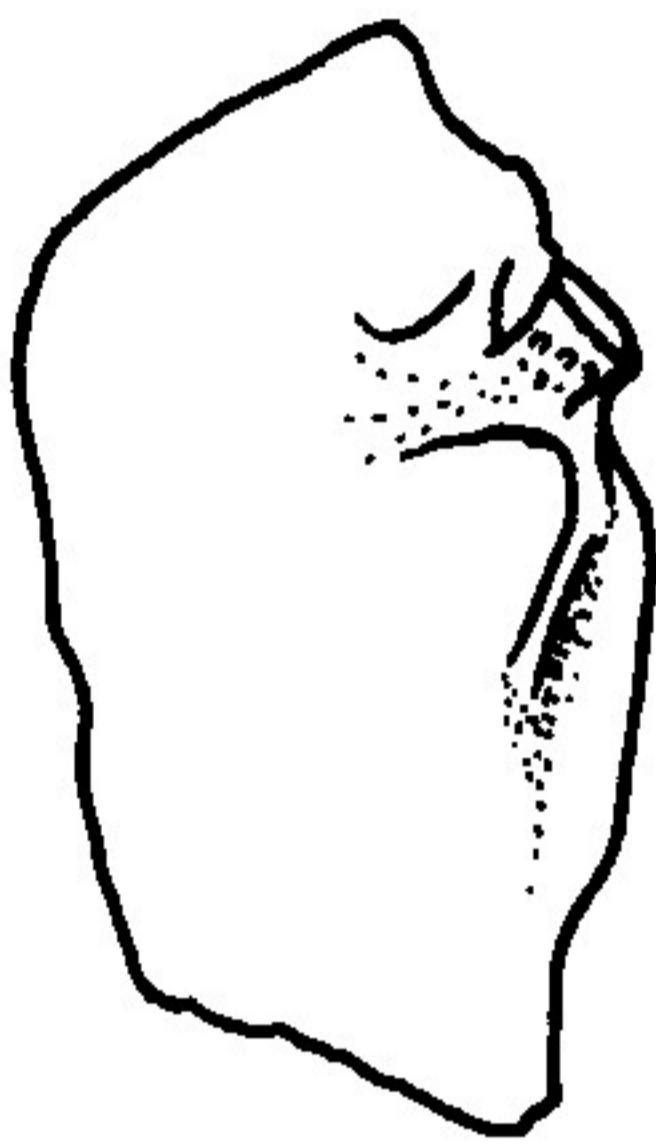
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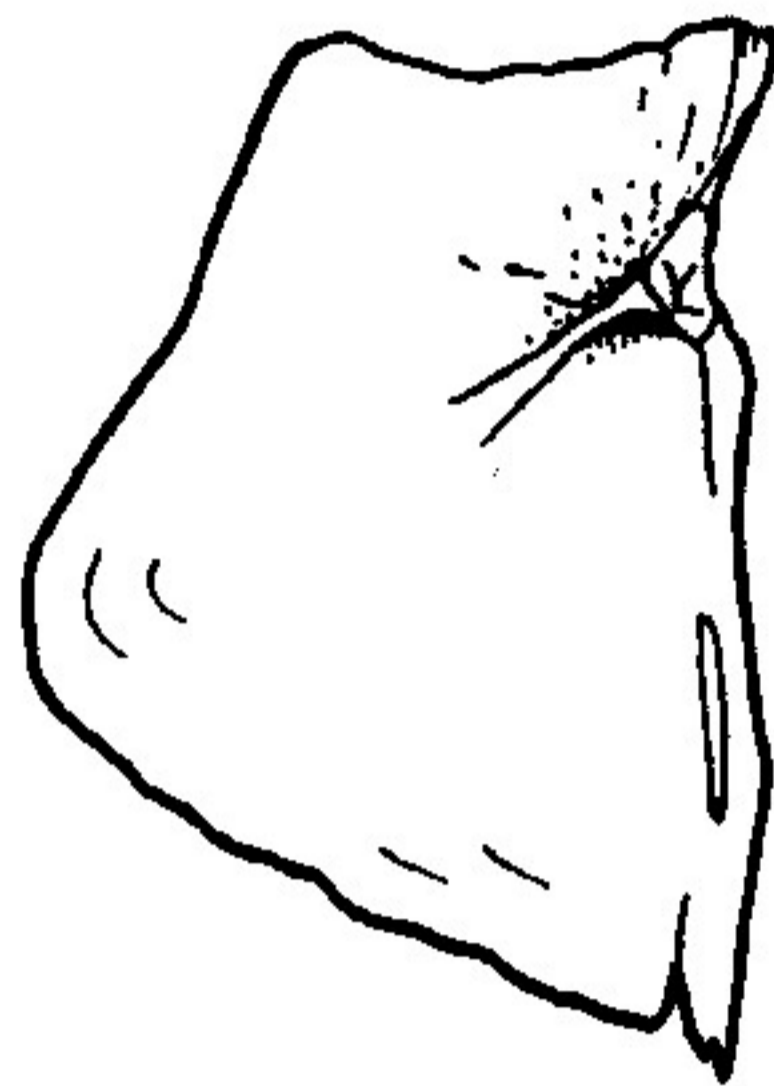
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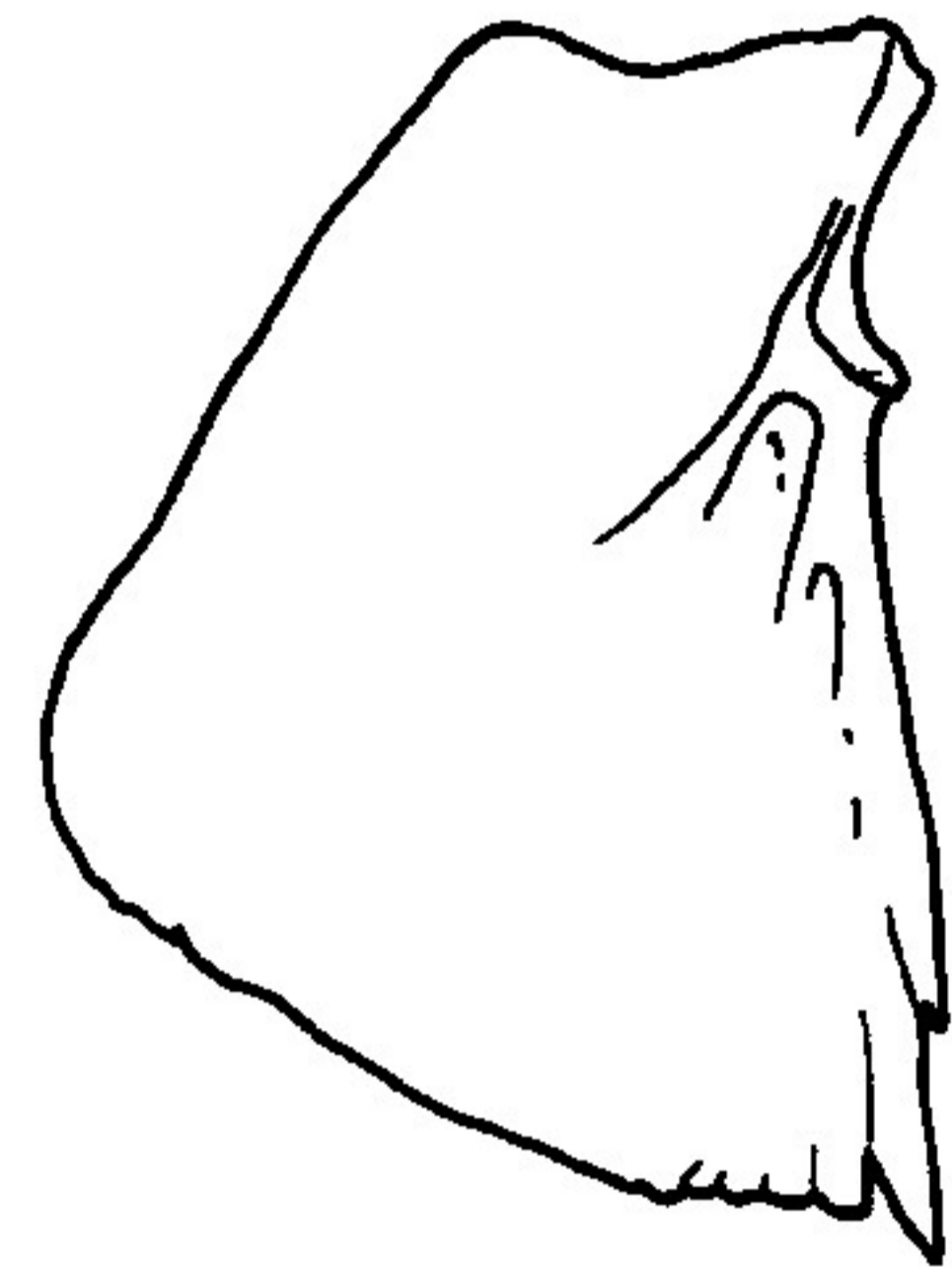
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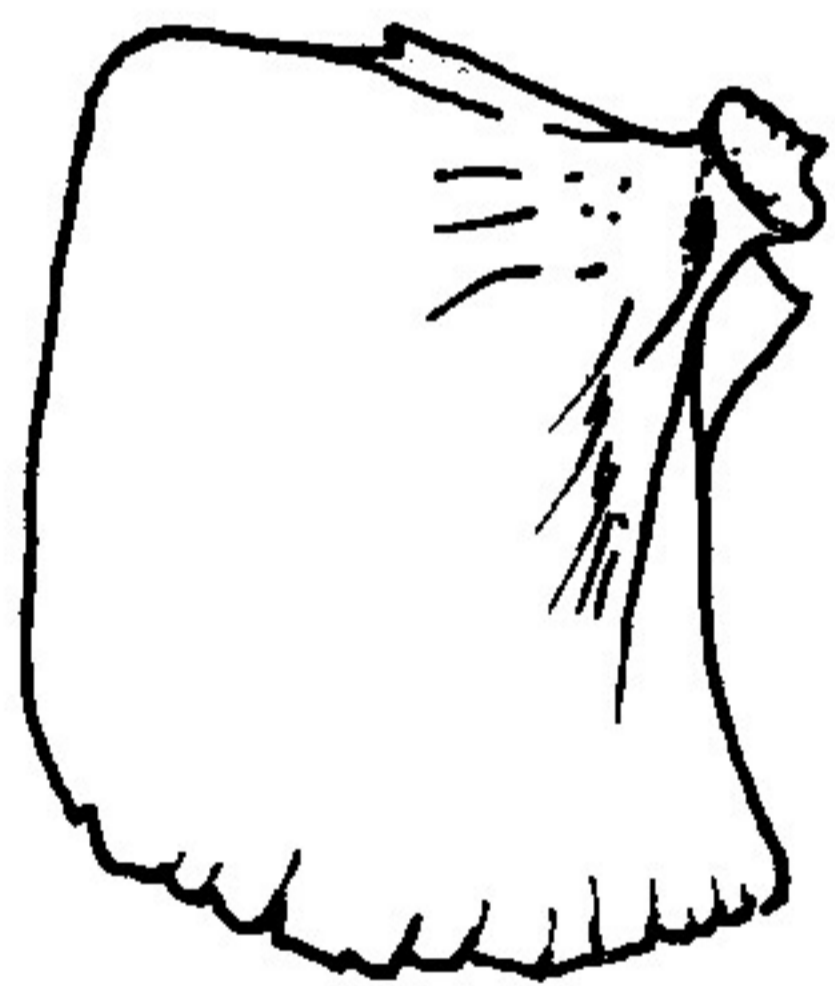
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*Alburnus alburnus*



*Leuciscus idus*



*Esox lucius*



*Aspius aspius*



*Rutilus rutilus*



*Silurus glanis*

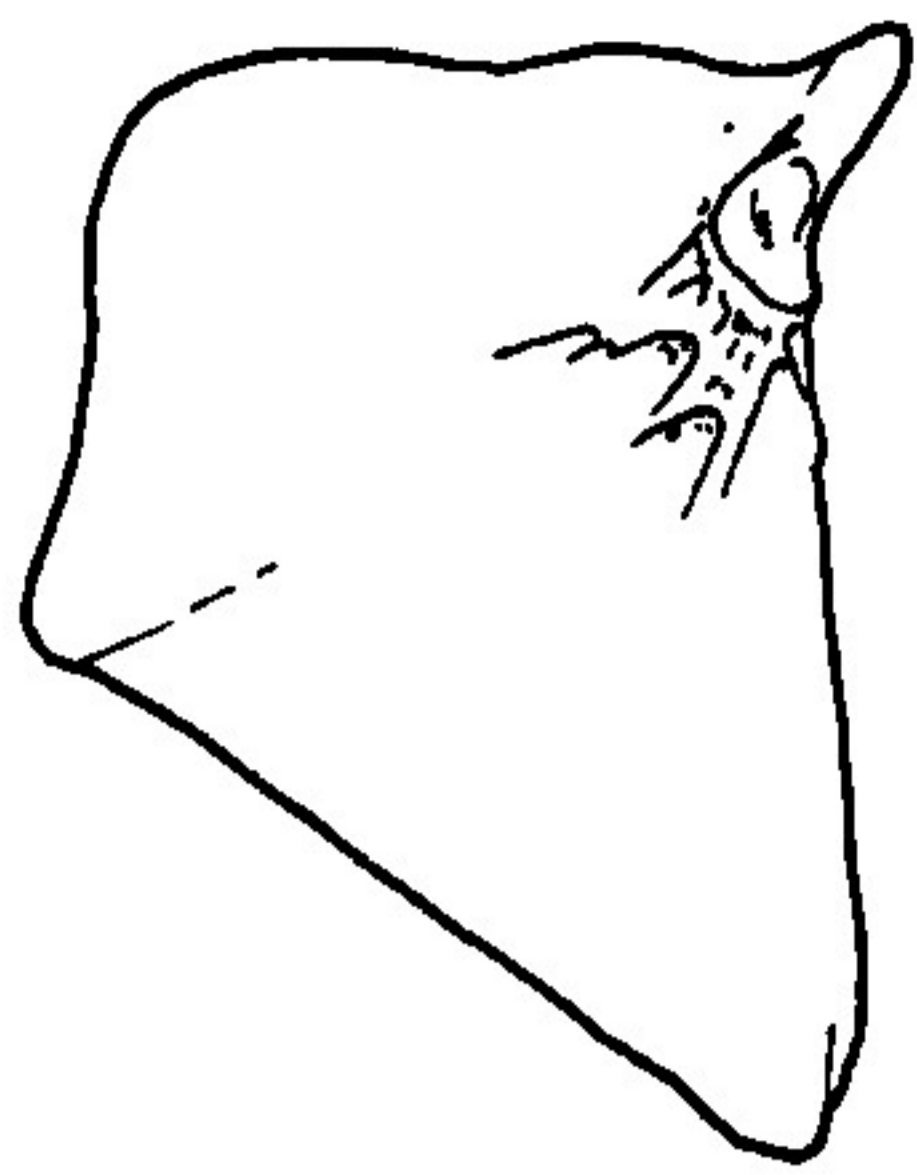


*Blicca bjoerkna*

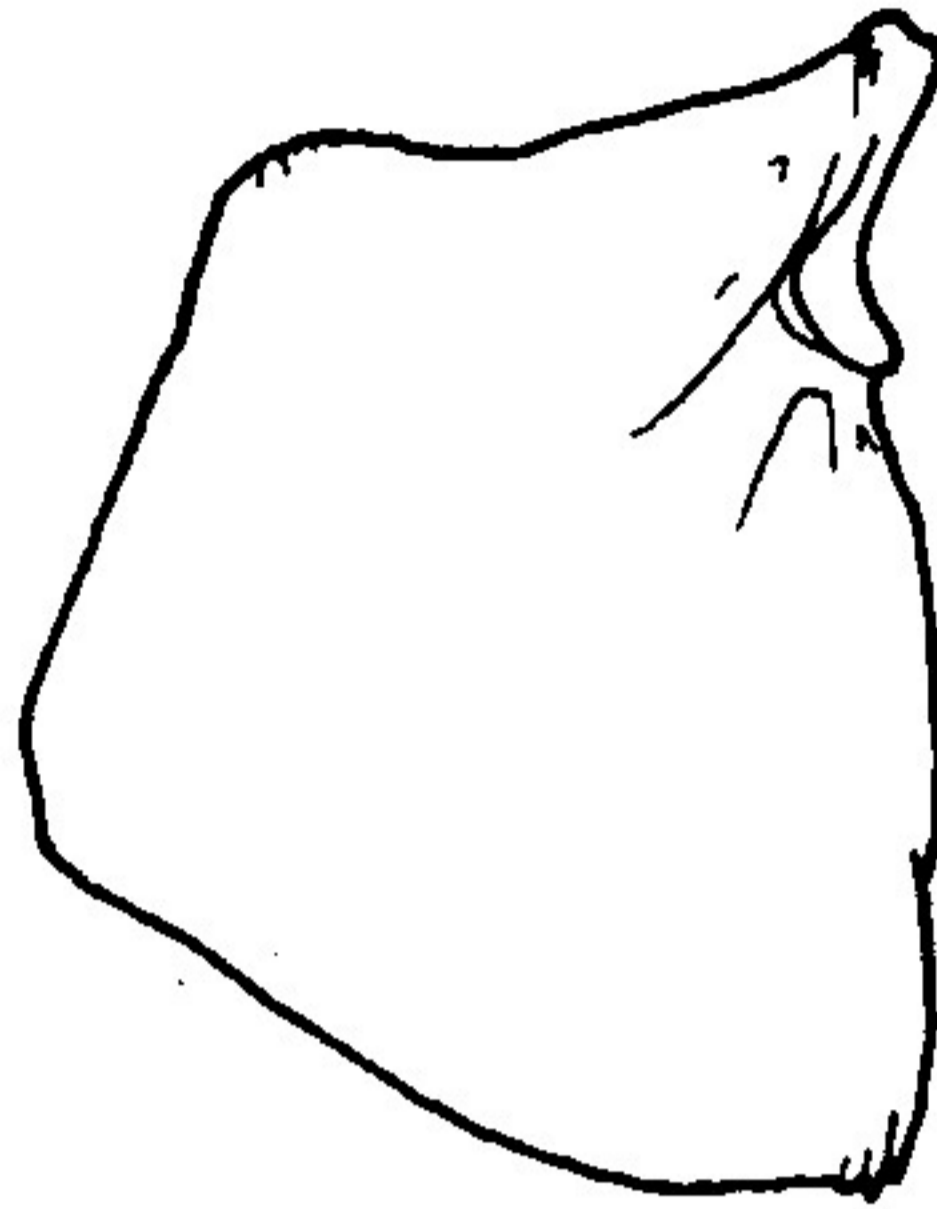


*Vimba vimba carinata*

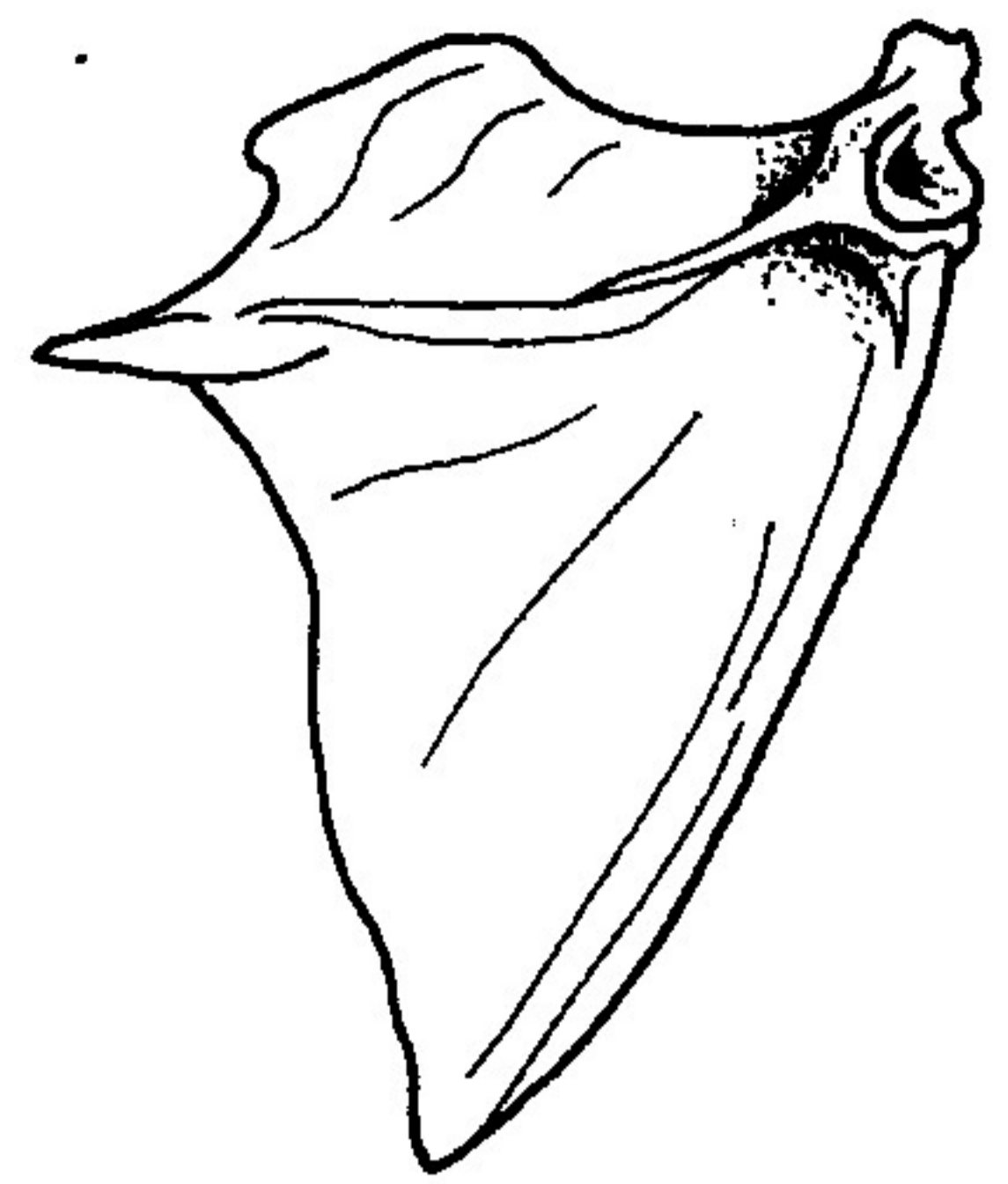
**OPERCULARE**  
**NORMA MEDIALIS**



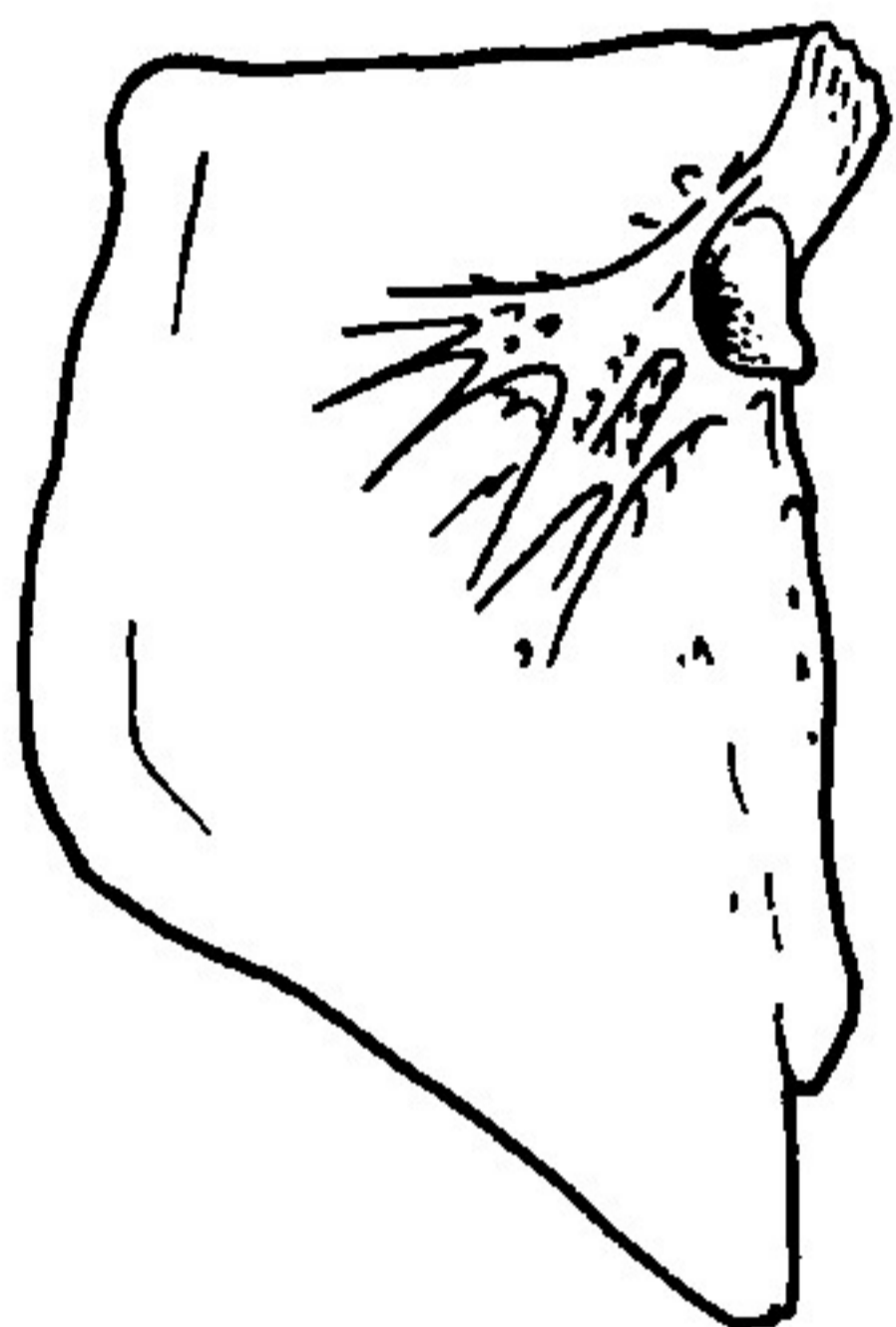
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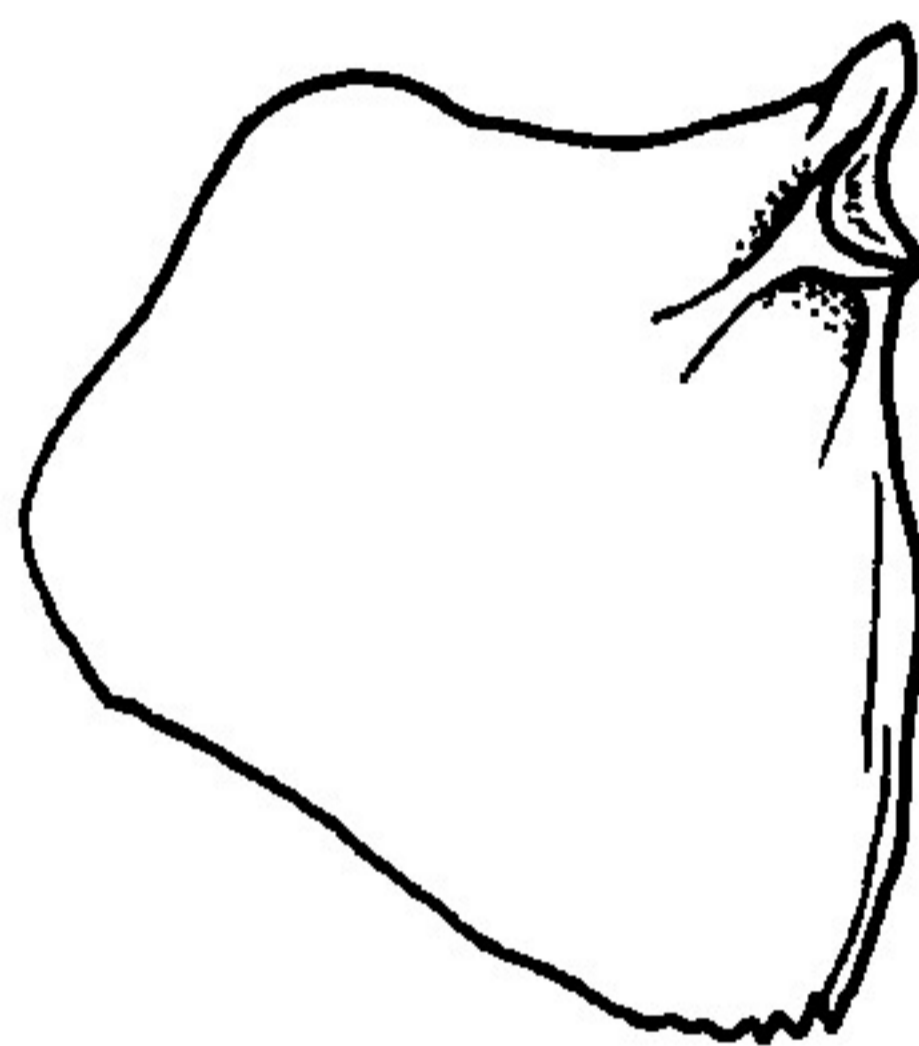
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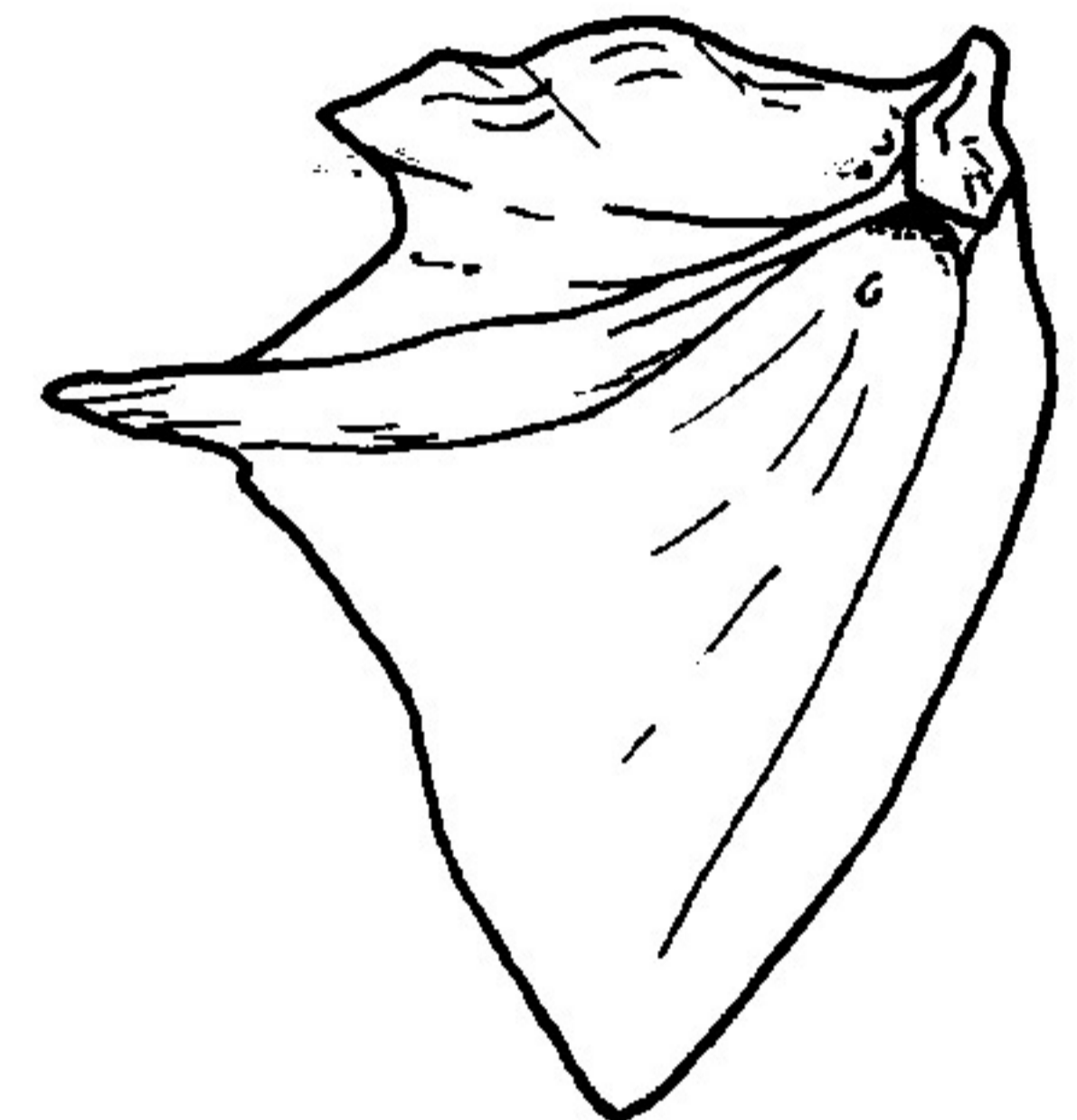
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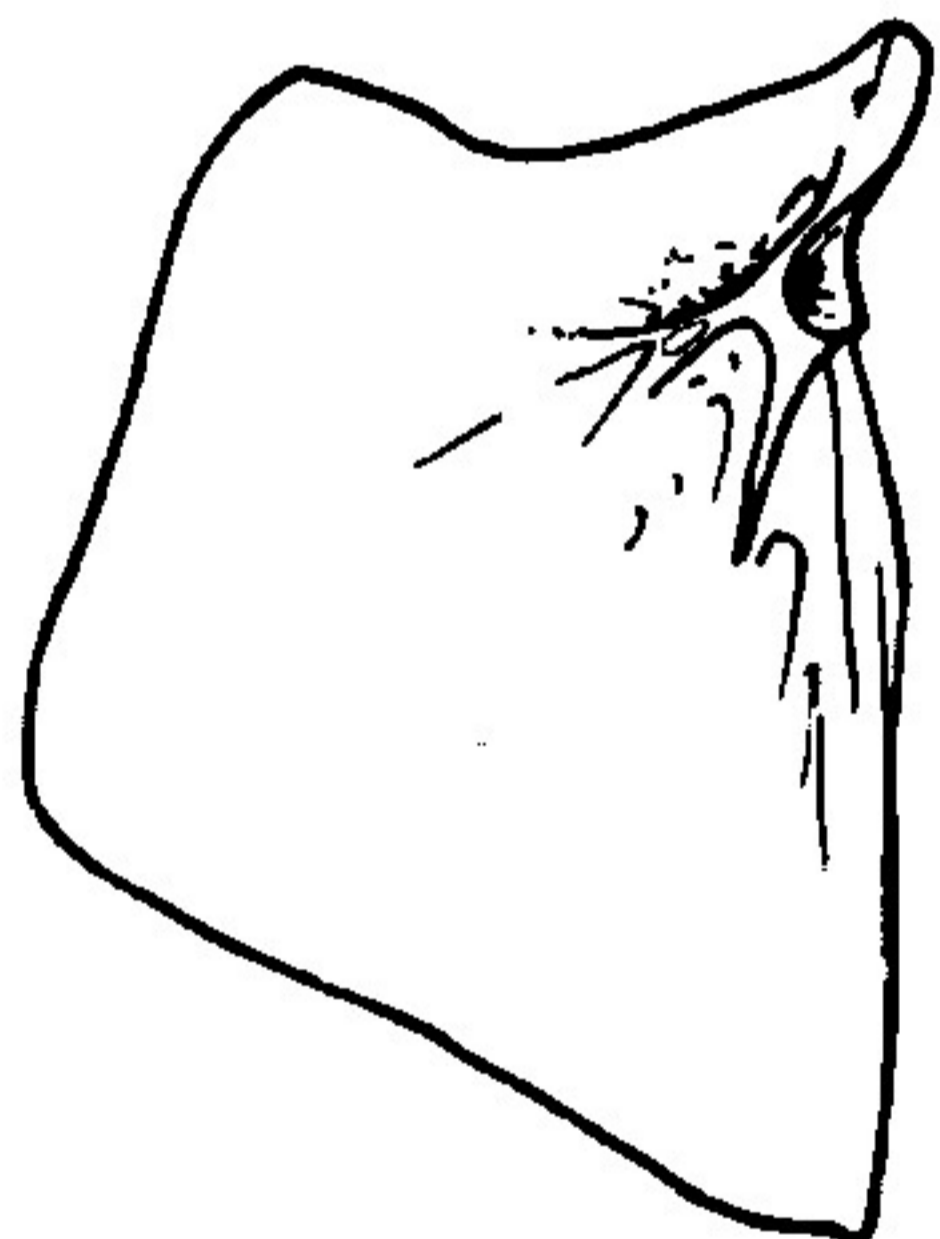
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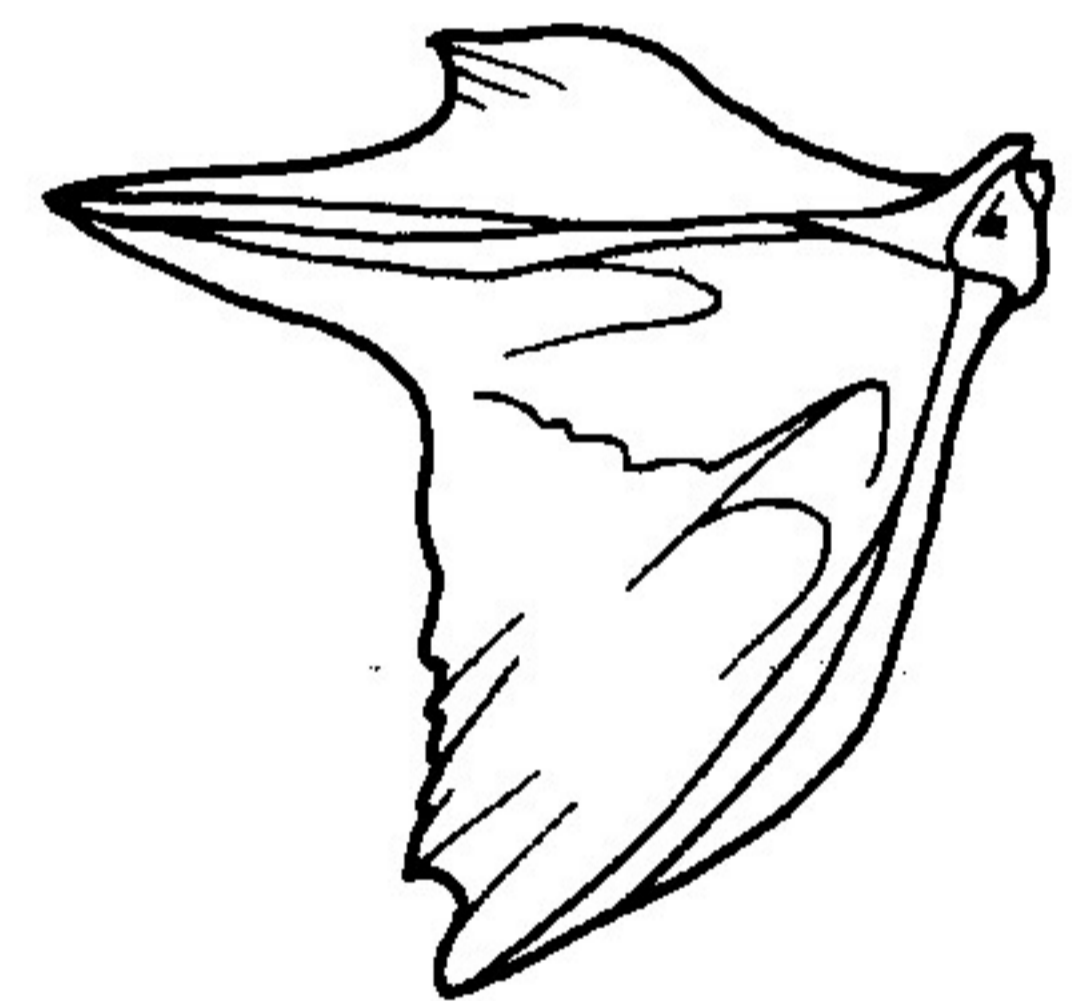
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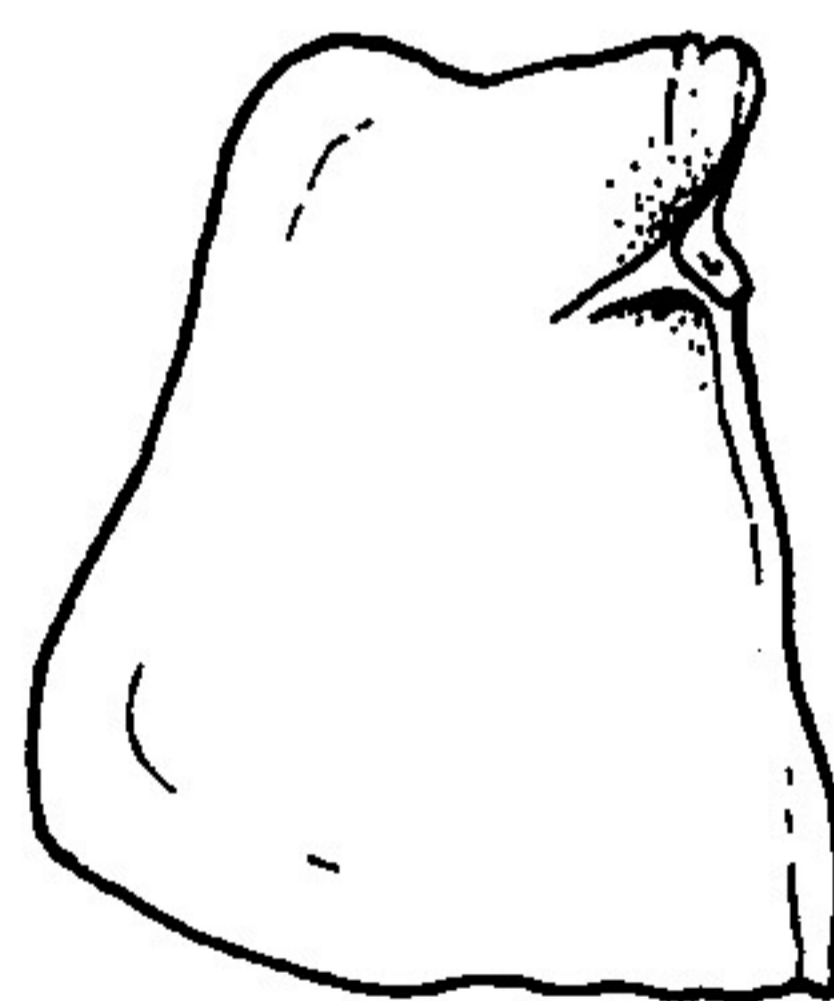
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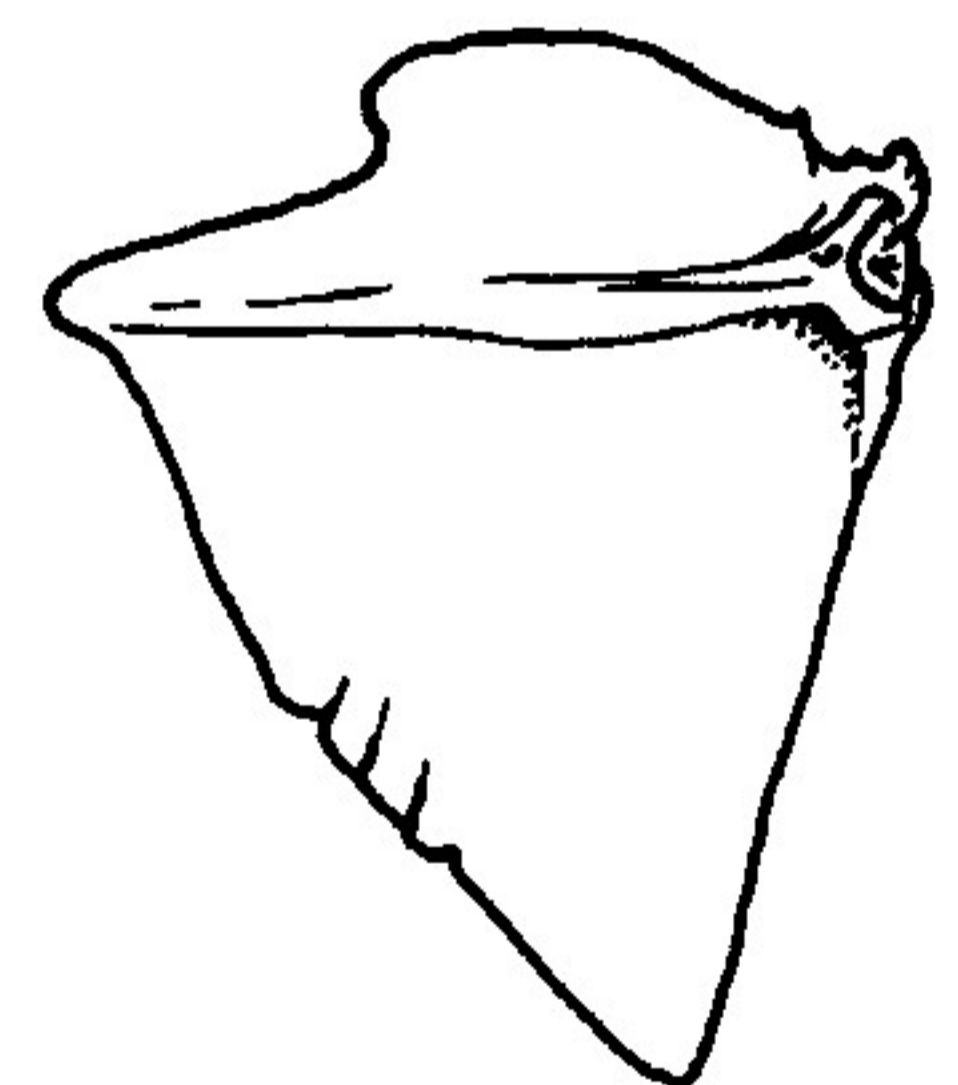
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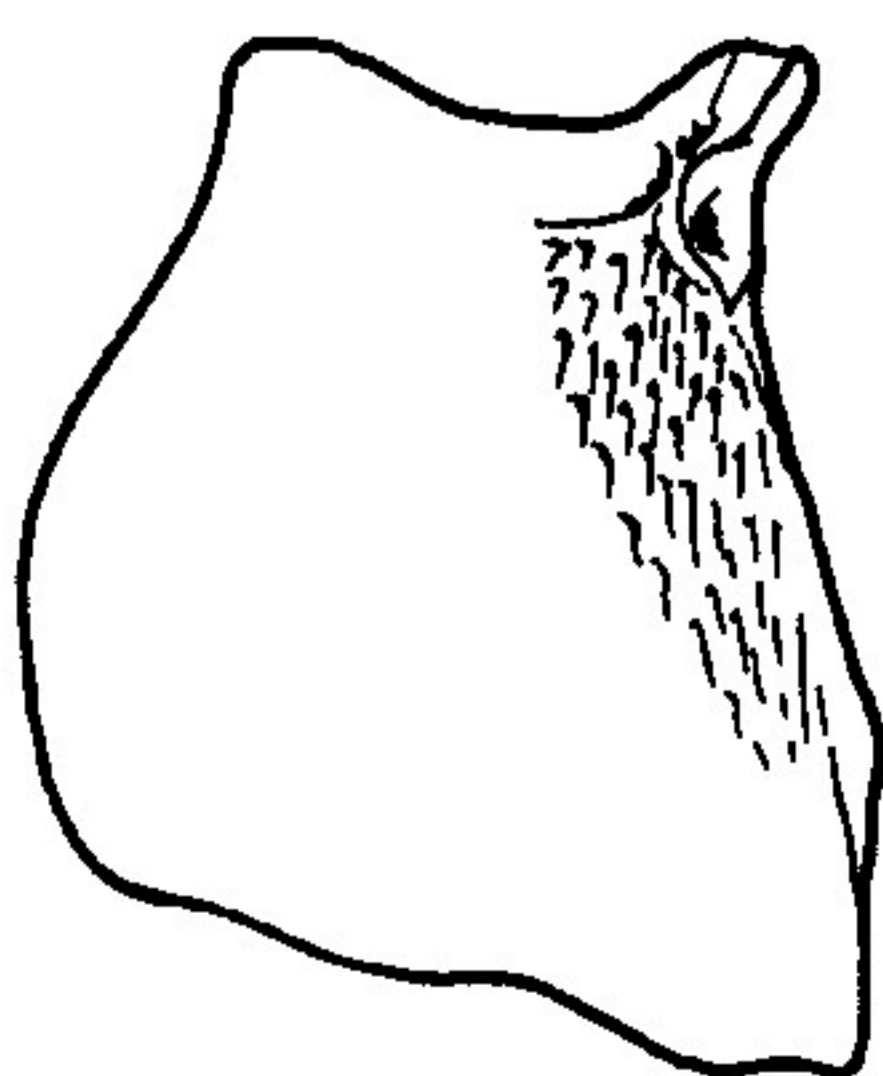
*Aspro zingel*



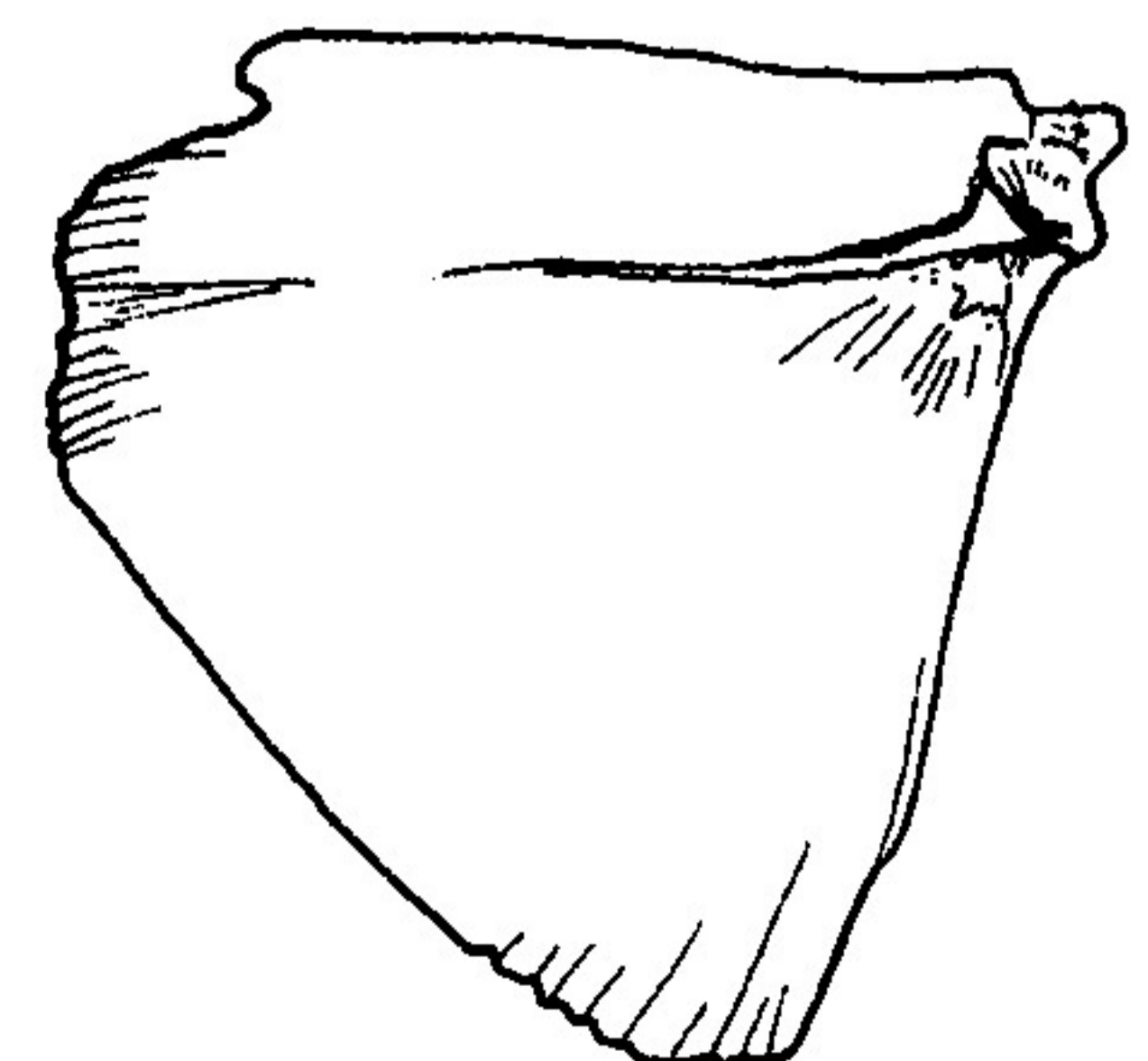
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*Perca fluviatilis*



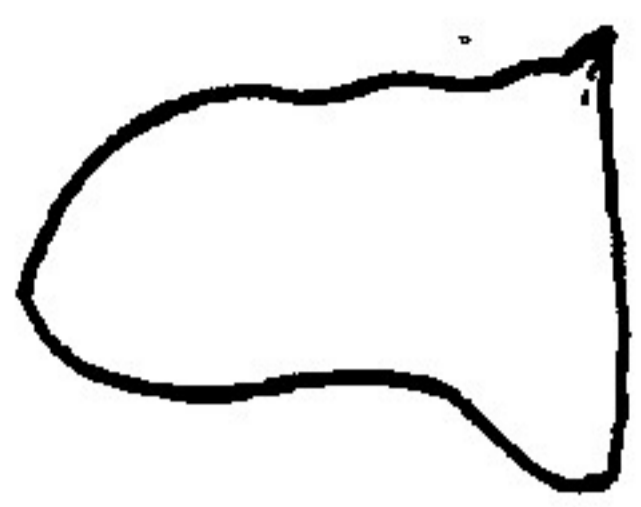
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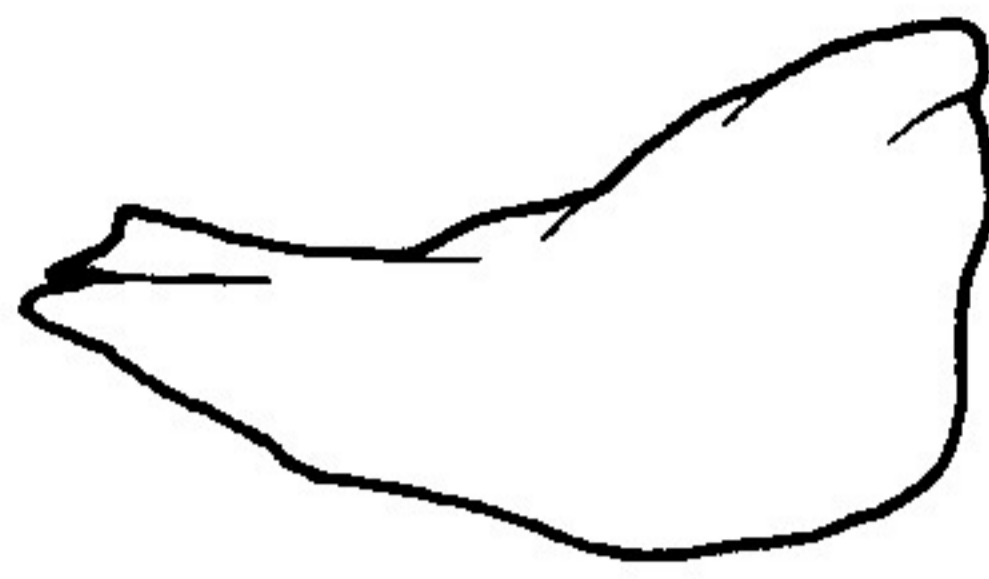
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# INTEROPERCULARE

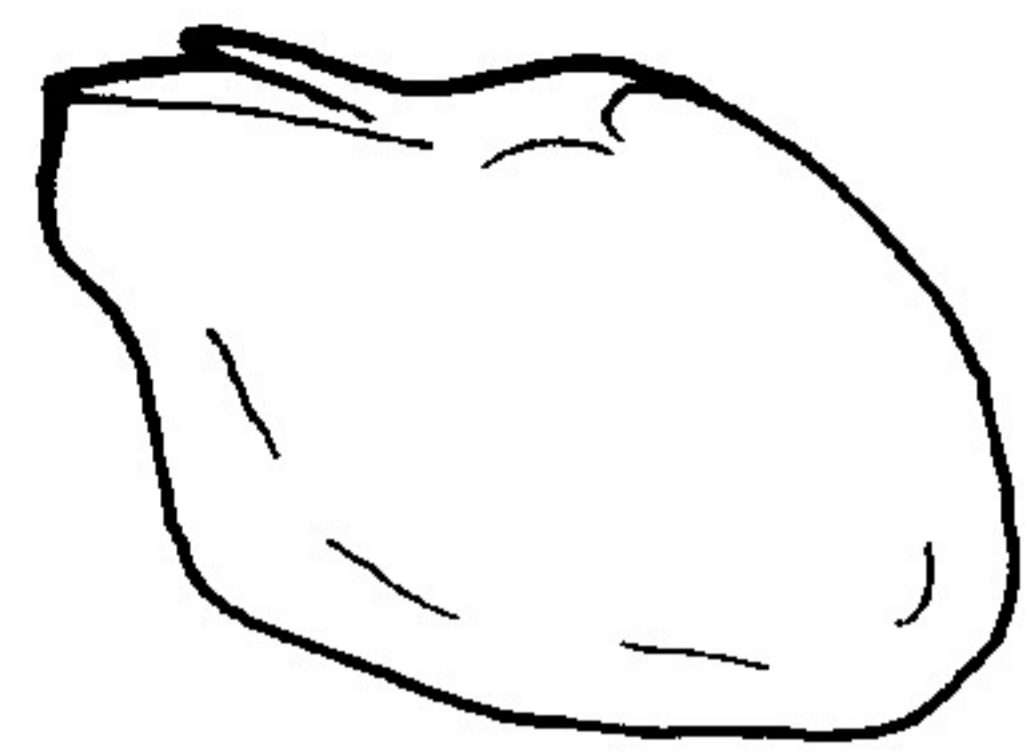
## NORMA LATERALIS



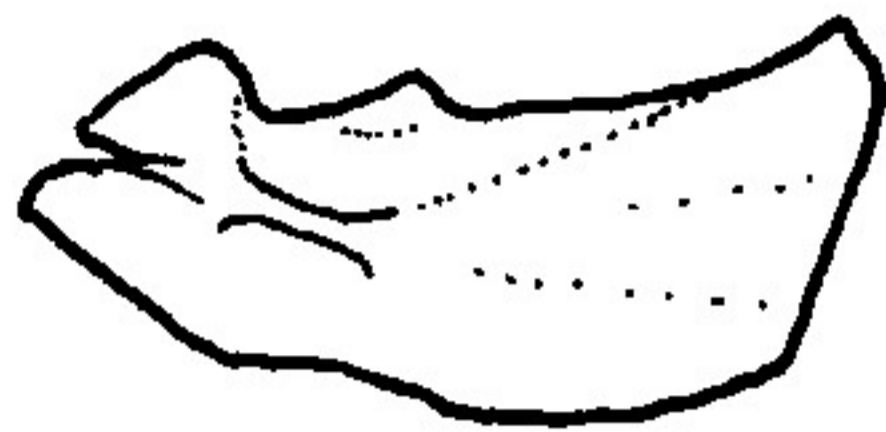
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*Abramis brama*



*Acerina schraetser*



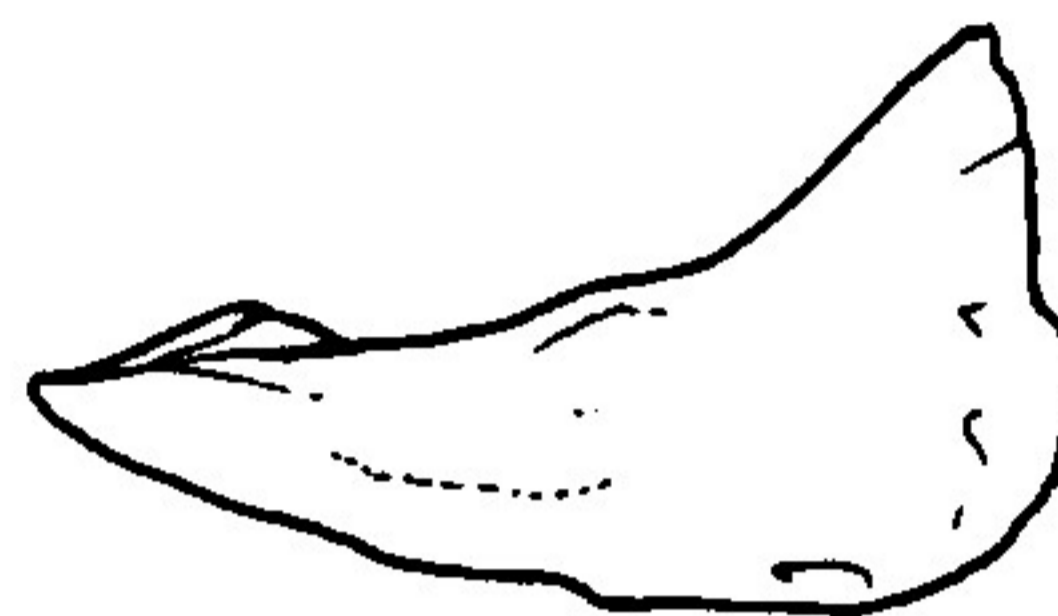
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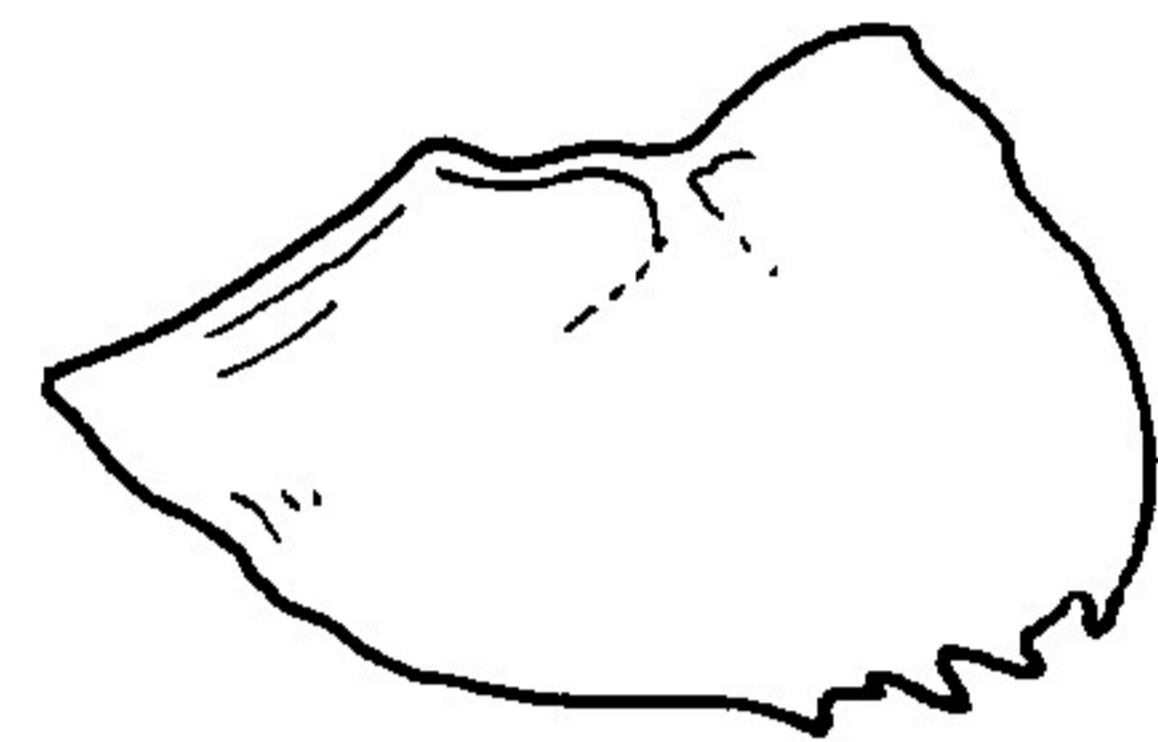
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*Esox lucius*



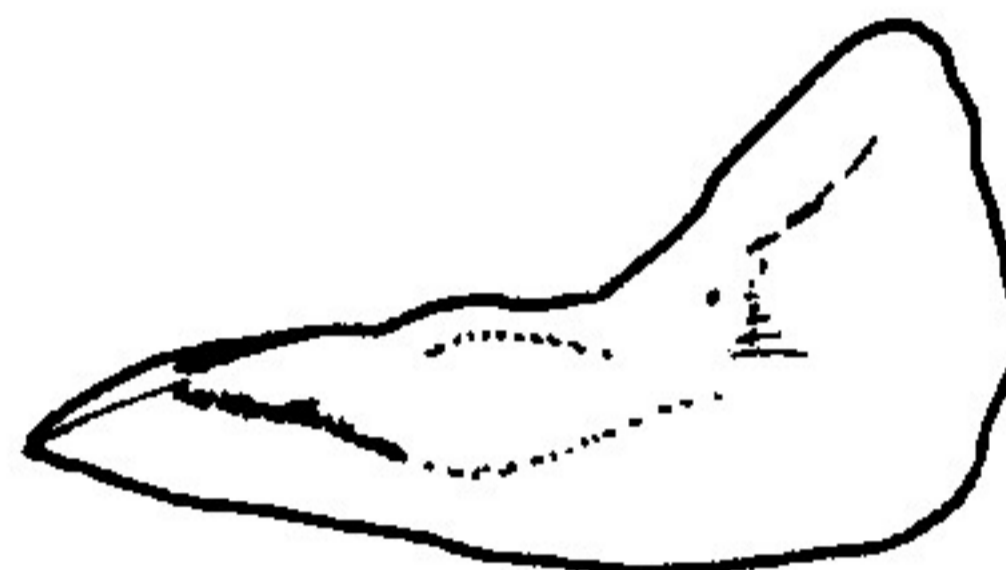
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*Gymnocephalus sp.*



*Silurus glanis*



*Carassius auratus*



*Rutilus rutilus*



*Aspro zingel*



*Barbus barbus*



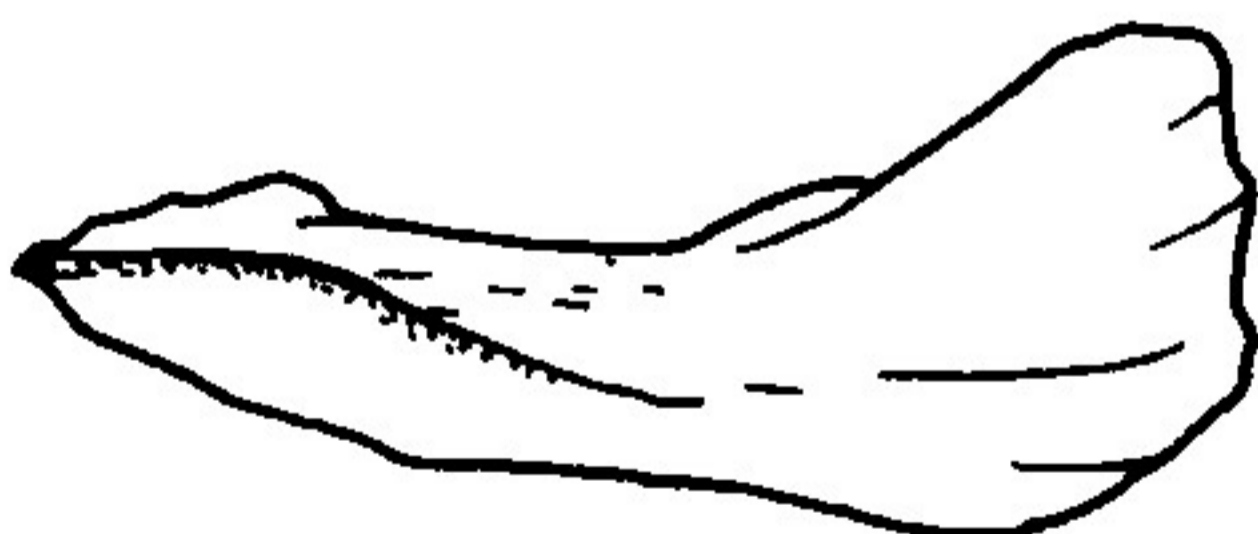
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*Pelecus cultratus*



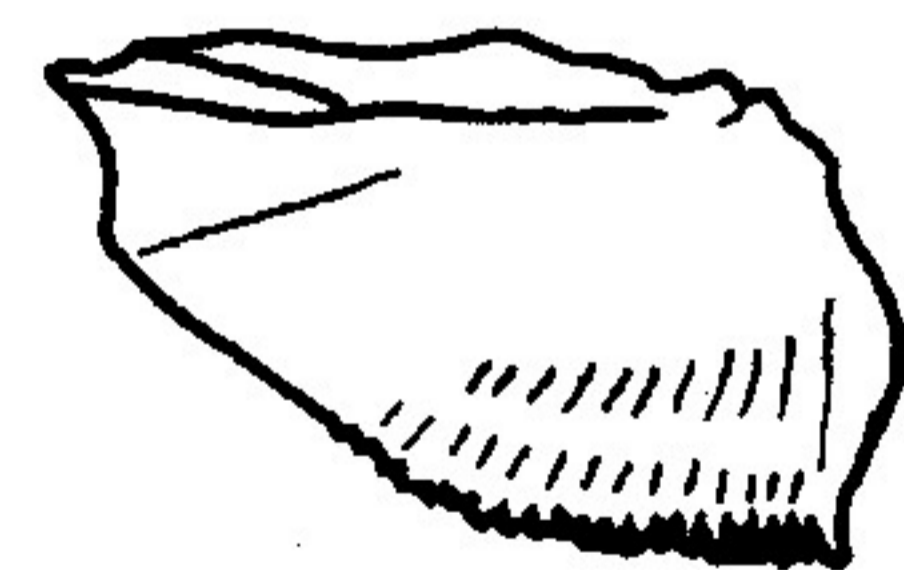
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*Cyprinus carpio*



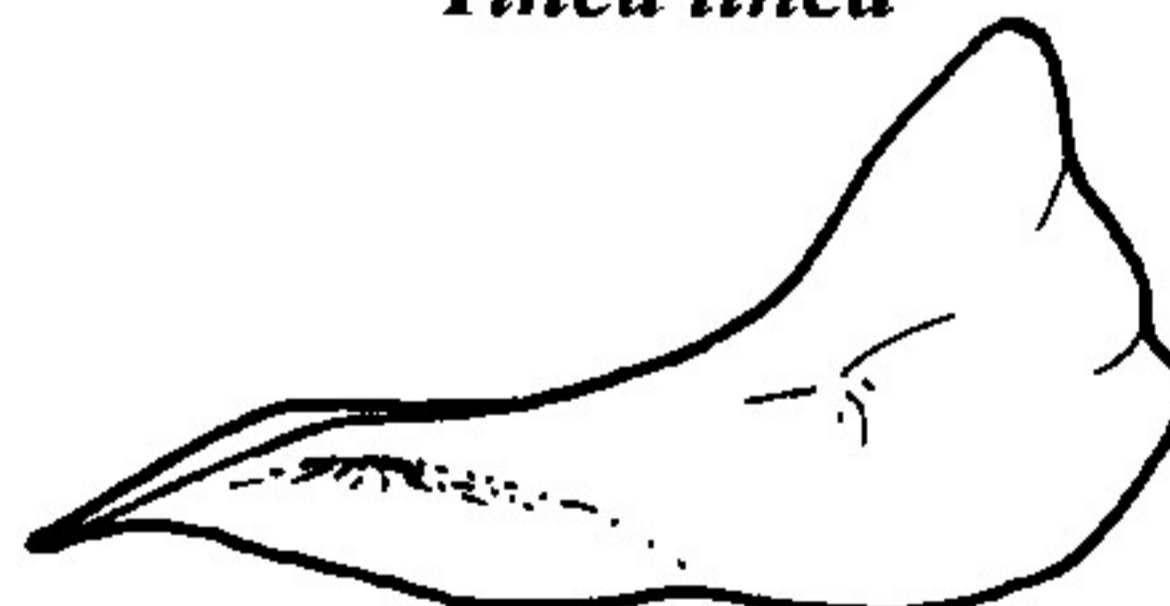
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*Perca fluviatilis*



*Aspius aspius*



*Alburnus alburnus*



*Vimba vimba carinata*

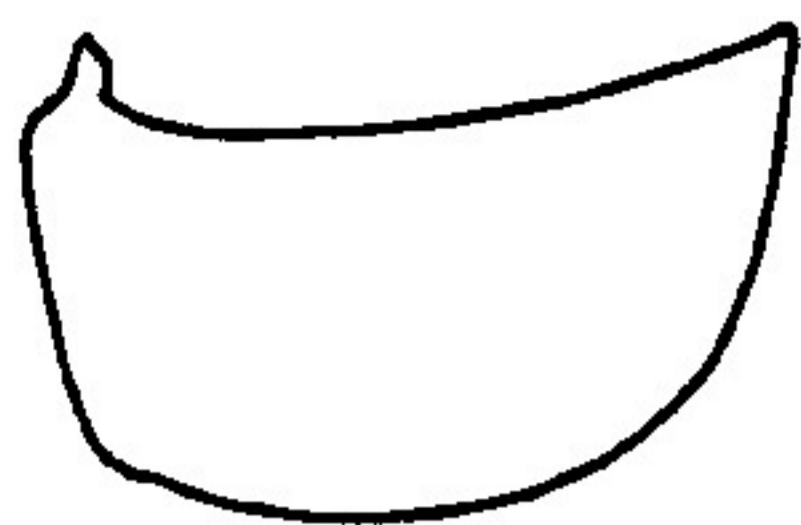


*Chalcaburnus chalcoides mento*



*Stizostedion lucioperca*

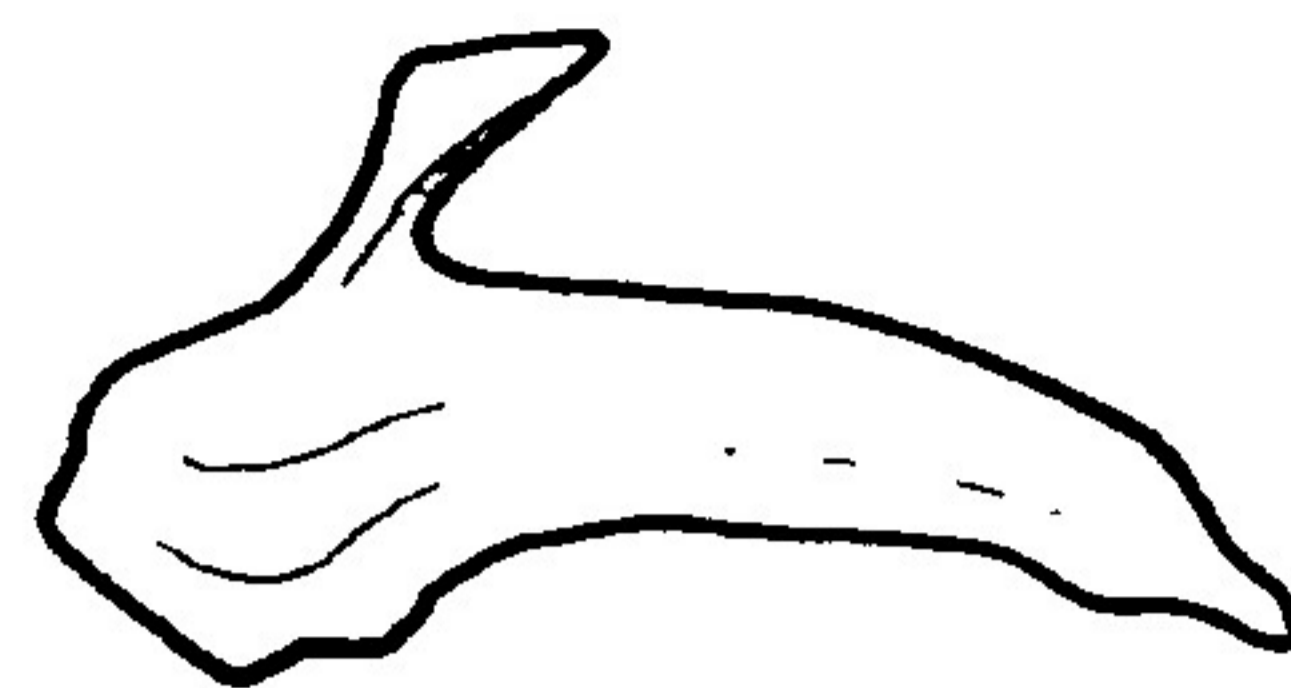
**SUBOPERCULARE**  
**NORMA LATERALIS**



*Salmo trutta lacustris*



*Abramis brama*



*Acerina schraetser*



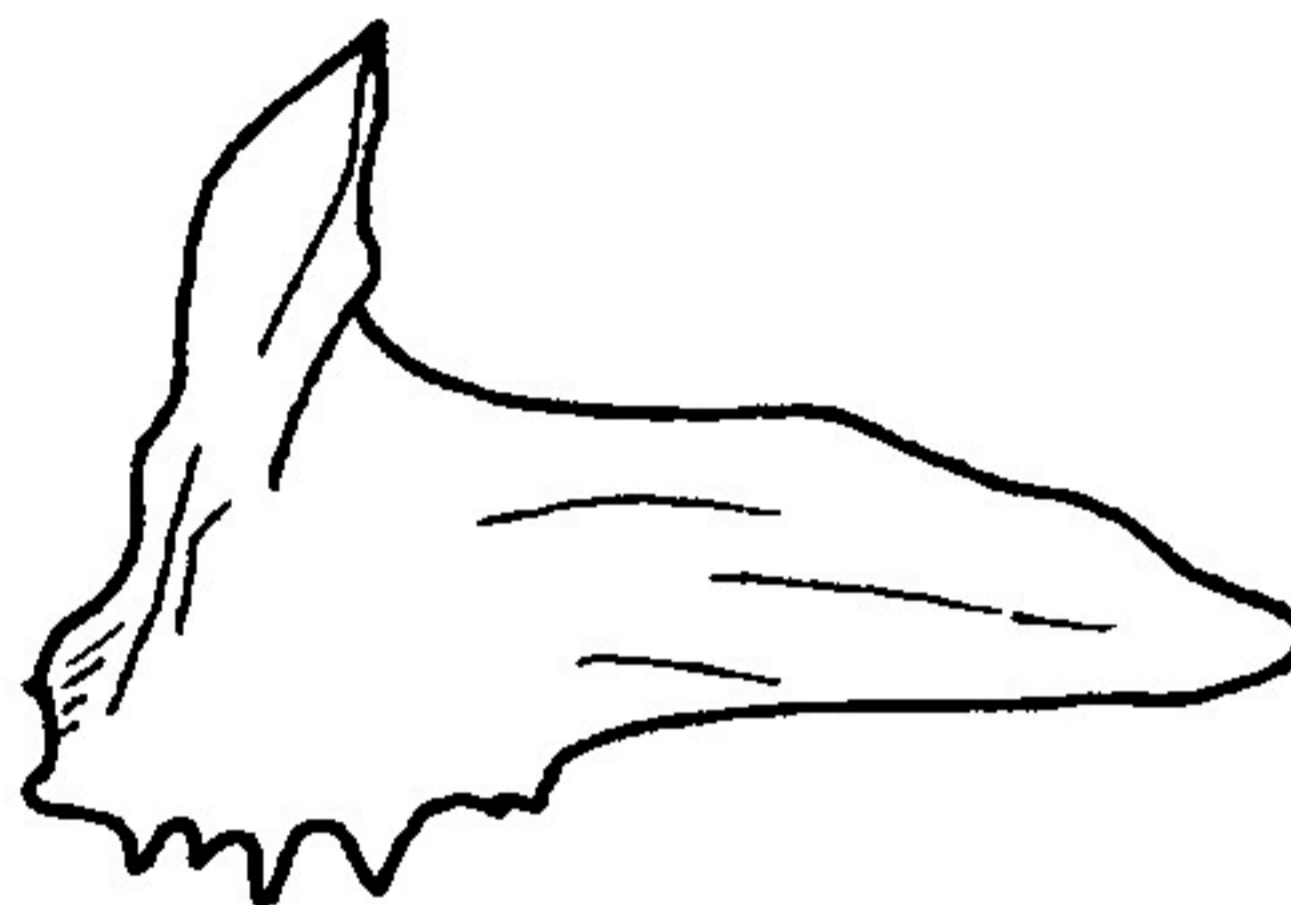
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*Vimba vimba carinata*



*Leuciscus idus*



*Gymnocephalus sp.*



*Esox lucius*



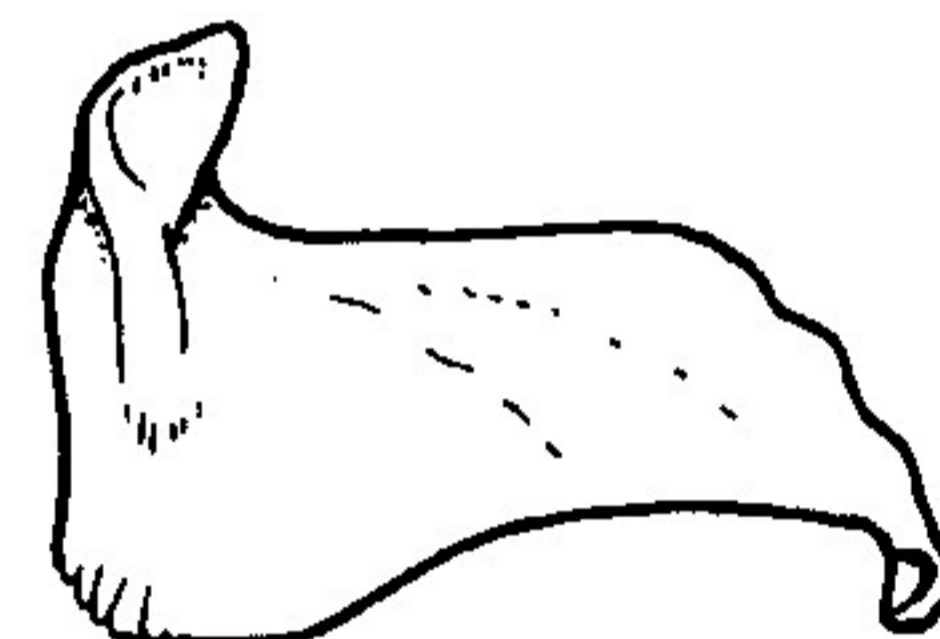
*Alburnus alburnus*



*Cyprinus carpio*



*Chondrostoma nasus*



*Aspro zingel*



*Barbus barbus*



*Blicca bjoerkna*



*Aspius aspius*



*Scardinius erythrophthalmus*



*Perca fluviatilis*



*Pelecus cultratus*



*Carassius auratus*



*Chalcaburnus chalcoides mento*



*Tinca tinca*

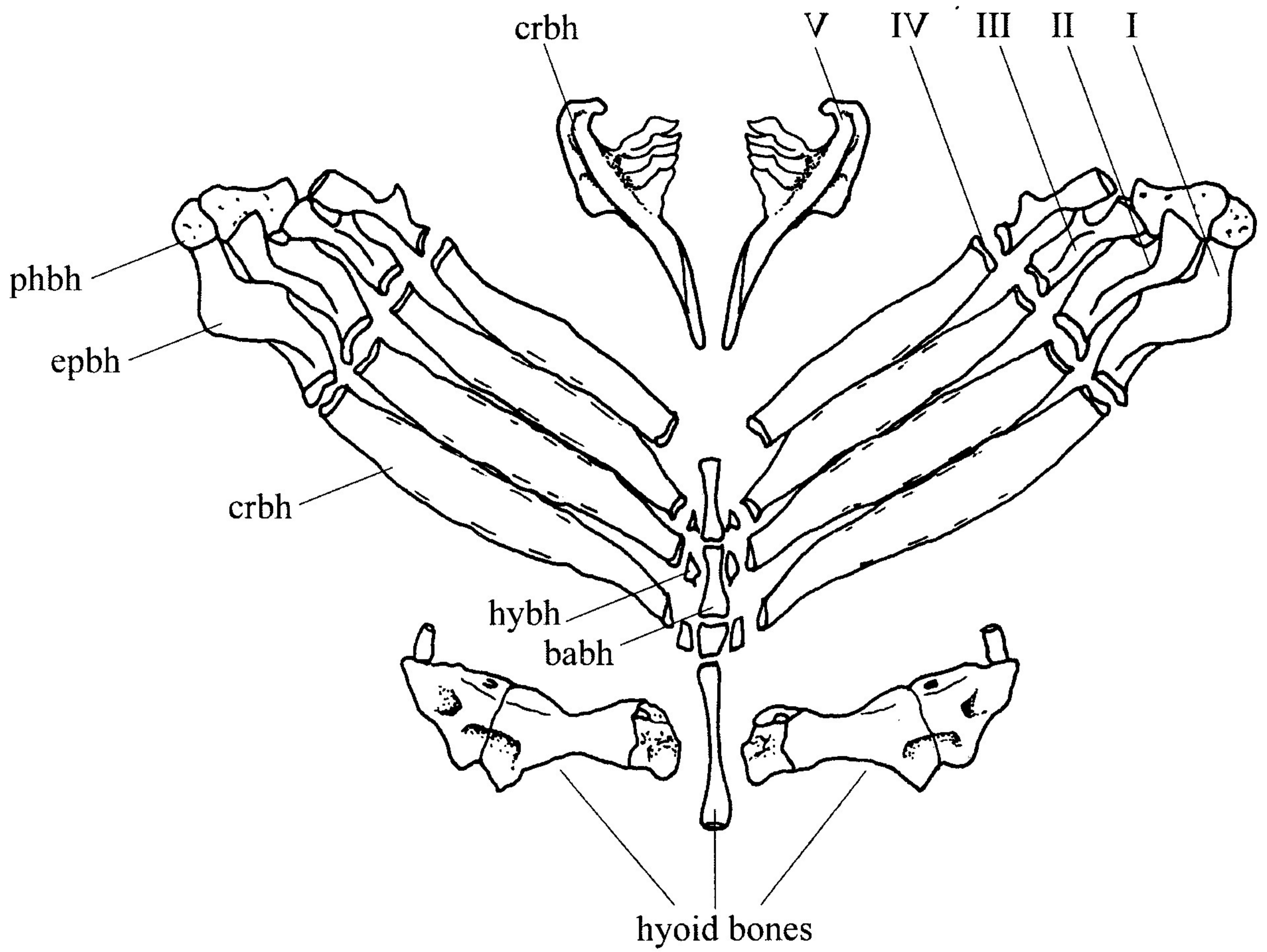


*Rutilus rutilus*



*Stizostedion lucioperca*

Element	Abbreviation	Names from Lepiksaar (1983)
<i>Branchial arches (I-V)</i>		
pharyngobranchial	phbh	pharyngobranchiale
epibranchial	epbh	epibranchiale
<b>ceratobranchial; lower pharyngeal bone</b>	<b>crbh</b>	<b>keratobranchiale; ossa pharyngea inferiora</b>
hypobranchial	hybh	hypobranchiale
basibranchial	babh	basibranchiale

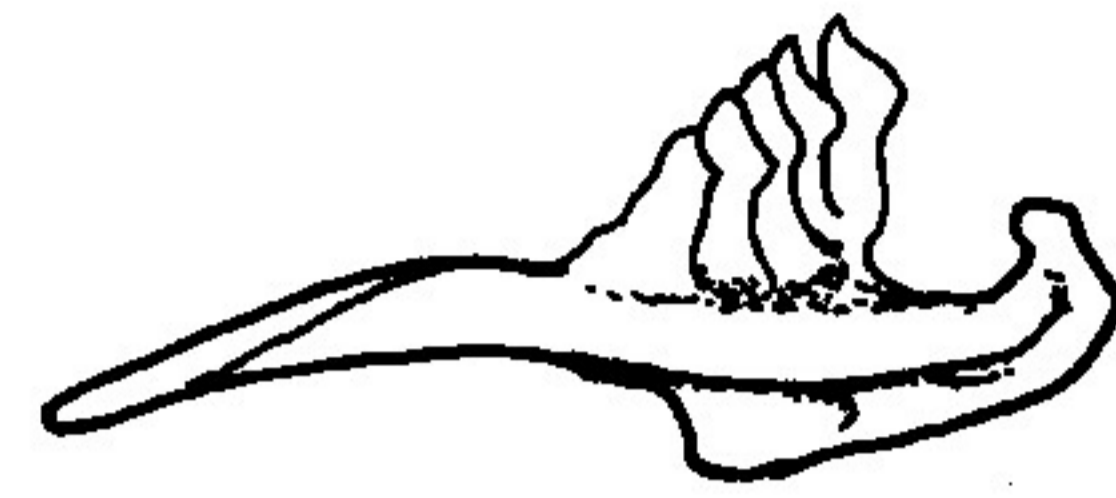
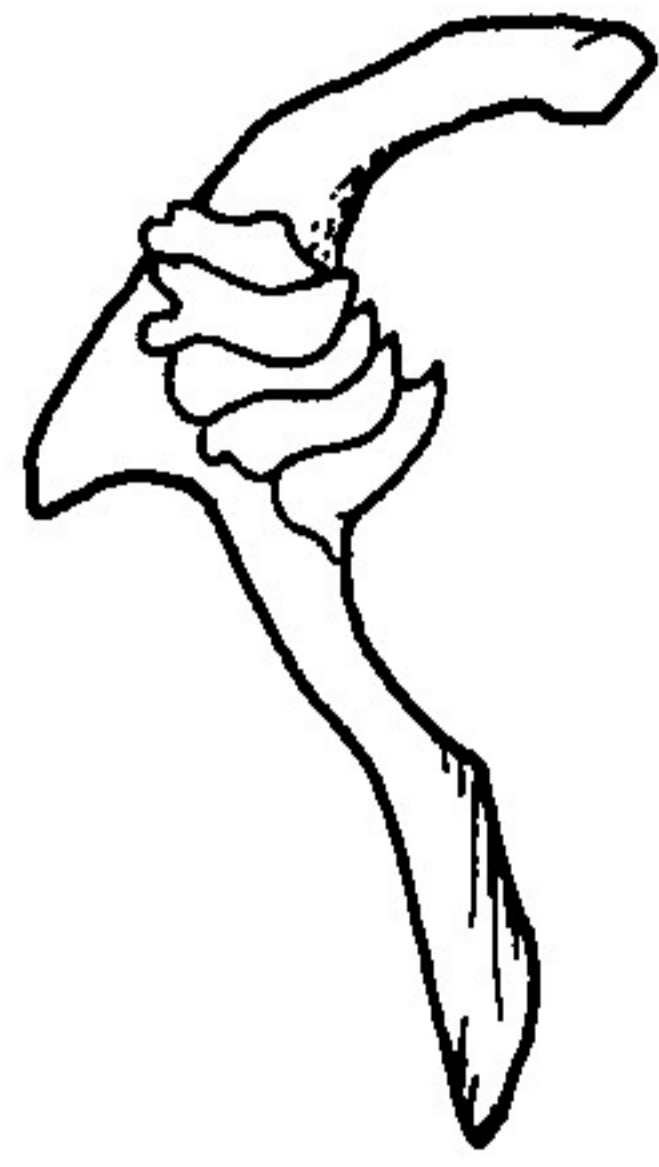


**Fig. 4.** Bream, *Abramis brama* (oral view). Branchial arches I-V.

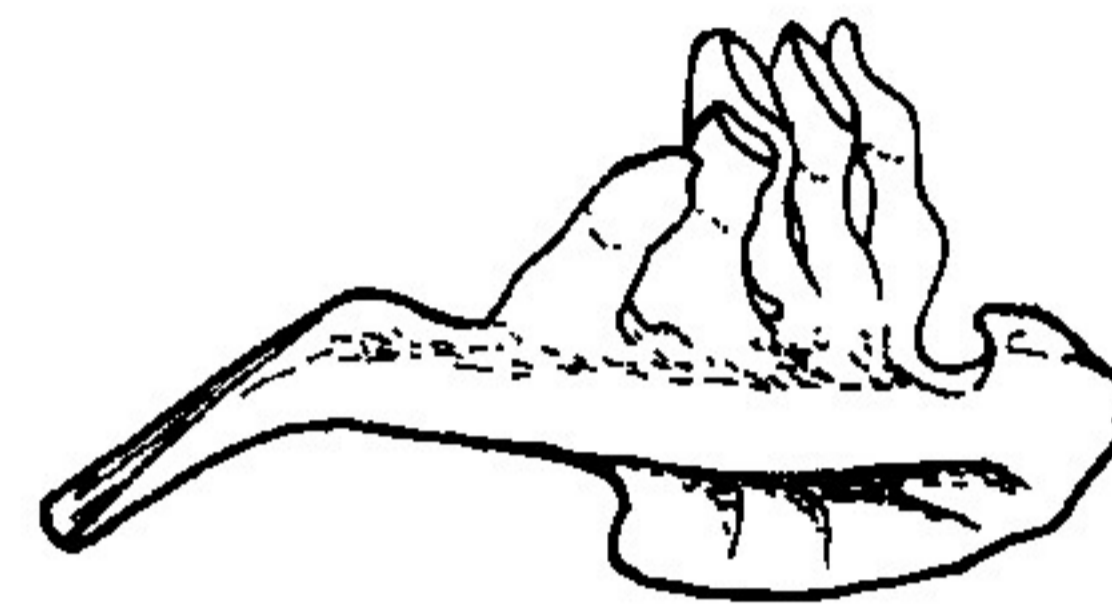
# OSSA PHARYNGEA INFERIORA

*NORMA MEDIALIS*

*NORMA DORSALIS*



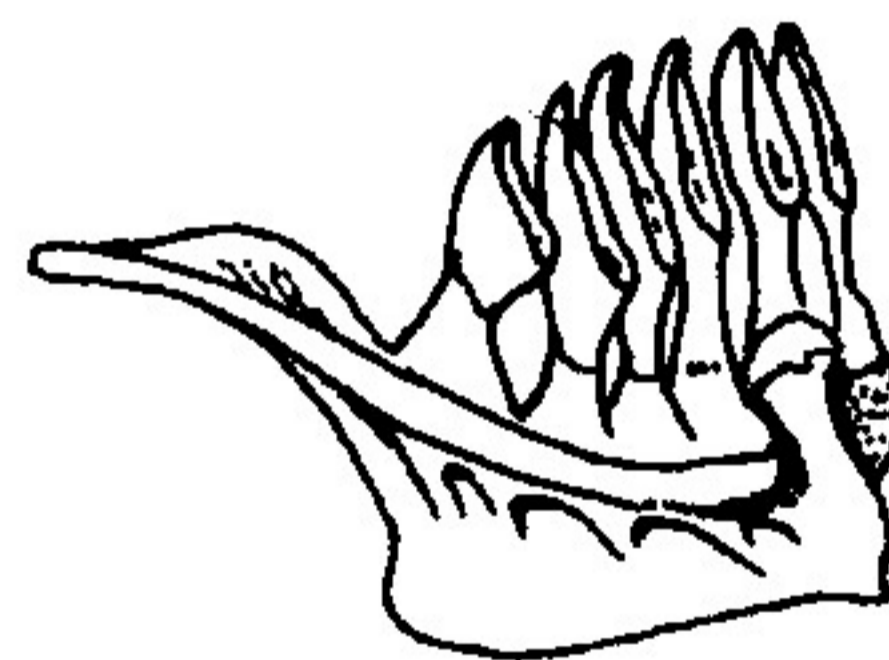
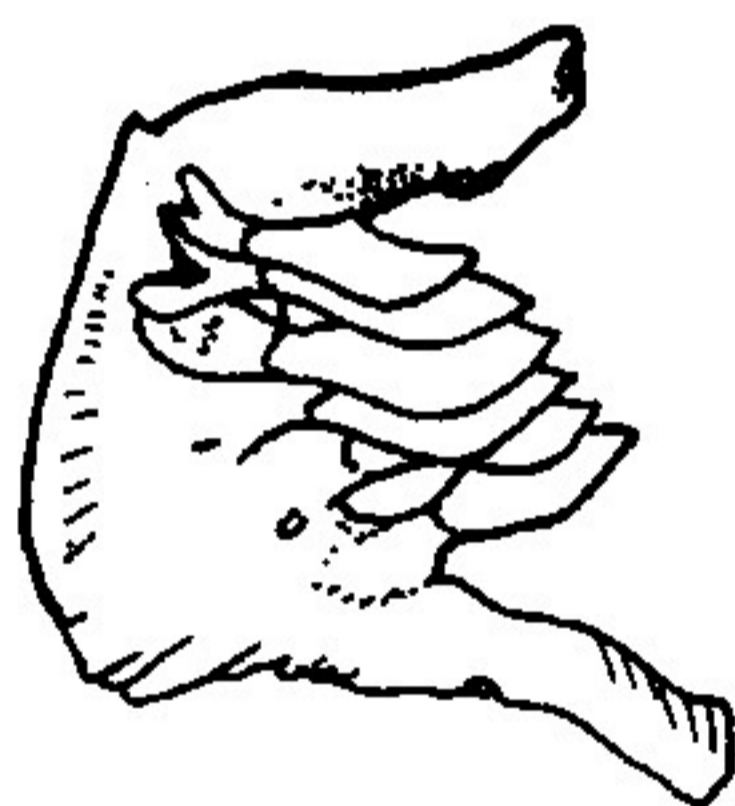
*Abramis brama*



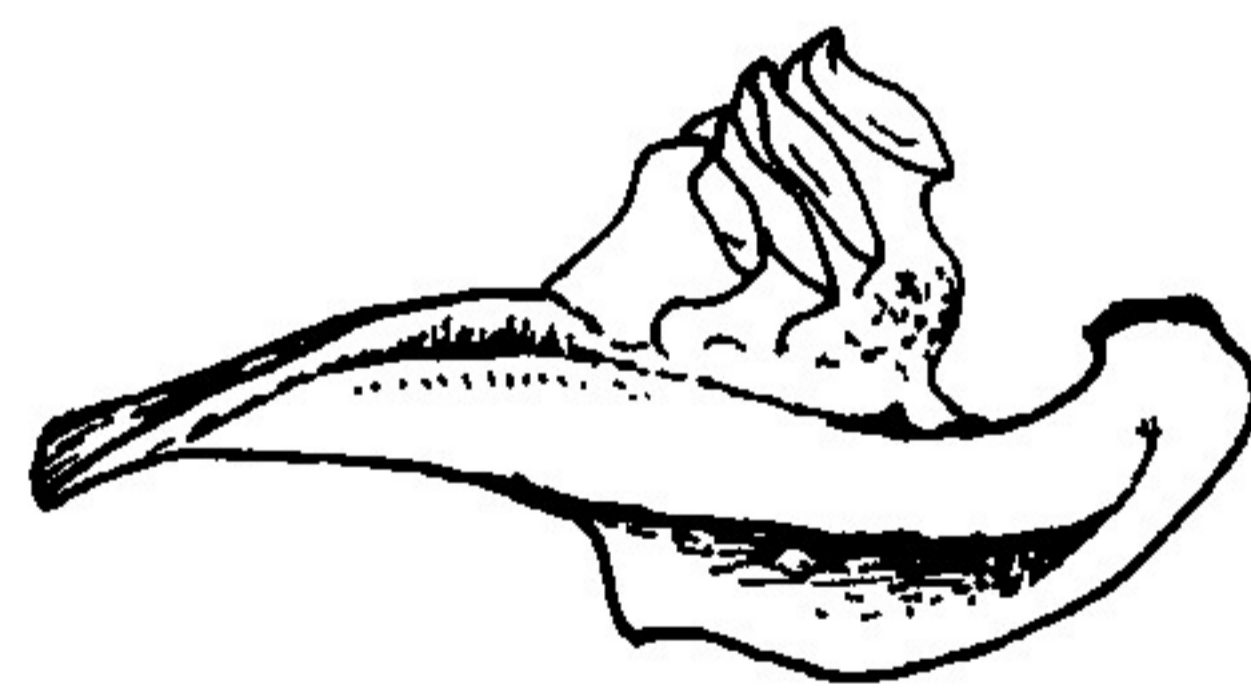
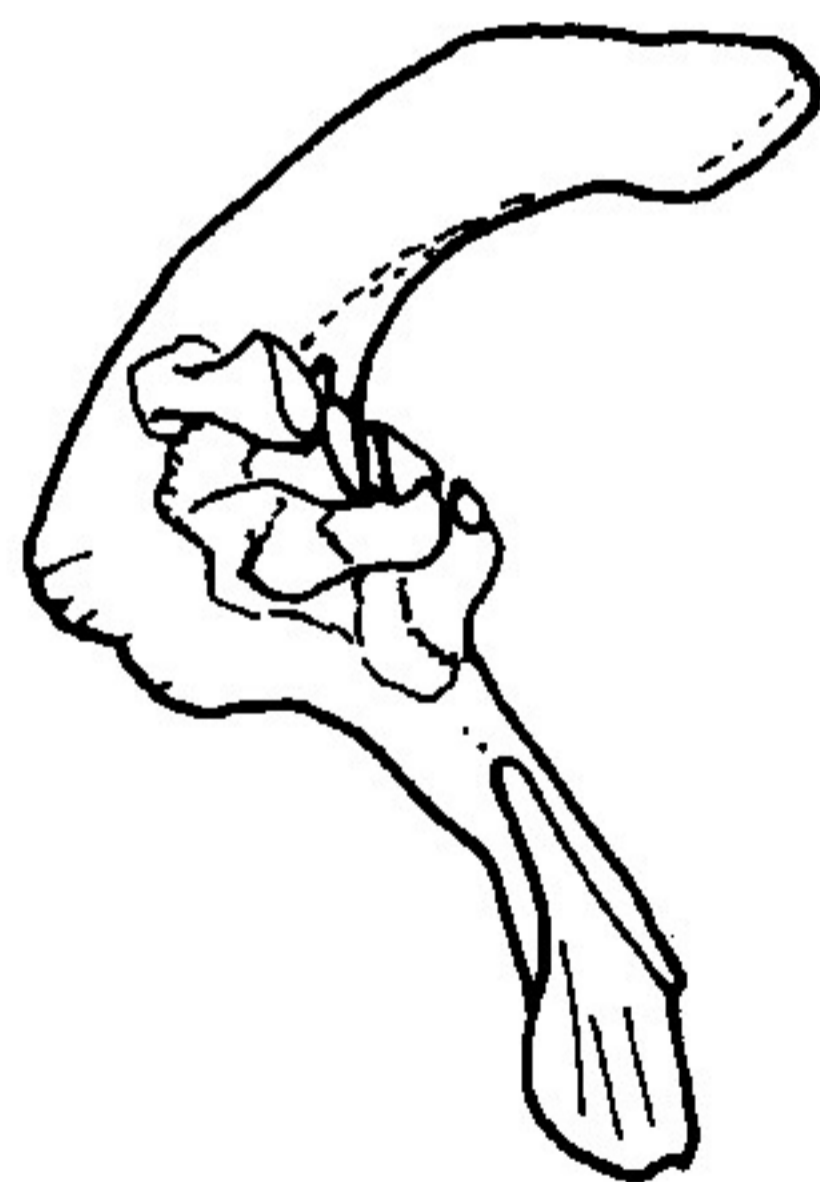
*Vimba vimba carinata*



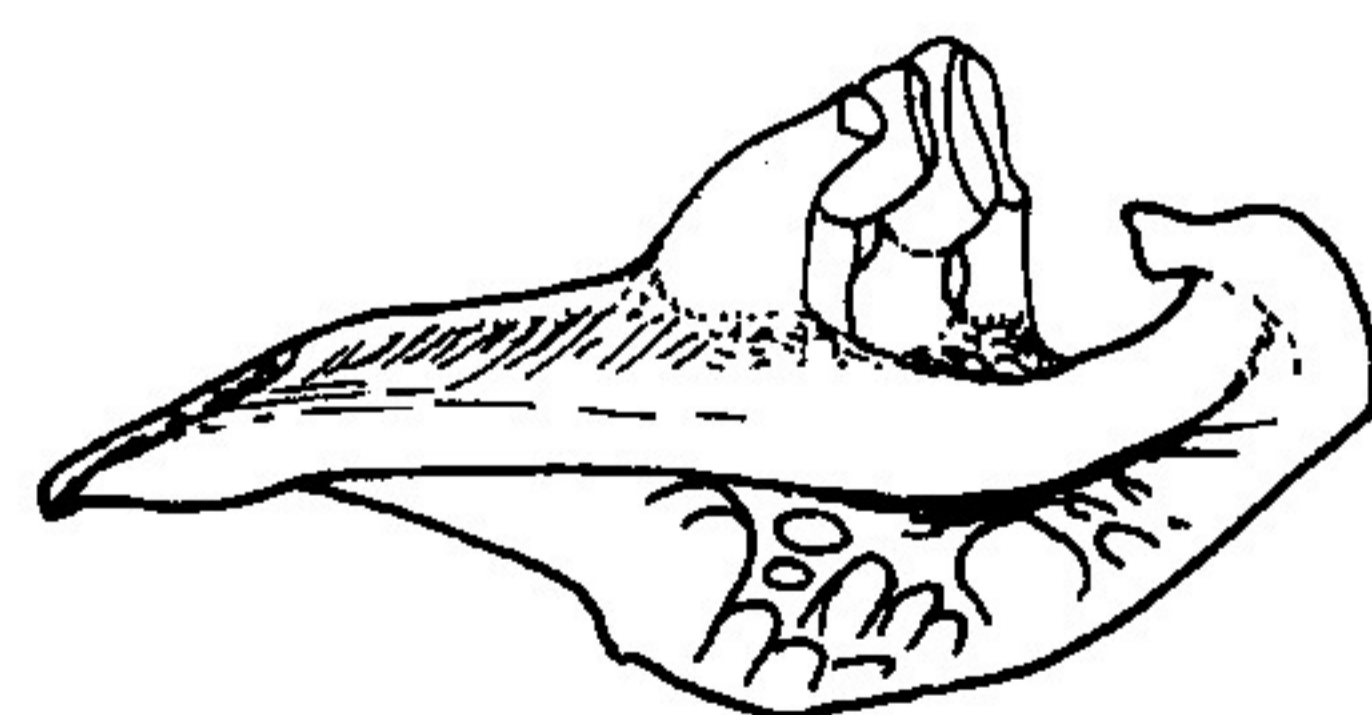
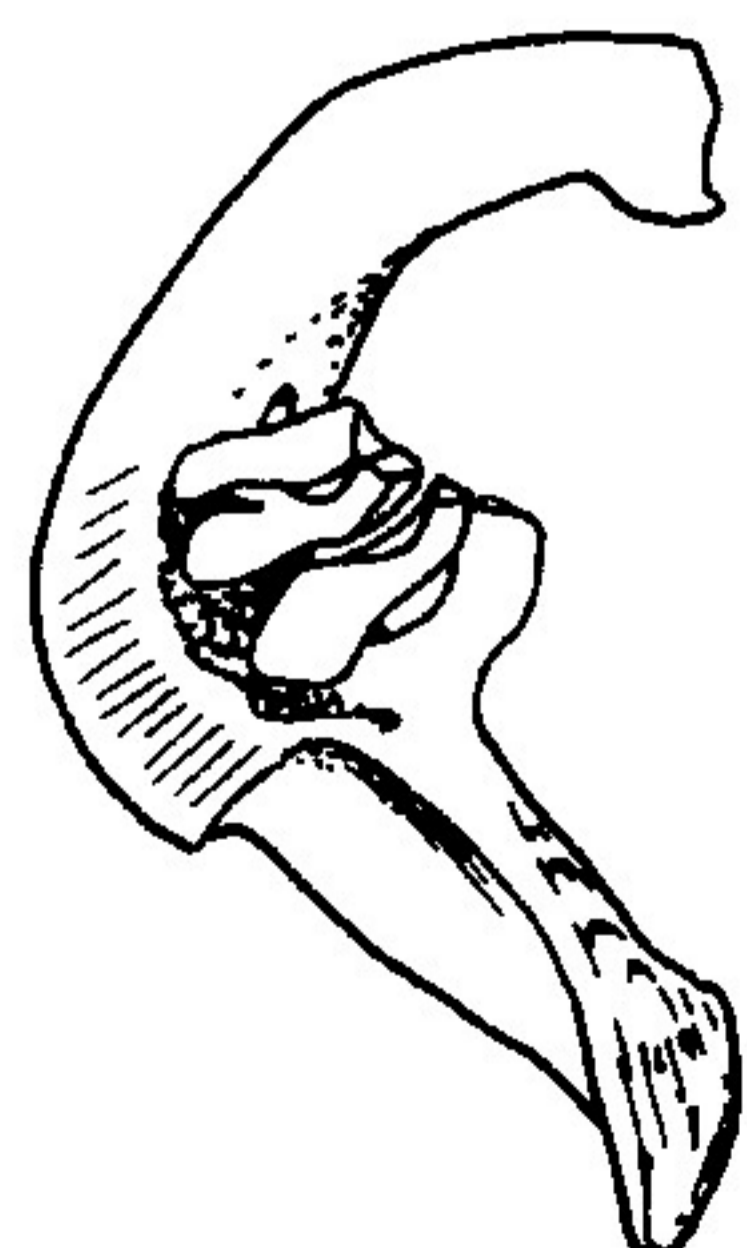
*Rutilus rutilus*



*Chondrostoma nasus*



*Tinca tinca*



*Carassius auratus*

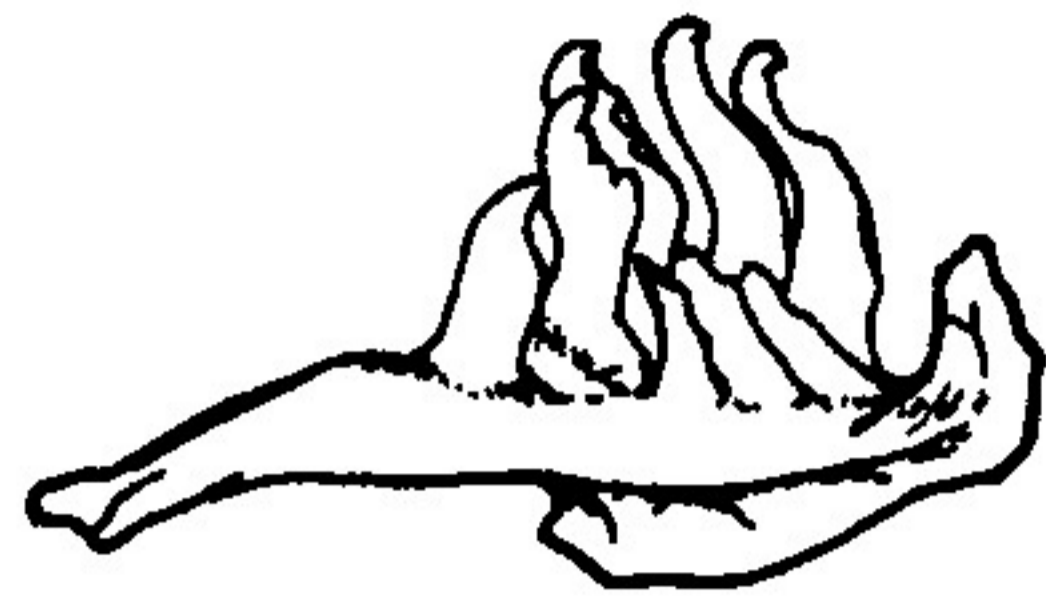
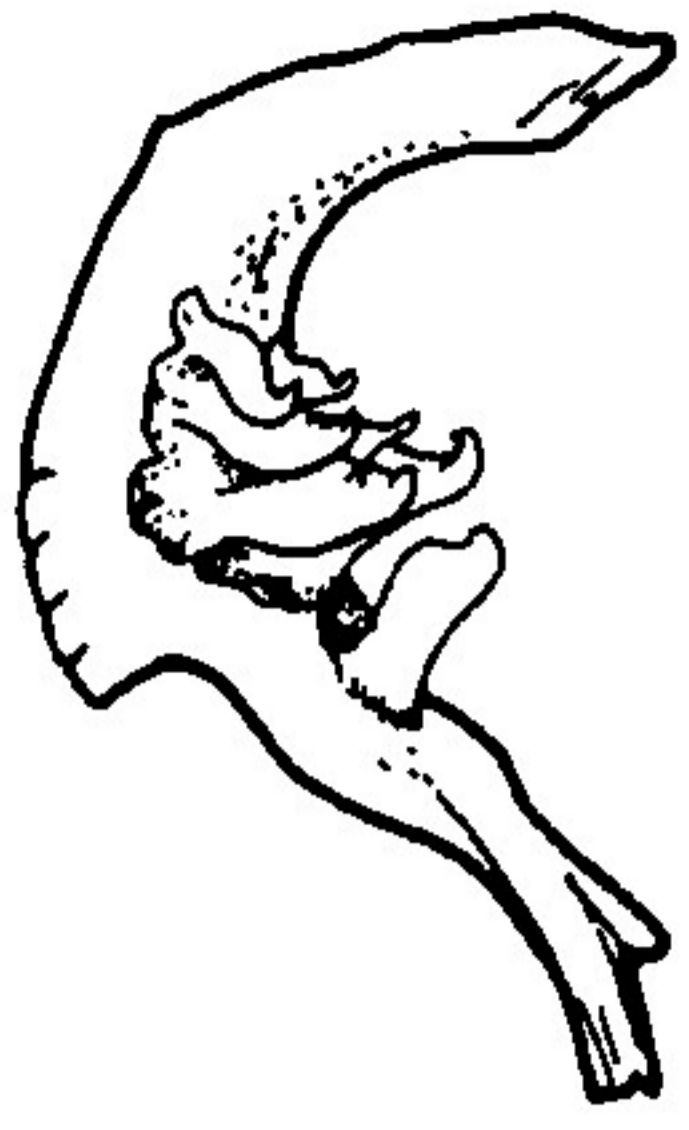
# OSSA PHARYNGEA INFERIORA

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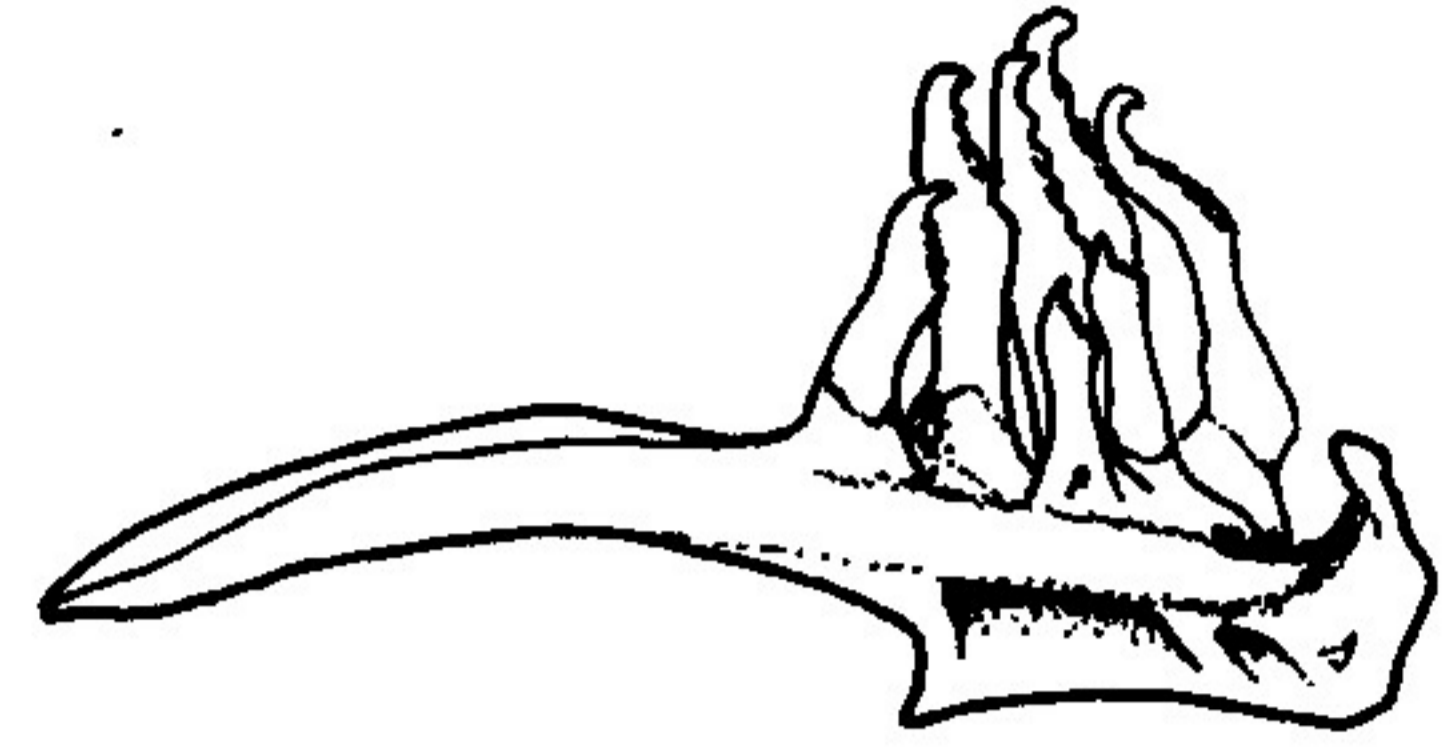
NORMA DORSALIS

NORMA MEDIALIS

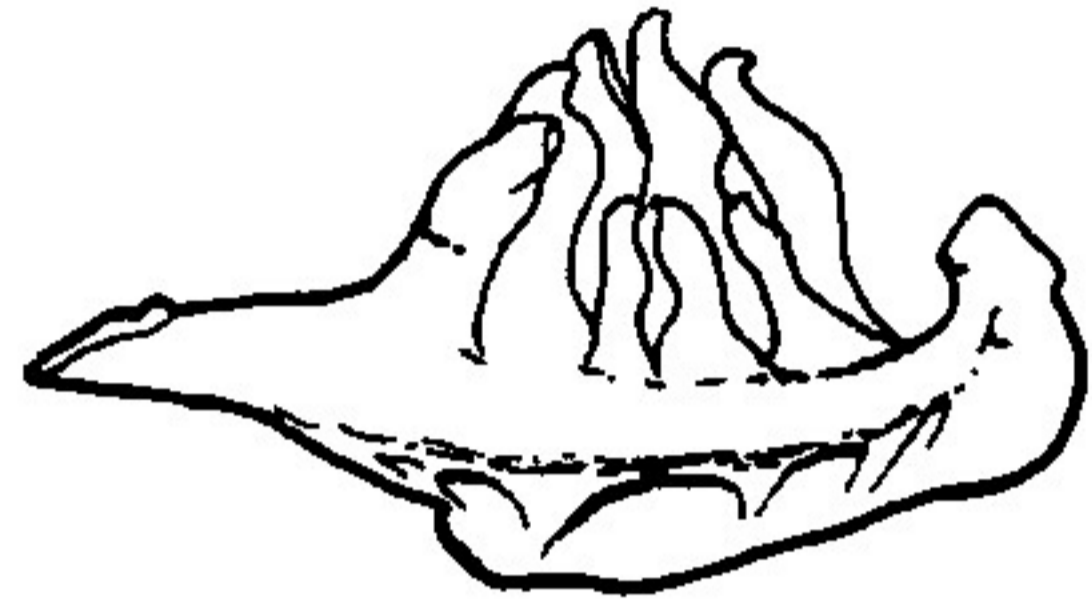
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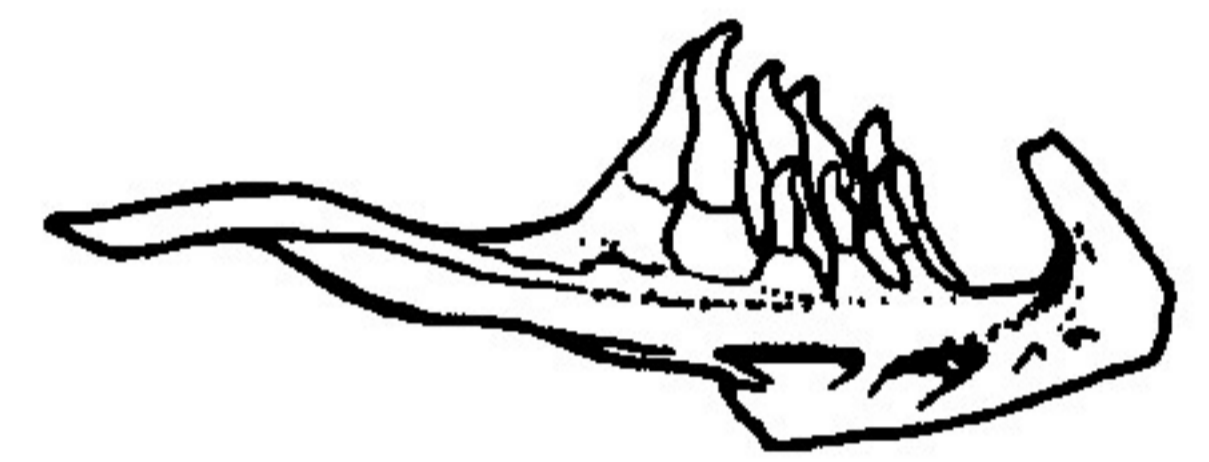
*Alburnus alburnus*



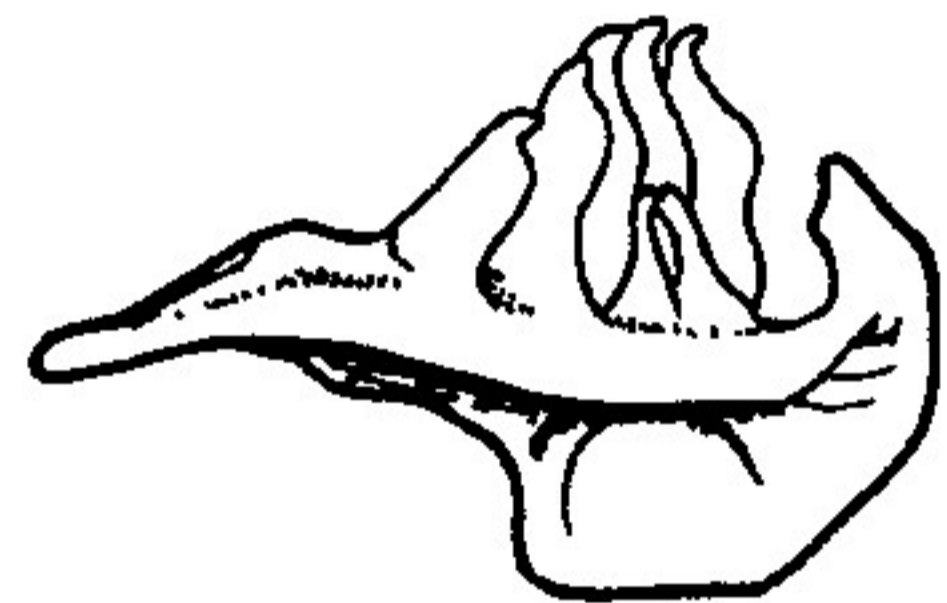
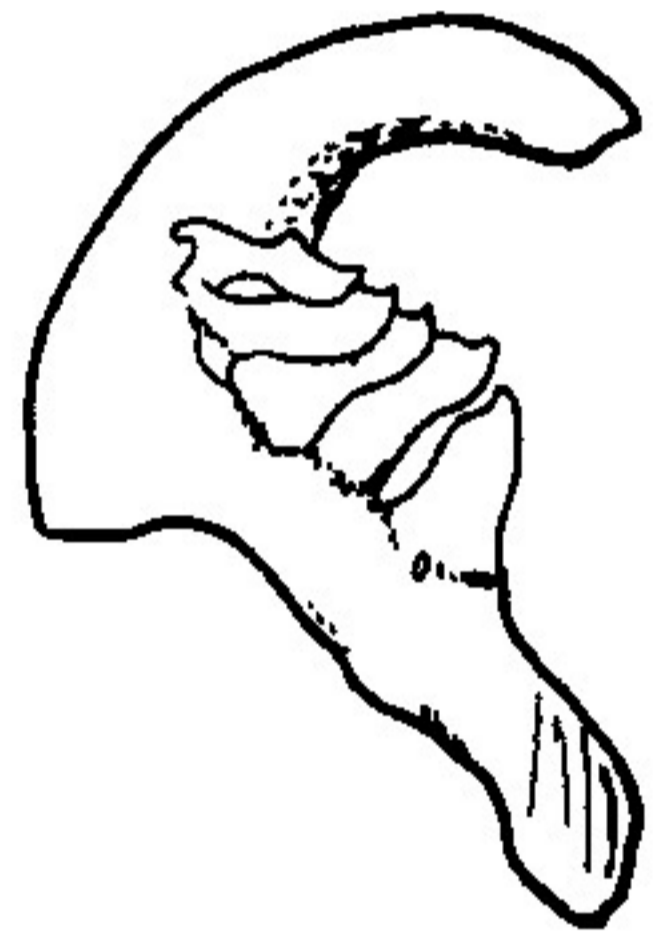
*Pelecus cultratus*



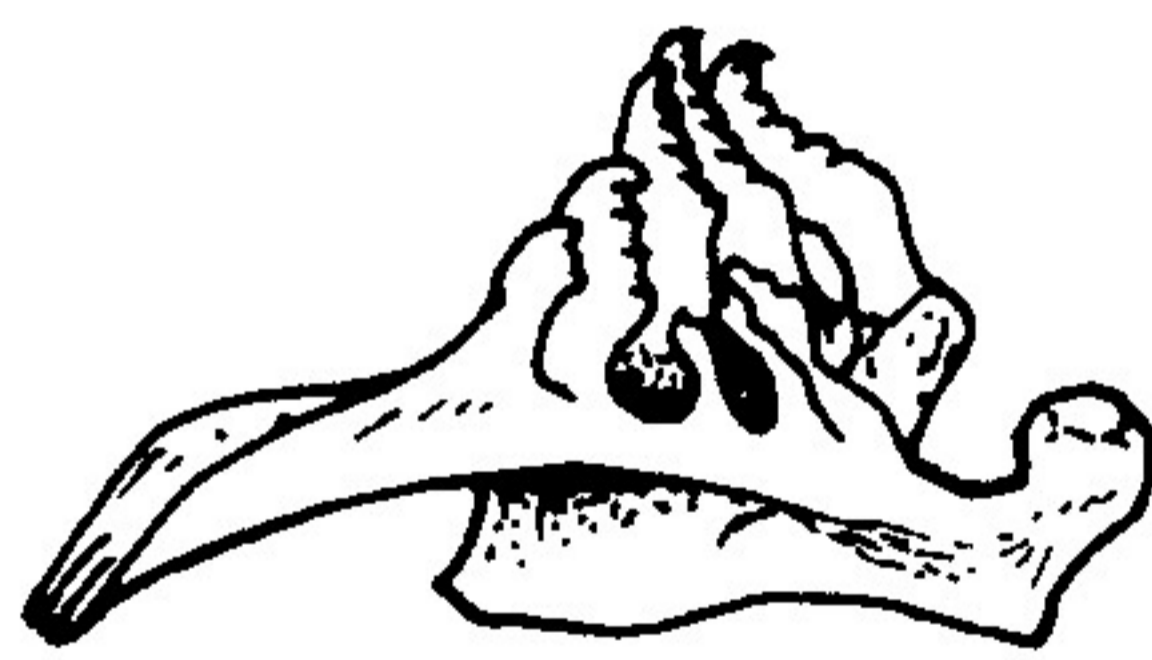
*Leuciscus idus*



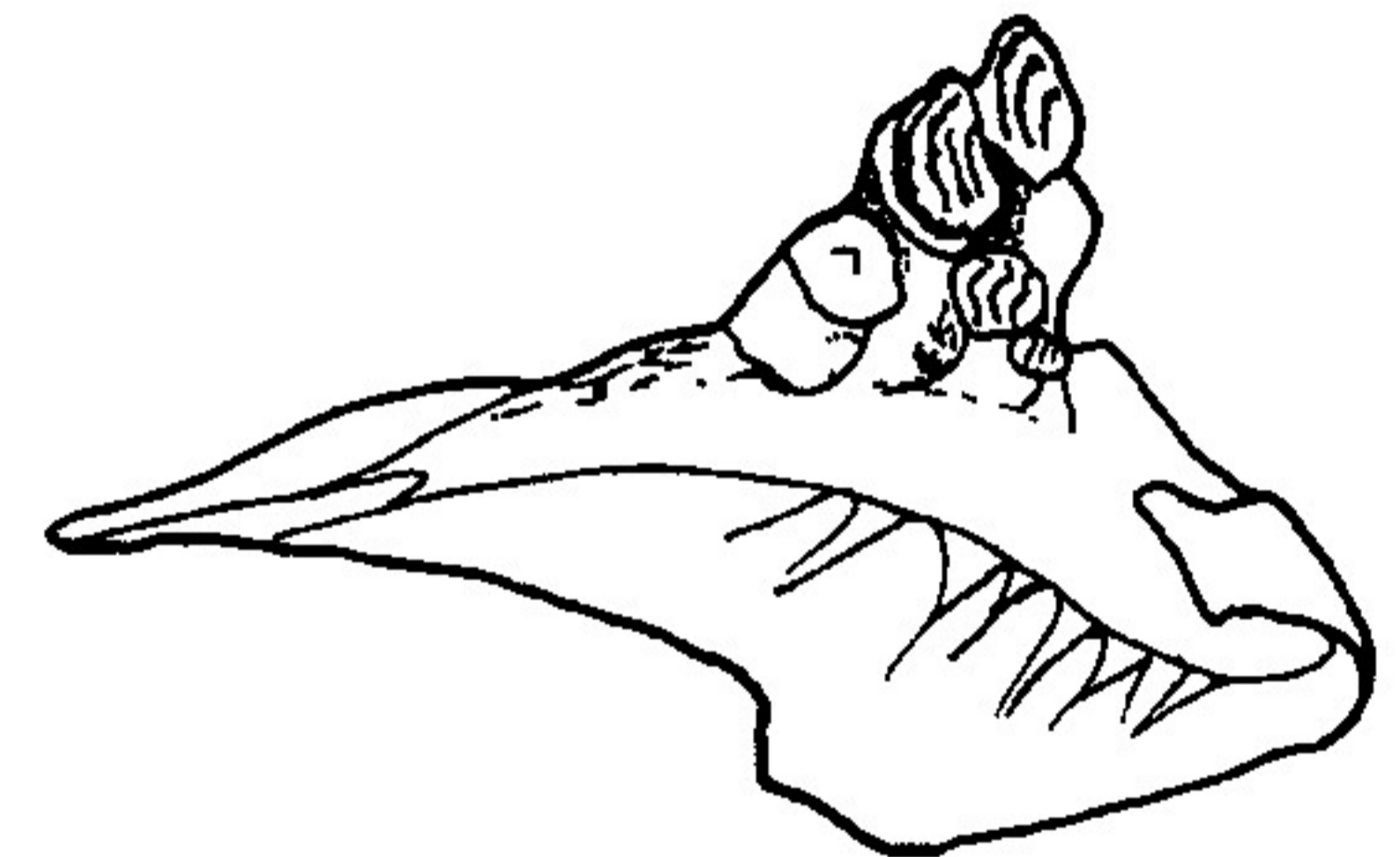
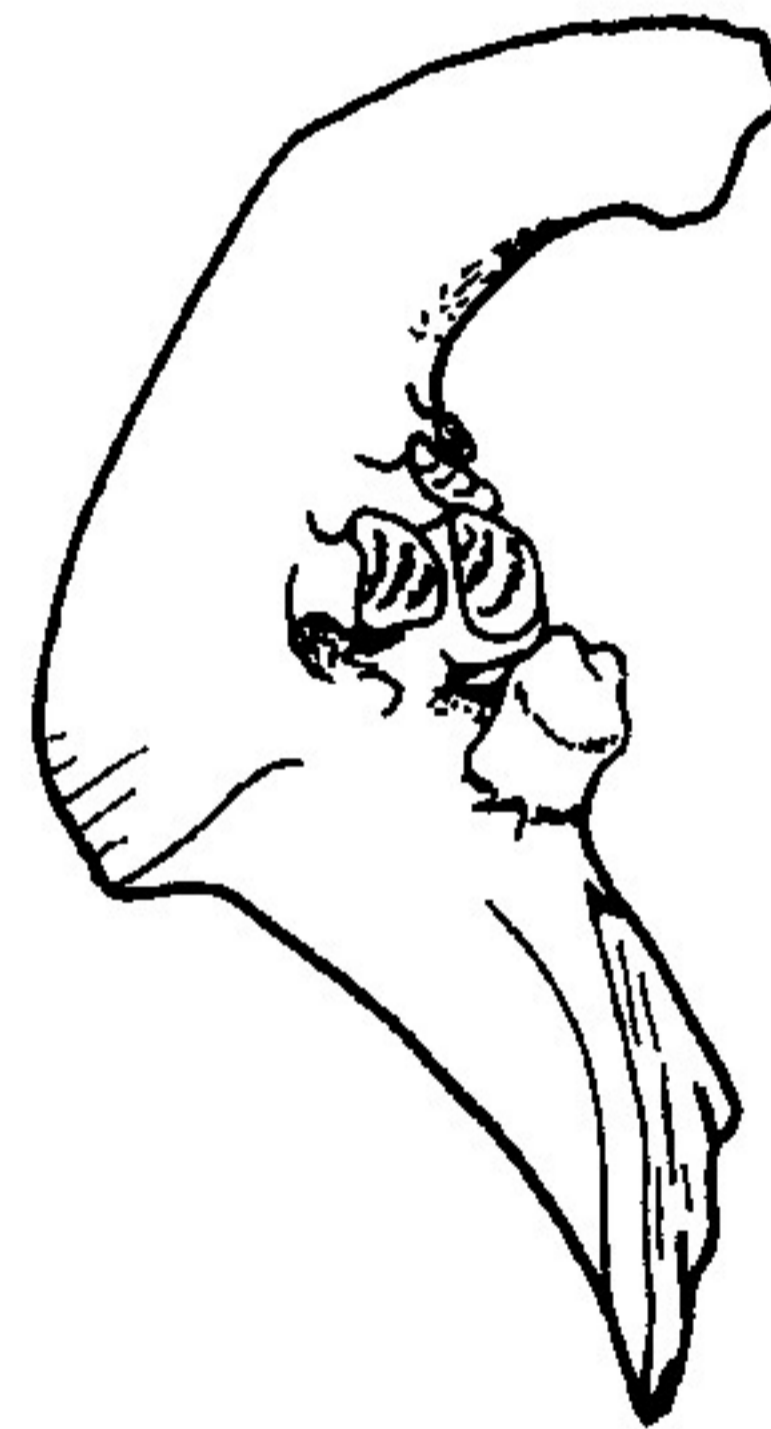
*Aspius aspius*



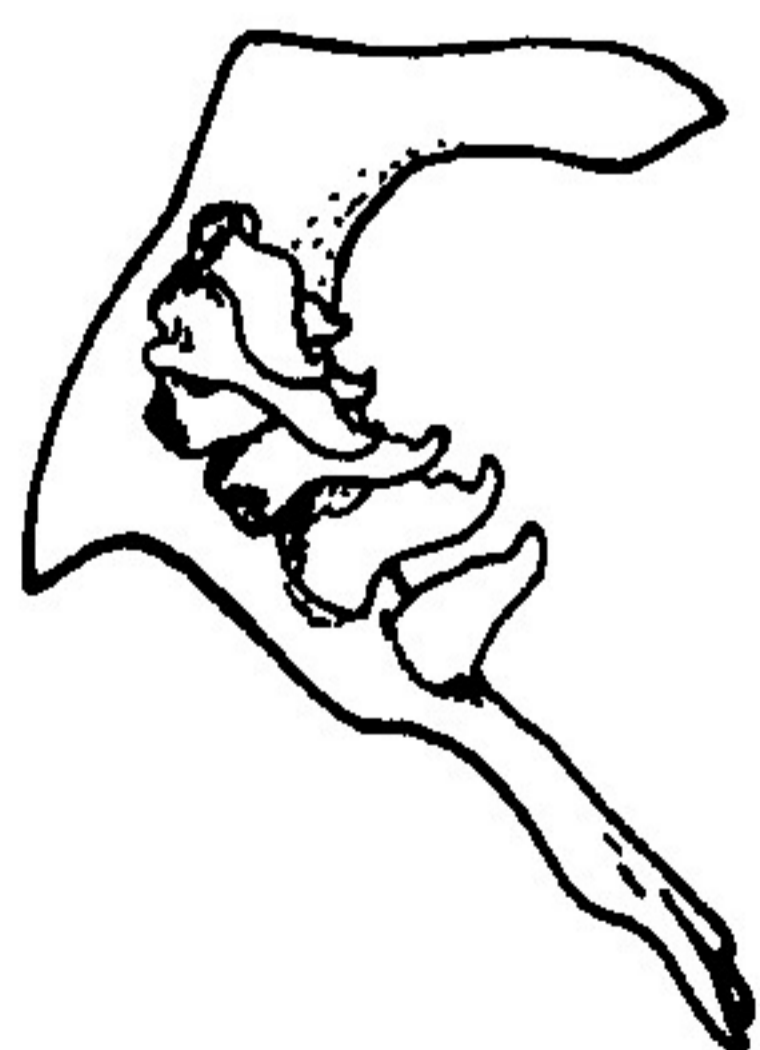
*Blicca bjoerkna*



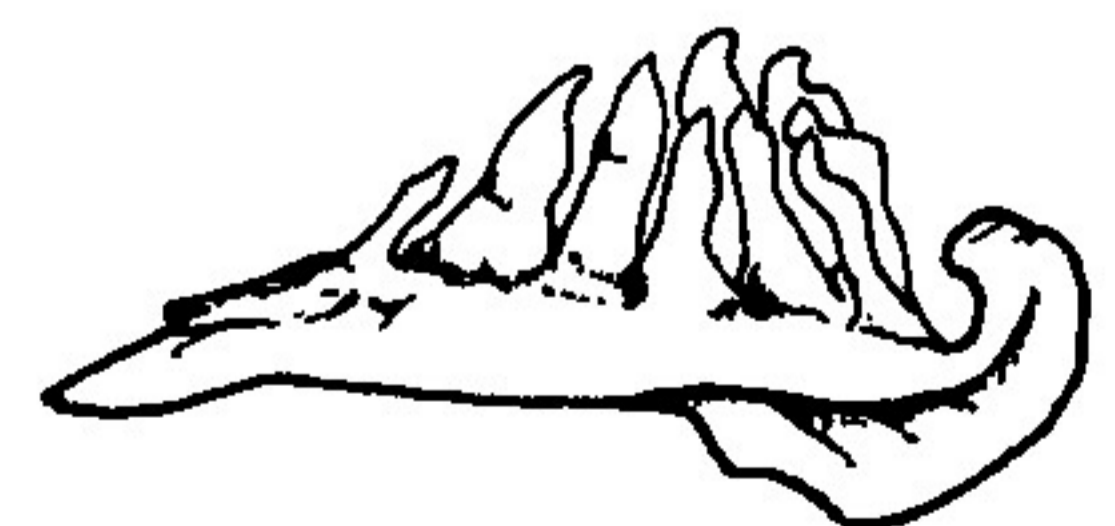
*Scardinius erythrophthalmus*



*Cyprinus carpio*



*Chalcaburnus chalcoides mento*

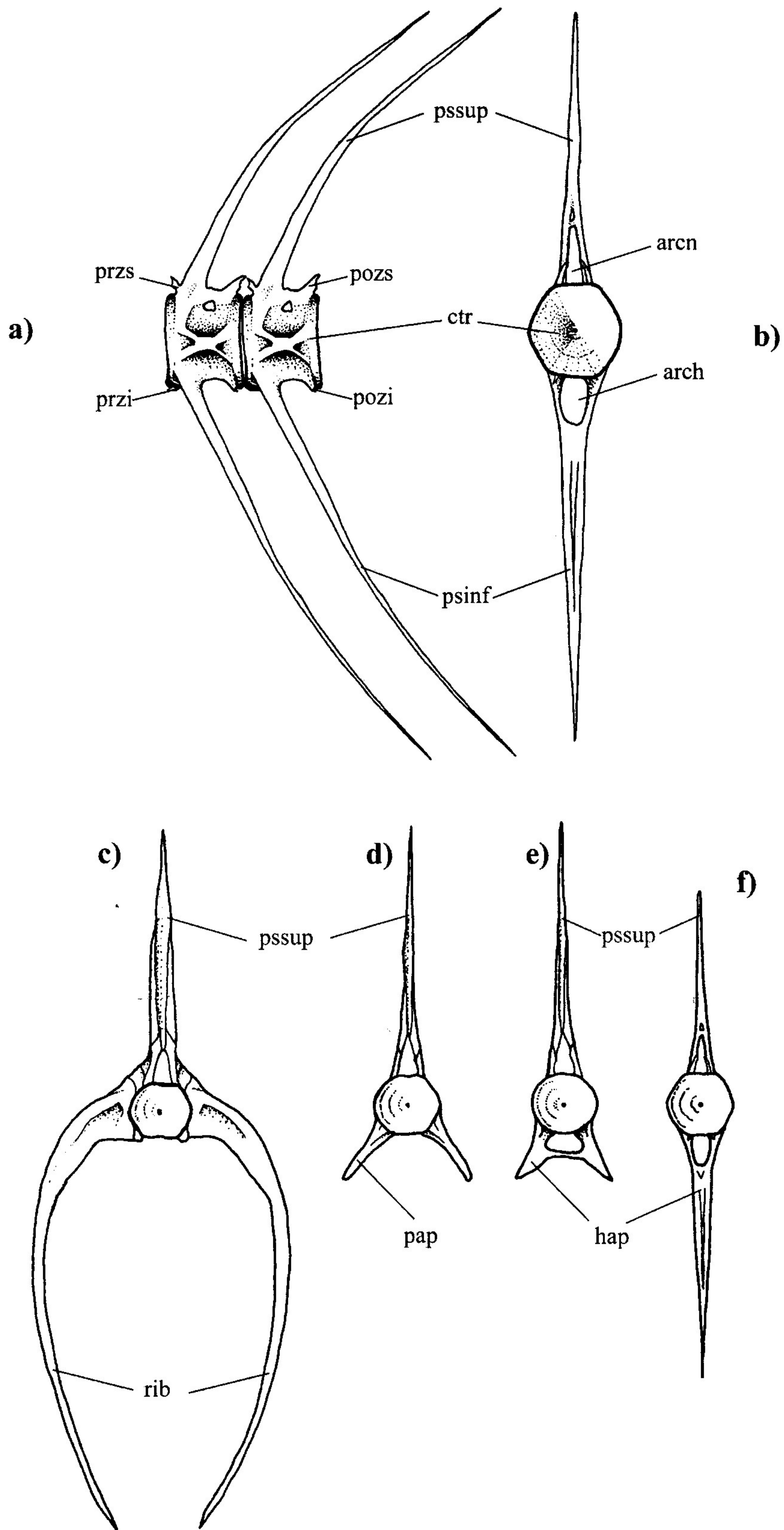


*Barbus barbus*

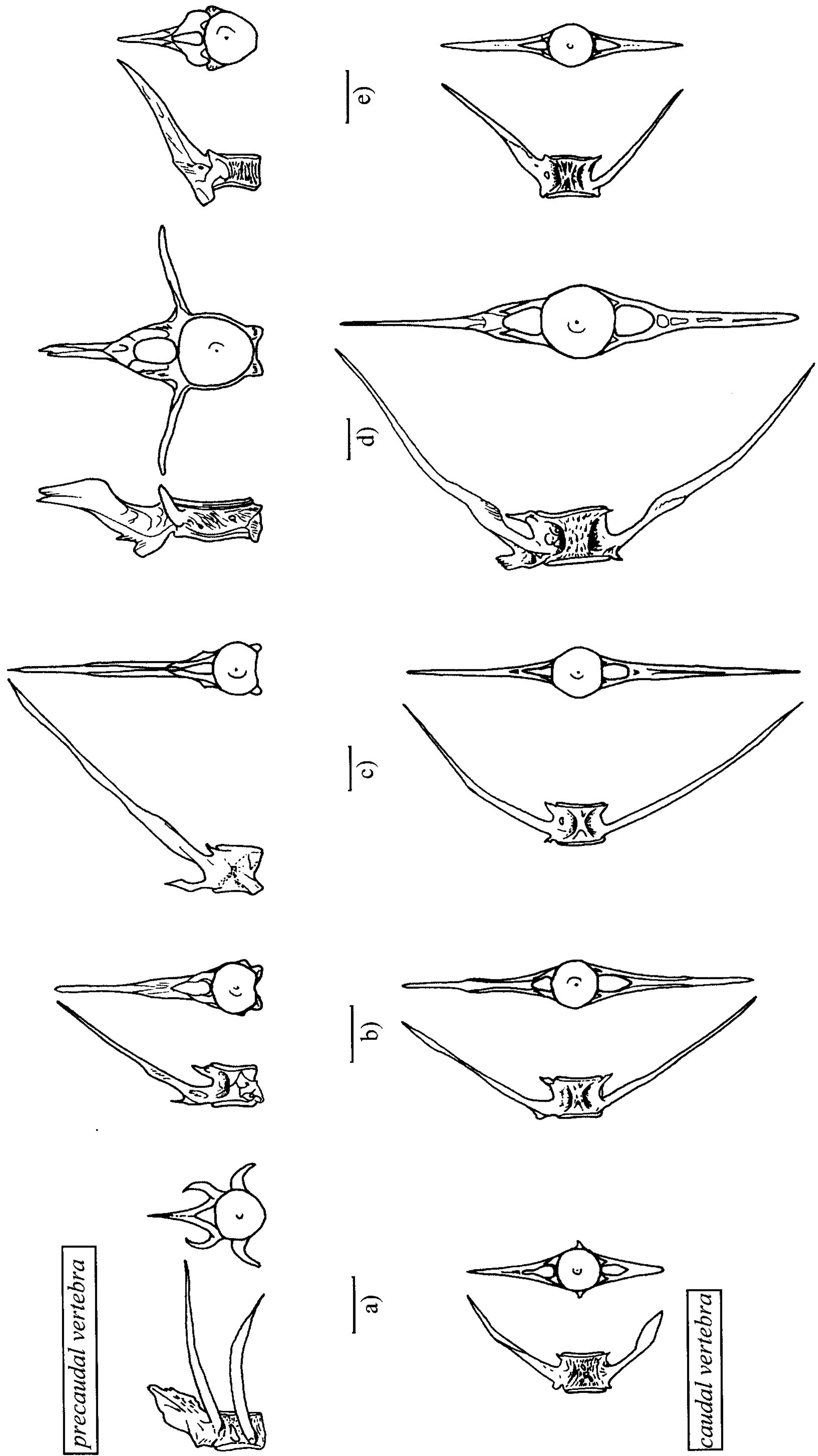
## THE SPINE

**The spine** (*columna vertebralis*) extends from the cranium to which it is attached through the first vertebra at the level of the dorsal face of the basioccipital bone. The spine is divided into a precaudal region and a caudal region. The precaudal region bears on some of the vertebrae ribs (*costae*) which protect the abdominal cavity. Vertebrae (fig. 5) consist of a main body (*corpus*) bearing the upper and lower prezygapophyses (*praezygapophysis superior* and *praezygapophysis inferior*) for articulation to the anterior adjacent vertebra, and the upper and lower postzygapophyses (*postzygapophysis superior* and *postzygapophysis inferior*) for articulation to the posterior adjacent vertebra. The neural apophyses (*neurapophysis*) are fused and form the neural arch (*arcus neuralis*) which ends in the upper spiny process (*processus spinosus superior*). The neural channel (*canalis neuralis*), formed of the totality of neural arches, hosts the marrow. Two parapophyses (*parapophysis*) bear the ribs on precaudal vertebrae, whereas in caudal vertebrae they are called haemapophyses (*haemapophysis*) and are fused to form the hemal arch (*arcus hemalis*) which ends in the lower spiny process (*processus spinosus inferior*). The last vertebra with its hypural and epural apophyses (*hypuralia* and *epuralia*) forms the urophore complex and contributes to the skeleton of the caudal fin.

Element	Abbreviation	Names from Lepiksaar (1983)
<i>Vertebral column</i>		
rib	rib	costae
Vertebral body	ctr	corpus
upper prezygapophyses	przs	praezygapophysis superior
lower prezygapophyses	przi	praezygapophysis inferior
upper postzygapophyses	pozs	postzygapophysis superior
lower postzygapophyses	pozi	postzygapophysis inferior
upper spiny process	pssup	processus spinosus superior
parapophyses	pap	parapophysis
haemapophyses	hap	haemapophysis
lower spinous process	psinf	processus spinosus inferior
neural arch	arcn	arcus neuralis
hemal arch	arch	arcus hemalis



**Fig. 5.** Bream, *Abramis brama*. Spine.  
 a) two caudal vertebrae (lateral view); b) caudal vertebrae (cranial view);  
 c) praecaual vertebrae with ribs (cranial view); d) praecaual vertebrae without ribs  
 (cranial view); e) first caudal vertebrae (cranial view);  
 f) caudal vertebra (cranial view).



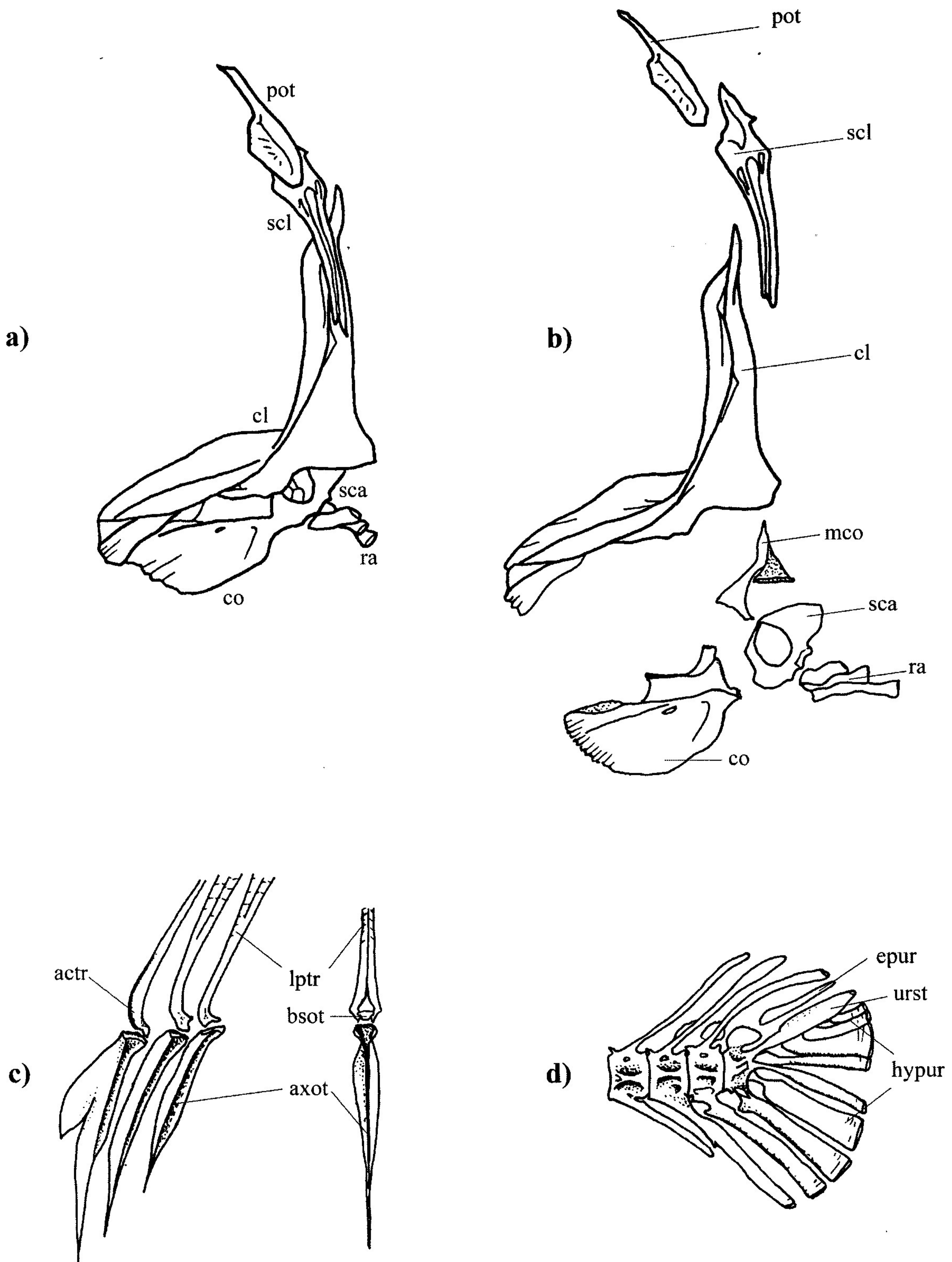
Precaudal and caudal vertebra (lateral and cranial view). a) Pike, *Esox lucius*. b) Bream, *Abramis brama*. c) Carp, *Cyprinus carpio*. d) Wels, *Silurus glanis*. e) Pikeperch, *Stizostedion lucioperca*.

## THE FINS AND APPENDICULAR SKELETON

**The paired fins** are the pectoral fins (*pinna pectoralis*) and the pelvic fin (*pinna abdominalis*). The pectoral fin consists of some acanthotrichs (spines), lepidotrichs (soft fin rays) and some radials articulated to the neurocranium through the pectoral girdle (*zonoskeleton*) (figs. 6.a and 6.b). The pelvic fin, made of lepidotrichs, is articulated to the pelvic girdle which consists of only one bone, the *basipterygium*.

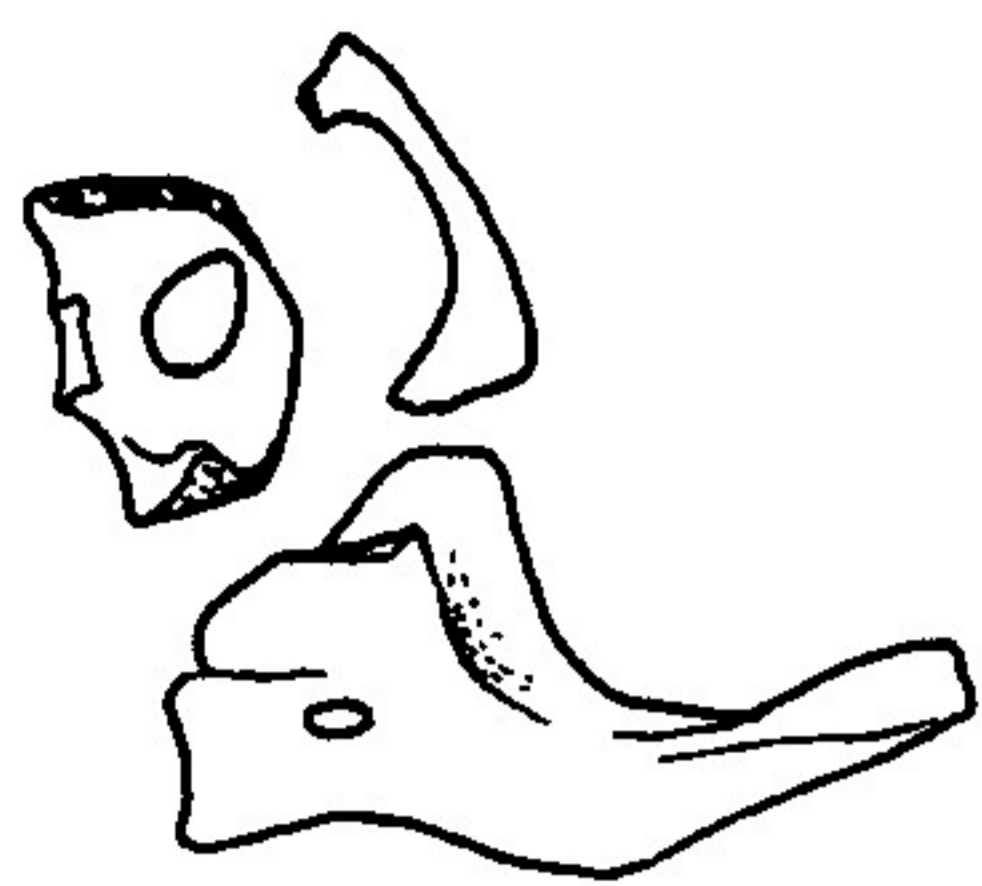
**The single fins** are the dorsal fin (*pinna dorsalis*), the anal fin (*pinna analis*) and the caudal fin (*pinna caudalis*). The dorsal and anal fins consist of fin spines and lepidotrichs (fig. 6.c) attached to the neural/haemal spine through pterygophores (baseost and axonost, the latter located between vertebral apophyses). The caudal fin (fig. 6.d) consists only of lepidotrichs articulated to the hypural and epural bones of the urophore complex.

Element	Abbreviation	Names from Lepiksaar (1983)
<i>Pectoral skeleton</i>		
<b>scapula</b>	<b>sca</b>	<b>scapula</b>
<b>coracoid</b>	<b>co</b>	<b>coracoideum</b>
<b>mesocoracoid</b>	<b>mco</b>	<b>mesocoracoideum</b>
<b>cleithrum</b>	<b>cl</b>	<b>cleithrum</b>
postcleithrum	pcl	postcleithrale
<b>supracleithrum</b>	<b>scl</b>	<b>supracleithrale</b>
<b>posttemporal</b>	<b>pot</b>	<b>posttemporale</b>
<i>Pelvic skeleton</i>		
basipterygium	bspt	basipterygium
<i>Fin skeleton</i>		
lepidotrich	lptr	lepidotrich
acanthotrich	actr	acanthotrich
pterygiophore	-	pterygiophorus
axonost	axot	basalia
baseost	bsot	radialia
radials	ra	radiale
epurals	epur	epuralia
hypurals	hypur	hypuralia
urostyle	urst	urostylus



**Fig. 6.** Bream, *Abramis brama*.  
a) Pectoral skeleton. b) Pectoral skeleton (exploded view). c) Pterygiophore (fragments of the dorsal fin). d) Caudal fin (lepidotrichium not shown).

MESOCORACOIDEUM  
 SCAPULA  
 CORACOIDEUM  
 NORMA MEDIALIS



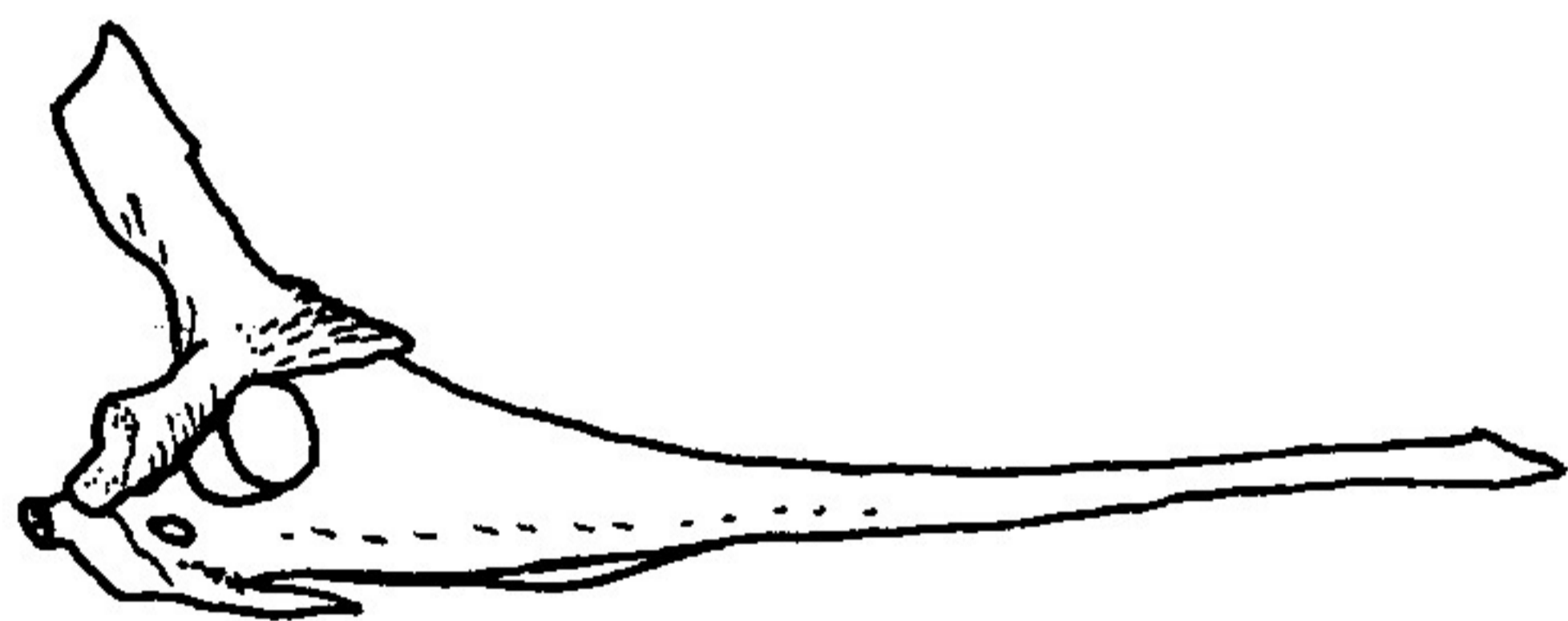
*Salmo trutta lacustris*



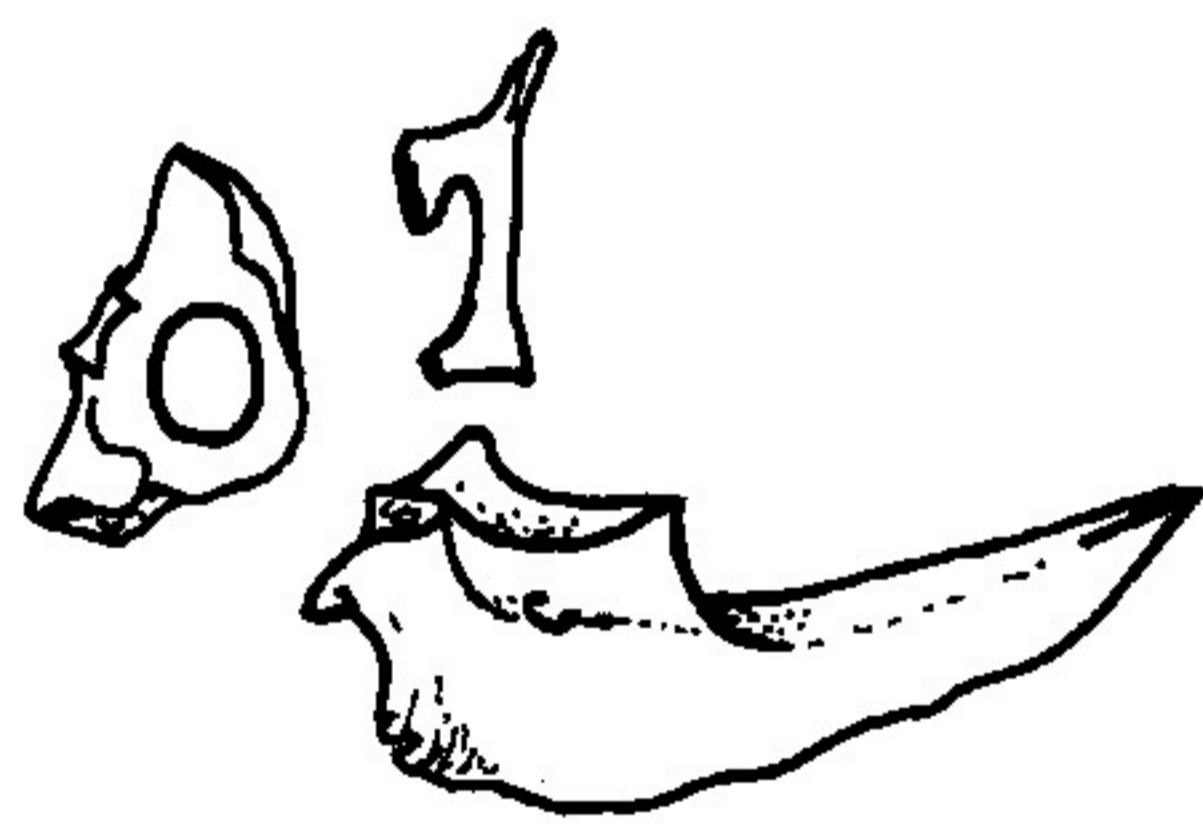
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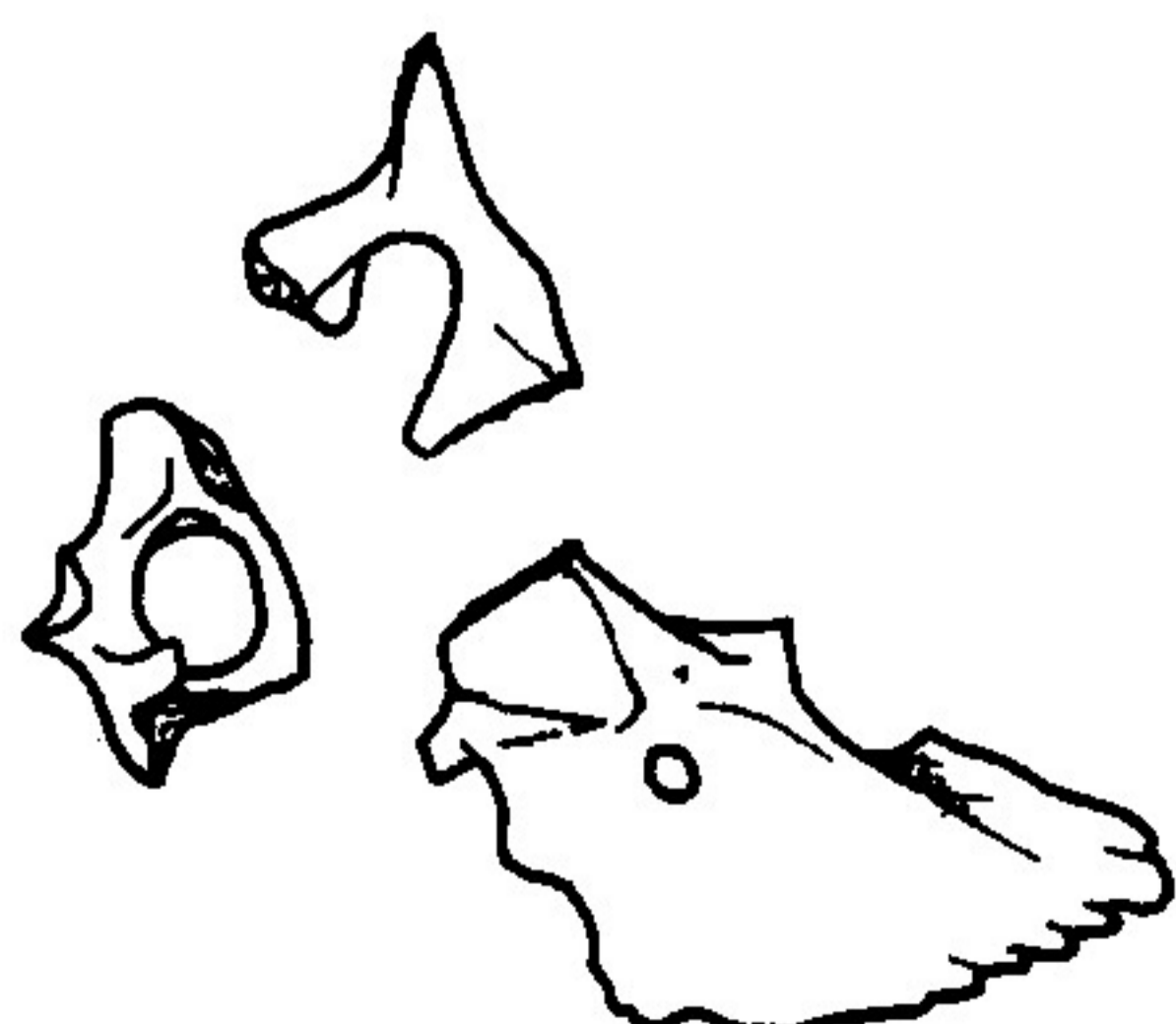
*Esox lucius*



*Silurus glanis*



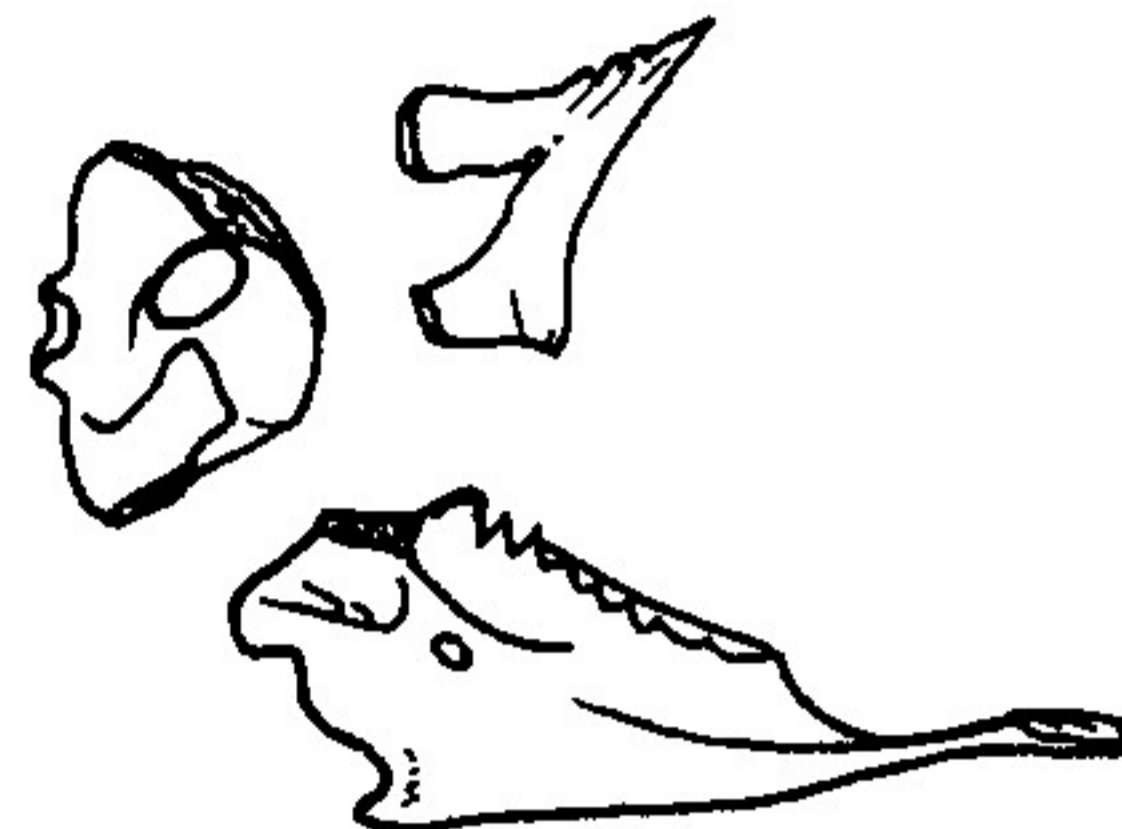
*Alburnus alburnus*



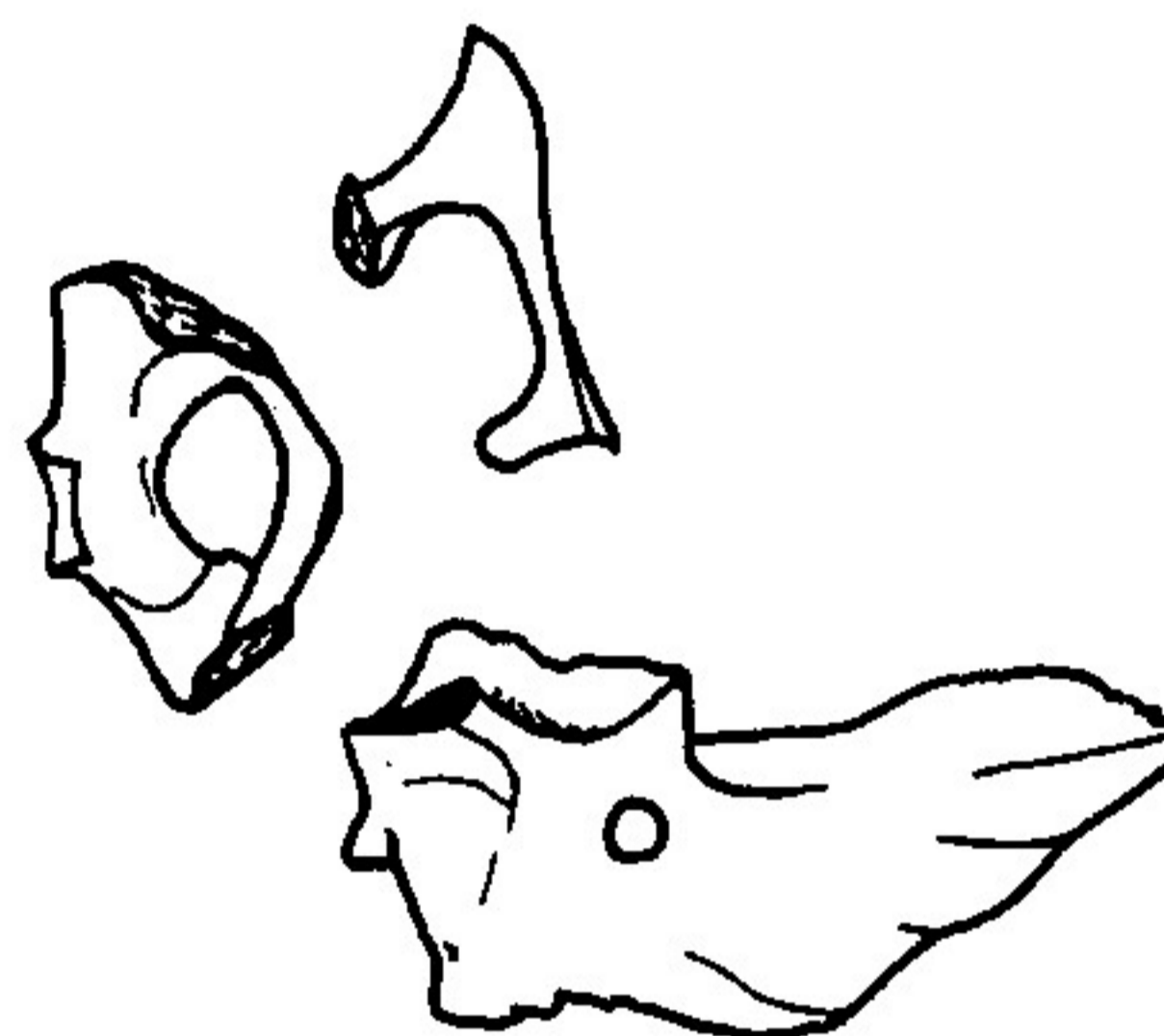
*Abramis brama*



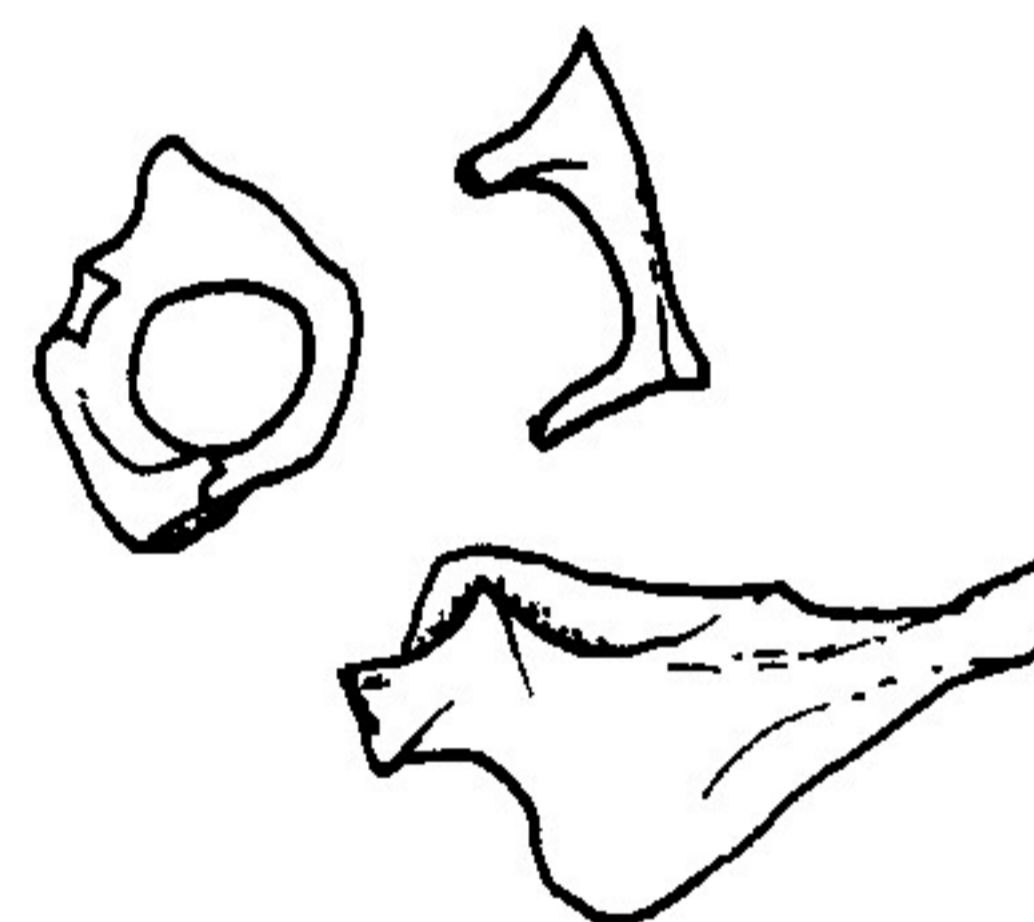
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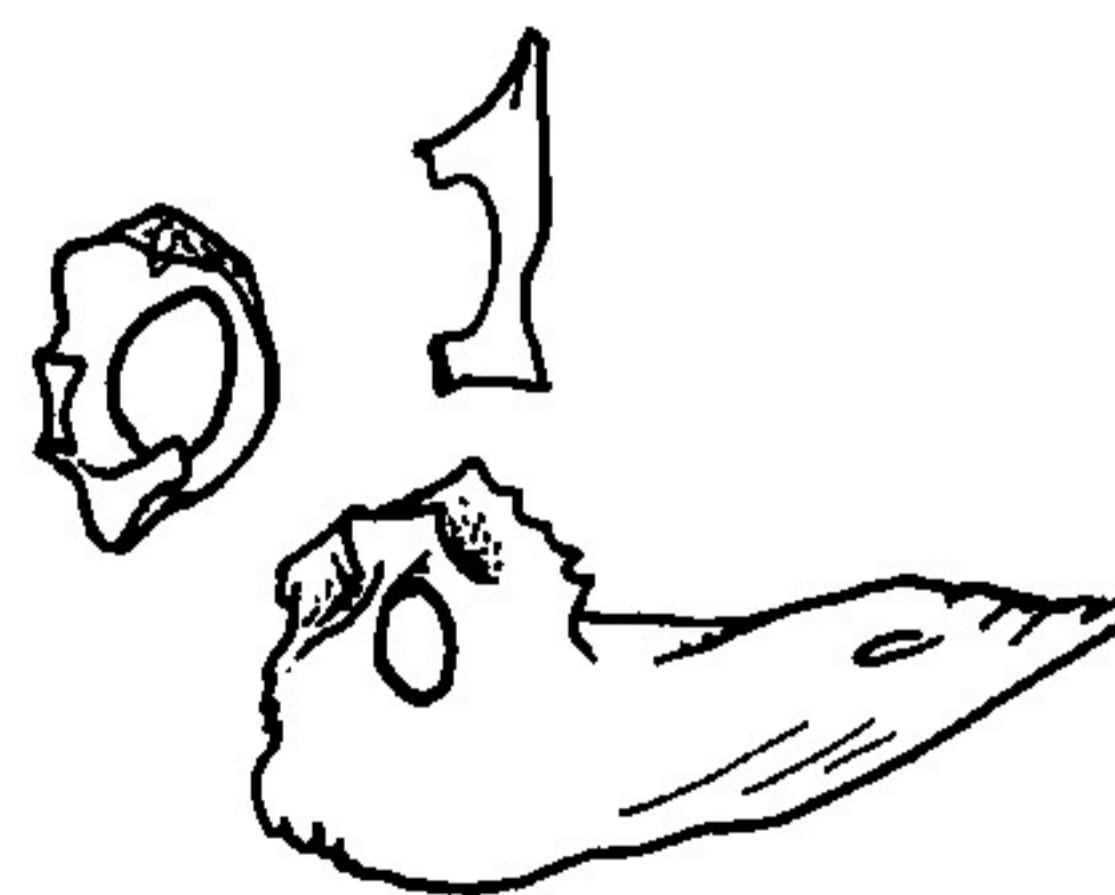
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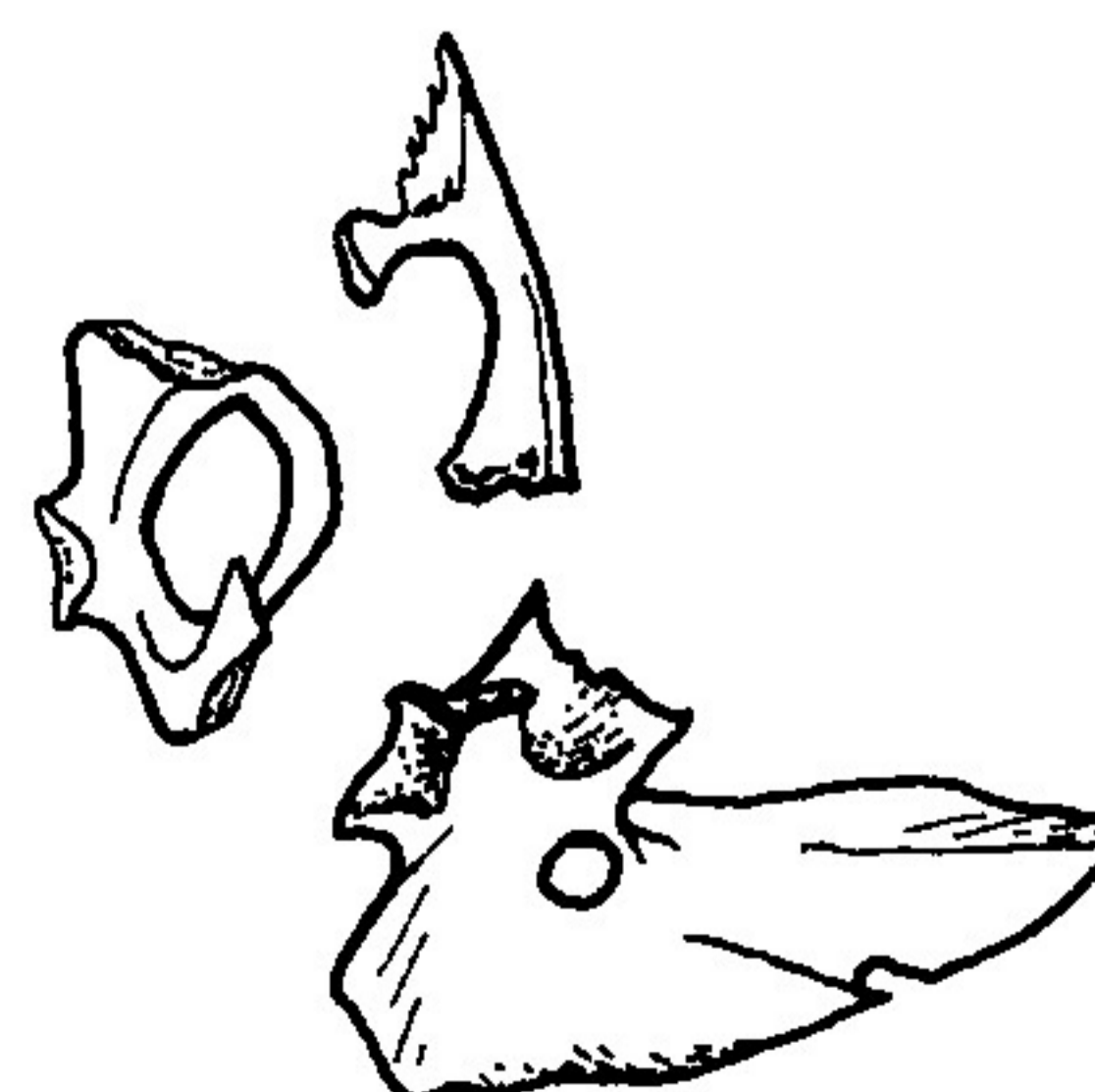
*Blicca bjoerkna*



*Carassius auratus*



*Chalcaburnus chalcoides mento*



*Chondrostoma nasus*

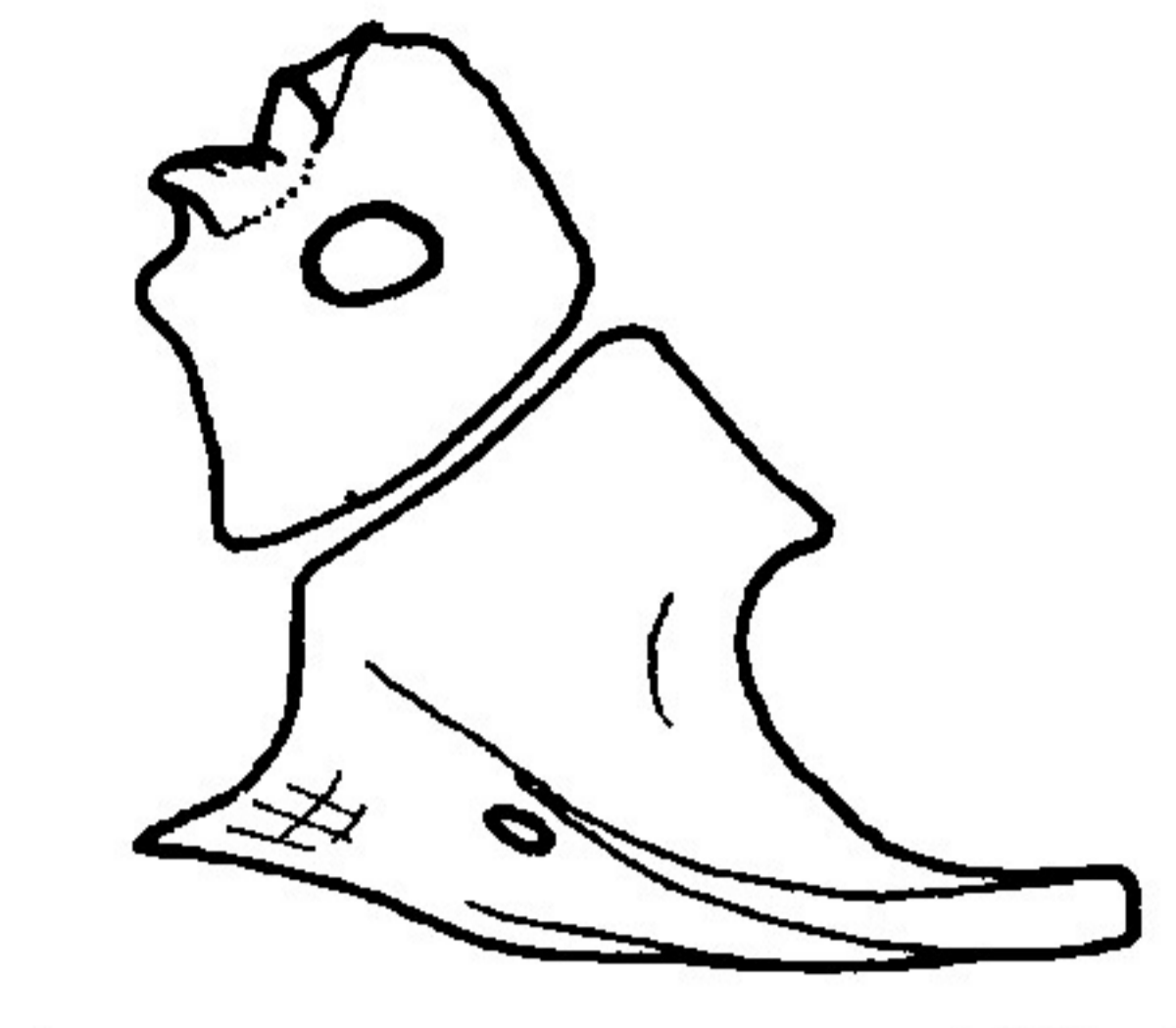
**MESOCORACOIDEUM**  
**SCAPULA**  
**CORACOIDEUM**  
*NORMA MEDIALIS*



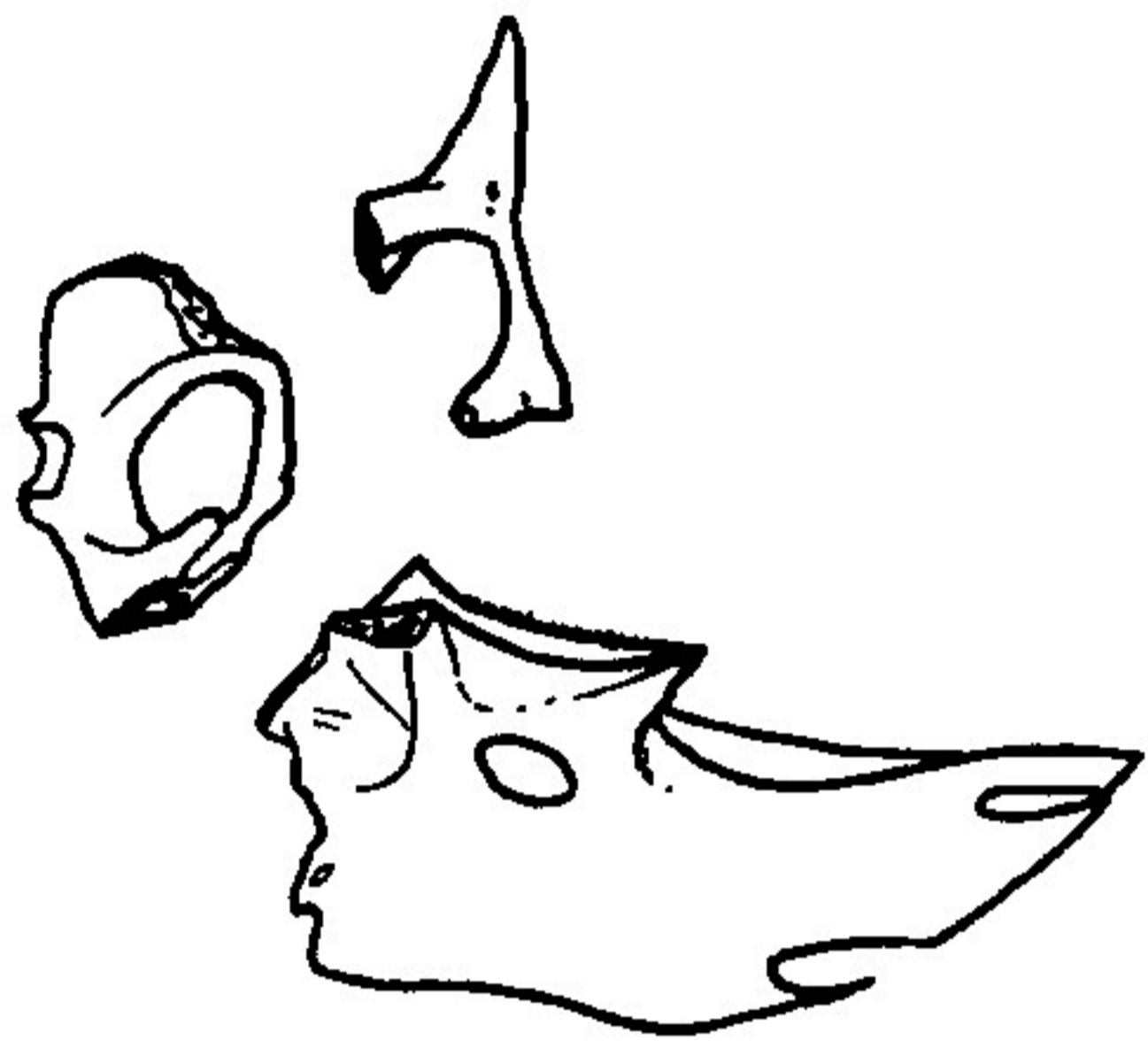
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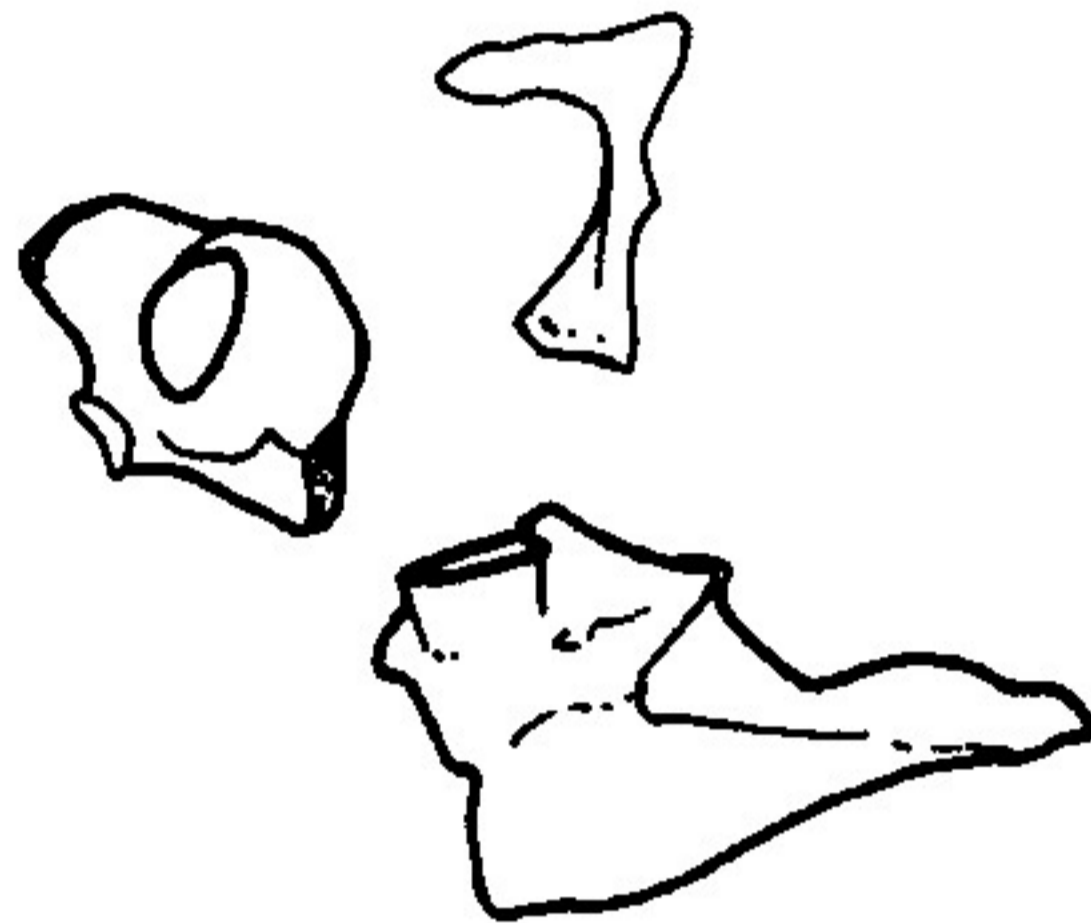
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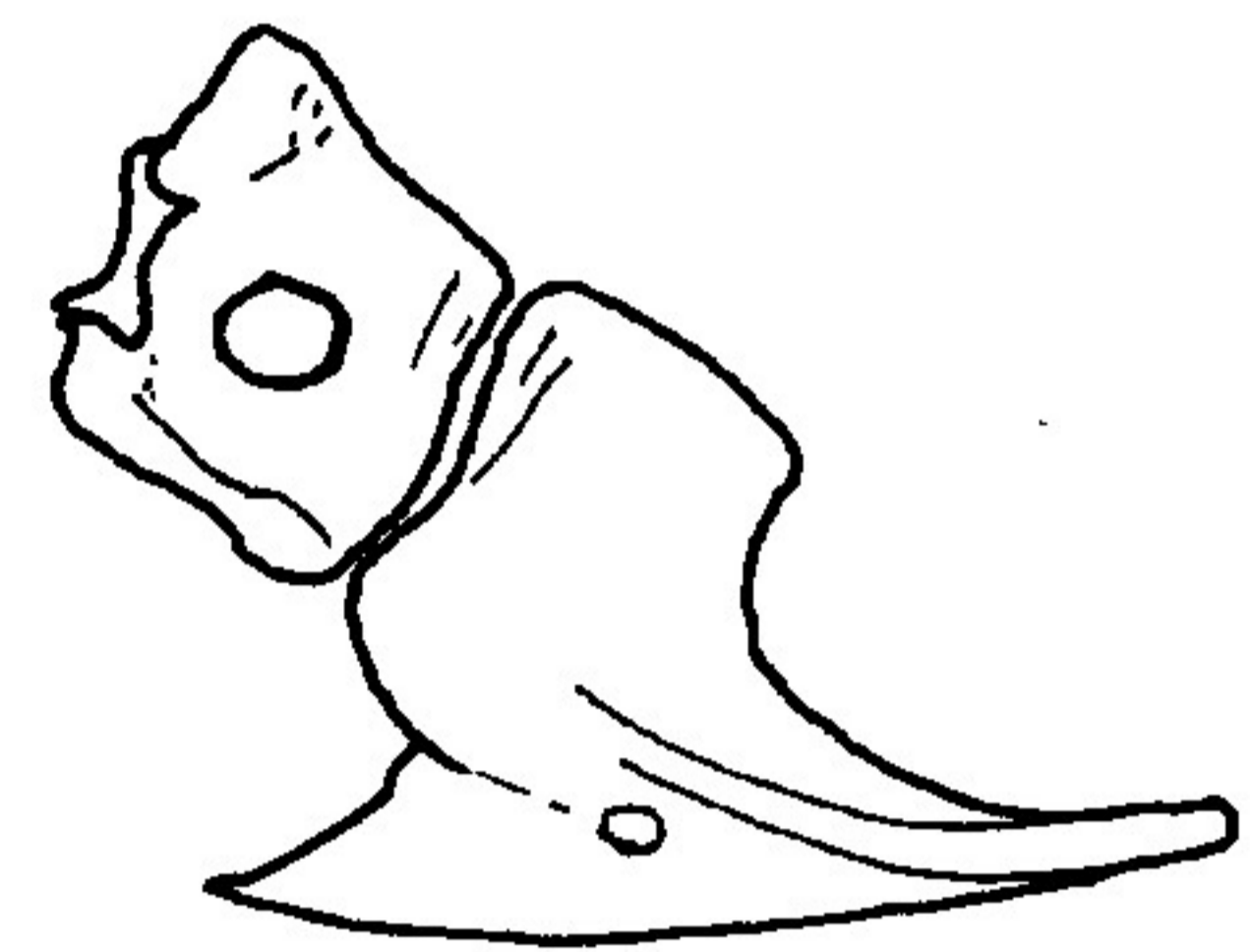
*Acerina schraetser*



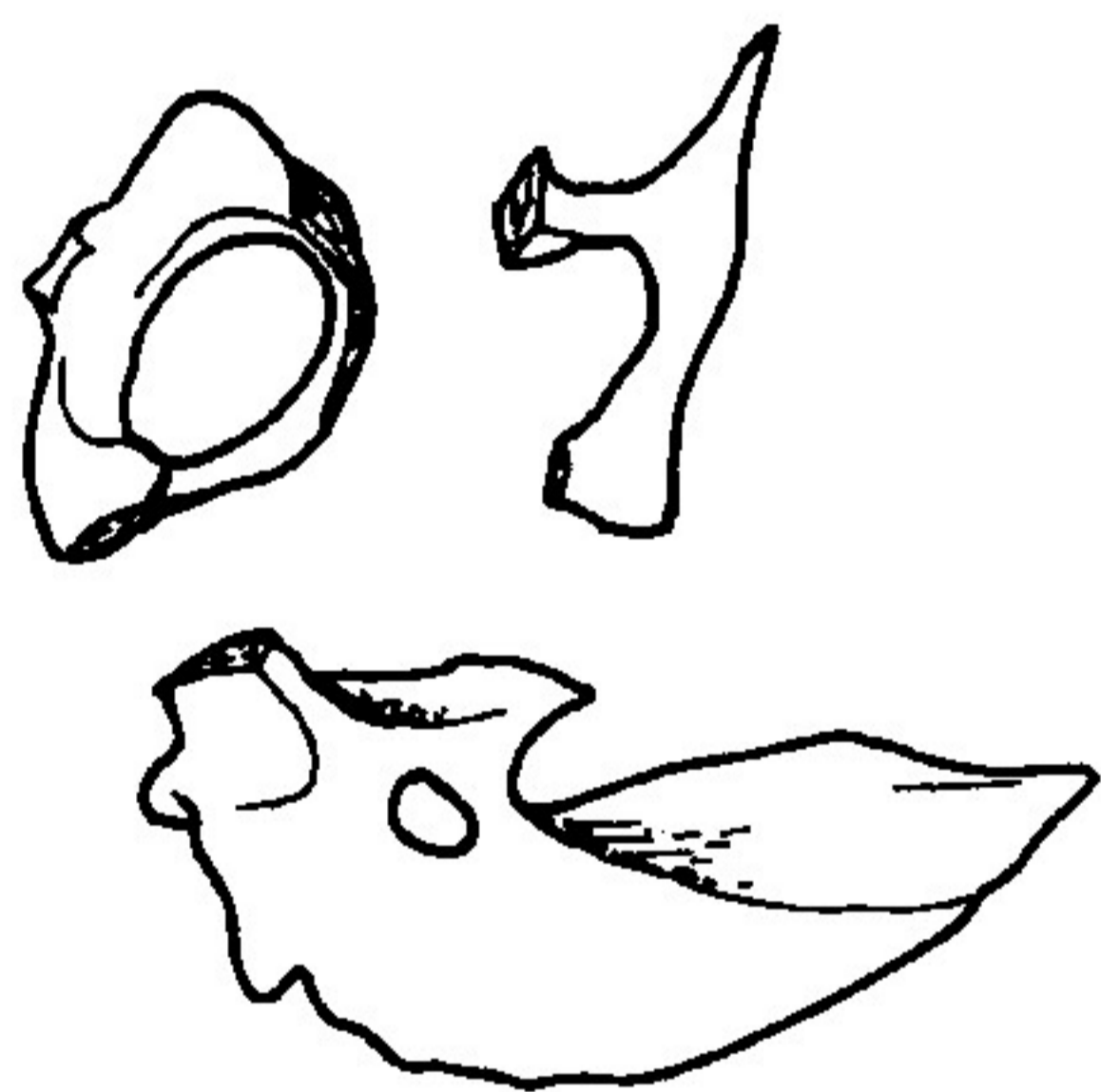
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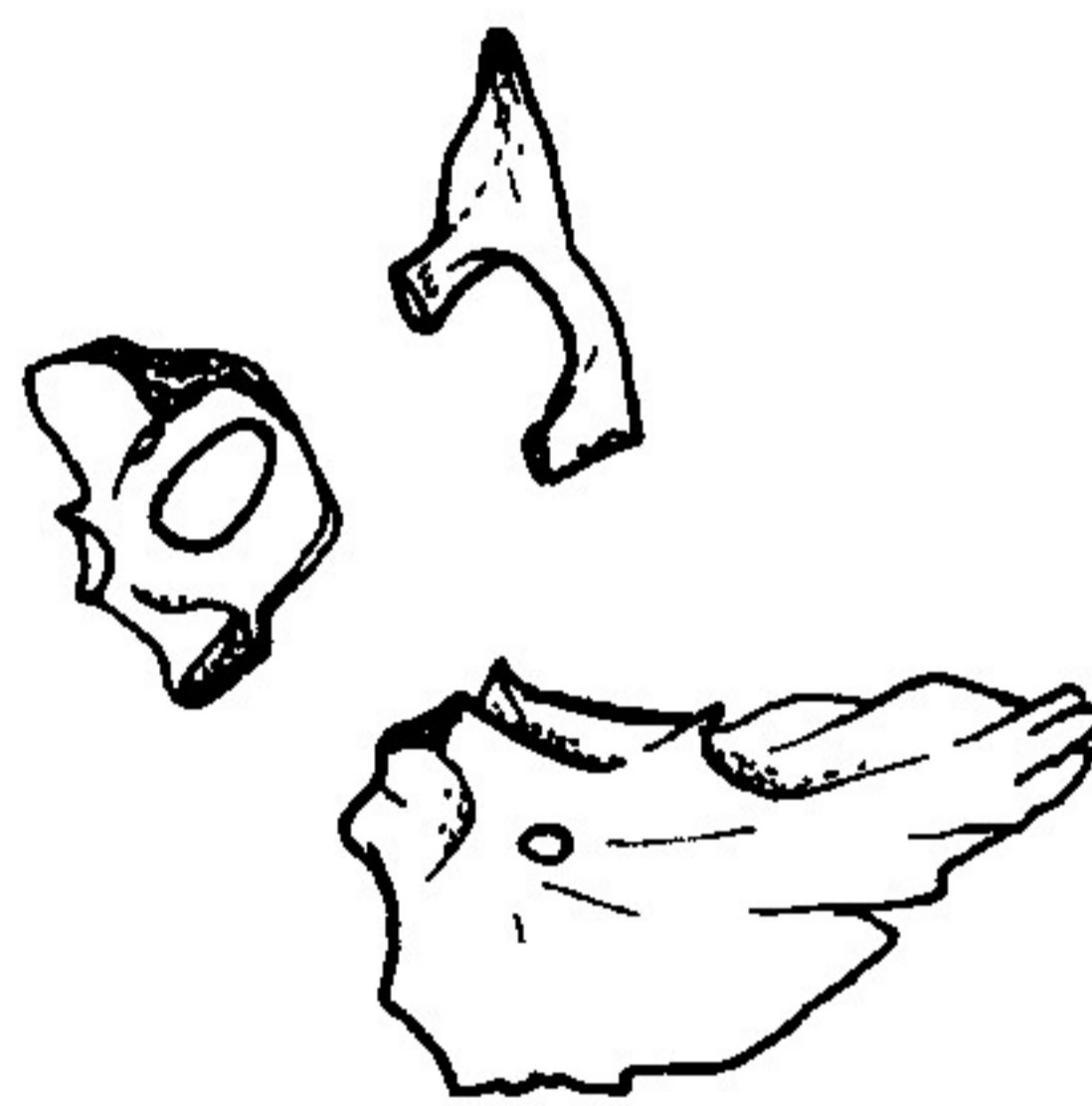
*Tinca tinca*



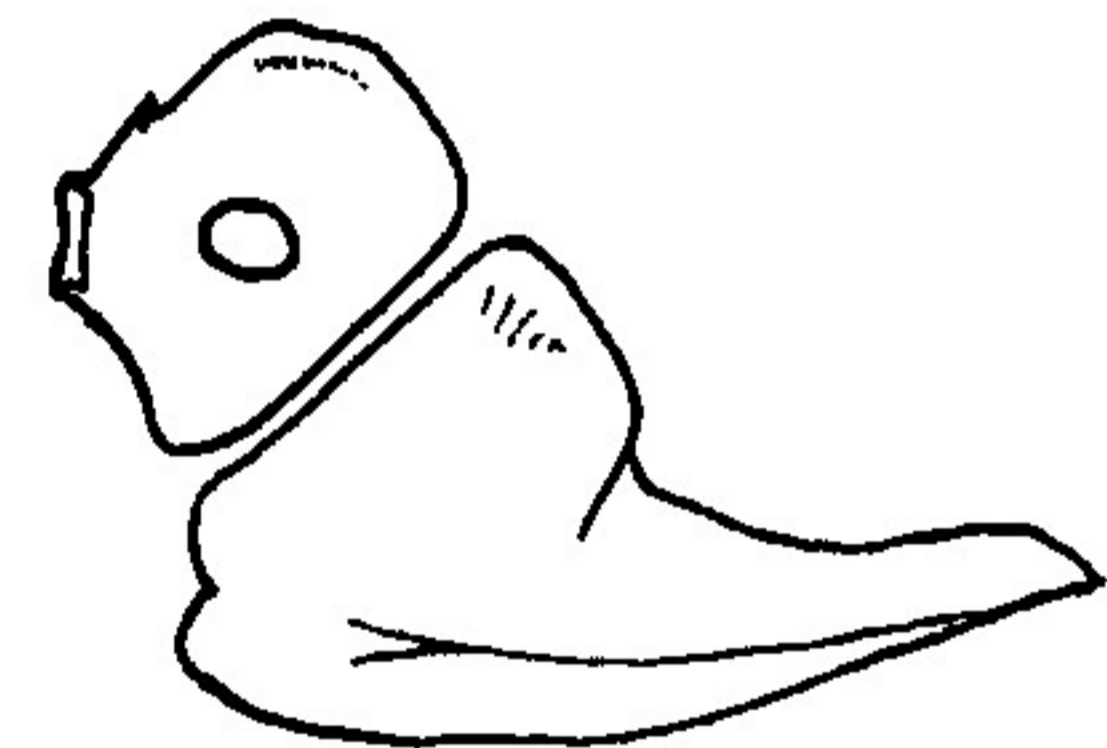
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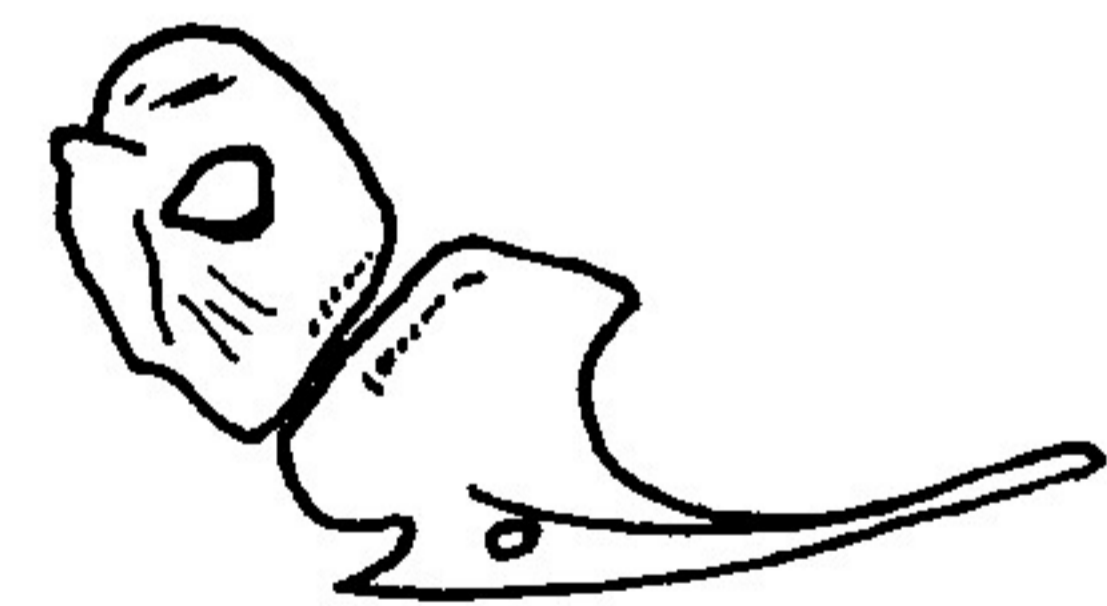
*Rutilus rutilus*



*Vimba vimba carinata*



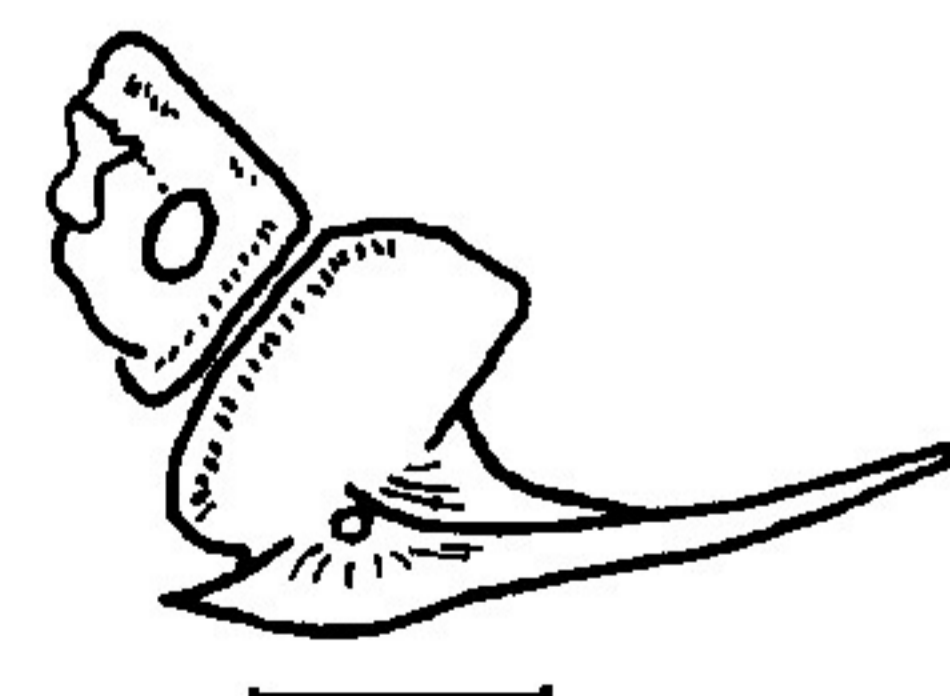
*Aspro zingel*



*Perca fluviatilis*



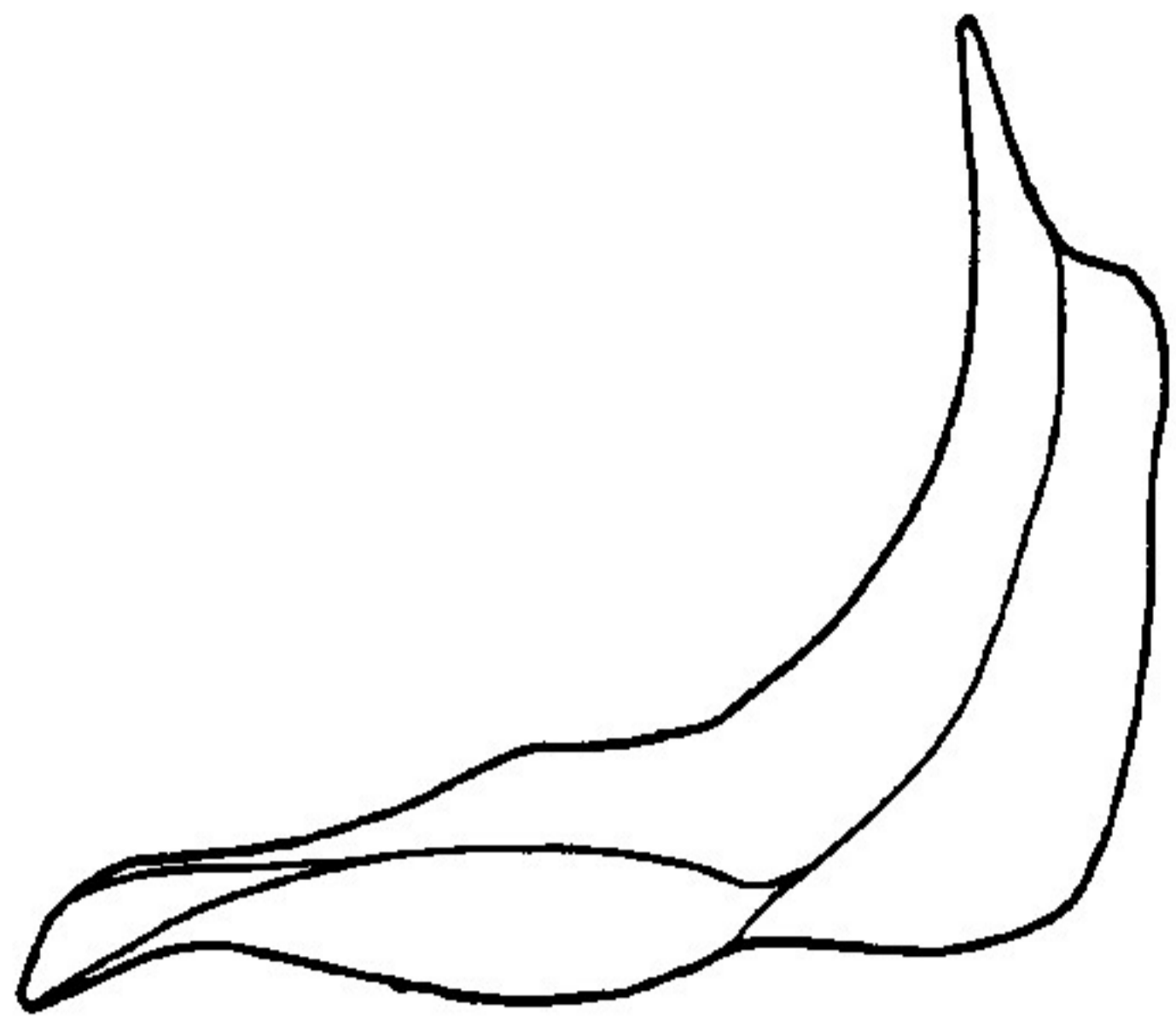
*Pelecus cultratus*



*Stizostedion lucioperca*

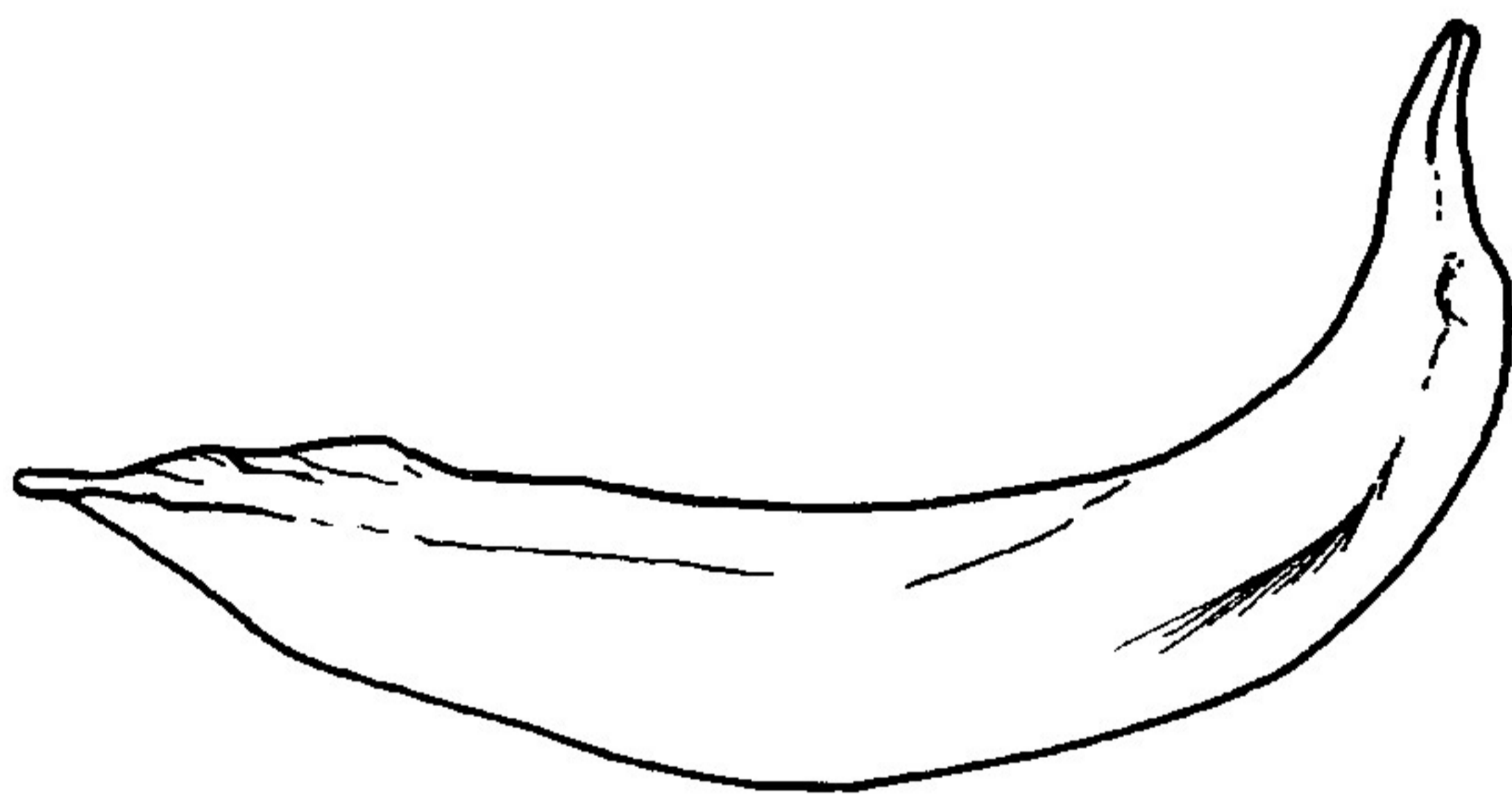
CLEITHRUM

NORMA LATERALIS



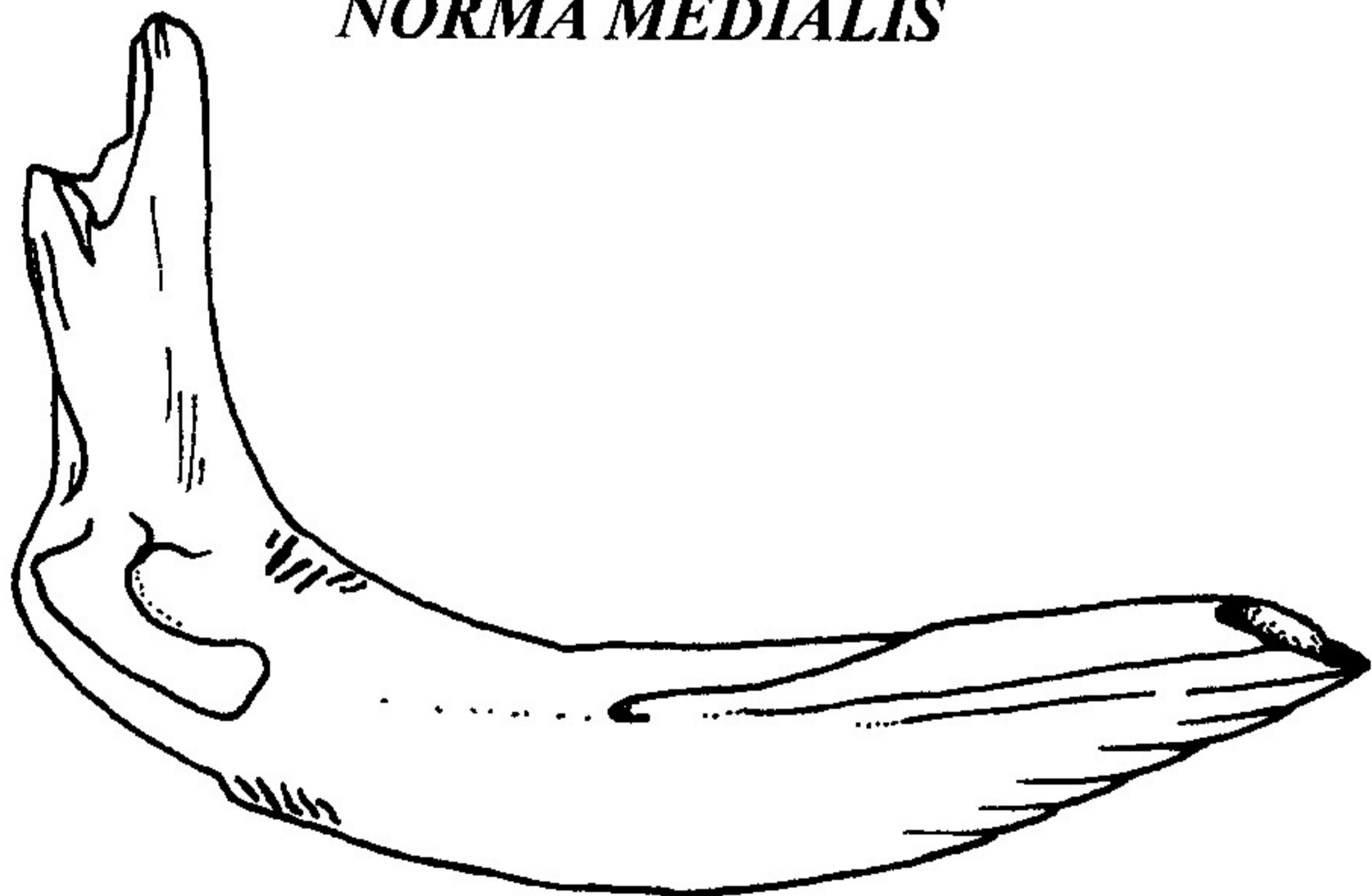
*Salmo trutta lacustris*

*Alosa pontica*



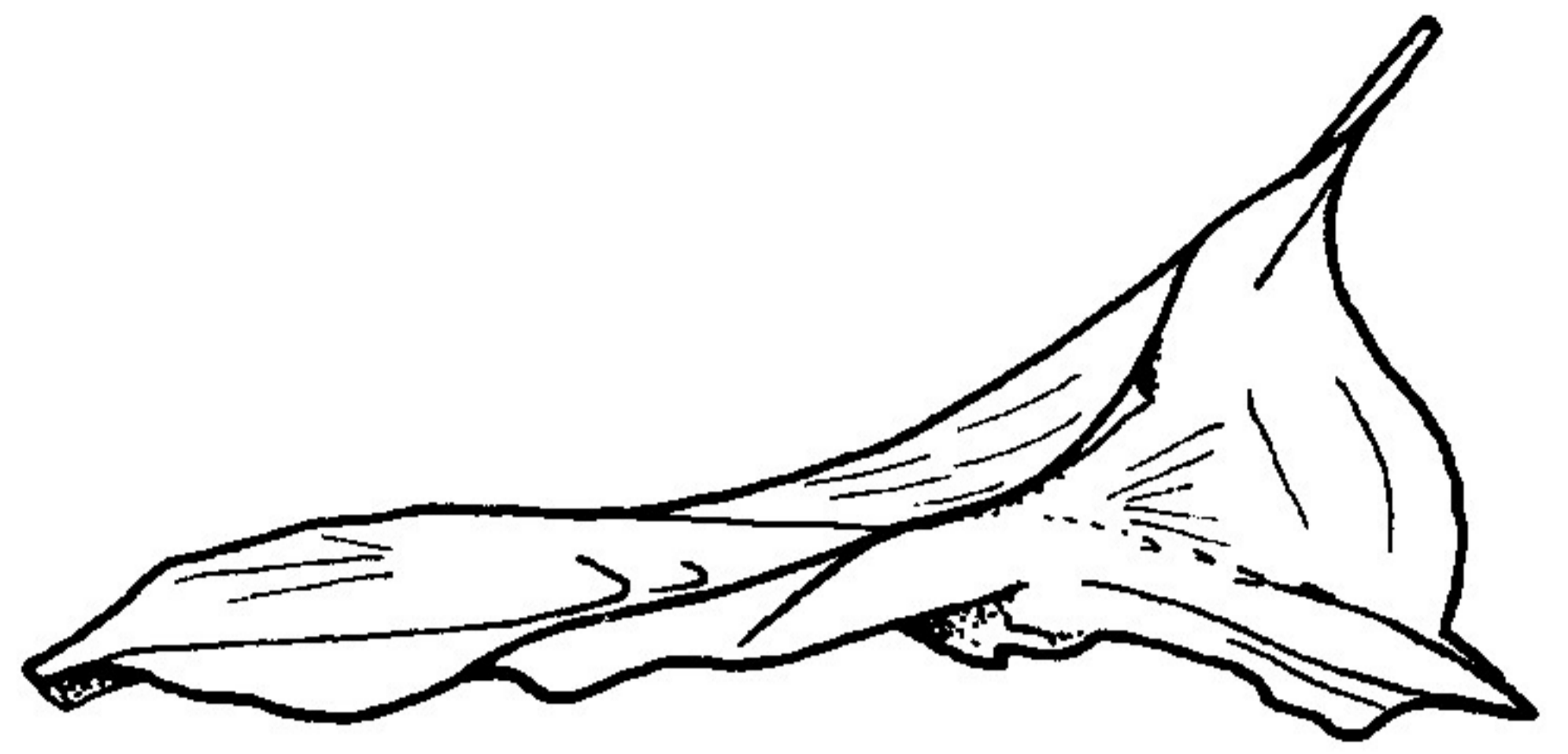
*Esox lucius*

NORMA MEDIALIS

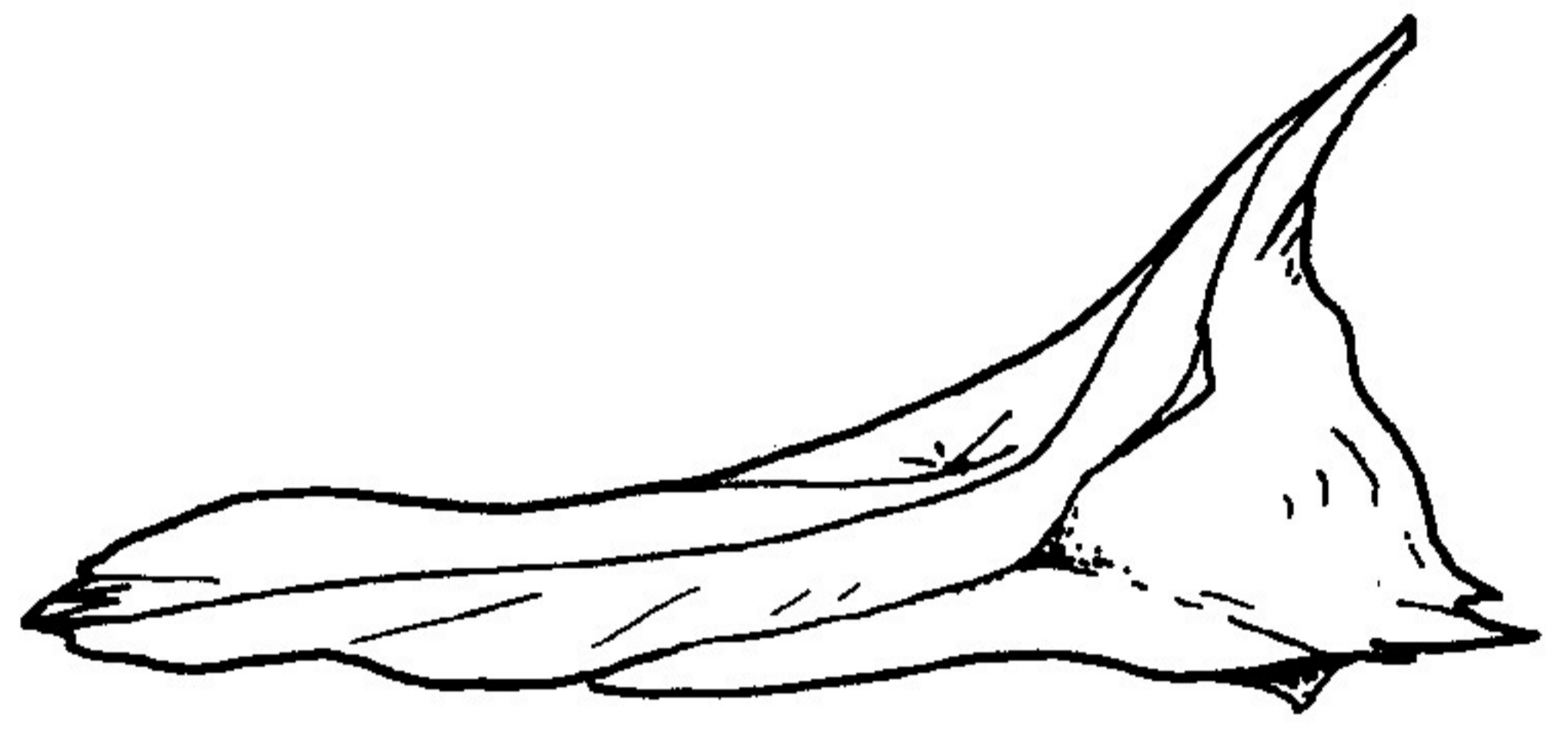


*Silurus glanis*

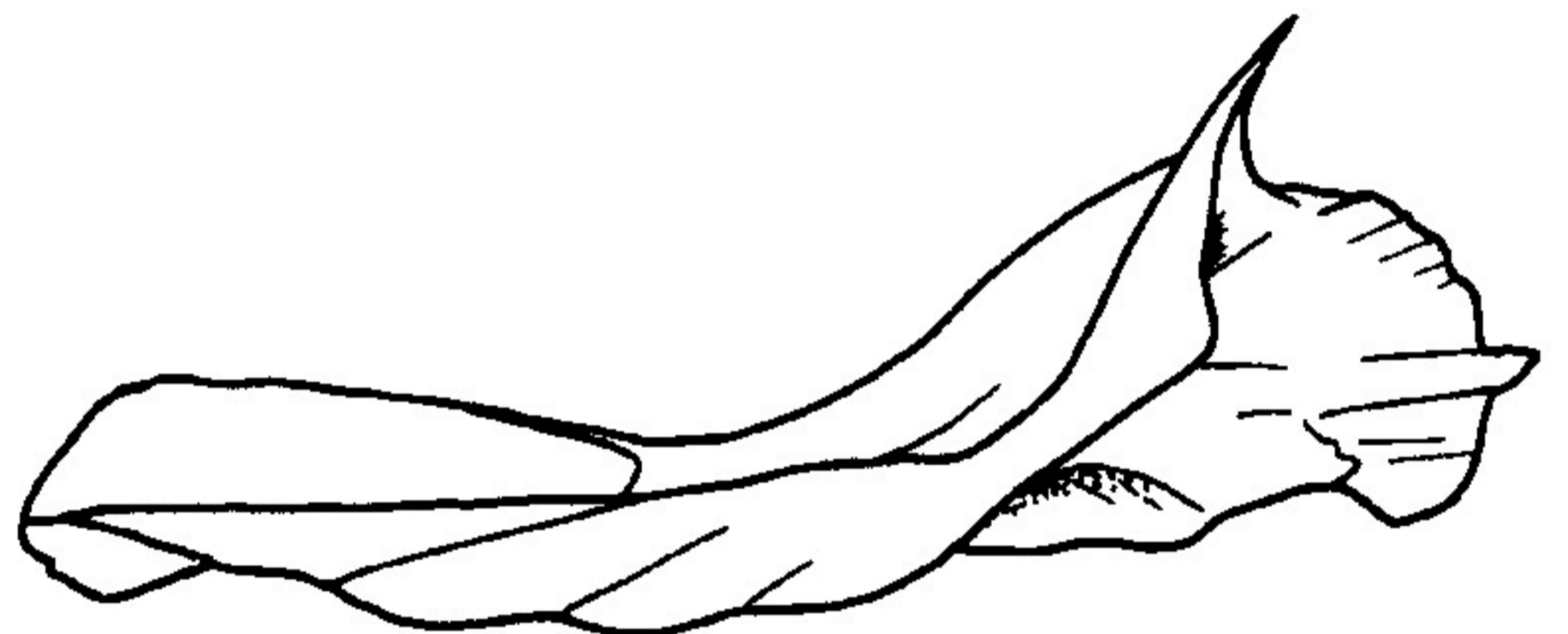
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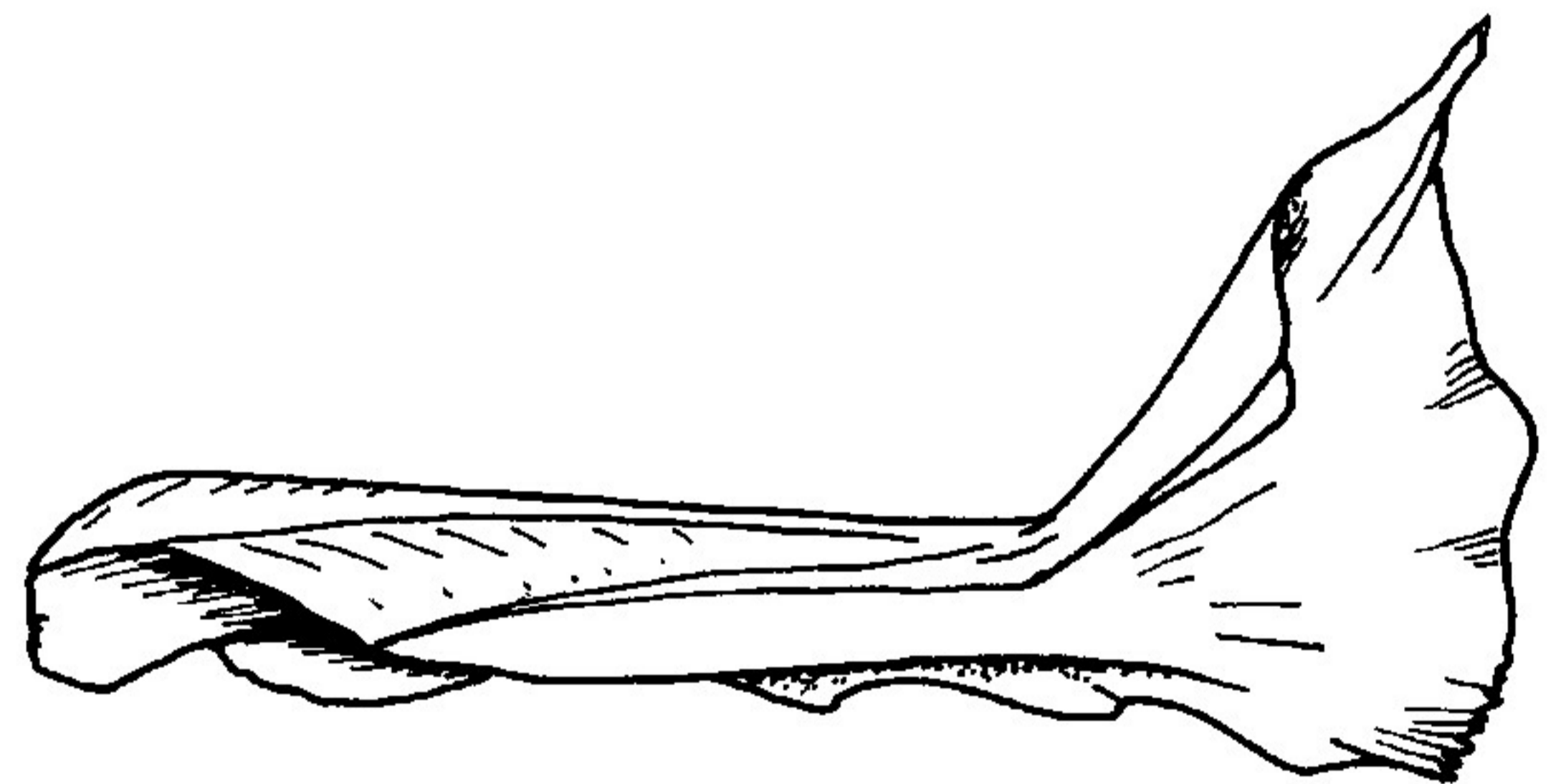
*Acerina schraetser*



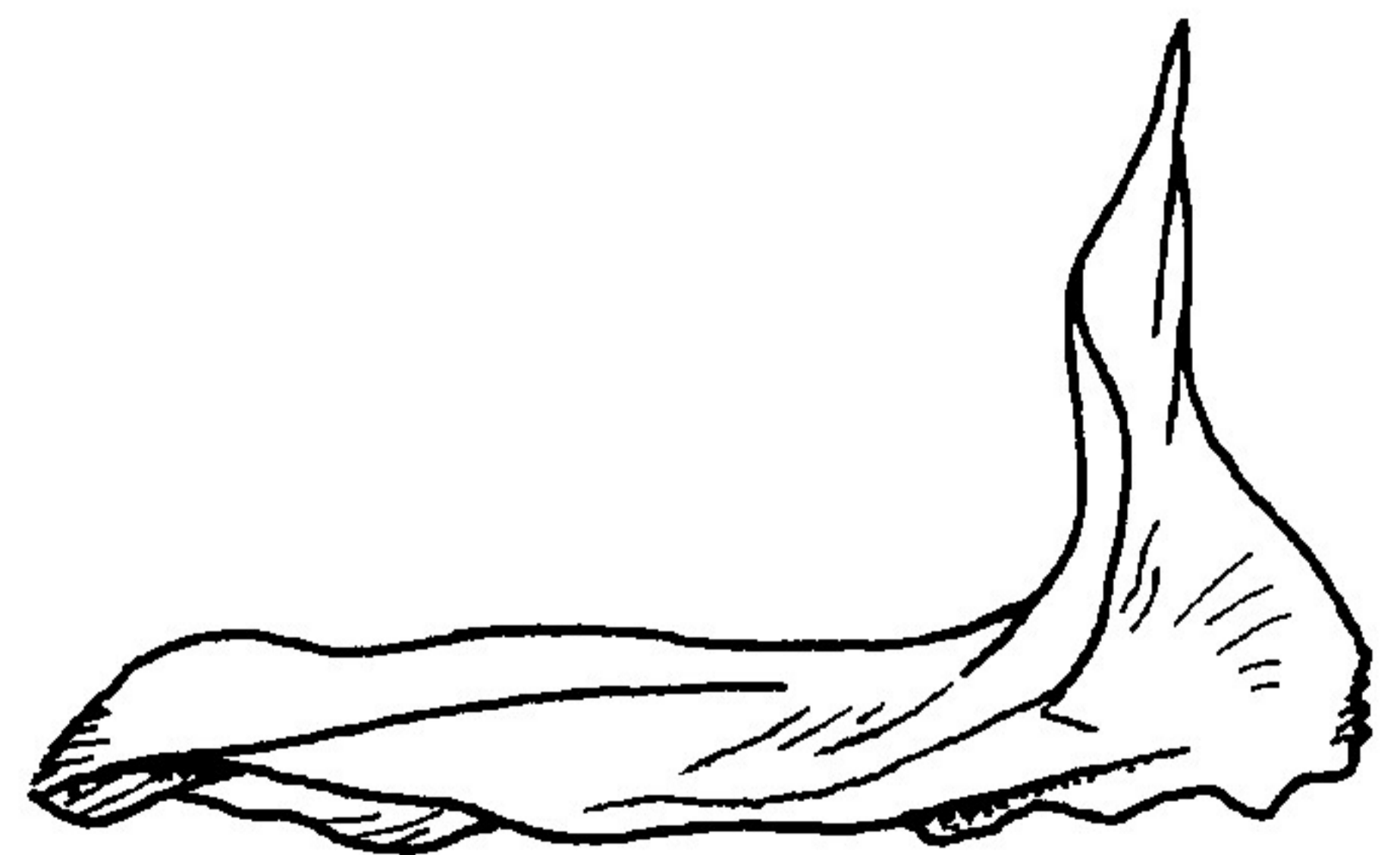
*Gymnocephalus* sp.



*Aspro zingel*



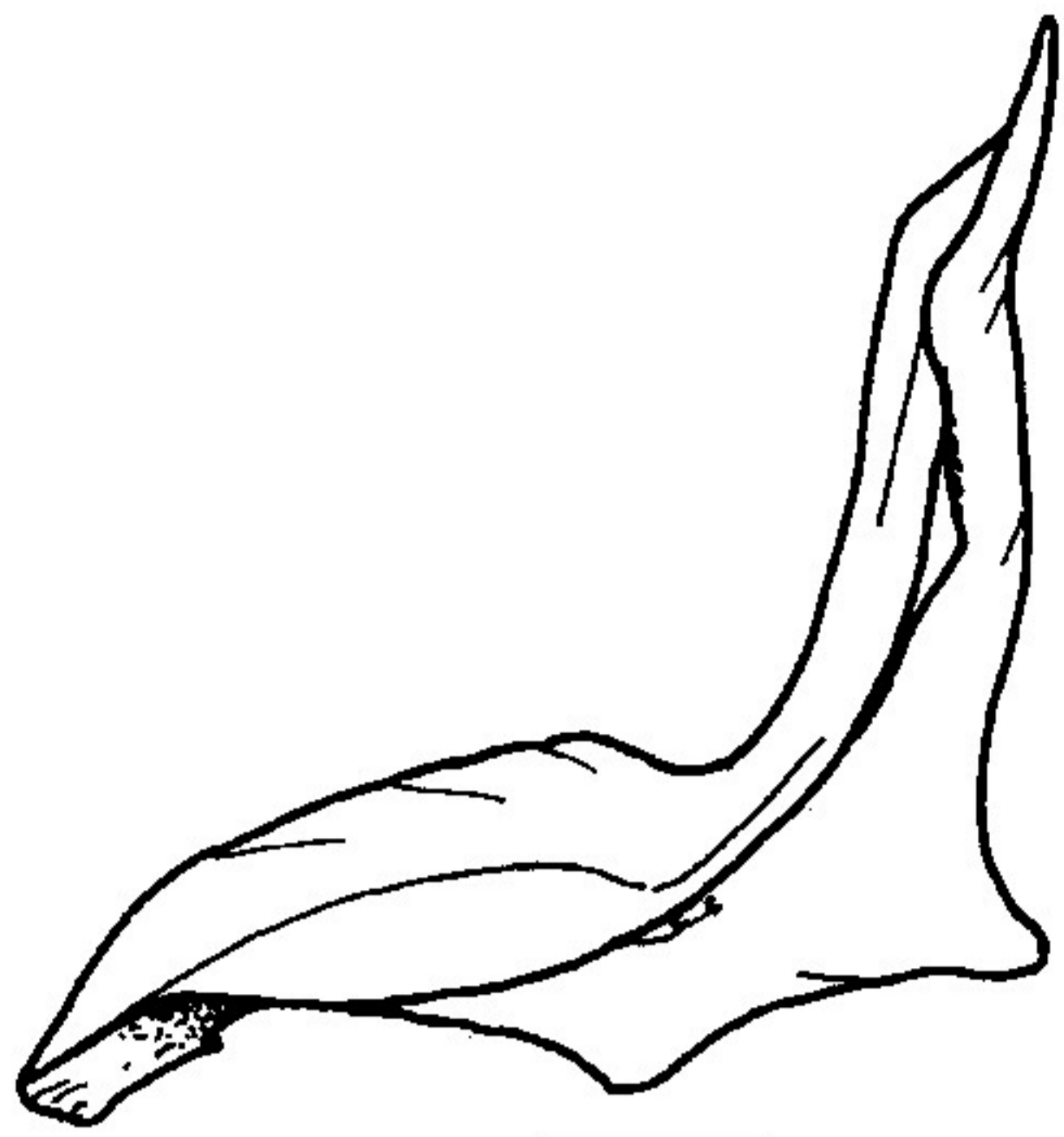
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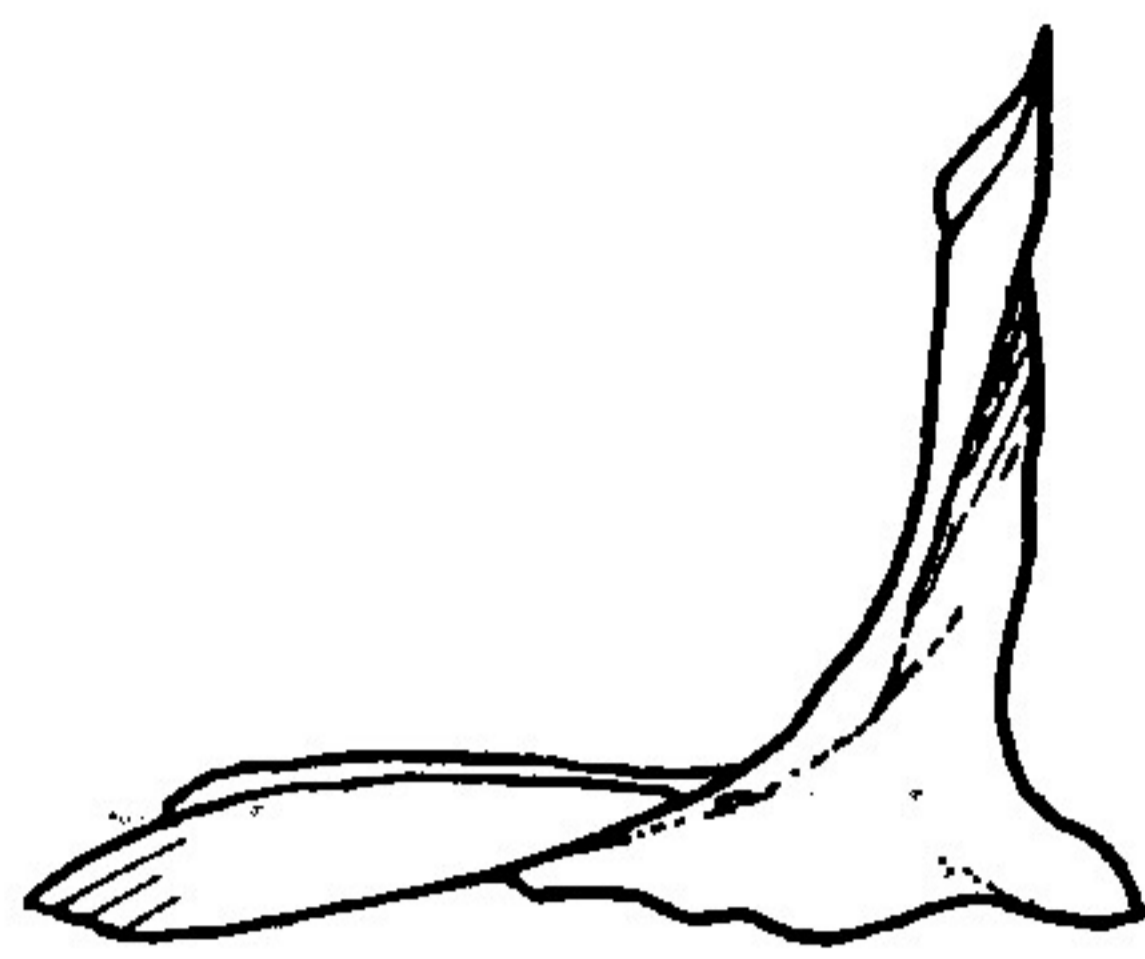
*Stizostedion lucioperca*

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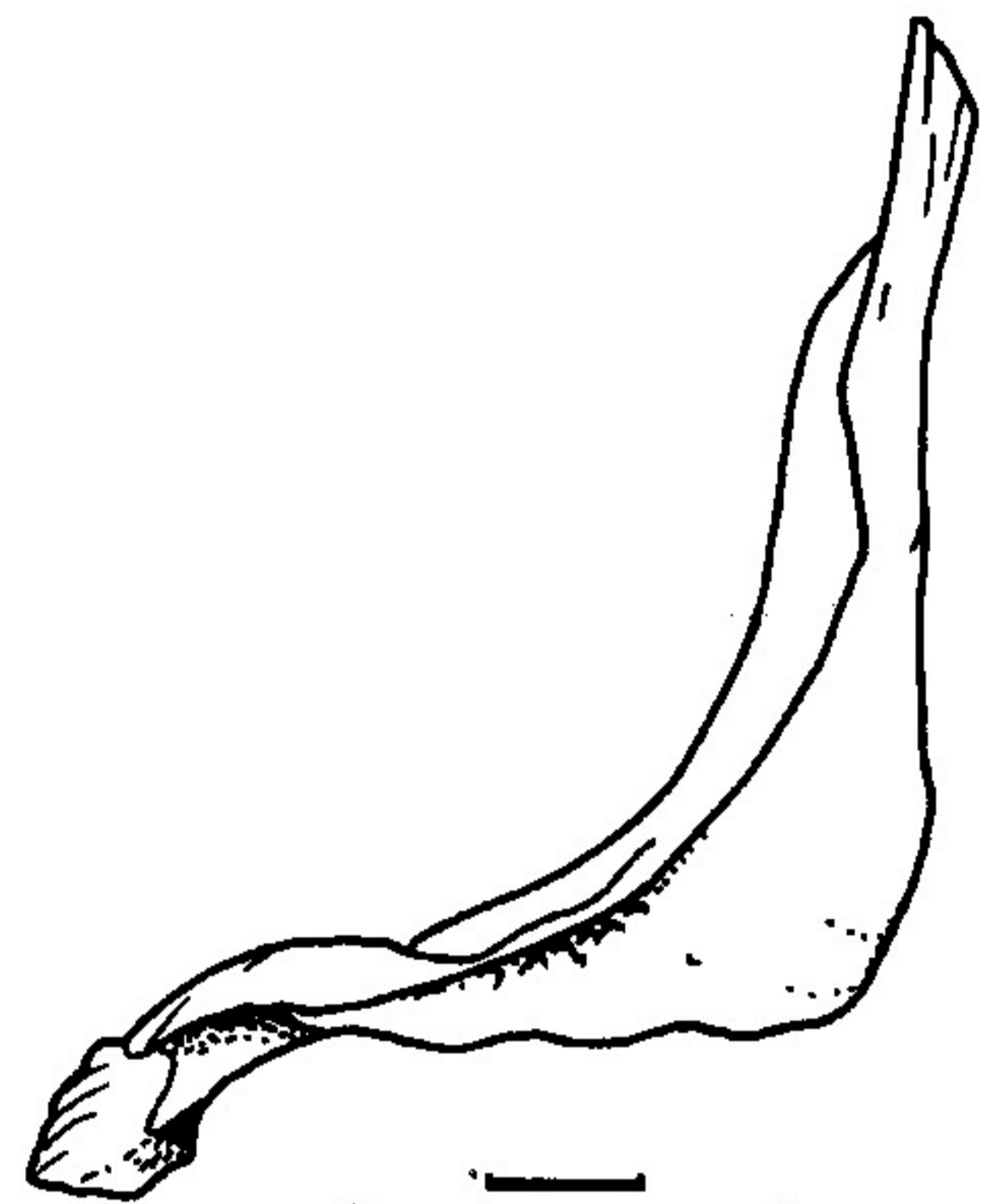
## NORMA LATERALIS



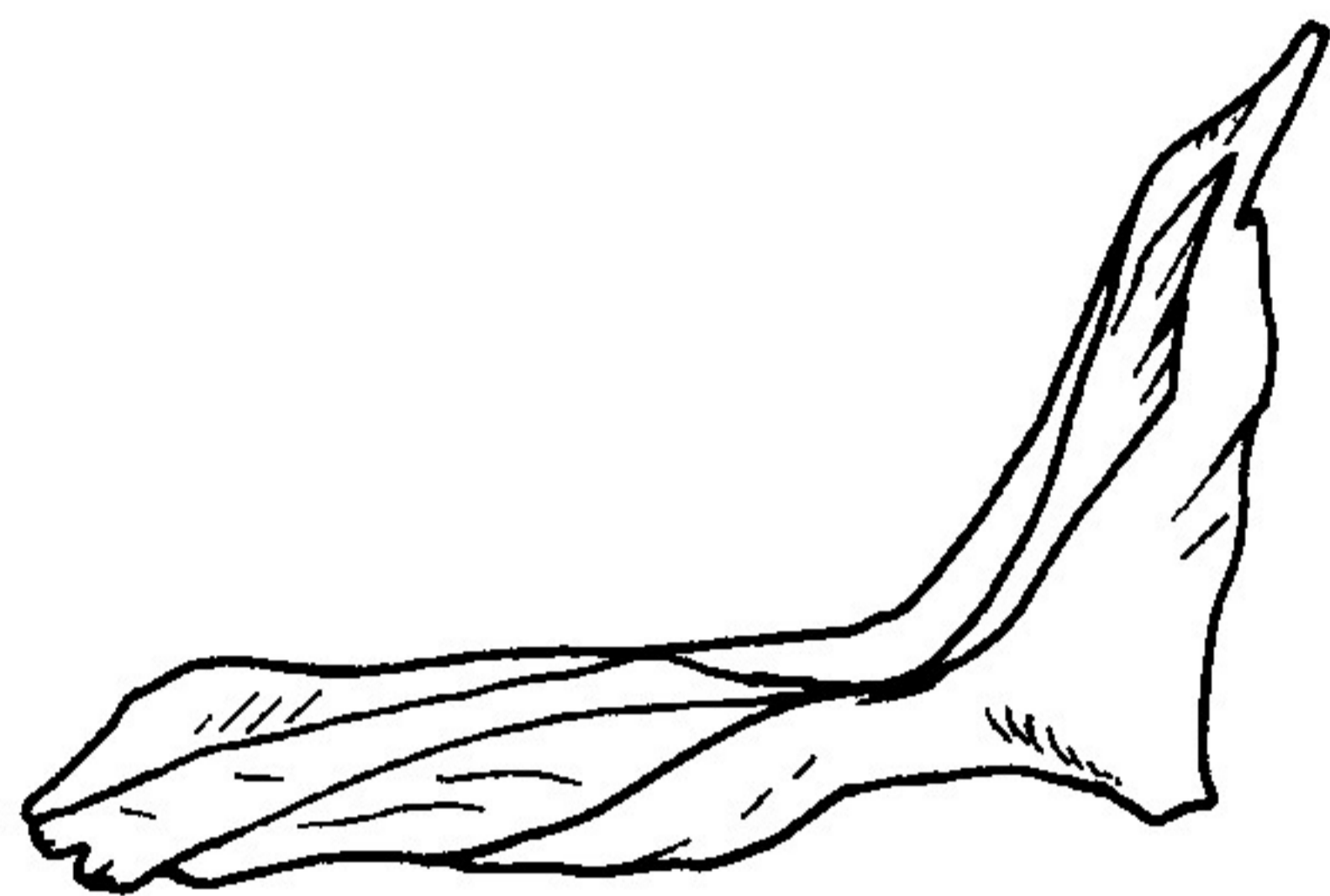
*Abramis brama*



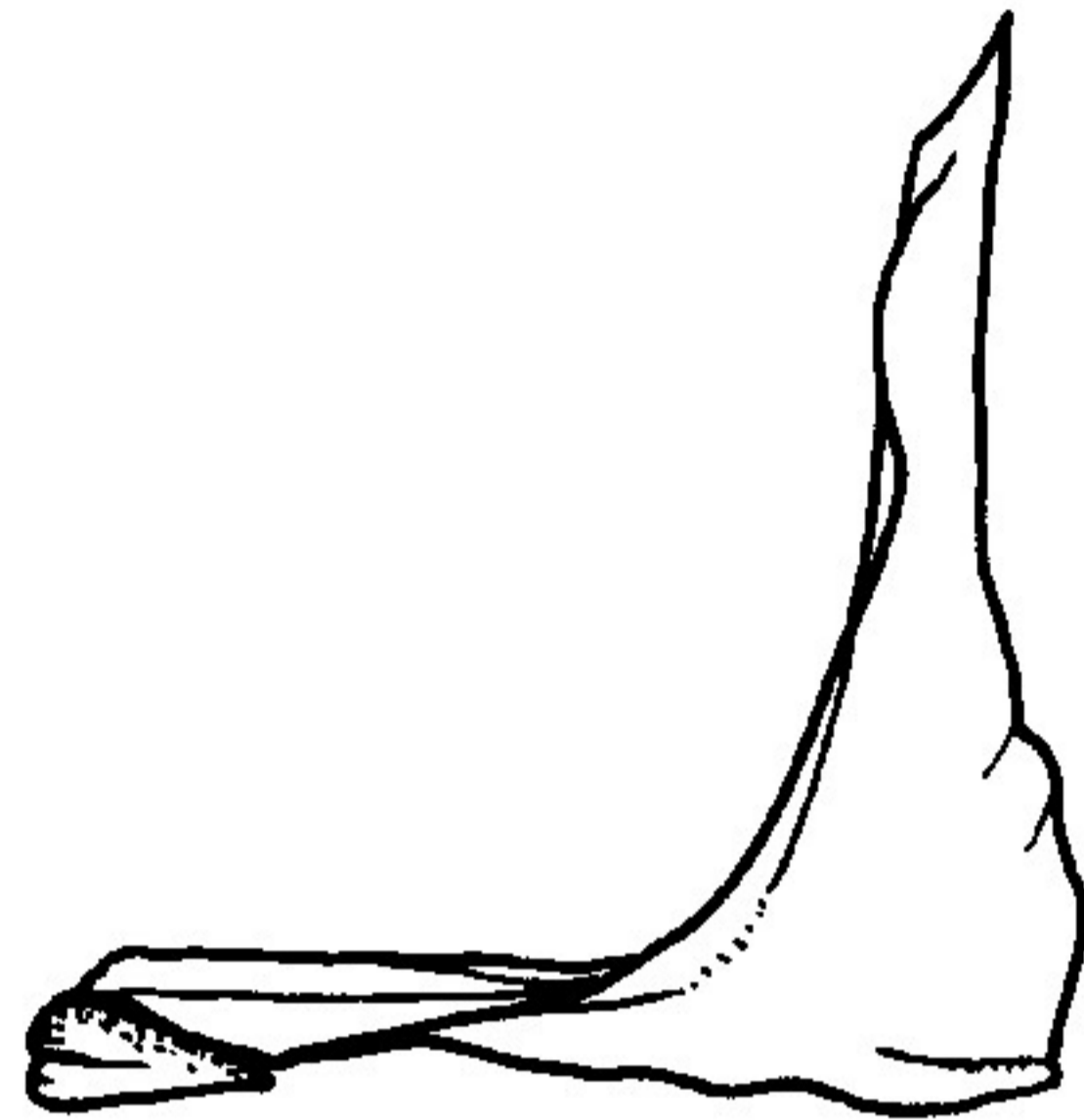
*Chalcaburnus chalcoides mento*



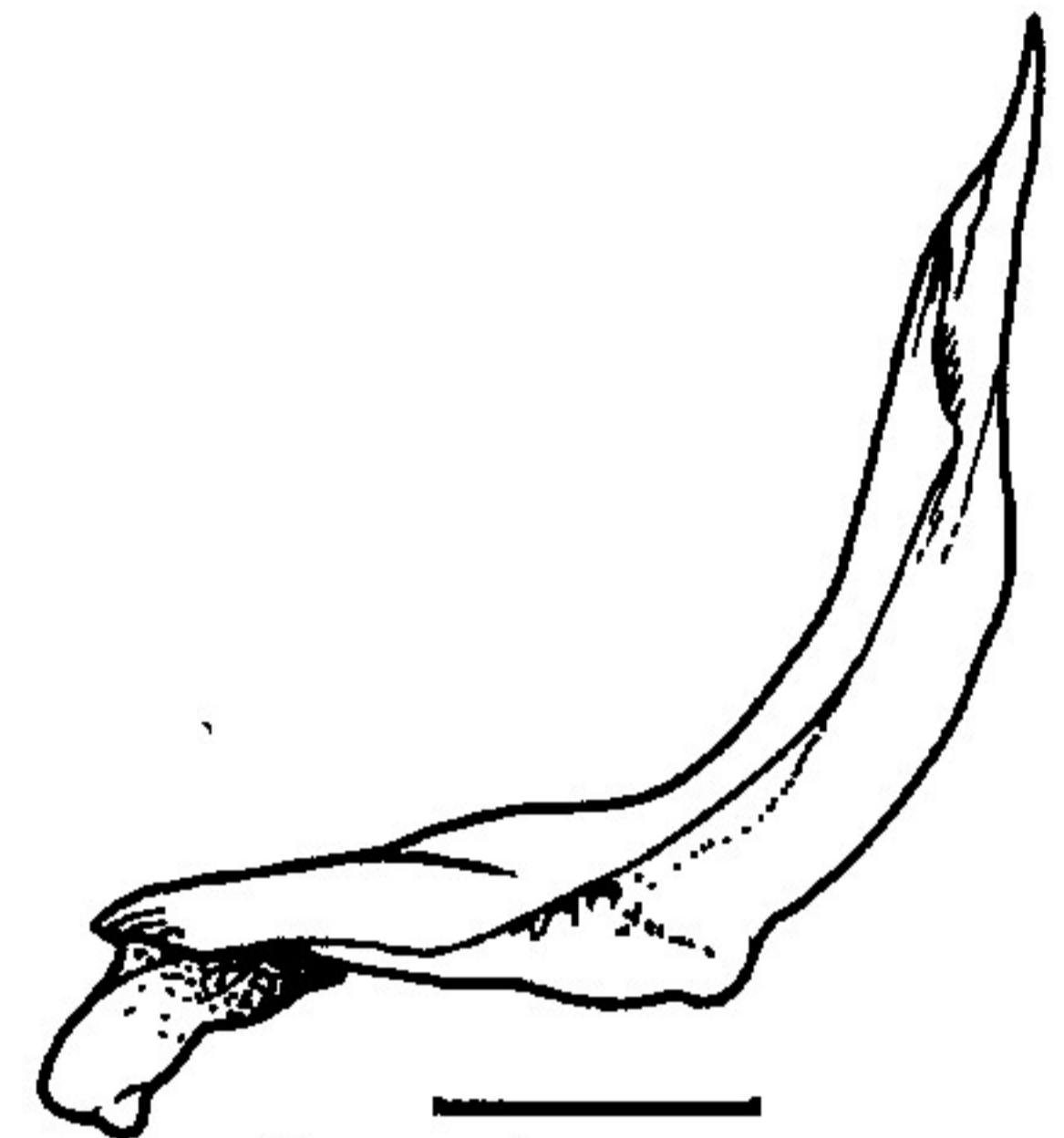
*Cyprinus carpio*



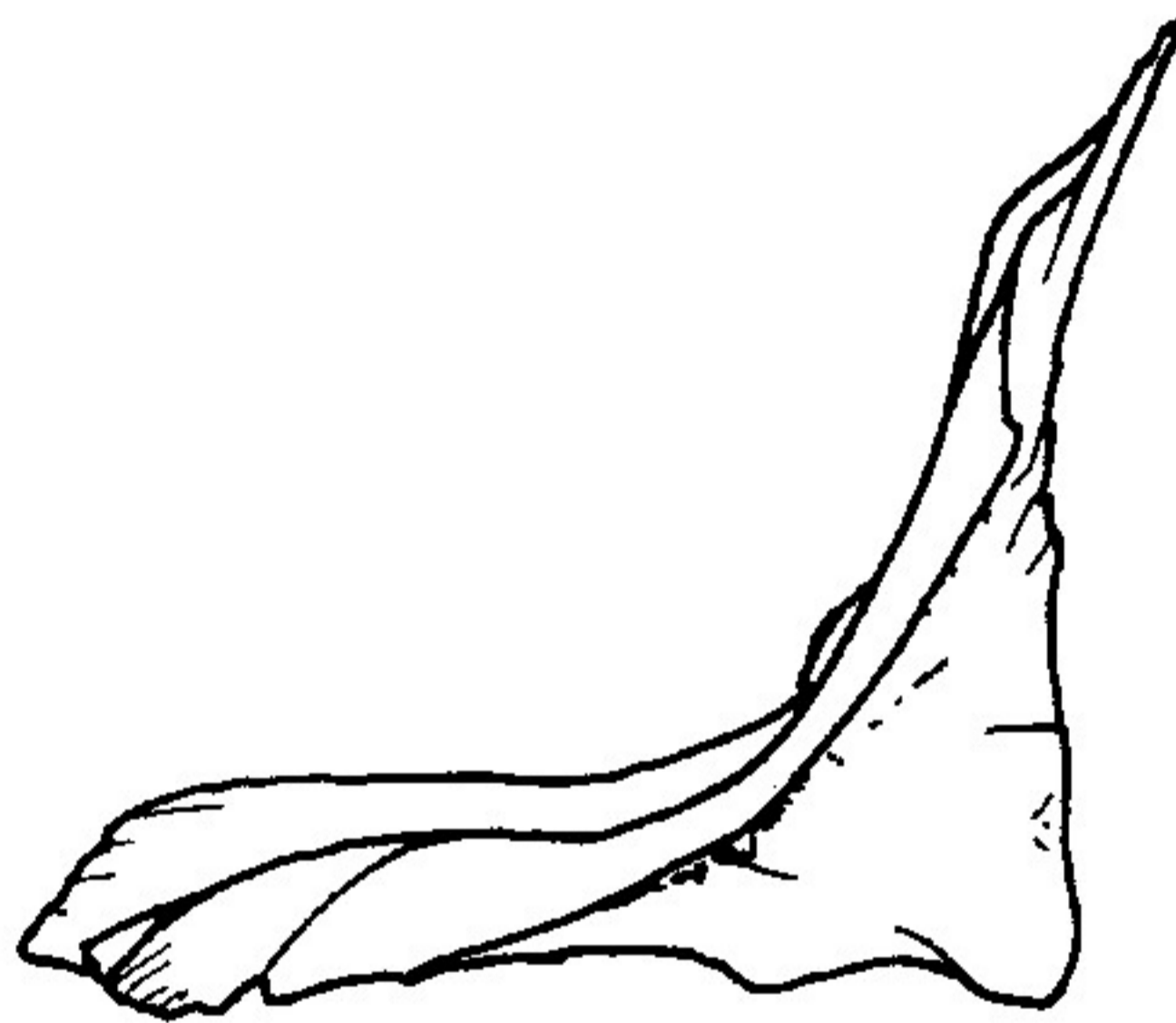
*Aspius aspius*



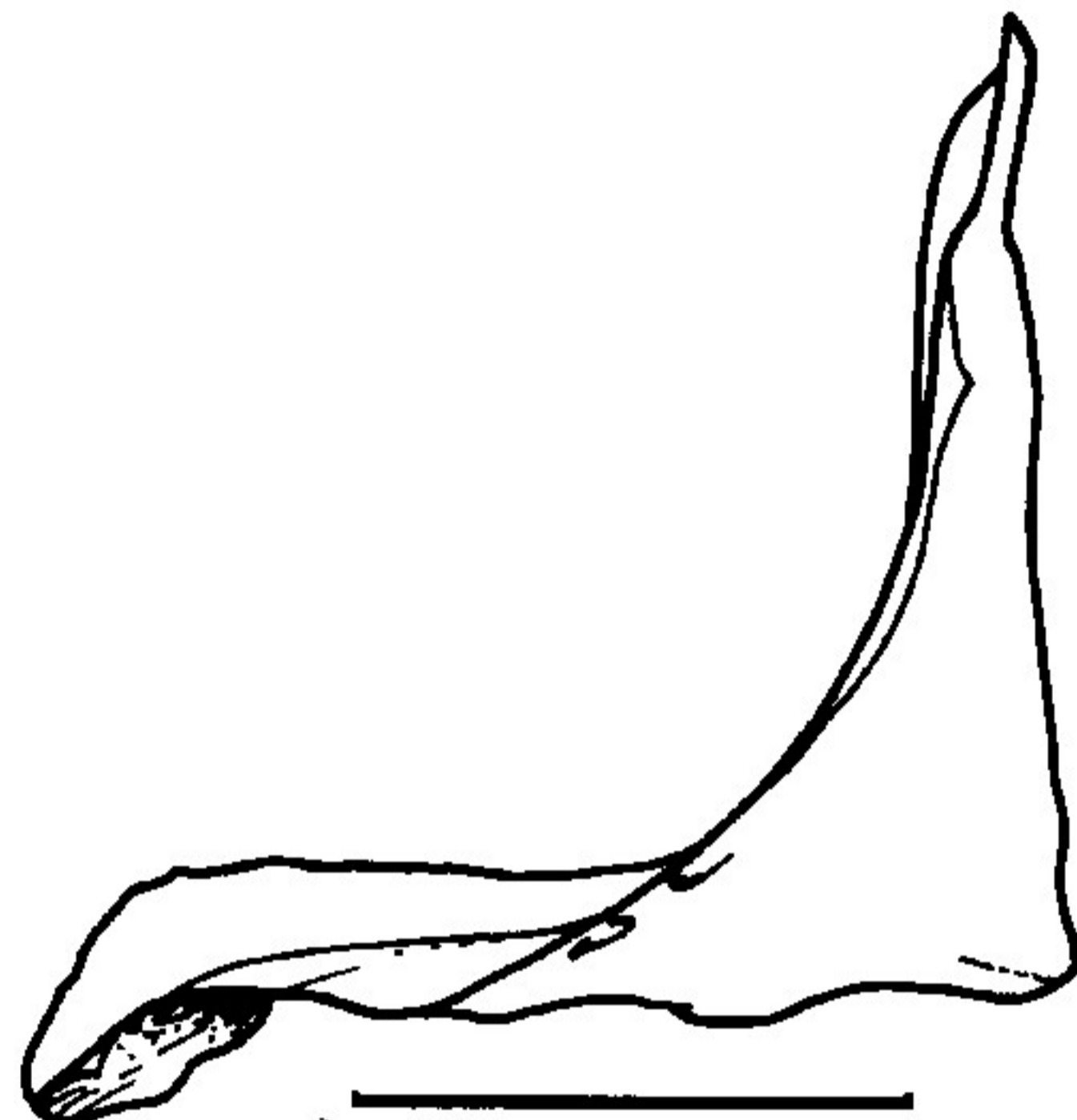
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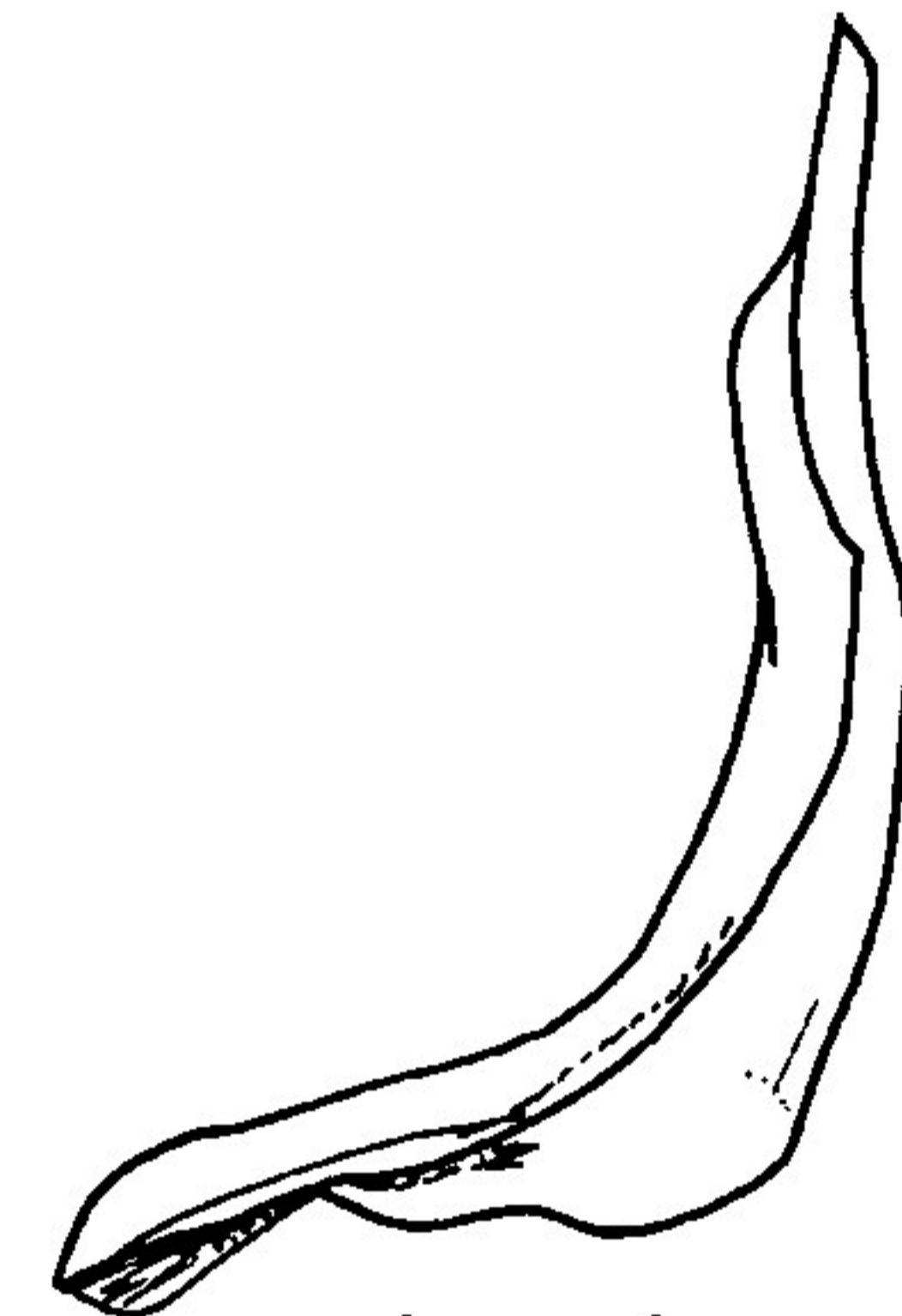
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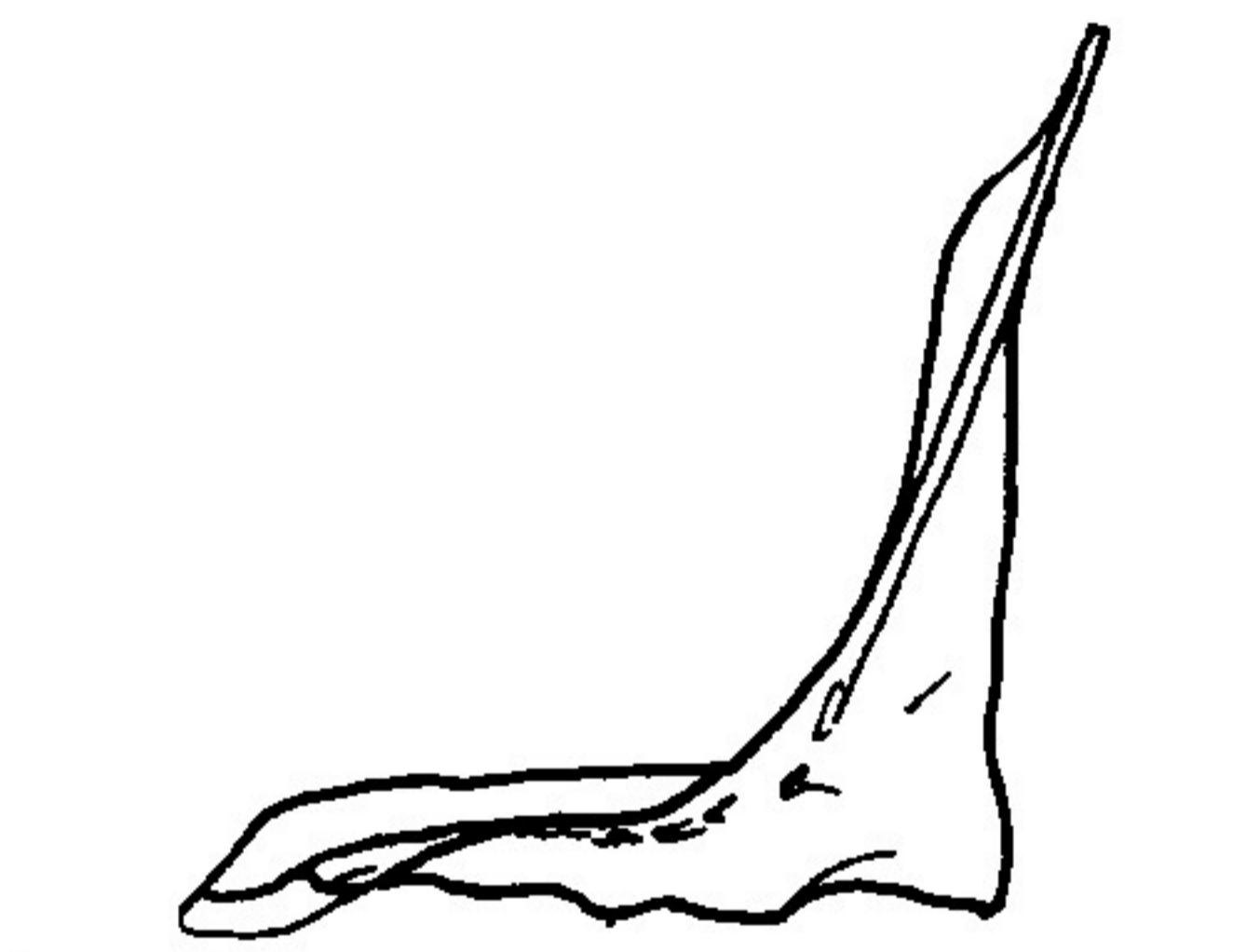
*Vimba vimba carinata*



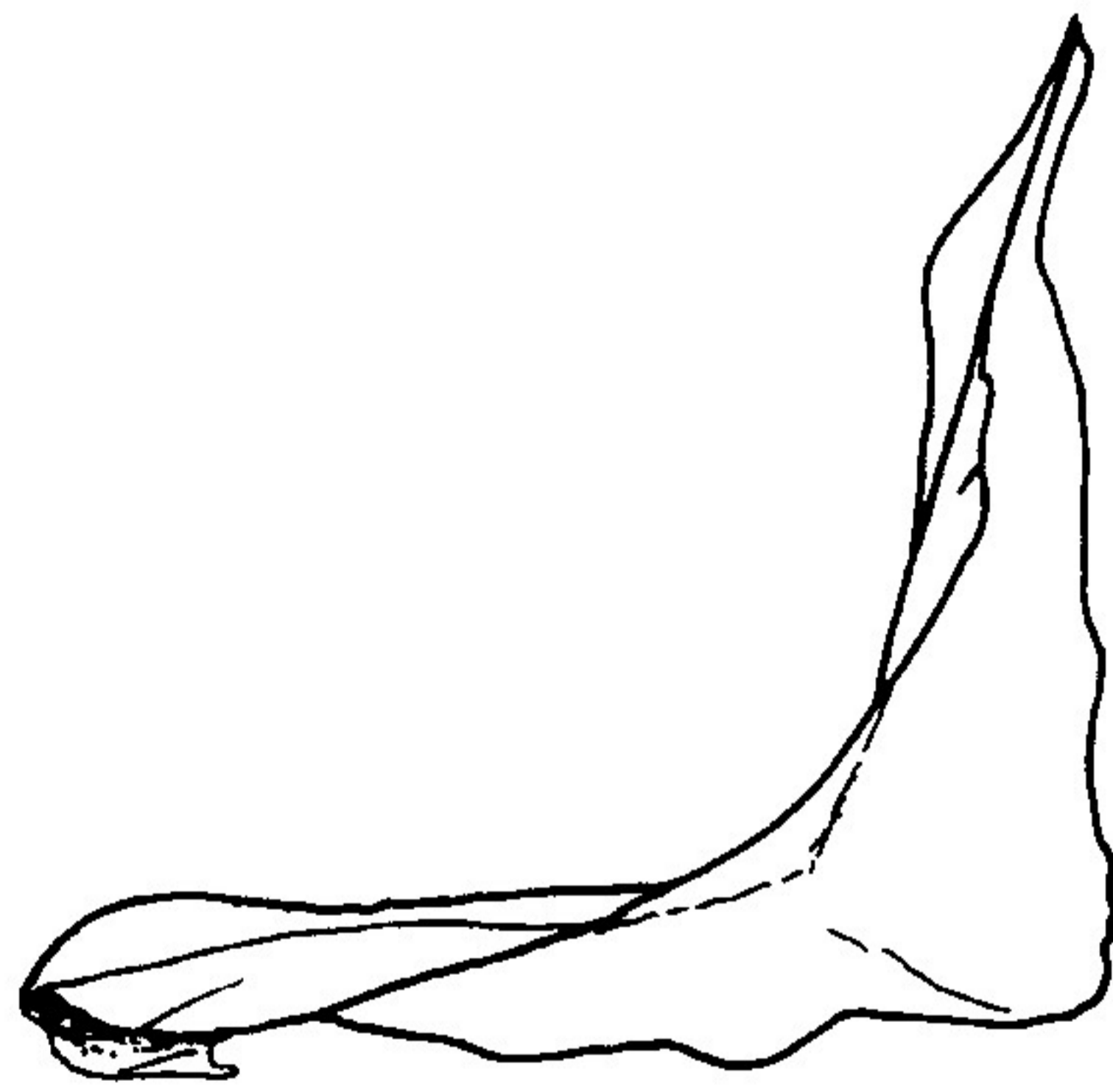
*Blicca bjoerkna*



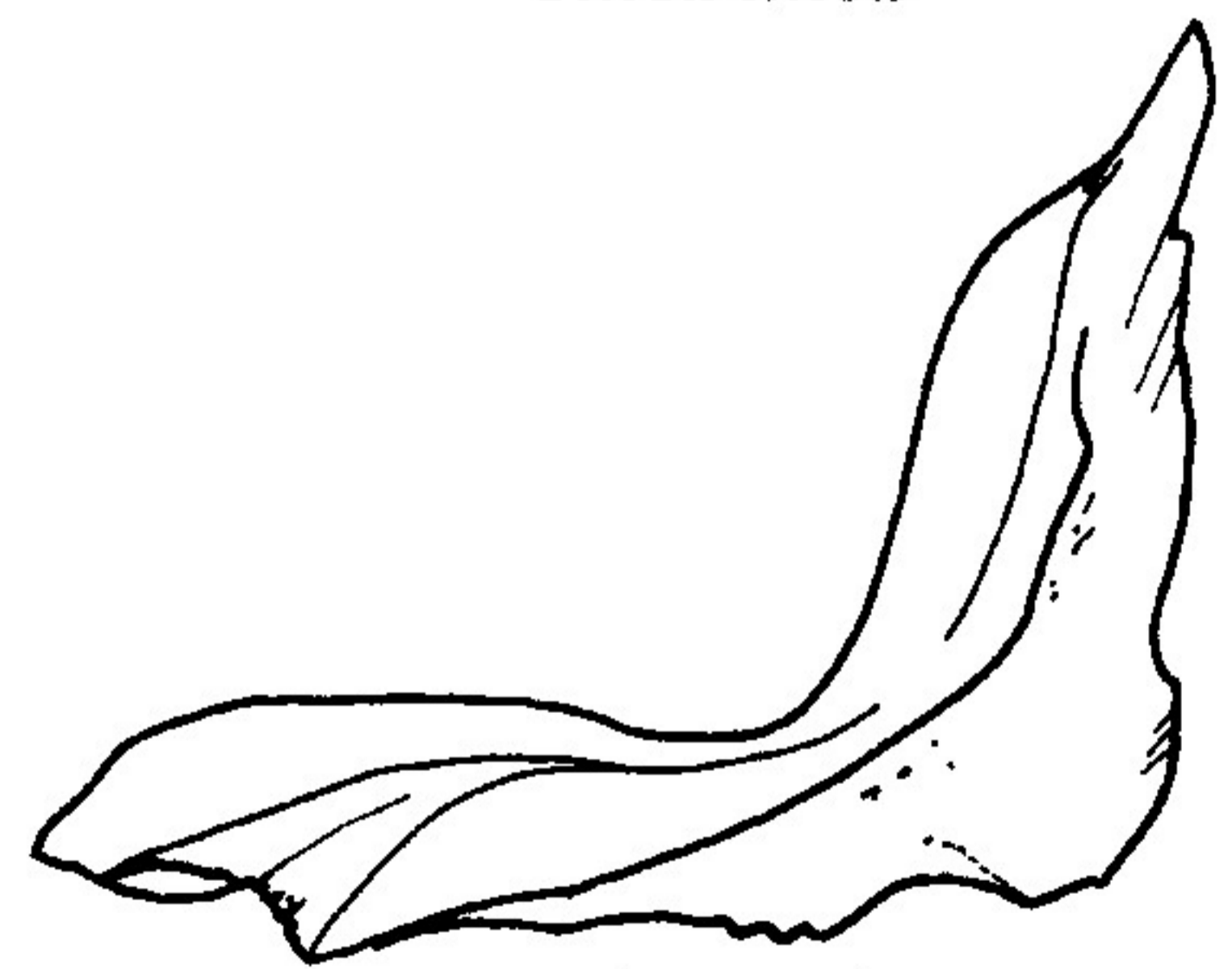
*Tinca tinca*



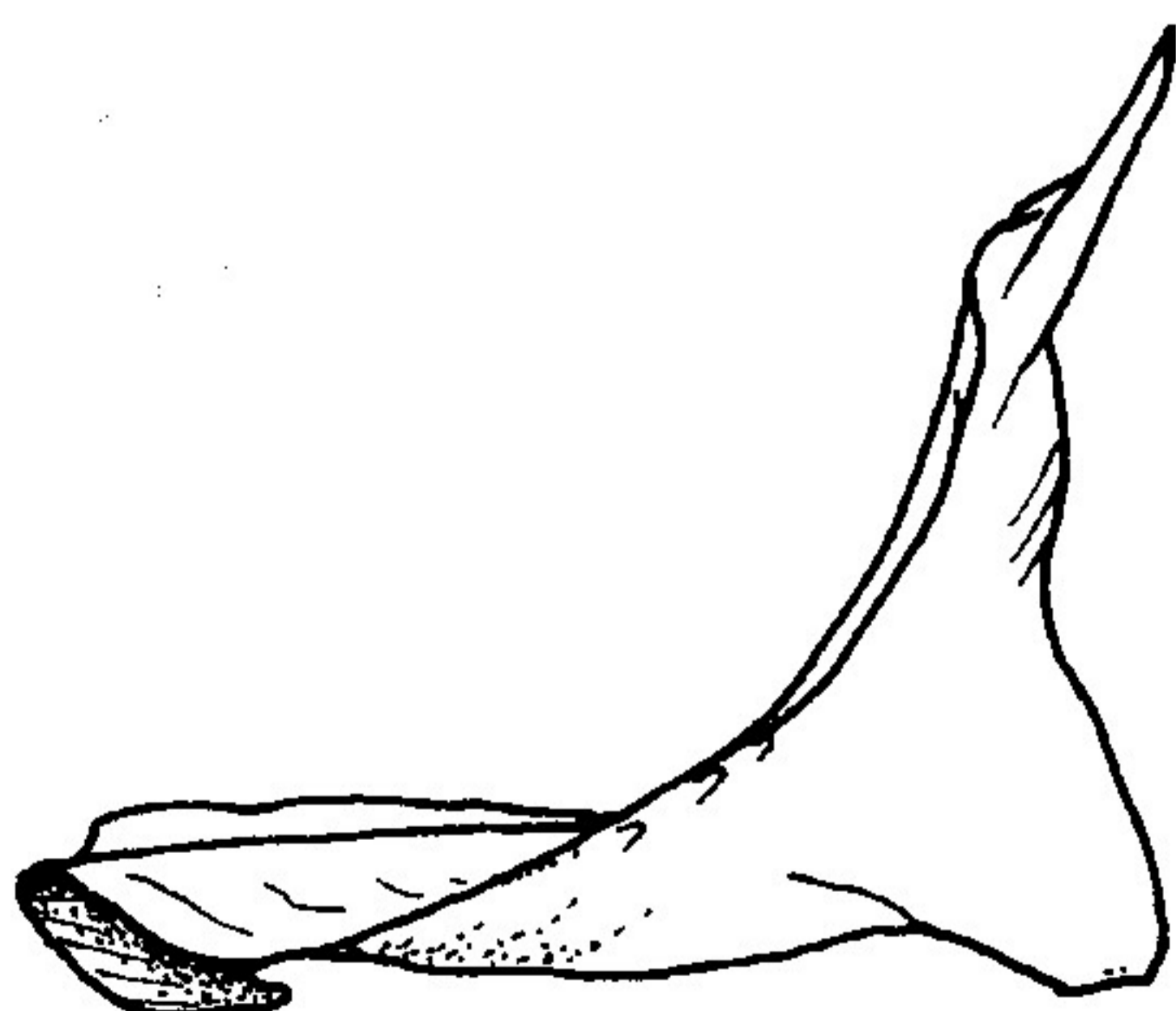
*Alburnus alburnus*



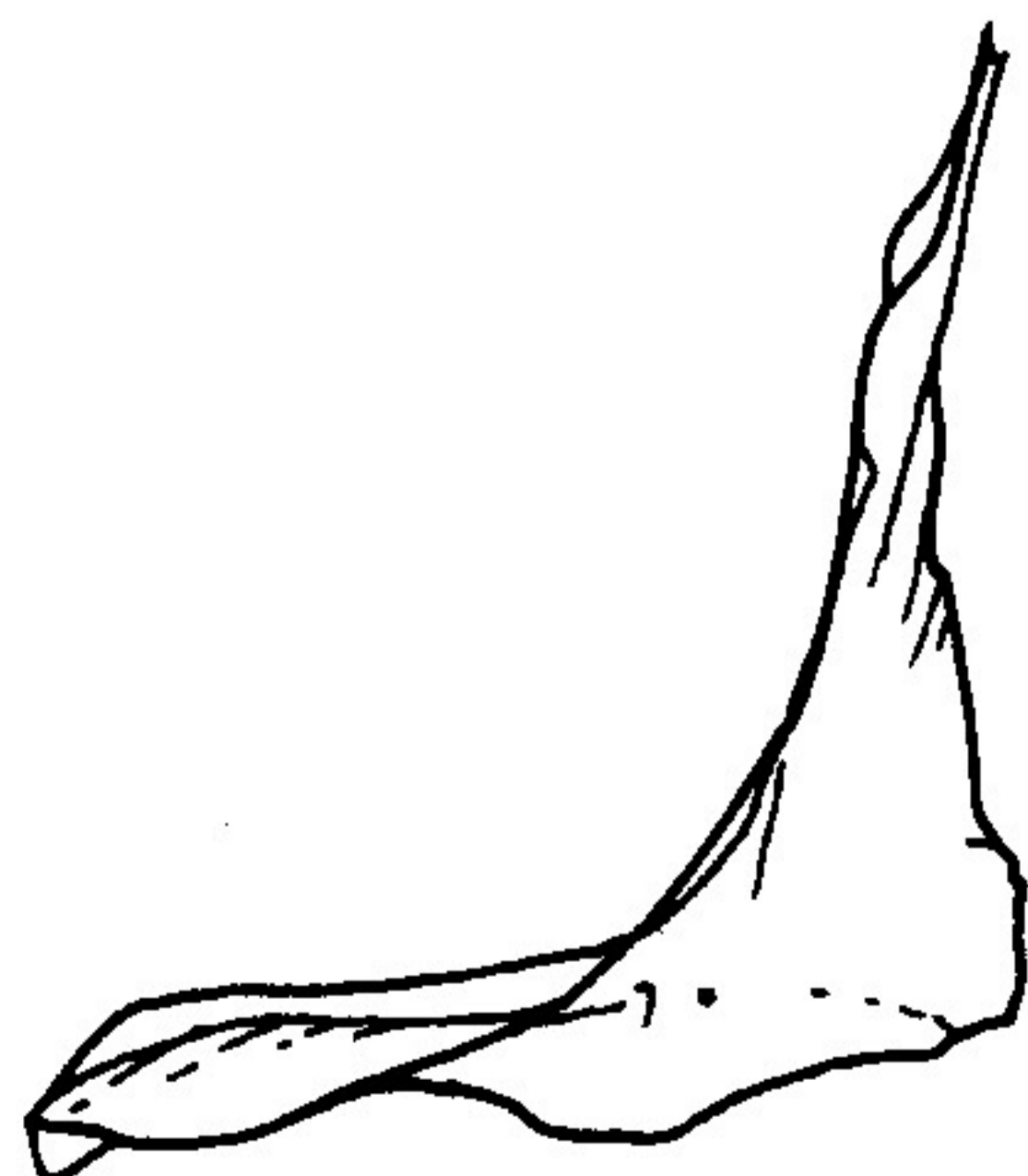
*Leuciscus idus*



*Barbus barbus*



*Chondrostoma nasus*

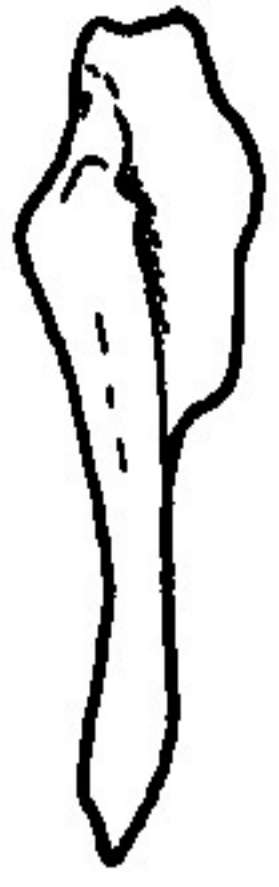


*Scardinius erythrophthalmus*



*Pelecus cultratus*

**SUPRACLEITHRALE**  
**NORMA LATERALIS**



*Alosa pontica*



*Abramis brama*



*Alburnus alburnus*



*Tinca tinca*



*Esox lucius*



*Carassius auratus*



*Chalcaburnus chalcoides mento*



*Chondrostoma nasus*



*Acerina schraetser*



*Scardinius erythrophthalmus*



*Gymnocephalus sp.*



*Barbus barbus*



*Vimba vimba carinata*



*Aspro zingel*



*Leuciscus idus*



*Blicca bjoerkna*



*Aspius aspius*



*Perca fluviatilis*



*Cyprinus carpio*



*Rutilus rutilus*



*Pelecus cultratus*

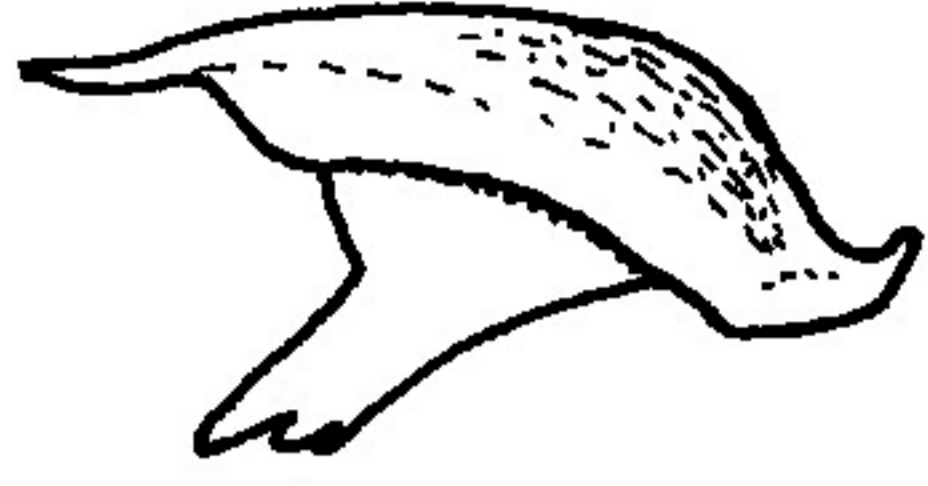


*Stizostedion lucioperca*

**POSTTEMPORALE**  
**NORMA LATERALIS**



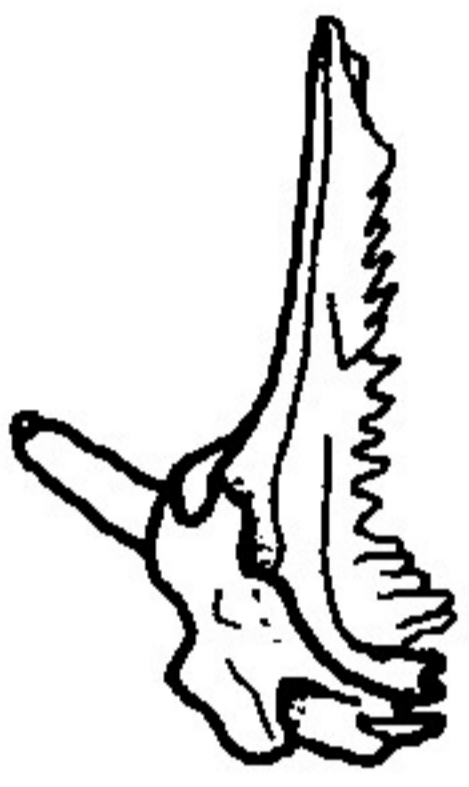
*Alosa pontica*



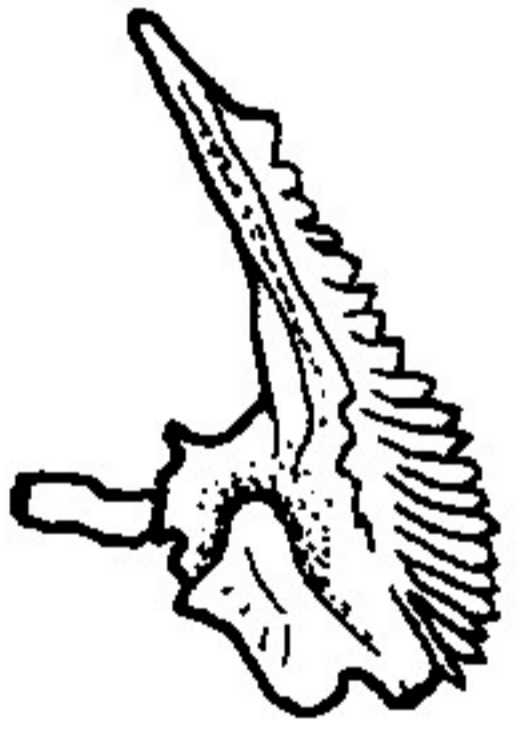
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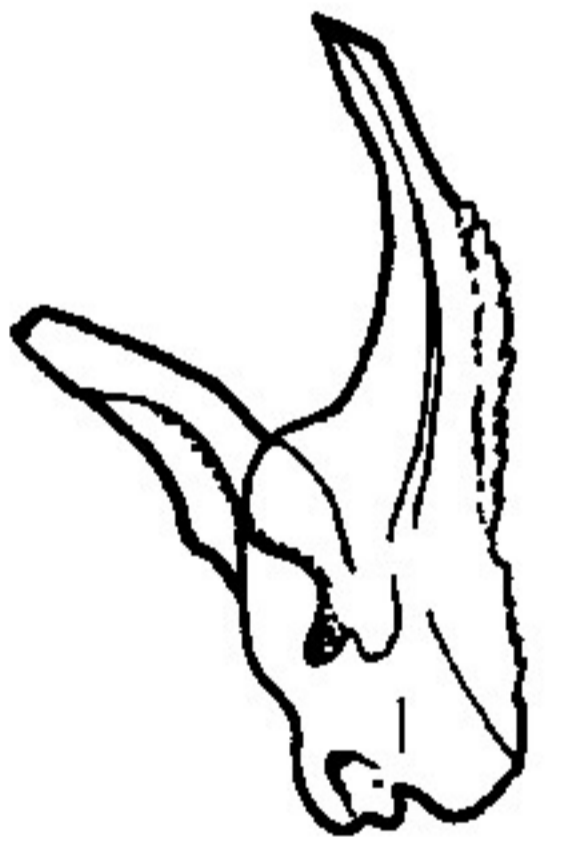
*Silurus glanis*



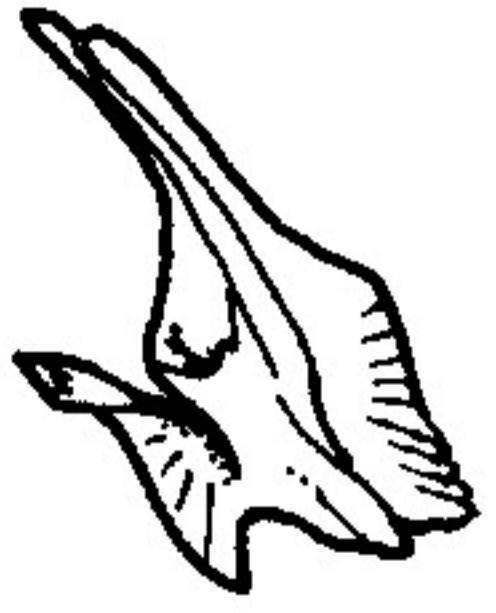
*Acerina schraetser*



*Gymnocephalus sp.*



*Aspro zingel*



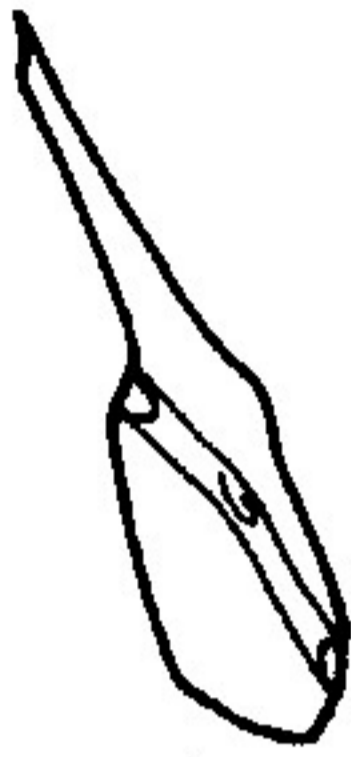
*Perca fluviatilis*



*Stizostedion lucioperca*



*Abramis brama*



*Blicca bjoerkna*



*Alburnus alburnus*



*Scardinius erythrophthalmus*



*Chalcaburnus chalcoides mento*



*Leuciscus idus*



*Rutilus rutilus*



*Aspius aspius*



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*Carassius auratus*



*Pelecus cultratus*



*Cyprinus carpio*



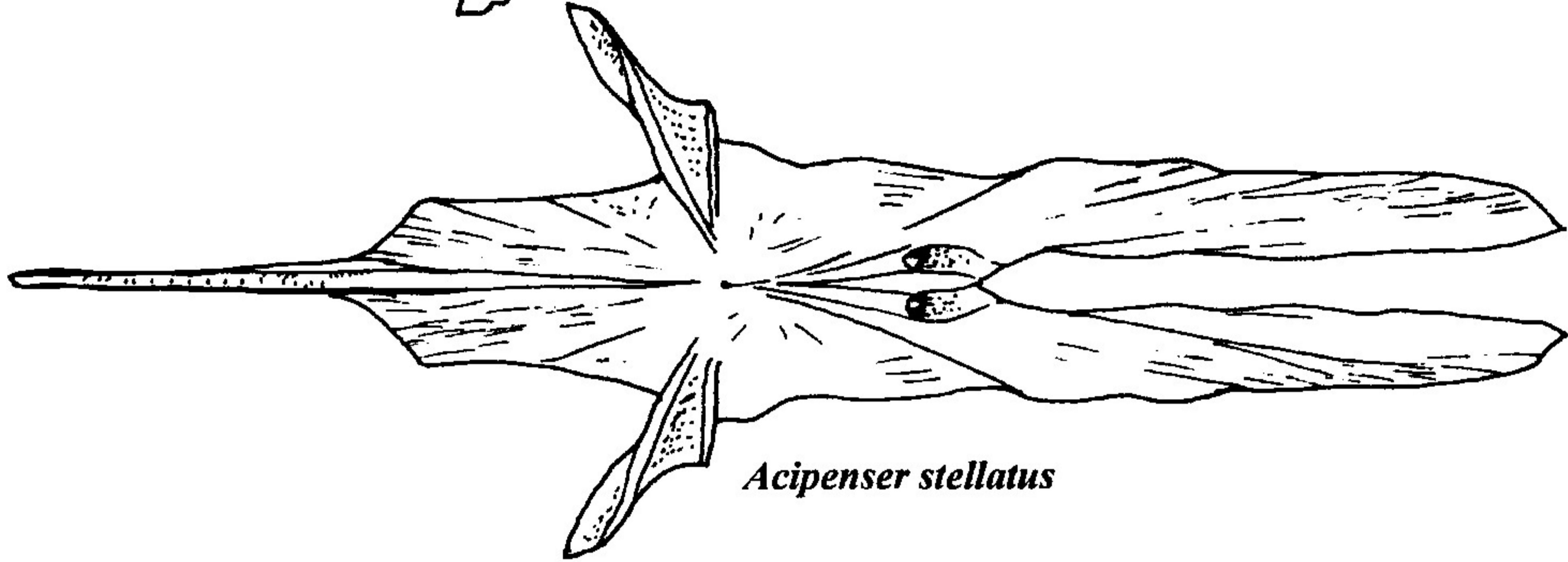
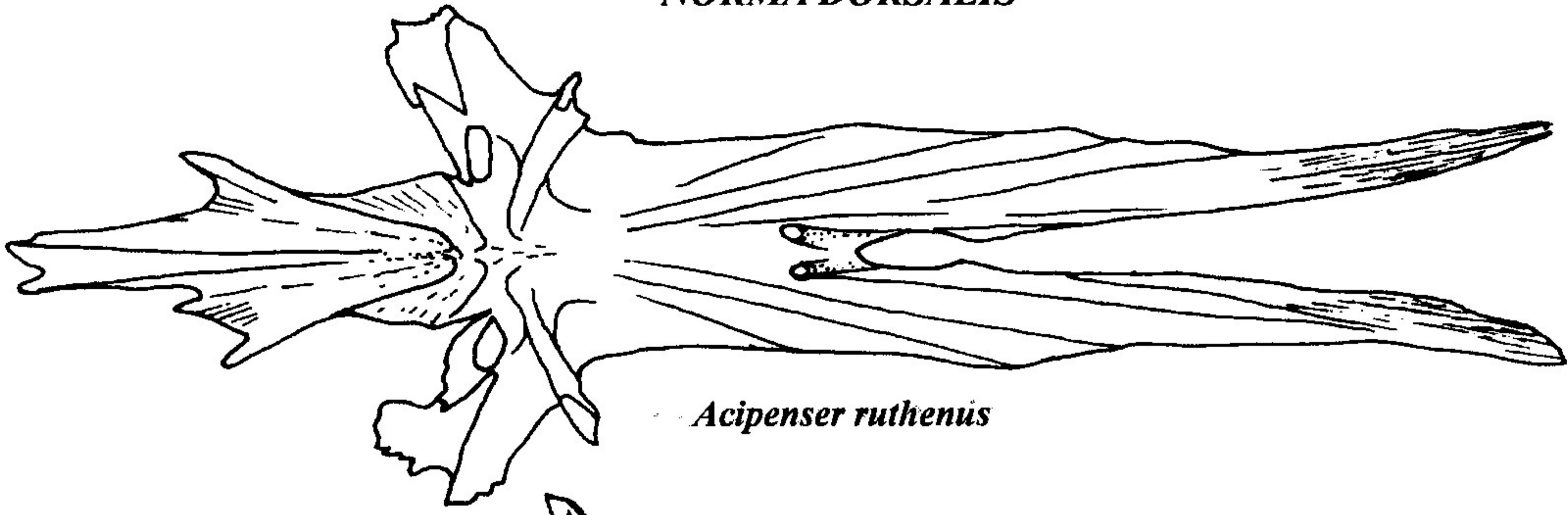
*Chondrostoma nasus*

## **THE STURGEON SKELETON**

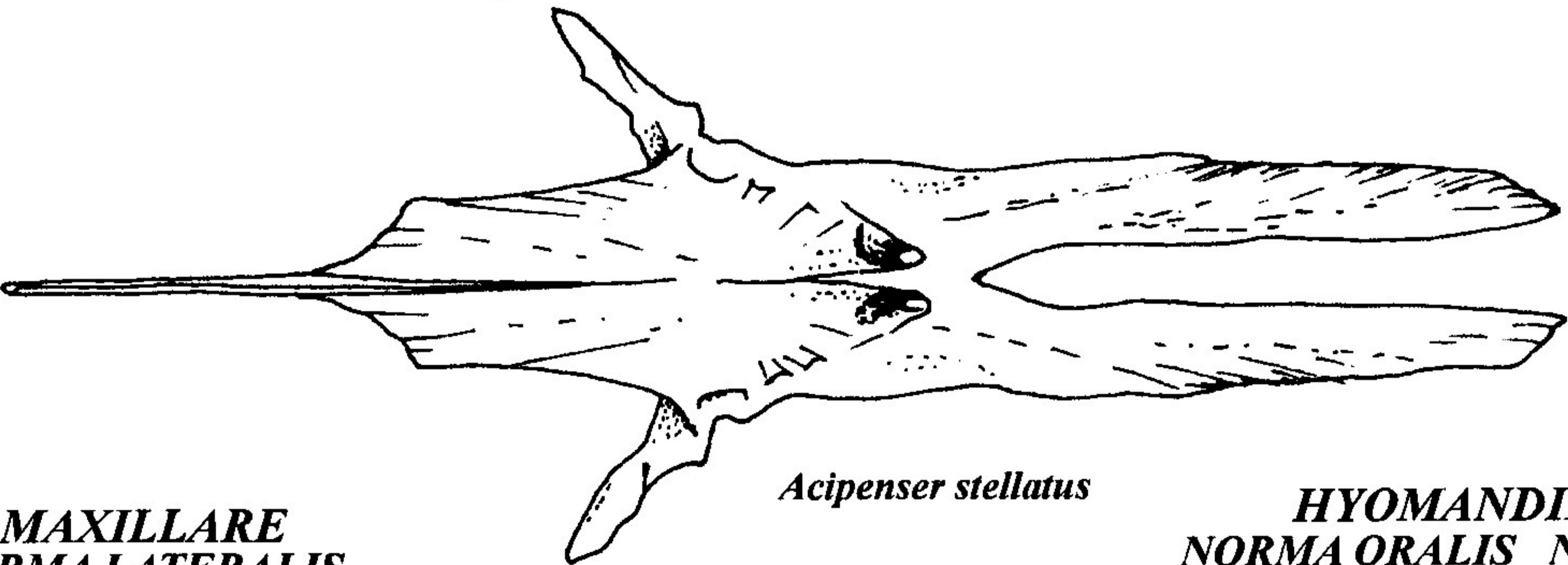
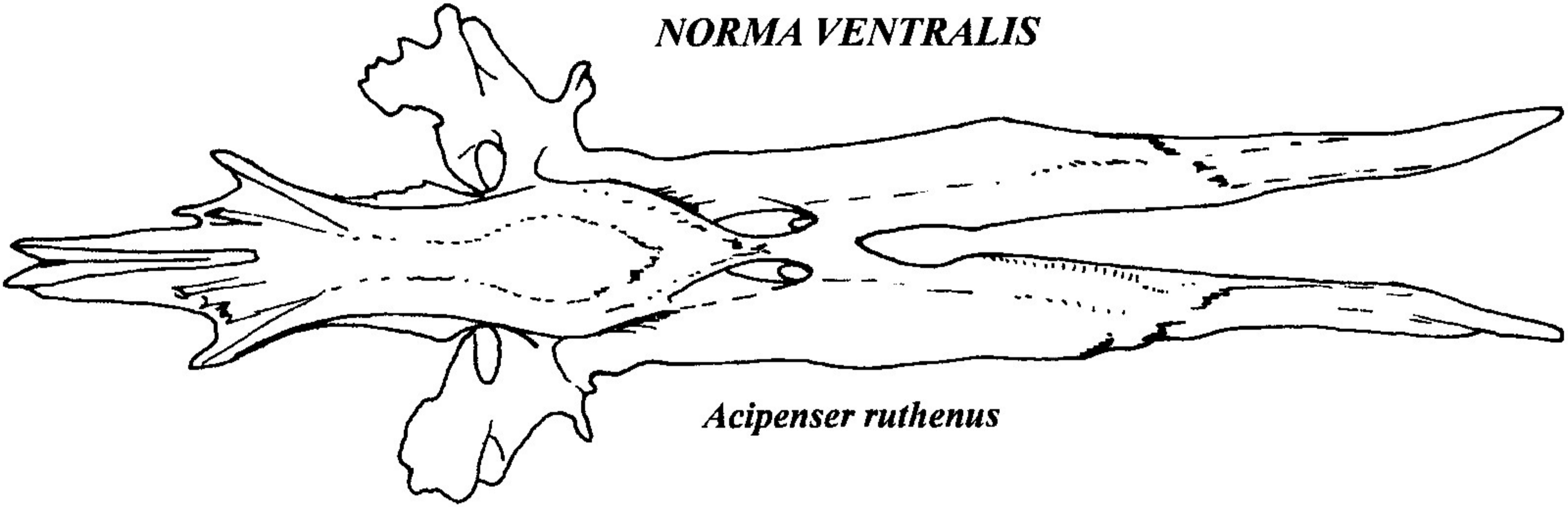
The internal skeleton of sturgeons is reduced and consists of only a few bones – the parasphenoid, premaxilo-maxilar, endopterygoid, ectopterygoid and palato-pterygoideum, dental, hyomandibular and simplectic, ceratohyal, hypohyal, stylohyal, branchial arches, opercular, subopercular and preopercular. The external skeleton of the cranium consists of bony plates named after the corresponding parts of the cranial skeleton of teleost fishes (postrostrals, frontals, parietals, pterotic, supracleitrals, claviculans, cleithrum, suboperculars, etc.).

**PARASPHEENOIDEUM**

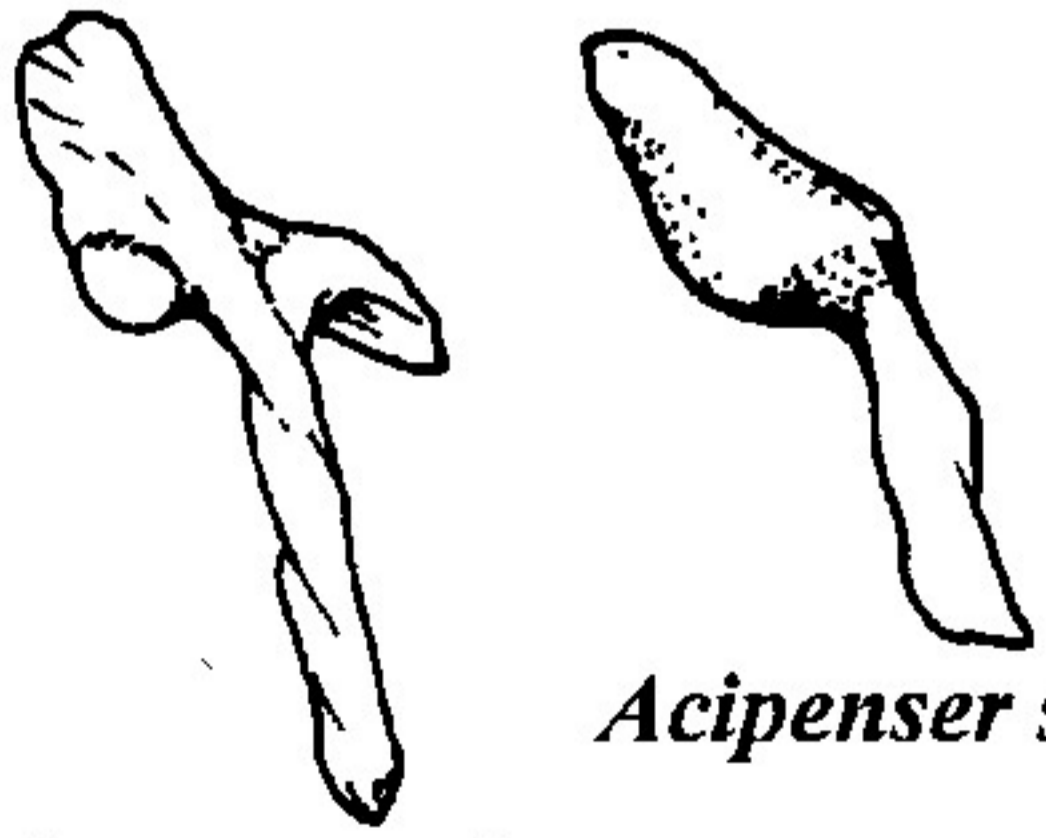
**NORMA DORSALIS**



**NORMA VENTRALIS**



**MAXILLARE  
NORMA LATERALIS**



*Acipenser ruthenus*

*Acipenser stellatus*

**DENTALE  
NORMA LATERALIS**

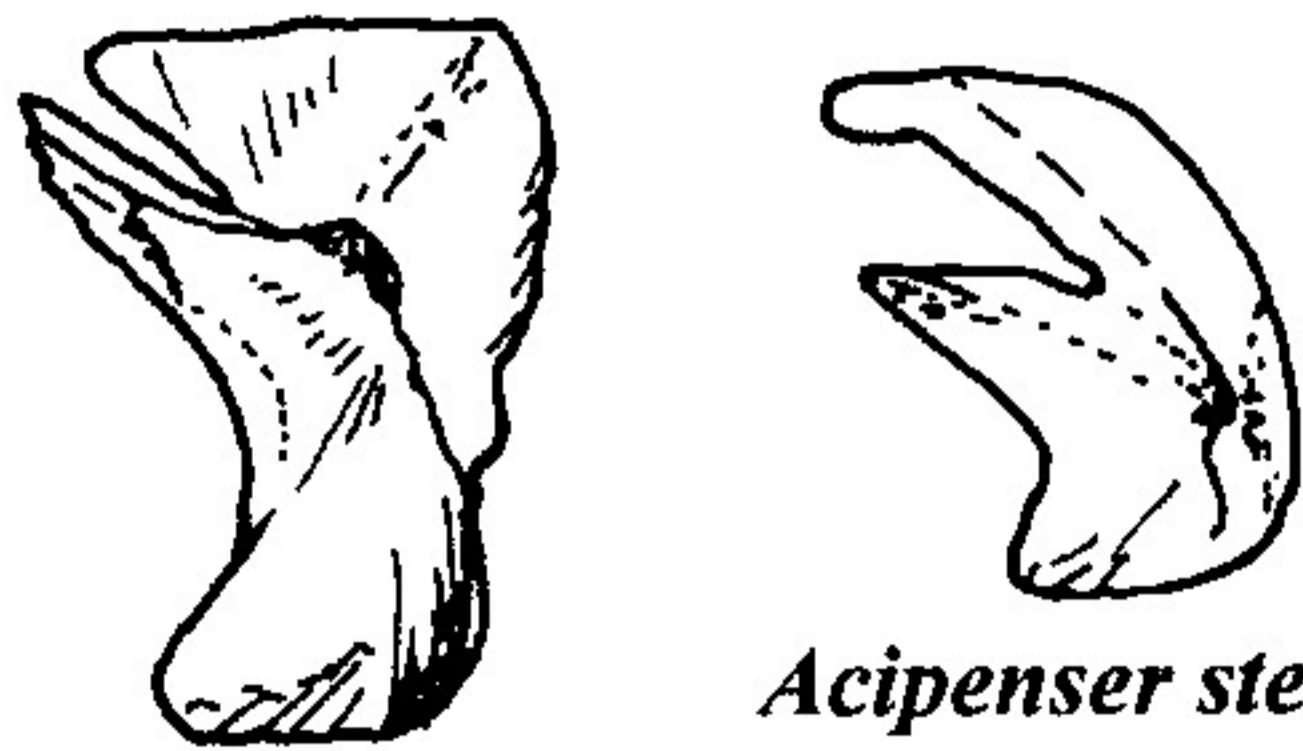


*Acipenser ruthenus*



*Acipenser stellatus*

**PALATO-PTERYGOIDEUM  
NORMA LATERALIS**



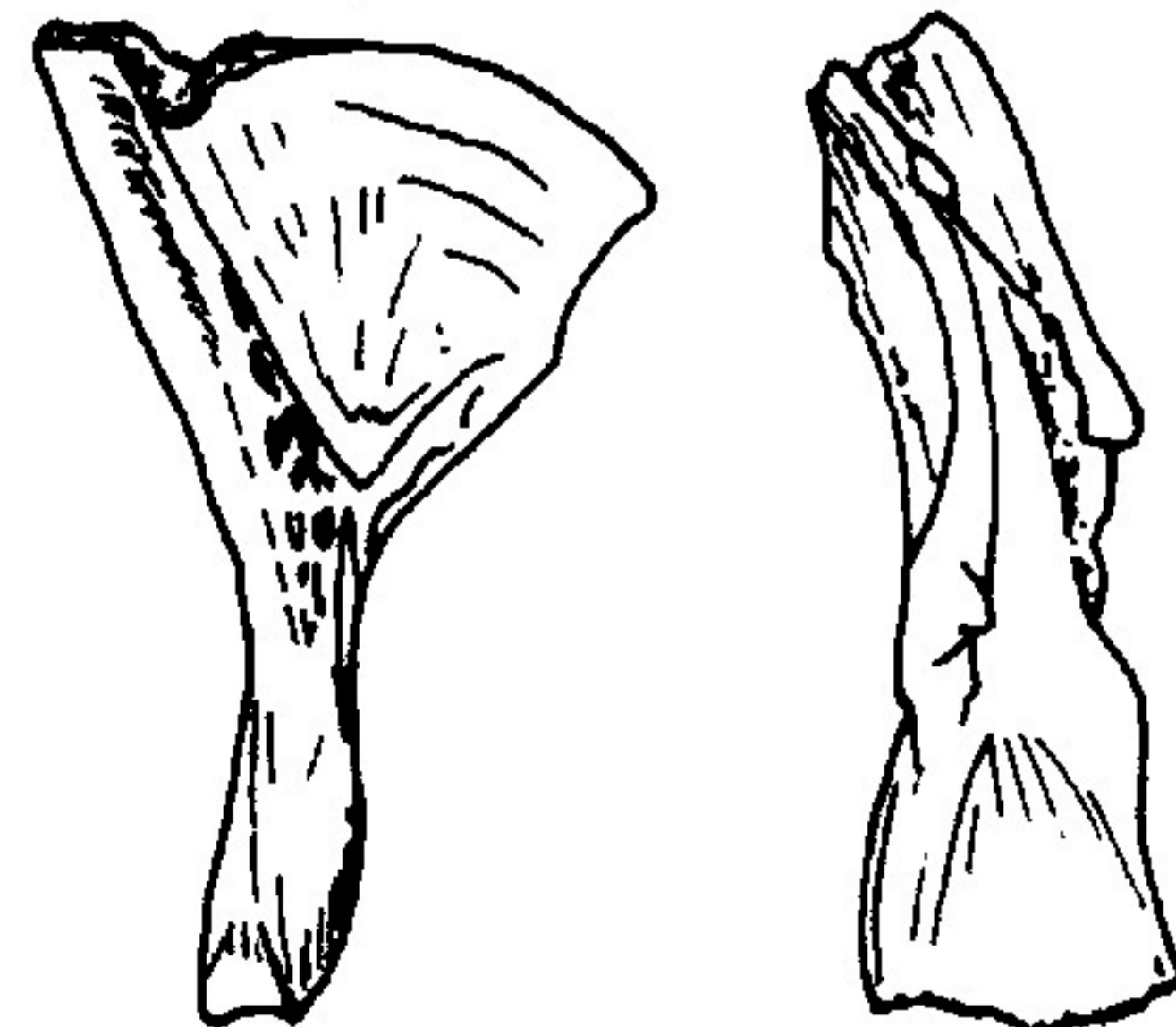
*Acipenser ruthenus*

*Acipenser stellatus*

**HYOMANDIBULARE  
NORMA ORALIS NORMA LATERALIS**



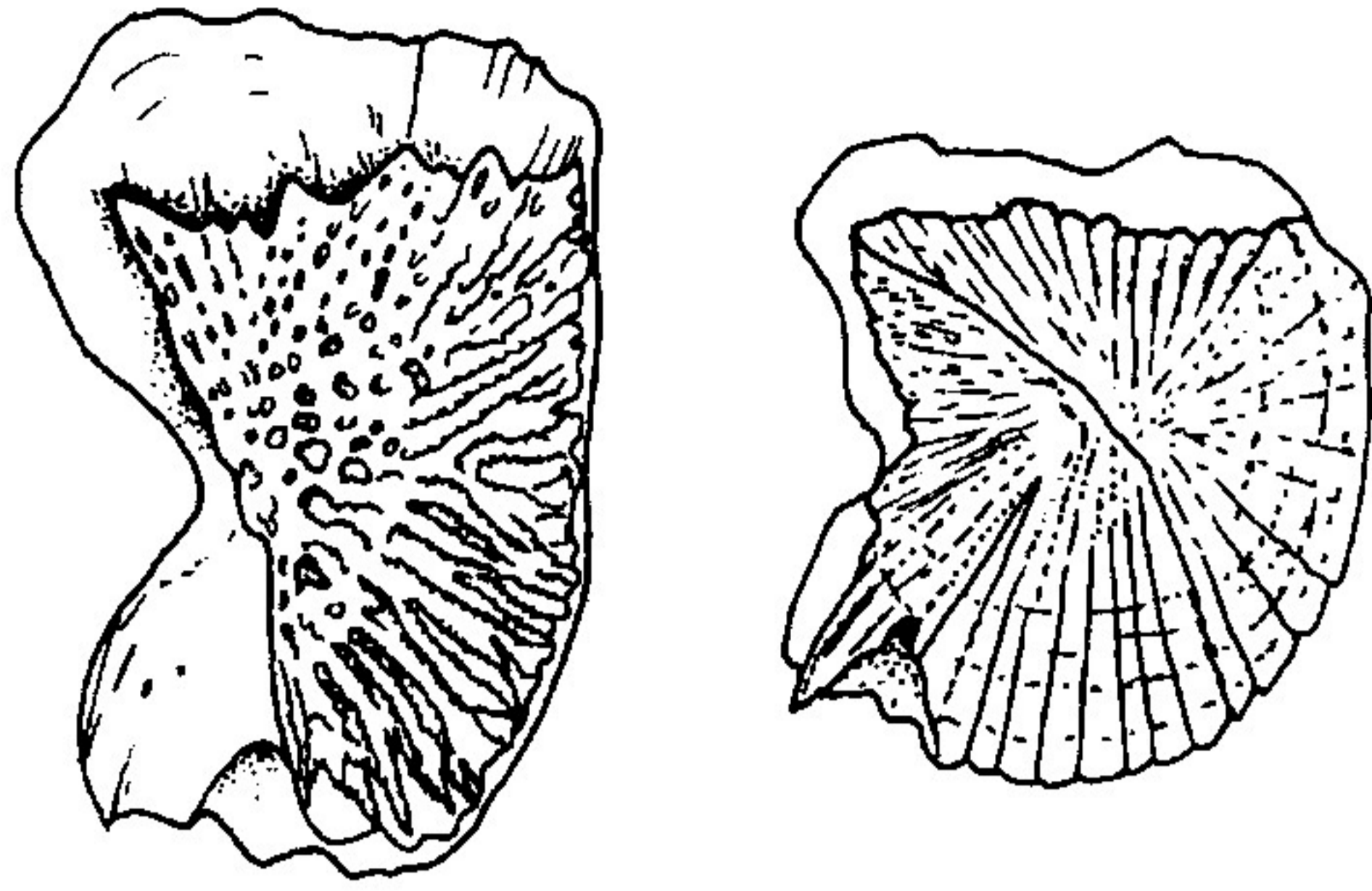
*Acipenser stellatus*



*Acipenser ruthenus*



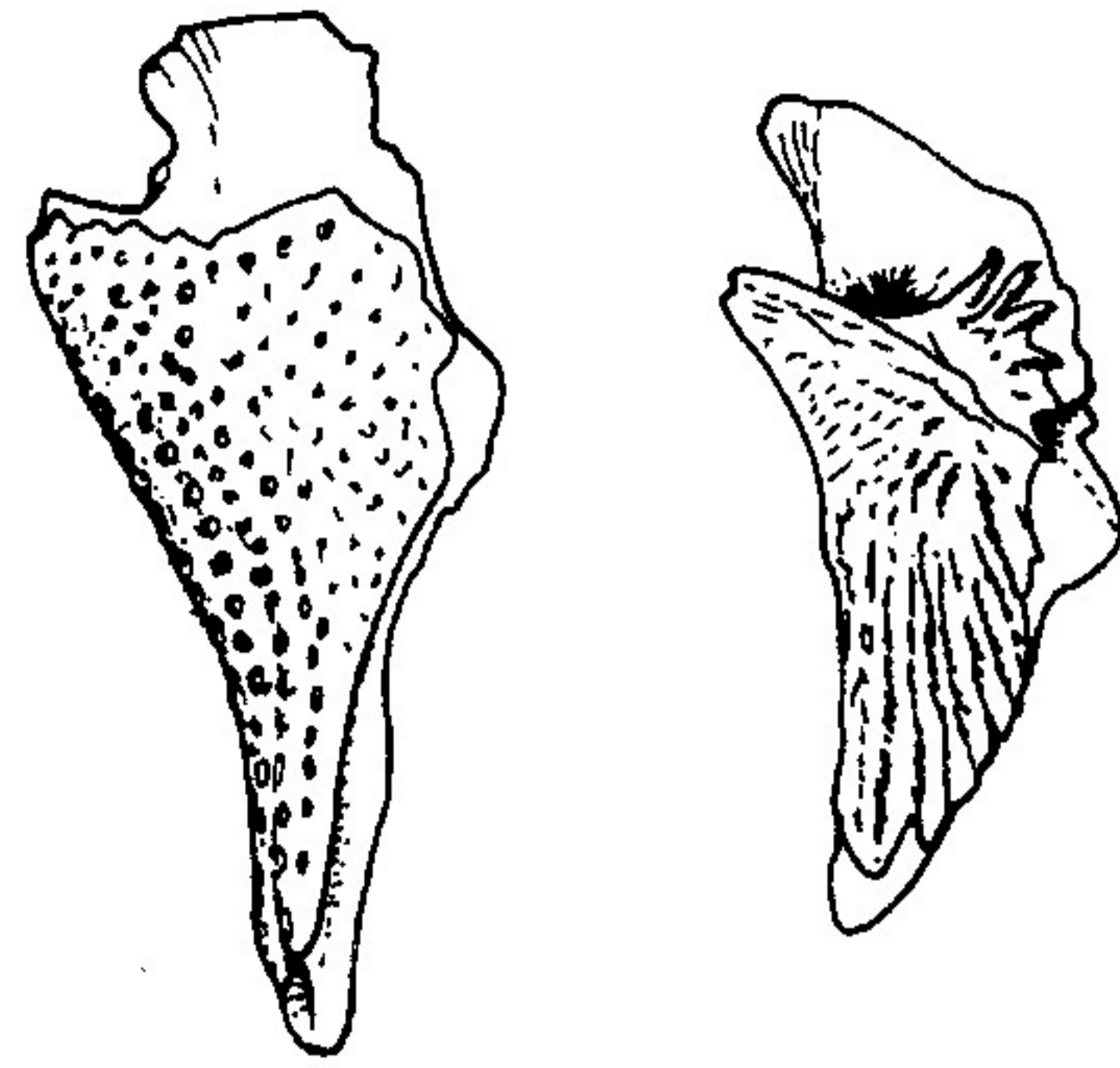
**SUBOPERCULARE  
NORMA LATERALIS**



*Acipenser ruthenus*

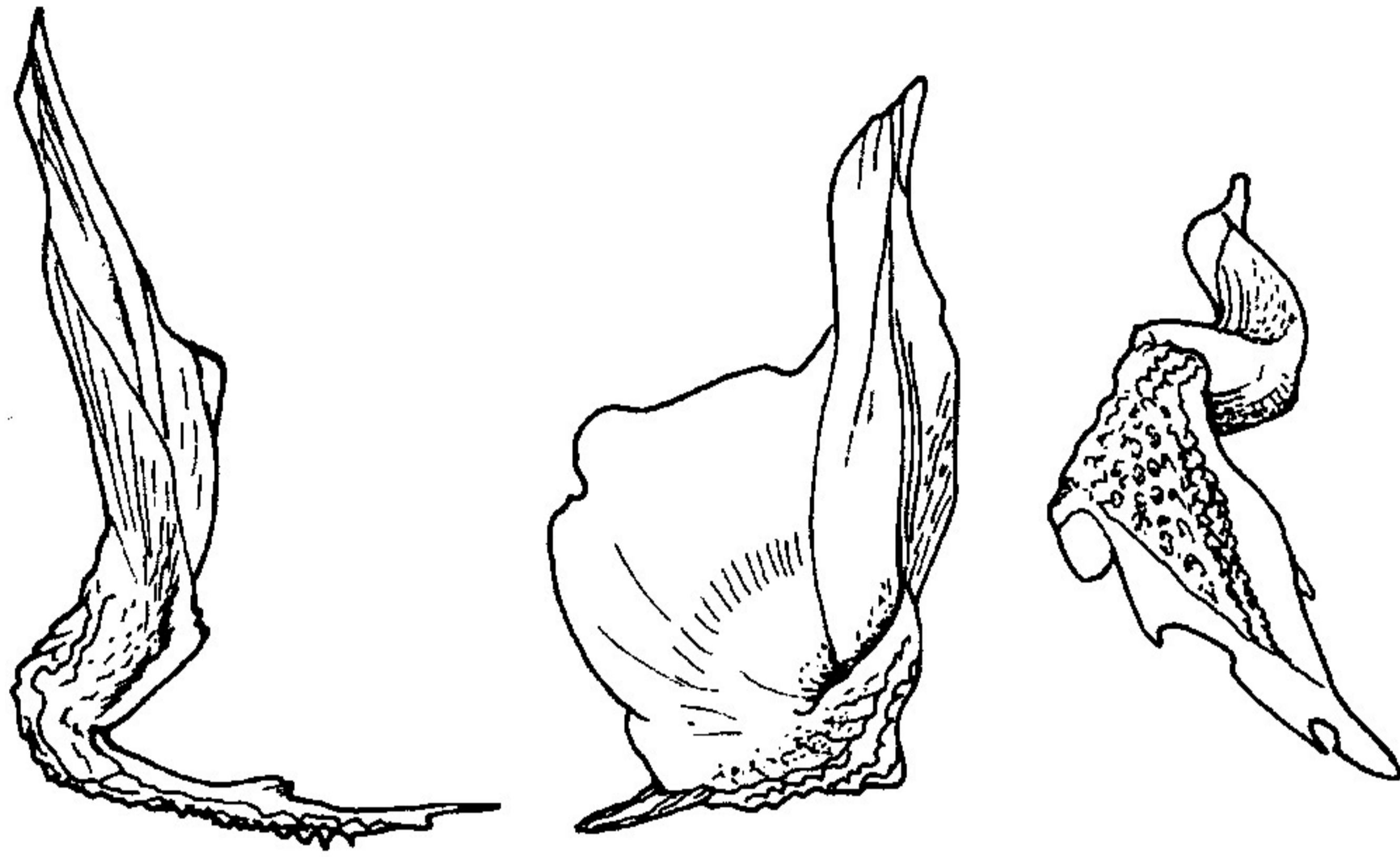
*Acipenser stellatus*

**SUPRACLEITHRALE  
NORMA LATERALIS**



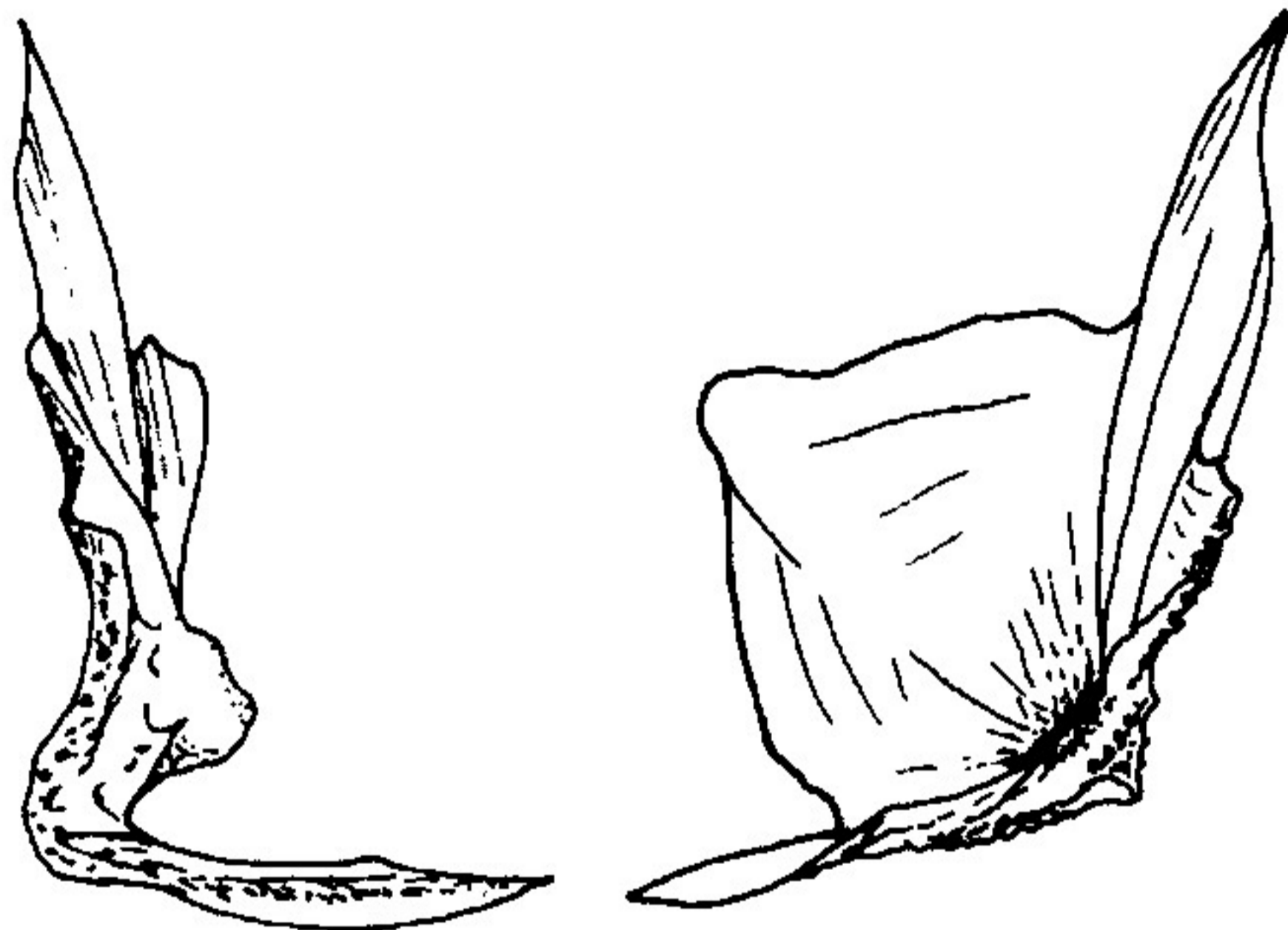
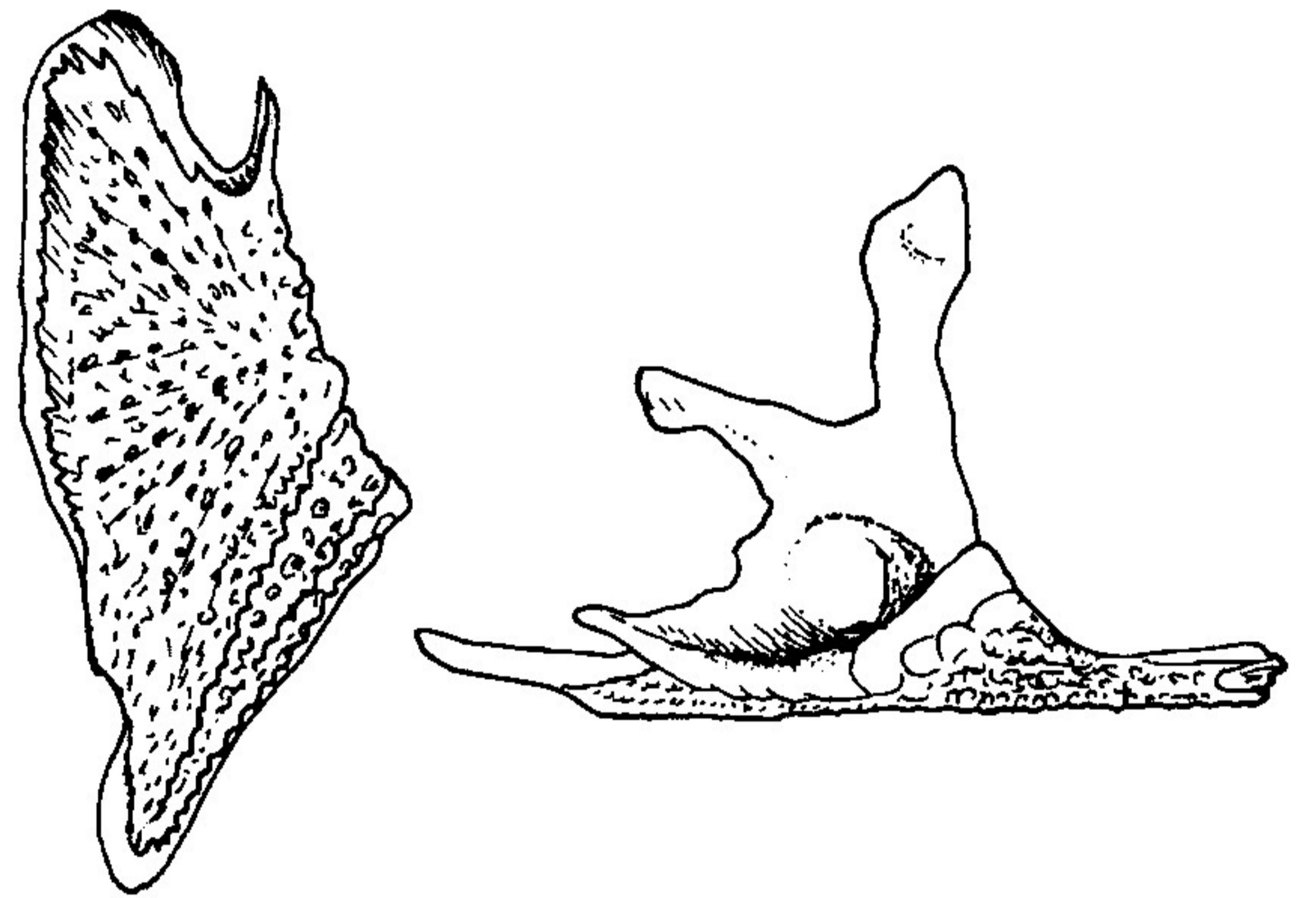
*Acipenser ruthenus* *Acipenser stellatus*

**CLEITHRUM  
NORMA DORSALIS NORMA LATERALIS NORMA VENTRALIS**



*Acipenser ruthenus*

**SUPRACLEITHRALE  
NORMA VENTRALIS NORMA LATERALIS**



*Acipenser stellatus*

**PINNA PECTORALIS I  
NORMA LATERALIS**



*Acipenser ruthenus*



*Acipenser stellatus*





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### STUDII DE PREISTORIE A publication of the Romanian Archaeology Association

Dedicated to prehistoric archaeology and interdisciplinary studies in archaeology, it publishes research articles and includes a supplement for the publication of monographs and other focused contributions.

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contact: ara.romania@gmail.com; aroarh@yahoo.com

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- Radian ANDREESCU, Douglass BAILEY, Steve MILLS, Steven TRICK, Pavel MIREA - Locuirea neo-eneolitică din valea Teleormanului, zona Lăceni-Măgura (Southern Romanian Archaeological Project) / *Neo-eneolithic occupation in the Teleorman valley, Lăceni-Măgura floodplain (Southern Romanian Archaeological Project)*
- Constantin HAITĂ - Studiu sedimentologic preliminar asupra locuirii neo-eneolitice din valea Teleormanului, zona Lăceni - Vitănești. Southern Romanian Archaeological Project, campania 2000 / *Preliminary results of the sedimentological study of the neo-eneolithic occupation in the Teleorman valley, Lăceni - Vitănești floodplain. Southern Romanian Archaeological Project, 2000 field season*
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- Cătălin BEM, Traian POPA, Valentin PARNIC, Carmen BEM, Daniel GARVĂN, Dan BĂRBULESCU, Irina GĂLUȘCĂ - Cercetări arheologice pe valea Neajlovului. Considerații generale asupra microzonei Bucșani / *Recherches archéologiques sur la vallée de Neajlov. Considérations généraux sur la microzone de Bucșani*

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#### **Book review**

Marin CARCIUMARU, *Evoluția omului în cuaternar. Partea a III-a: Tehnologie și tipologie preistorică*, Târgoviște, 2000 (ROXANA DOBRESCU)

Marin CARCIUMARU, *Peștera Cioarei Boroșteni. Paleomediul, cronologia și activitățile umane în Paleolitic*, Târgoviște, 2000 (ADRIAN DOBOȘ)

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Adina BORONEANȚ - The *Tardenoisian* in Romania – a false problem?

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Cristian SCHUSTER - Zu den *Ochsenhautbarren(?)* in Rumänien

Cătălin DOBRINESCU - Noi puncte de vedere privind cronologia bronzului târziu și a începutului epocii fierului în Dobrogea / Nouvelles points de vue concernant la chronologie de l'époque du Bronze tardif et le debut de l'Epoque du Fer en Dobroudja

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George TROHANI - Obiecte getice din fier descoperite la Căscioarele *Ostrove* / *Objets gétiques en fer découverts à Căscioarele Ostrovel*

#### **Serving the archaeology**

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#### **Book review**

Linda ELLIS (editor), *Archaeological Method and Theory: An Encyclopaedia*, Garland Publishing Inc., New York & London, 2000, 795 pag. (Cătălin NICOLAE)

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### **Supplementum 1/2005**

Valentin RADU - Atlas for the identification of bony fish bones from archaeological sites