

THE FAMILY OF CYPRINIDS AND THE CARP AS ITS TYPE

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By far the largest element of the fish fauna of the fresh waters of the northern hemisphere is the family of Cyprinids represented by the common carp, goldfish, dace, chub, bream, and their numerous relations. These have attracted considerable attention in Europe, but in America they have been comparatively neglected, so that but little is known of their habits. Nevertheless they may repay attention, for very interesting peculiarities are manifested by some of the species, especially during the breeding season, and some unexpected results may be obtained by observation of others. One of the main reasons for inattention to the species is the want of knowledge of how and what to look for and the scattered nature of the data already published relating to the economy of the species of the family. To supply to some degree at least this deficiency the following notes, gathered from many sources, are offered.

The popular names applied to the Cyprinids are numerous and in Europe most of the species are well distinguished and provided with distinctive names. The early English immigrants to America brought over a number of such names and applied them in a reckless manner to new species they found in the new land. None of the American species were much like any of the English ones and different persons were differently impressed by their appearance and consequently applied names expressing such differing impressions. The result is that on the one hand the same American species may be variously known as dace, roach, chub, or bream, and on the other hand each of those names may be applied to very different species. The old names are of much philological and historical interest and therefore the true owners of the names current in America are illustrated and the history of such names briefly indicated.

RELATIONS OF THE CYPRINIDS

The family of Cyprinids is one of four now generally recognized, either as independent families or subfamilies, belonging to a group (superfamily of Cyprinoideans or suborder of Eventognaths) which is itself a major subdivision of the order of Plectospondyles.

The families, besides the Cyprinids, are the Catostomids, Cobitids and Homalopterids;¹ the four may be recognized by the following selected characters:

The *Catostomids* or suckers have the upper margin of the mouth partly formed at the sides by the supramaxillary bones, the pharyngeals are falciform and armed with a single comb-like row of numerous more or less compressed teeth; there is no palatal pad, and the air-bladder is either bipartite or tripartite.

The *Cyprinids* or carp-like fishes have the upper margin of the mouth formed entirely by the intermaxillary bones, the pharyngeals are truly falciform and armed with few teeth in any row; there is a molariform pad behind the palate, and the well-developed air-bladder is generally bipartite, being divided into two chambers, an anterior and posterior, but sometimes tripartite, the posterior chamber itself being transversely constricted.

The *Cobitids* or loaches have the upper margin of the mouth, as in the Cyprinids, formed entirely of the intermaxillaries, the pharyngeals are only subfalciform and a single row of teeth is borne on a ridge-like margin; there is no molariform palatal pad, and the air-bladder is more or less reduced, disconnected from the stomach, divided into lateral halves enclosed in a bony capsule, and often open to the skin on the sides.

The *Homalopterids* have the upper arcade of the mouth formed exclusively by the intermaxillary bones, the pharyngeal bones are most like those of the Cobitids and the teeth in considerable number and uniserial; there is no palatal molariform pad, and the air-bladder is suppressed or rudimentary and representative of the anterior chamber of the Cyprinoid bladder, divided into lateral halves which are enclosed in a bony capsule.²

The geographical distribution of these groups is noteworthy. The Catostomids are almost peculiar to North America, the only extra-American species being several Siberian forms of the genus *Catostomus* and one generic type peculiar to eastern Asia (*Myrocyprius*). The Cyprinids, as will be more fully explained further

¹ The four families were first named and defined as now understood by Gill (*Proc. Acad. Nat. Sc. Phila.*, 1861, pp. 6-9), and have been adopted by American ichthyologists generally and by Smitt (1895); the Cyprinidæ, Cobitidæ and Homalopteridæ were recognized by Fatio (1882) and the four groups have been ranked as subfamilies by Boulenger (1898 and 1904).

² A remarkable generic type from Borneo (*Gyrinochilus*) with double branchial apertures, a mouth resembling a tadpole's and a small but free air-bladder was described in 1902 by Vaillant. It is the type of a peculiar family, Gyrinochilidæ, and not a member of the family Homalopteridæ.

on, occur wherever any other Eventognaths do. The Cobitids are mainly Asiatic, but several are African and three species have extended into Western Europe. The Homalopterids are confined to India and the continent and islands to the eastward.

CHARACTERISTICS OF THE CYPRINIDS

The form varies from high as in the breams and catlas to elongate as in the American *Phenacobius* and *Platygobio* and the African *Chelathiofs*, the belly being generally rounded, rarely (as in the sichling and *Chelathiofs*) compressed and trenchant; the scales are cycloid, confined to the body (not extending onto the head)—rarely wanting; the lateral line is more or less decurved and parallel with the belly, rarely atrophied; the fins, especially the dorsal and anal, vary greatly in size and relative position.

The carp-like fishes are the "leather-mouthed fish" of Izaak Walton; they have no teeth in the jaws, but to some extent divide or prepare their food by the operation of teeth on the concave side of the sickle-like pharyngeal bones which are just behind the gill-arches. The character was long ago observed but not understood and fishes distinguished thereby were designated by the English fishermen as "leather-mouthed."

"By a leather-mouth," Walton explained, "I mean such as have their teeth in their throat, as the chub or cheven, and so the barbel, the gudgeon, the carp, and divers others have." These "teeth in their throat" are, as just remarked, really on special bones behind the gills called "pharyngeal."

The pharyngeal bones and especially the teeth which beset them, are so much used in classification that a little attention to them is called for here. They were first utilized for the arrangement of the genera by Agassiz (1835) and later much more extensively by the Austrian naturalist, J. Heckel (1843) and ever since have been made use of in all works treating of these fishes.

The pharyngeal bones are not only immediately behind the branchial arches, but are considered to be "serially homologous" with them; in other words, derived from primitive generalized arches but greatly modified from them. They tend to preserve the same general form as the arches and are more or less falciform, or like a sickle, having a short base of insertion or handle and an ample arched body. In the suckers or Catostomids these bones are provided with numerous processes or teeth inserted at right angles to the axis of the bone. In the carp-like or Cyprinoid fishes, the teeth are in reduced number and variously modified. There is

always a main row, generally of five or about five teeth, very often a secondary row, and in other types a third one.

In the common carp (*Cyprinus*) there are generally said to be three rows of "molar" teeth, but there are only three teeth in the main row and one in each of the others; in the nearly related goldfish (*Carassius*) there is only one row of teeth which are "scalpriform"; in the barbel (*Barbus*) the teeth are again in three rows (five in the main one, three in the next and two in the third) and "cochleariform" or excavated like a spoon. These kinds of teeth are coördinate with a very long intestine.

In the chub and roach (*Leuciscus*) the teeth have pinched or "contusory" crowns and are uniserial and five or six in a row; in the rudd (*Scardinius*) they are "raptatorial" and in two rows (five in main, three in secondary). The intestinal canal concomitant with these hooked teeth is more or less abbreviated.

Such are examples of four of the modifications of the pharyngeal dentition recognized by Johann Jakob Heckel. That author, as the result of prolonged studies of the dental characteristics of the Cyprinids, formulated in 1842 an elaborate classification of the teeth and this has been the basis of and standard for most of the work since done on the parts in question. Heckel's essay was buried in a publication accessible to but few—Joseph Russegger's "Reisen in Europa, Asien und Afrika," etc. Most of it is contained in the first volume (second part, pp. 1001–1043). An author's edition of Heckel's ichthyological contributions to Russegger's work was published in 1843 (258 pp., 22 pl.).

The species were ranked under genera characterized in the first place by the form and number of teeth, the genera were combined under tribes distinguished by characters drawn from the mouth, lips, cirrhi, position of preopercle, and form of dorsal and anal fins as well as their spines. Thus was a natural classification attempted. To facilitate comprehension and description of the pharyngeal dentition, a detailed classification of the kinds of armature independent of the collective characters of the tribes was prefixed. On account of its usefulness and the rarity of the work in which the essay was published the following outline is given:

I. MACROENTRI. (Elongate alimentary canal.)

A. DENTES EXCAVATI. Hohlzähne. (Teeth excavated.)

Dentes cochleariformes. Löffelzähne. (Teeth spoonlike.)—*Barbus barbus*. (Barbel.)

Dentes palcaformes. Schaufelzähne. (Teeth spadelike.)—*Capoeta* (or *Scaphiodon*) *capoeta*. (Capoeta.)

- B. DENTES MASTICATORII. Kauzähne. (Teeth for grinding.)
Dentes aggregati. Pflasterzähne. (Teeth crowded.)—*Labeo niloticus*.
Dentes molares. Mahlzähne. (Teeth molariform.)—*Cyprinus carpio*.
 (Carp.)
Dentes calyciformes. Becherzähne. (Teeth cuplike.)—*Carpio kol-
 larii*. (Hybrid between Carp and Karass.)
Dentes scalpriiformes. Meisselzähne. (Teeth chisel-like or scalpri-
 form.)—*Carassius carassius*. (Karass.)
Dentes pectiniformes. Kammzähne. (Teeth comblike.)—*Catostomus
 commersonii*. (Sucker.)
Dentes cultriformes. Messerzähne. (Teeth knifelike or cultriform.)
 —*Chondrostoma nasus*.
- II. BRACHYENTRI. (Shortened alimentary canal.)
- C. DENTES UNCINATO-SUBMOLARES. Hakenzähne mit Kauflächen. (Teeth
 hooked and with grinding surfaces.)*
Dentes clavati. Keulenzähne. (Teeth clublike.)—*Tinca tinca*.
 (Tench.)
Dentes contusorii. Drückzähne. (Teeth bruising.)—*Rutilus rutilus*.
 (Roach.) *Abramis brama*. (Bream.)
Dentes prehensiles. Greifzähne. (Teeth prehensile.)—*Notropis cor-
 nutus*. (Redfin.)
- D. DENTES UNCINATO-SUBCONICI. Hakenzähne ohne Kauflächen. (Teeth
 hooked and without grinding surfaces.)
Dentes raptatorii. Fangzähne. (Teeth raptorial.)—*Lenciscus ce-
 phalus*. (Chub.) *Scardinius erythrophthalmus*. (Rudd.) *Idus
 idus*. (Ide.) *Aspius aspius*. (Asp.) *Gobio gobio*. (Gudgeon.)
Dentes voratorii. Würgezähne. (Teeth for strangling.) *Barilius
 niloticus*. *Danio alburna*.

It must be distinctly understood, as Heckel himself recognized, that this arrangement is one of the pharyngeal teeth alone and not one of the fishes. Nor is the arrangement of the genera under tribes a natural one. A natural classification of the family is still a desideratum and one not likely to be discovered for many years to come. Only by a comparative study of the anatomy and especially of the bones can a natural system be obtained. Two most important agencies will be requisite to this end, (1) a collection of skeletons of the genera (disarticulated so that all parts may be examined) and (2) a man prepared to utilize it; the former might be procured without extreme difficulty and without excessive cost but for the latter we may have to wait for a long time.

The pharyngeal bones of the principal European genera of Cyprinids have been well illustrated by Dr. Victor Fatio in his excellent work on the fishes of Switzerland and these have been reproduced for the present article.

On or behind the palate is an apparatus against which the pharyngeal teeth work in the tearing and mastication of the ingested food.

The palate, as Smitt explains, is lined with a mucous membrane, thickly covered with papillæ and arranged in longitudinal folds, "which is continued backwards, smooth but with large gustatory papillæ, on the tumid, soft, cushion-like mass of muscles and fat—the carp's tongue so highly prized by the epicure—situated under the posterior part of the cranium. Backwards and downwards from the body of the occipital bone runs an osseous (pharyngeal) process, pierced at its base for the passage of a blood vessel (*aorta abdominalis*), the under surface of which process, just at the end of the said cushion, is shod in a depression with a cartilaginous, more or less hard and tumid disk, the so-called *carp-stone* or *pharyngeal cartilage*," by the Germans called *Karpfenstein*, by the French *la meule*. This carp-stone is characteristic and its modifications serve to indicate the affinities of genera; for example, in the carps, gudgeons and tench, it is triangulate and very hard with a yellowish-brown surface; in the barbels it is also triangulate but semi-cartilaginous, thus differing from that of the Cyprinines and more like that of the other European forms; in the chubs, daces and breams it is somewhat pentagonal or oval, comparatively soft and elastic, and has a whitish surface. The carp-stone has been entirely neglected by American naturalists, but its characteristics have been more or less used by some European ichthyologists, and especially by Fatio, for the distinction of genera of the old world. The illustrations given by Fatio are in a plate accompanying this contribution. They will serve as a basis for comparison of American types.

The ingesta, or at least some of them, appear to be soon reduced; "as a rule food passes rapidly through the intestinal canal; a goldfish fed with wheat-bread passes after some minutes a white vermiform mass of excrement, which hangs from the vent."

The diet is in accordance with the nature of the pharyngeal teeth; fishes with hooked and pointed teeth and shortened intestines being carnivorous, while those with molar teeth and extended intestines are more or less herbivorous.

DISTRIBUTION

Somewhere over a thousand species of this family are known. Asia, and especially India, harbors the greatest number; Africa is less rich, Characinids to some extent taking their place. North America, with about two hundred and fifty species, is on a par with India. None are found in South America, where their place is entirely taken by the Characinids; Australia also has none.

Two species have been domesticated and extensively introduced

into many countries. One is the carp (*Cyprinus carpio*) utilized for food purposes, and the other the goldfish (*Carassius auratus*), so well known as the tenant of aquaria and globes in numerous houses. Other European species domesticated to a slight extent are the ide, id or nerfling (*Idus*, or *Leuciscus, idus*) and the tench (*Tinca tinca*). All these have been imported into the United States from Europe.

In the aggregate the Cyprinids supply a large proportion of the fishes which serve for the consumption of the inhabitants of the inland countries whose waters they frequent. In the eastern and central portions of the United States, however, they are regarded with little favor, as they are mostly too small to furnish food to the table or sport to the fisherman. Their numbers and their presence everywhere, nevertheless, force them on the attention of the inhabitants, and even if they fail to appeal to the palate of the epicure or to satisfy the desire of the "scientific angler," their pursuit gives pleasure to thousands of juvenile anglers; and men, too, after all are boys of riper growth and, disdaining the capture, yet take. Old Ausonius has given a vivid picture of the youthful angler which may recall boyish days.

Poised on a rock, hid from fish's gaze,
His slender line the cautious angler plays,
Inclining downward from his shadowed nook,
The pliant rod, whose tip with graceful crook,
Yields gently to the plummet's chosen weight;
The eager fish quick bites the flattering bait,—
Then writhes in terror at the pang, that thrills
From the barbed iron through his wounded gills,
Down sinks the float, and, with repeated nod,
The struggling captive agitates the rod,—
The ready stripling, through the hissing air,
From right to left now springs the straining hair,
And, flung upon the shore, his welcome prize
Flounces awhile in death, and gasping dies.

In spite of the fact that the family is abundantly represented in the waters of the most progressive nations of the globe as well as others, the paleontological history is almost unknown. Numerous remains have been found of middle and later tertiary age (not older than the oligocene) but all have been identified with existing genera. Not a single well differentiated and determined extinct genus has been discovered and no light has been thrown on the past history or origin of the family. A few distinct generic names, it is true, have been proposed for extinct species, but the remains have not been sufficient to allocate them in the system. The sup-

posititious "new genera" have been based almost entirely on pharyngeal bones and teeth.

SEXUAL DIFFERENTIATION

As the breeding season approaches, and during that season, the males of many species assume and exhibit brilliant colors and marked cutaneous excrescences. The colors are in some extremely vivid and chiefly bright red, blue, and steel color; the excrescences or tubercles vary in position; they are mostly on the head and especially about the snout, but in some are also developed on the sides and on the fins. These excrescences are correlated with the manner in which the males approach the females and attach themselves during the period of oviposition, and there appears to be considerable variation, according to species, in the manner of juxtaposition of the male and female during the process of oviposition.¹

The eggs are mostly laid on the ground and, after fertilization by the males, left to themselves. Of some species, however, the parents, generally only the males, assume charge of the eggs and watch over them until they are hatched. None of the European fishes are known to do so, but the American horned dace (*Semotilus atromaculatus*), black-headed dace (*Pimephales promelas*), and stoneroller (*Camptostoma anomalum*) do, and their actions have been especially studied by Professor Reighard. But the most remarkable mode of oviposition is that manifested by the Central European bitterling (*Rhodeus amarus*). The sexual differences are well marked; the male being larger and brilliantly colored in the breeding season. The ripe female has a long ovipositor in front of the anal fin, by which she introduces egg after egg into a gill of a fresh-water mussel (Unionid) and therein the egg is developed and hatched. Nothing like this has been found in America where the mussels so abound, but it is not impossible that analogous species may occur here.

Naturally the habits of the common and widely distributed carp are best known, and a summary of what has been learned about it may give not only its history but hints as to points to be observed for other species of the family.

LIFE HISTORY OF THE CARP

The genus *Cyprinus*, though designated as the type of the family and giving name to it, is only to that extent typical, it being a group

¹ Another kind of sexual differentiation will be noticed in connection with the Tench (p. 210).

of only two known species at most, of temperate Asiatic origin. It is characterized by an oblong compressed body, large scales, two pairs of barbels, long dorsal with an osseous (third) ray in front, short anal, and pharyngeal teeth which are mostly molariform and in three rows (3|1|1—1|1|3). The principal species is the well known common carp (*Cyprinus carpio*); a doubtful second is a peculiar Chinese species with larger scales (*Cyprinus fossicola*).

The common carp (*Cyprinus carpio*), in its most natural condition, has its body covered with scales of moderate size, thirty-five to forty along lateral line and in five or six longitudinal rows between the line and fore part of back. In artificial condition sports from this standard have been derived and two varieties largely cultivated. One is the mirror carp, in which the body has become for the most part naked, but very much enlarged scales developed in three rows, along the lateral line on the tail, on the back below the dorsal fin, and below above the anal; the other is the leather carp, in which the scales are wholly or almost entirely lost.

The carp's behavior is well worthy of attention. In water which it has not been able to befoul too much, it may be seen listlessly swimming about with the dorsal folded backwards, the anal slightly less so, the caudal lazily moved from side to side, the pectorals horizontal or slightly oblique, and the ventrals folded on the abdomen. Tired even of this, it retires down to the bottom and there rests largely on its ventrals, now horizontally outspread and with the surface touching the ground. It never ceases its inspirations which occur mostly from twenty to forty times a minute, rarely more or less. The gulping at the mouth is quickly succeeded by the uplift of the gill-cover; sometimes they appear to be almost synchronous with each other. It may frequently ascend to the surface to take in a breath of free air. Indeed, according to some authors (Smitt for example), "during the warm season" the carp "soon dies of suffocation if prevented from coming to the surface to breathe." The commotion which it causes in the water by such excursions has given rise to a curious superstition in Ireland. Frank Buckland was told that "fairies could be seen dancing on bright moonlight nights in a certain lake" of that favored land of the fairies, and he went to enjoy the sight. "The water was very still but showed rings innumerable. These," he found, "were caused by large carp coming to the surface and smacking their lips as they took in great gulps of air."

The carp is ubiquitous and will live in almost any water, but experienced carp-culturists (*e. g.*, R. Hessel) insist that it is "par-

tial to stagnant waters or such as have not a too swift current, with a loamy, muddy bottom and deep places covered with vegetation"; further, "it is an advantage that the carp is able to live in water where other fishes could not possibly exist; for instance in the pools of bog-meadows or sloughs." Nevertheless, "it is not by any means to be inferred from this that the best locality for carp ponds of a superior kind" should be "in such situations. The presence of too much humic acid is unfavorable to the well-being of the carp." In short, its preference generally appears to be for "places with a luxuriant vegetation, being by no means averse to a muddy bottom, but requiring clear water and free access to the sunlight."

But it is not even confined to the fresh water; it is, to some extent, tolerant of salt; in the words of Smitt, it can "endure salt water." In the Caspian sea even, if Pallas is to be credited, "the carp lives in water so salt that hardly any other fish can sustain life there." Its occurrence in brackish waters in many places has been recorded.

Although individuals endure for a time wide differences of temperature, they flourish best in water which is not overheated or too cold. Tropical countries and those where cold prevails for nearly half of the year, as in Scandinavia or the northern part of the Canadian Dominion, are not favorable to their continuous development. They are indeed "highly sensitive to heat and cold."

They manifest the effect of cold by seeking warmer resorts and by abstention from food. "In the moderate zone" (*e. g.*, Central Europe or the middle United States), "the carp will, at the beginning of the cold season, seek deeper water to pass that period in a kind of sleep. This will sometimes occur as early as the beginning of November if the winter should set in early; and it is to be remarked that they will retire at an earlier period in ponds than in rivers. They do so always in groups of from fifty to one hundred and more. They make a cavity in the muddy ground, called a 'kettle'; in this they pass the time until spring, huddled together in concentric circles with their heads together, the posterior part of the body raised and held immovably, scarcely lifting the gills for the purpose of breathing, and without taking a particle of food. They do not take any food from the beginning of October and continue to abstain from it, in some countries, until the end of March, and in colder districts even somewhat later."

Tenacity of life is another attribute of the carp. It is claimed that in this respect the carp surpasses all its compatriots except the eel. This characteristic enhances its commercial value as a market fish, for it can be carried for long distances and displayed on the

fish-stall alive. "Packed in damp moss or ice and with a bit of bread dipped in spirits in the mouth, the carp can live at least twenty-four hours." It can also endure deprivation of water for quite a long time. Smitt tells of a mirror carp sent to the Royal Museum of Stockholm in a bucket and kept alive for several days. "One morning it was found to have leapt out of the tub, and lay on its side apparently dead. It was restored to the water, but floated belly upwards and did not move a limb. It was then given a dessert-spoonful of spirits, and began after some minutes faintly to move its pectoral fins. After a quarter of an hour the dose was repeated, and within an hour the fish moved about with ease, as if nothing had happened." A judicious admixture of spirits and water, it seems, is not to be restricted to man!

Omnivory has truly been attributed to the carp; it will feed not only on fish, flesh and fowl, but on vegetables as well as all kinds of small organisms. "After its first awakening from the long winter sleep, it seeks most diligently after the contents of the seeds of the *Nuphar luteum* and *Nymphaea alba*, the yellow and white water-lily, the *Phellandrium aquaticum*, *Festuca fluitans*, etc."¹

The faculty of rumination has been claimed for the carp. W. Houghton (1867) quotes a communication by Richard Owen affirming that a carp, "after having fed voraciously on ground bait," when "laid open, shows well and long the peristaltic movements of the alimentary canal; and the successive regurgitations of the gastric contents produce actions of the pharyngeal jaws as the half-bruised grains come in contact with them, and excite the singular tumefaction and subsidence of the irritable palate, as portions of the regurgitated food are pressed upon it. The shortness and width of the œsophagus, the masticatory mechanism at its commencement, and its direct terminal continuation with the cardiac portion of the stomach relate to the combination of an act analogous to rumination, with the ordinary processes of digestion, in all fishes possessing these concatenated and peculiar structures."

It need only to be added that the "analogy" in this case is, at best, remote.

The awakening from their winter sleep is followed not long after (about May) by the season for spawning. The female has become

¹ The *Nuphar* and *Nymphaea* are now called by many botanists *Nymphaea* and *Castalia*; the plant called by Hessel *Phellandrium aquaticum* is better known as *Cenanthe phellandrium* or fine-leaved *Cenanthe*; it is not a native American plant; the *Festuca fluitans* is popularly known as the floating fescue or water grass.

turgid about the abdomen, the ovaries fully developed and the eggs ripe. The number of eggs is approximately proportioned to the size of the ovaries and consequently that of the mother-fish; in one of four or five pounds weight there may be 400,000 to 500,000 or even more. In one weighing sixteen and a half pounds, whose ovaries weighed five and one half pounds, over 2,000,000 eggs were accounted for. The male has assumed external sexual characteristics in the form of protuberances, like warts, on the skin of the head and back, which disappear after the spawning season. His color also brightens. Some days before spawning, both sexes show increased vivacity, and "rise more often from the depths below to the surface." Two or three or more of the males keep near a female and the latter swims near the surface followed by the males. "The female prefers spots which are overgrown with grasses and other kinds of aquatic plants." The males follow close to the very water's edge. "They lose all their timidity and precaution, so that they may be taken quite easily. They lash the water in a lively way, twisting the posterior portion of the body energetically, and shooting through the water near the surface with short tremulous movements of the fins. They do so in groups of two or three males to one female fish and forming an almost compact mass. This is the moment when the female drops the eggs, which immediately are impregnated by the milt. As this process is repeated several times, the female drops probably only from four hundred to five hundred eggs at a time, in order to gain resting time, so that it will require days and weeks" before she gives up "the last egg." These eggs are adhesive, not detached, and adhere in lumps to the object upon which they have fallen. They average about a millimeter and a half in diameter and are of a yellowish color.

As soon as the eggs have left the body they begin to swell and their mucus-like investment serves to fasten them to "some aquatic plant, stone, or brush-wood. Those eggs which have no such object to cling to are lost." The eggs develop rapidly and development is hastened by increased warmth. Under ordinary conditions, "as early as the fifth or sixth day the first traces of dusky spots, the eyes, will be visible, and towards the twelfth, or at the latest the sixteenth, day the little embryo fish will break through its envelop."

After the yolk-bag has been absorbed, the young seek food for themselves and feed mostly on minute rotifers and copepod crustaceans, later on larval insects (the larvæ of mosquitoes are especially acceptable), and in a few weeks are prepared to add to their diet.

If the food be abundant, by the time cold weather causes cessation

of feeding, the fishes of the year will weigh a pound or more; recommencing with nearly that weight the next spring, at the end of the second summer they will weigh three pounds, more or less. In the spring of the third year they will be prepared to do their share in the perpetuation of the race. They continue to grow almost indefinitely and it has been claimed that a weight of a hundred pounds and an age of a hundred and fifty years have been attained, but fifty pounds is almost a maximum weight and extremely rarely realized.

According to some authors, especially Hessel, "some time before the spawning season sets in, the falling out of the pharyngeal teeth takes place" and "these grow anew every year." If such is the case, confirmation is required and details are needed; alcoholic specimens appear to contradict the claim.

Not all carp develop the sexual organs. "Sterile carp are not uncommon, and have always been highly esteemed for their fat, delicate flesh. An English fisherman of the name of Tull discovered a method of castrating carp in order to fatten them with better success." The method of castration was detailed in "An Account of Mr. Samuel Tull's Method of Castrating Fish," by W. Watson, in an article in the "Philosophical Transactions" for 1754 (XLVIII, 870-874). Tull castrated "both the male and female fish" and thought that "when fishes have spawned a few weeks, they are fit for the operation." Carp culturists do not appear to have availed themselves of this method of improving the flesh.

The carp, at the present day is, with one exception, the most widely distributed of the family and its name the most generally diffused. The latter occurs with slight variants among all the Latin and Teutonic and even Slavonic nations; it is represented among the French by *Carpe*, the Dutch by *Karper*, the Germans by *Karpfe*, and the Russians by *Carpa*. These seem to be derivatives of a southeast European word and the earliest reference to it occurs in Cassiodorus, who wrote about 575; he refers to it as a fish of the Danube ("destinet carpam Danubius").

The carp is by far the most important of the Cyprinids and its range has been extended much beyond its natural habitat by the favor or industry of man. This extension commenced early and it was planted in many European waters at various times. It has been supposed that its introduction into England was effected after the discovery of America. Many may remember that father Walton (1653) wrote that "there doubtless was a time about a hundred or a few more years ago, when there were no Carps in England,

as may seem to be affirmed by Sir Richard Baker, in whose Chronicle you may find these verses :

Hops and turkies, carps and beer,
Came into England all in a year.

The distich has no foundation in fact; the earliest known reference to the carp occurs in Dame Berners' "Boke," published in 1496.

The first successful introduction of the carp into America was made in 1877 when Rudolph Hessel brought three hundred and forty-five fishes for the United States Fish Commission. These were released into breeding ponds and in 1879 distribution of their young was made and continued for many years afterwards. Now the species is thoroughly naturalized and widely distributed throughout the United States. It has become a regular market fish and is by many held in considerable esteem, but there is also much prejudice against it. Expressions of opinion as to the merits of the fish were collected by the United States Fish Commission a few years after its introduction and published in its Annual Report for 1884 (pp. 659-890). The range of opinion among the two hundred and forty-two answering was not less remarkable than some of the modes of expression.

A belief that male frogs and toads, driven by urgent sexual passion, will leap upon a carp's head and remain there for some time has been long entertained. Izaak Walton was told of a pond being drawn and that *every* carp left in it had "a frog sticking so fast on the head of the said carps, that the frog would not get off without extreme force or killing." The excellent Walton was overcredulous and such a statement (which has been ridiculed) would not deserve consideration if it rested on his belief only, but a very eminent naturalist has lent his own high authority to an analogous statement. Smitt, in his magnificent work on Scandinavian fishes, also tells that "carp are often troubled by the male frogs, which under the influence of sexual excitement attach themselves firmly to the head of the sluggish carp, and with their forefeet press the eyes of the fish so hard as to produce blindness."

Incredible as the frequent occurrence of such assaults may appear, Smitt had sufficient reason for his statement in data published by reputable eye witnesses. In 1870 (April 11), M. Duchemin presented to the Academy of Sciences of France a report on some cases that he and M. Deroche had observed. In a large pond numerous carp live and thrive except in early spring when, every year, "an extraordinary mortality occurs among them." Every dead fish was

found to be blind, a kind of film covering the eyes and even part of the head. After much investigation, the gentlemen named were convinced that the mortality was caused by a toad (*Bufo calamita*). "They examined all the carp in the pond, and found squatting on the head of each of those that were diseased an enormous toad, the fore-paws of which were placed on the two eyes of the unfortunate fish. Thus, this ugly batrachian, which presents so stupid an aspect, has yet sufficient intelligence to assume the offensive and to overcome a large fish. It has not agility and energy, but it has cunning and perseverance. It would appear to kill by exhaustion, but it remains to be ascertained whether the acrid secretion of the skin assists in the conquest."

Such assaults on a fish are the more remarkable on account of the specialized manner in which male frogs and toads connect with and grasp the females. The manner in which they do this is so characteristic that it has been utilized by some herpetologists for the classification of the order to which they belong. The toads, for example, grasp the female around the body just behind the forelegs and the *Bufo calamita* has what is called a pectoral amplexation.

The carp readily interbreeds with the goldfish (*Carassius auratus*), or rather with its very close poor relation, the karass (*Carassius carassius*); the hybrid has intermediate characters so distinct from each parent that it was formerly considered to be a distinct generic type and named *Carpio kollarii*. Hessel succeeded in getting young from (1) a female carp and male karass, as well as from (2) a female karass and a male carp, and all had the characteristics of *Carpio kollarii*. He also found that hybrids were fertile, for he obtained hybrids of the second degree from an original female hybrid (*Carpio kollarii* and a male carp; this was distinguishable "with difficulty" from "the genuine carp." On application to the palate, however, judgment was pronounced that the "flesh was exceedingly poor and bony." (It could have been bony only so far as leanness and deficiency of flesh to cover the bones were involved, for the number of bones must have been the same in the two fishes.)

The latest use found for the carp is an eradicator of the trematode worm which is the cause of the fluke-disease so prevalent in some regions. Doctor Stiles, in 1902, published testimony to the effect that, since carp had been introduced into Oregon and Washington the disease (*distomatosis* or *fascioliasis*) had been very much reduced and the reduction was attributed to the agency of the carp

which devour the young worms in the cystic stages as well as the snails (*Limnæids*) in which they pass part of their lives.

OTHER NOTEWORTHY CYPRINIDS

The GOLDFISH (*Carassius auratus*) has been still more extensively diffused throughout the world than the carp. It is of a genus (*Carassius*) distinguished from the carp by the absence of barbels and the development of only one row of pharyngeal teeth. The type of the genus is the karass, or crucian carp, and the generic name is latinized from the popular one. Closely related to the karass is the goldfish, which originally was of Chinese origin and in China (where it is widely known as the *Ken-ju*) for unknown time it has been the object of culture and innumerable varieties have been bred. (Savigny, in 1780, gave colored illustrations of eighty-nine varieties.) It is generally maintained that it was introduced into continental Europe about the early part of the eighteenth century, although it may have found its way there long before. Anyway, it was not until the eighteenth century that the fish became common and much cultivated; about 1730 it was introduced into England, and from England it was diffused among the continentals. It was early brought to the United States. In Europe and the United States, wherever the climate is not too rigorous, the species has been acclimatized and in the United States may be caught near almost every large city in some pond or other. Many of the variations to which the fish has been subject are of the nature of monstrosities, such as the double, triple or greatly extended caudal fin, the finless back, and the "telescopic eyes."

The TENCH (*Tinca tinca*) is recognizable by its very small scales, deeply embedded in the smooth and slippery skin, which remind one of an eel's. The fins are rounded rather than angulate as in most of its relatives, and the males are peculiar in the development of much thickened and flattened outer rays to the ventral fins, the females having ordinary rays. Sexual differentiation extends even to the pelvic bones.¹ The species sometimes attains a weight of three or four pounds or occasionally even more. It prefers still and rather warm waters with a muddy bottom and abundant vegetation. In a natural condition it lives near the bottom and "is always working in the mud." It has been much cultivated in ponds

¹ The remarkable sexual differentiation manifest in the pelvic bones as well as ventral fins of the Tench was fully noticed and illustrated by Dr. Günther in the *Annals and Magazine of Natural History* (III, 385-387, 1859). The plate is reproduced for this article.

and several varieties have been originated, one of which is the golden tench. Its introduction into the United States was effected many years ago but it has not been extensively distributed like the carp.

Some curious myths have originated about the tench.

Walton commenced his chapter on the fish with the assertion that "the tench, the physician of fishes, is observed to love ponds better than rivers"; he says that it is the physician "for the pike especially, and that the pike, being either sick or hurt, is cured by the touch of the tench," and that the pike "forbears to devour him though he be never so hungry." (Some anglers nowadays say that "you cannot put a better bait on a trimmer than a young tench. Trout will also eat tench." In the stomach of one trout twenty-two small tenches were found.) Nevertheless Carbonnier tells us that in France it is to this day called "fish-doctor" and that "tench are often placed in tubs with other fish which manifest signs of sickness, whereupon the tench, occupying the bottom of the tank, force the sick fish from their state of inactivity, and compel them to circulate freely through the water, an exercise which of itself often proves beneficial. Healing properties are also attributed to the mucus which flows freely from the skin."

Not only was the tench supposed to be a physician of fishes; it was of use to man himself. Walton reports that "Rondeletius says, that at his being at Rome, he saw a great cure done by applying a tench to the feet of a very sick man," and gives a long account of it. Now Rondeletius (or rather Rondelet) was a good ichthyologist as well as physician, for his time, and if he believed in such an unsubstantial "fact" it is not to be wondered that Walton did.

Again Walton repeats that "in every tench's head there are two little stones which foreign physicians make great use of." These two stones are the otoliths or ear-bones which occur alike in all the fishes of the same family as well as in almost all other true fishes.

There may be some basis for the belief that most other fishes leave the tench alone. Perhaps the best evidence known has been given by J. G. Odelly (1868). He took from an overstocked tank "three or four carp and an equal number of tench and put them into another tank containing sticklebacks. Almost immediately after they were put there the sticklebacks set upon the carp and gave them no rest till they died," three or four days later, when no "vestige of fin and tail were left." The tenches, however, were "not molested at all" and remained with the sticklebacks, "appar-

ently happy and comfortable." Their immunity may be due to superficial secretions which are disagreeable to other fishes.

Tench is a name derived from the old Latin *Tinca* which has developed into *Tenca* in modern Italy and *Tanche* in France. The Teutonic nations have very different words, *Schleihe* or *Schley* being the most common in Germany, *Qeelt* in Holland, and *Lindaren* in Sweden. No traces of cognate names have been found in Britain. The scientific equivalent is *Tinca tinca* or *vulgaris*. The chief characteristics, as already indicated, are the small, thin, closely-adherent scales, and also the peculiar dark color.

The *GUDGEON* (*Gobio gobio*) is a neat, symmetrical fish with the dorsal fin about its middle over the ventrals, and with a conspicuous barbel at each side of the mouth. It is gregarious and mostly keeps near the bottom. "To the fisherman living on the banks of the Thames the gudgeon is one of the most valuable of British fishes, inasmuch as fishing for the brave little fellow, which gives such excellent sport, is an excuse for many a pleasant outing." It is the chief fish of the order in the Seine near Paris.

Gudgeon is a name derived from the French *Goujon*; the German name is *Gründling* and the Dutch equivalent is *Grondell*. No congener of the gudgeon is found in America.

The *BARBEL* of northern Europe (*Barbus barbus*) is the type of a genus of very numerous species peculiar to the Old World, represented by many forms in Asia, especially in its southeastern regions, and about sixty in Africa. The name is cognate with those occurring in other countries and in the thirteenth century the same form was prevalent in France, but now *Barbeau* is the French name, *Barbe* the German, and *Barbeel* the Dutch. *Barbel* is a derivative of the late Latin *Barbellus*, a diminutive of the old name *Barbus*. The four barbels or barbs on the sides of the upper jaw (two on each side) are the distinctive characteristics of the common barbel but are not manifest in all the species of the genus.

The collective characters of all the species are the three rows of pharyngeal teeth, as already indicated, which are cylindrical, hooked and excavated at the base of the crown, and there is also a general conformity in the head, course of the lateral line, and size of the fins. As might naturally be expected in such an enormous group, the variation otherwise is very great; in length they range from little more than an inch to five or six feet; in weight, from an ounce to nearly if not over a hundred pounds;¹ although four barbels

¹ A much greater weight has been claimed for one of the species of *Barbus*. Dr. Günther in 1868 (Catalogue, VII, 86) says unqualifiedly of the *Barbus eso-*

are generally developed, many have only two and not a few have none; in the size of the scales there are the extremes of at least eighty and twenty transverse rows. Some of the other features in which species differ may be known from the differential characters of three specially noteworthy ones representing different sections of the genus. All of these have two pairs of barbels.

According to Professor Max Weber, a South African barbel, described in 1897 (*Barbus viviparus*) is viviparous!

The common barbel of Europe (*Barbus barbus*) is representative of a group characteristic of Europe and Asia Minor, distinguished by a strong and coarsely serrated dorsal spine, five branched anal rays, and small or moderate scales; specifically, it has about sixty (54-63) scales along the lateral line and there are about seven (7) rows between the lateral line and ventral fin; the snout is very prominent and the lips are regularly thick.

The barbel is an outlier of an immense aggregate of tropical and subtropical species and as such prefers warm water and does not ascend as far north as most of the European Cyprinids; it is not a tenant of the Scandinavian streams for instance.

It furnishes very poor food, although it is a favorite angler's fish. Captain Buckland thought that "a good day's barbel fishing is enjoyable beyond all measure, but it is most advisable to employ a professional fisherman to ground-bait the 'swim,' arrange the tackle, etc."

All the preceding species except the barbels belong to the typical subfamily, *Cyprinines*, distinguished by the triangular and very hard carp-stone or mill-stone, very short anal fin, and lateral line median along the tail. Most of the European species belong to another subfamily (*Leuciscines*) which have a pentagonal or irregular and elastic pharyngeal carp-stone and moderately short anal, the lateral line being median on the tail as in the carps. Many of the best known of the European fishes belong to it and are the delight not only of the youthful angler, but of numerous men who know not the joy of contest with fishes of nobler kind or have not the means of reaching such. The familiar names chub, dace, minnow and roach are given to members of the subfamily. These names have been so much misapplied and are so interesting themselves that an

cinus, a fish of the "river Tigris, near Mossul," that it "attains to a weight of 300 pounds," but this statement is not corroborated, so far as known, by any other author or by Dr. Günther himself in his later writings. The original describer's (Heckel's) largest specimen was only two feet and a quarter long. ("Die Exemplare unseres Museums sind 2 Zoll bis 2 Schuh 3 Zoll lang.")

account of the original uses of the names and of the fishes to which they were given may be welcome.

The chub, roach, dace, rudd, ide and minnow of Europe are quite closely related to each other and by some ichthyologists are united in a single genus (*Leuciscus*), although by others they are isolated in as many genera as there are names.

The CHUB, or cheven (*Leuciscus cephalus*), is a rather large and thick-headed fish with the dorsal fin somewhat arched and not emarginated as in most of its congeners. Its average length is less than a foot, though sometimes much greater; its weight about a pound. It is a restless fish which "lives almost entirely near the surface of the water"; it is because it does so, according to Carbonnier, that it does not contract that taste of mud which characterizes fish which live at the bottom," and consequently of all the European Cyprinids it is by him esteemed to be "one of the best for eating." "In most hot days," according to Izaak Walton, "you will find a dozen or twenty chevens floating near the top of the water." It was this habit that enabled "Piscator" to see the biggest of the school of chubs when he had approached the brook with Venator and to identify it by the "bruise upon his tail" which looked "like a white spot"; it was caught, it will be remembered, as Piscator promised, and Venator had received his first lesson.

The chub is unique in bearing a name which is entirely isolated from all by which the fish is known in other lands. Its etymology and history are quite obscure, although much attention and speculation have been spent on it, and its earliest known recorded use is in the celebrated Book of St. Albans (1496). It evidently is connected with the same word which has given us "chubby" and has reference to the form of the fish and especially its head.

The chub, besides being the first fish which Piscator Walton taught his pupil Venator to catch, was also an object lesson as to how it might be so managed that, though by some "reckoned to be the worst of fish," it might be made "a good fish by dressing it."

The chub has been claimed by a recent writer (Buckland) to be "remarkable for his hawk-like quickness of sight; even the shadow of the rod or a passing cloud will make him sink instantly." Yet Piscator selected it for his first lesson in angling because he thought "there is no fish better to enter a young angler, he is so easily caught." The Frenchman's opinion as to the chub's sapidity also may be contrasted with that voiced by "Venator" and half endorsed by "Piscator." "A chub is the worst fish that swims," expostulated "Venator," and only by cooking could the fact be disguised

by "Piscator." It is indeed good cooking that makes any Cyprinid palatable!

The DACE (*Leuciscus leuciscus*) is closely related to the chub but is conspicuous for its shiny, silvery appearance, which renders it a favorite lure for the pike. Its average length is about eight or nine inches. It affects clear streams and rather deep water with a gravelly bottom. It is a very lively and active fish and its frequent dart-like movements, it has been claimed, have suggested the names dard and dart. Dace (also rarely spelled Dase and Darce) is perhaps a curtailed derivative of the French Vandoise or its original, and Dart as well as Dort of the French Dard. Vandoise is now the most prevalent name in France, Dart being more restricted. The most current German name is Louben.

The ROACH (*Rutilus rutilus*) is one of the most esteemed angle fishes of Europe and a special "Book of the Roach" has been published for the benefit of anglers. At one time, as by Walton, it was "accounted the water-sheep, for his simplicity or foolishness." But many now are convinced, with Frank Buckland, that "to catch him the fisherman must have a subtle eye and a steady hand." It sometimes attains a weight of two pounds or even more, but that is very much above the average.

It thrives in stagnant water and muddy ponds and is the most common fish in the river (Lea) which Walton often fished.

The RUDD (*Scardinius erythrophthalmus*) is distinguished by its high back, reddish fins, and red eyes. It occurs in such localities as the roach affects, but is less generally distributed. According to Day, "It has been asserted that where Rudd exist roach are almost invariably present, whereas the converse does not hold good." It rarely attains a length of two pounds, and is "scarcely eatable."

The name is supposed to be connected with red and ruddy. Red-eye is another (rare) English name of the fish and parallels the German Rothauge.

The MINNOW (*Phoxinus phoxinus*) is the smallest of the Western European Cyprinids, has small scales, and is at once distinguished by the incompleteness of the lateral line. It is usually found about three or four inches long. The males develop tubercles on the head and are brightly colored during the breeding season.

The present name was preceded, in the usage of our predecessors by such forms as menow, mine, and the like, and has been supposed to be "possibly from the root of min, less, with *me* termination -ow due to the confusion with some other word, perhaps *of*, menu

(thus the Century Dictionary indicates) small. cf. *me*. Menuse, small fish." More facts are wanted.

Many fishes, really very close to the Leuciscines but with a longer anal fin, have been segregated from the latter because of that character and named the Abramidines. Different as are the extremes of the two groups, they grade into each other.

The BREAM (*Abramis brama*) is characterized as well by its deep and compressed body as by the long anal fin. It is a fish of considerable size and one recorded by Buckland measured two feet two inches in length and weighed nearly twelve ($11\frac{3}{4}$) pounds. The name is cognate with the French Brême, while the German name is Brachsen or Blei. There are a number of species in the continental waters more or less related to the bream. The nearest relation to it in America is the common silver fish or golden shiner (*Abramis* (or *Notemigonus*) *chrysolucas*).

It spawns in June about Paris and the male and female keep on the surface of the water at spawning time, moving and rubbing themselves one against the other. They then proceed to the emission and fecundation of eggs, which burst out in all directions and are disseminated on all sides.

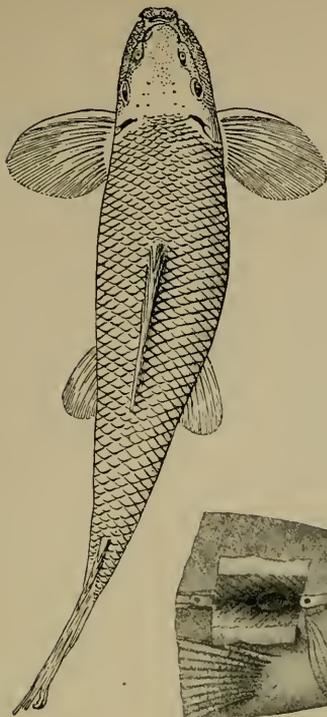
Such are the fishes truly entitled to the names that have been used for them. The fishes themselves are sufficiently common and conspicuous to become to some extent familiar to the sport-loving Englishmen, and the early emigrants from England took the names with them to the new world; the old names were given to the new fishes found in their adopted homes. Often they were very much misapplied and the American species called by the familiar names are frequently extremely different. Carp was appropriated for a Catostomid (*Carpiodes*); roach was devolved on a sunfish (*Eupomotis gibbosus*) which is more like the English perch; chub was used for a relative of the sunfish (black-bass) in one colony and in another for a kind of sucker which belongs to a family (Catostomids) not found at all in England; minnow is largely used for small species of an unrelated family (Pœciliids); tench was attached in Carolina to the salt-water labrid now generally known as the tautog or blackfish (*Tautoga onitis*); barbel was applied in some regions to the American suckers (*Catostomus*). None of the fishes so misnamed belong to or very near the family of the real owners of the names.

Fewer of such names were transferred to Australian fishes, mostly no doubt on account of the poverty of the fresh-water fauna of the southern continent. Bream, however, is given to half a dozen

species at least; in most cases to sea fishes of the family of Sparids from a supposed resemblance to the sea bream of England (*Sparus auratus*), but also to a couple of fresh-water fishes with a superficial likeness to the *Abramis*; the fresh-water fishes are mostly of the family of Dorosomids (*Dorosoma richardsonii*), related to the hickory shad of the United States; a perch-like fish of the family of Theraponids, called also silver perch (*Therapon richardsonii*), also bears the name of bream. Carp is equally misapplied, being forced on an excellent marine food fish of the perciform family of Chilodactylids.

One of the old English names (Barbel) has been singularly, though not inaptly, applied in South Africa to a Silurid (*Clarias gariepinus*), which indeed has barbels, and long ones too, but is not at all related to the real English barbel, and yet a number of Cyprinids congeneric with the true barbel are inhabitants of South African streams.

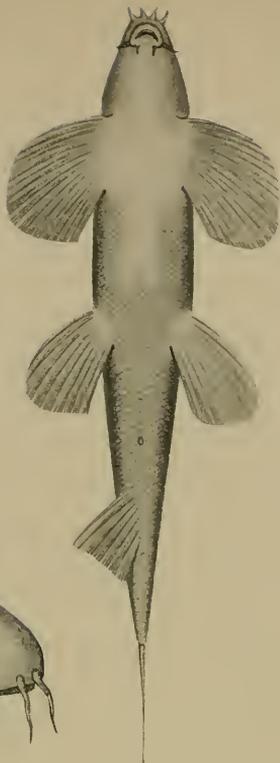
The misapplication of these names to some American Cyprinids will be considered in a subsequent article.



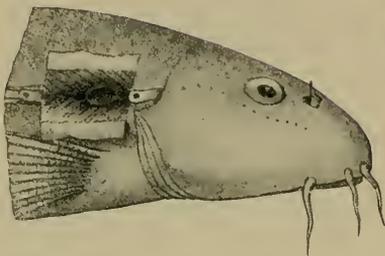
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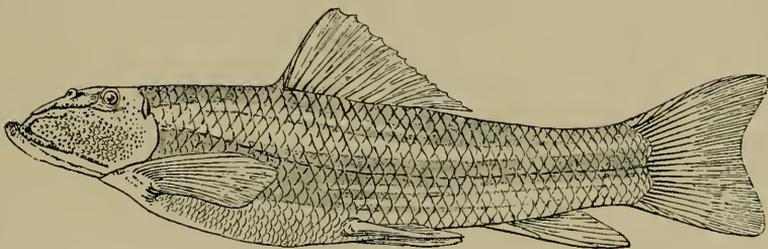
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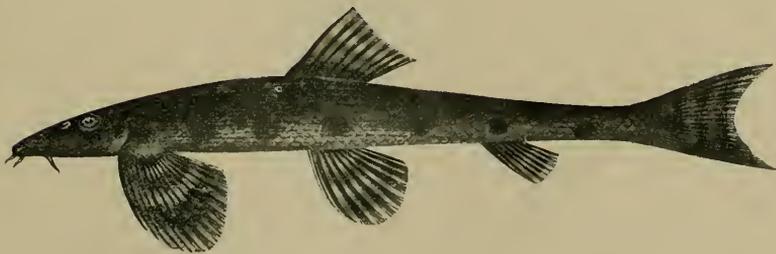
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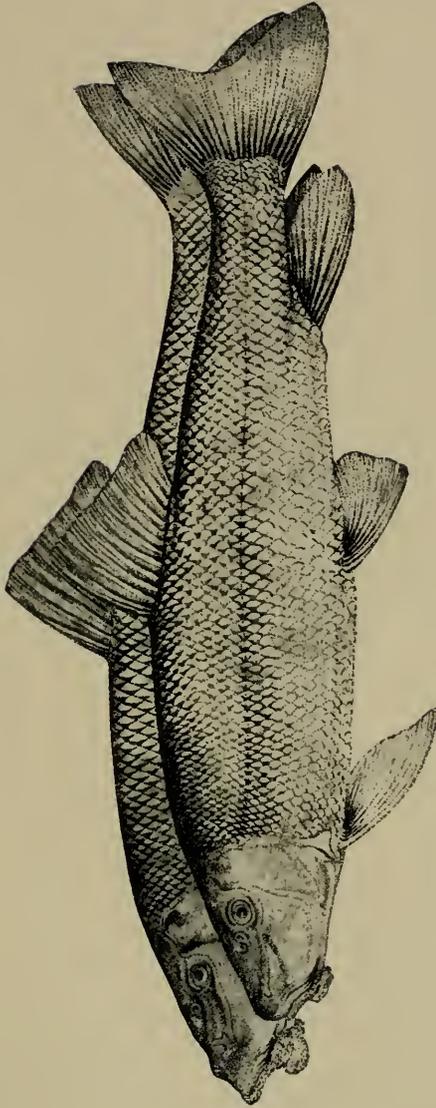


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1. *Gyrinochilus*, rom above. 2. *Gyrinochilus*, lateral view. 3. *Gyrinochilus*, mouth. 4. *Homaloptera ocellata*, from below. 5. *Homaloptera ocellata*, lateral view. 6. *Nemachilus barbatula*, head and thoracic region to show the double subcutaneous aperture of the air bladder.



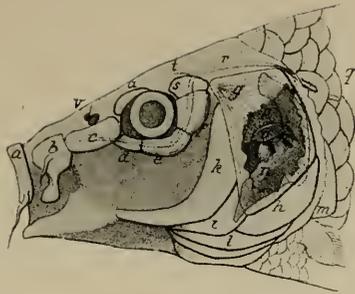
COMMON SUCKER

(*Catostomus commersonii*). After Lesueur.

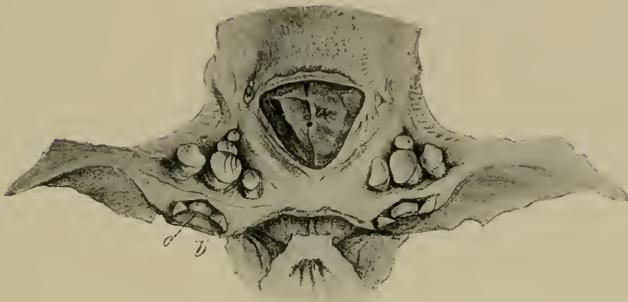
PLATE XLVII

(After Owen.)

- FIG. 1. Carp's head with operculum cut away to show pharyngeal bones and carpstone.
2. Pharynx of a Carp open from below, with the two pharyngeal bones divaricated. *a*, occipital pharyngeal plate or carpstone; *b*, part of a cell in the fleshy pharynx cut open, to show *c*, the germ of a pharyngeal tooth. The small upper figure shows the basal pulp-cavity of a large pharyngeal tooth.
 3. Pharynx of a Tench open from below, with the two pharyngeal bones divaricated.
 4. Pharyngeal teeth, *in situ*, of a Barbel (*Barbus barbuis*).



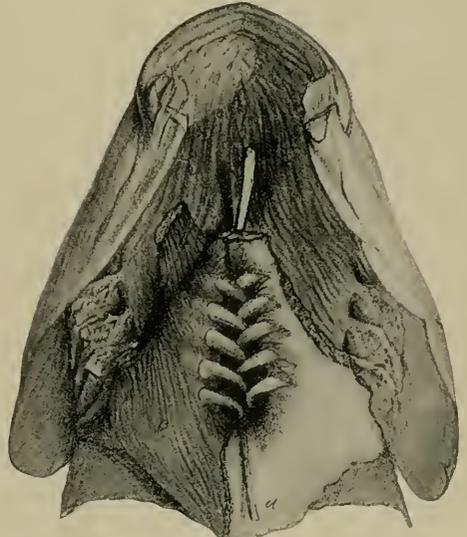
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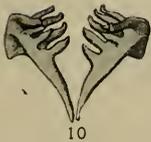
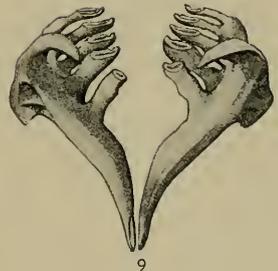
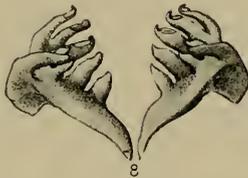
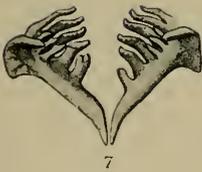
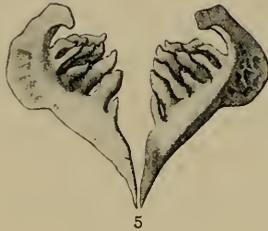
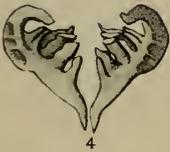
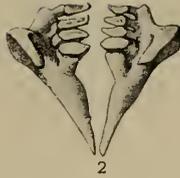
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PHARYNGEAL TEETH OF CARP, TENCH AND BARBEL (AFTER OWEN)

PLATE XLVIII

Pharyngeal bones of chief European Cyprinoid genera according to Fatio.

- FIG. 1. *Cyprinus carpio*. Carp.
2. *Tinca tinca*. Tench.
3. *Tinca tinca*. Tench. Right pharyngeal with the abnormal number of 5 teeth and 2 young replacing teeth at the roots.
4. *Gobio gobio*. Gudgeon.
5. *Barbus barbus*. Barbel.
6. *Rhodeus amarus*. Bitterling.
7. Hybrid between *Scardinius* and *Abramis*.
8. *Abramis brama*. Bream.
9. *Abramis (Blicca) bjoerkna*.
10. *Spirulinus bipunctatus*.
11. *Alburnus alburnus*. Bleak (variety).
12. *Alburnus alburnus*. Bleak.

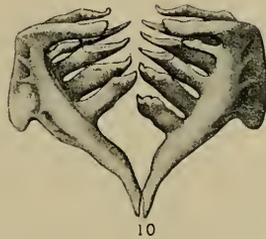
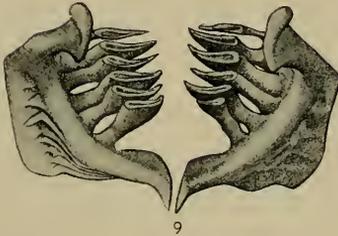
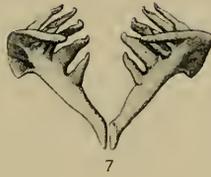
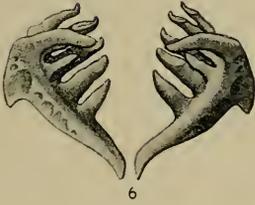
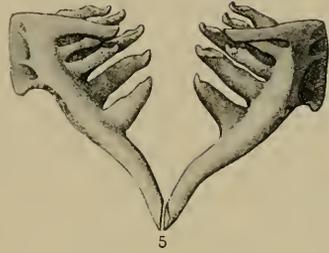
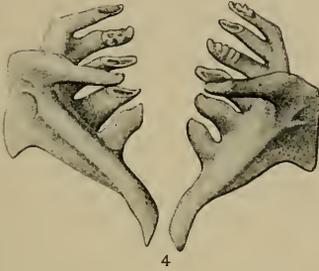
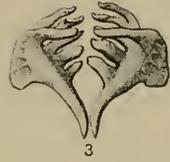
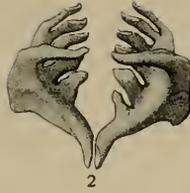
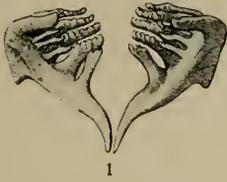


PHARYNGALS (AFTER FATIO)

PLATE XLIX

(After Fatio.)

- FIG. 1. *Scardinius erythrophthalmus*. Red eye.
2. *Rutilus rutilus*. Rudd.
3. *Rutilus aula*.
4. *Rutilus pigus*.
5. *Leuciscus cavedanus*.
6. *Leuciscus leuciscus*.
7. *Leuciscus agassizii*.
8. *Phoxinus phoxinus*. Minnow.
9. *Chondrostoma nasus*.
10. Hybrid between *Leuciscus cephalus* and *Chondrostoma nasus*.

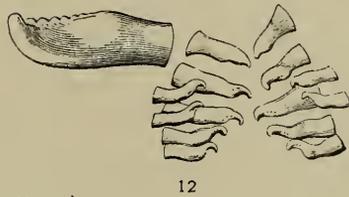
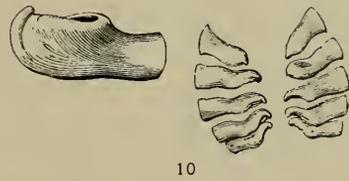
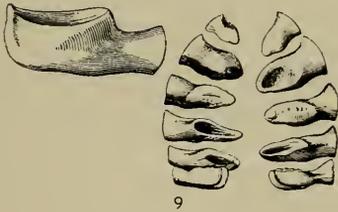
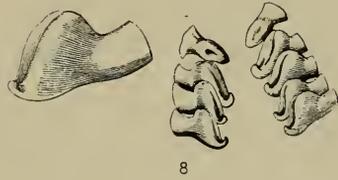
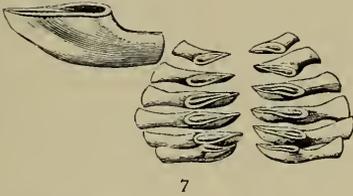
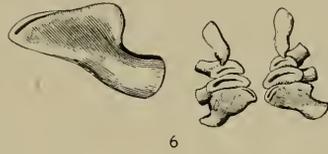
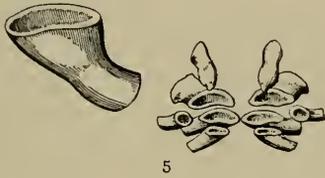
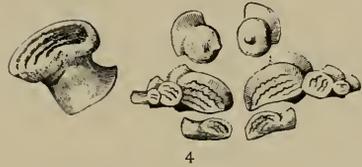
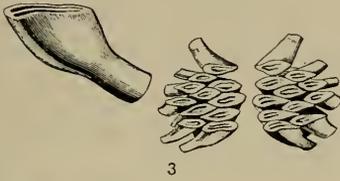
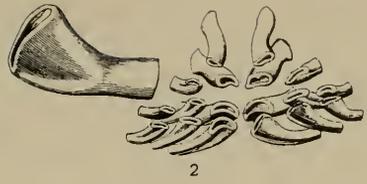
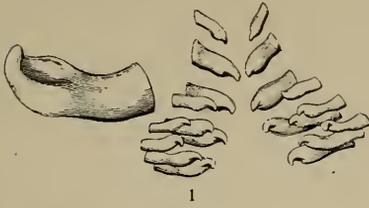


PHARYNGALS (AFTER FATIO)

PLATE L

Teeth of Cyprinoid genera according to Heckel.

- FIG. 1. *Barbus barbus*. Barbel.
2. *Capoeta damascina*.
3. *Labeo niloticus*.
4. *Cyprinus carpio*. Carp.
5. Hybrid between Carp and Karass.
6. *Carassius carassius*. Carass (Karausche).
7. *Chondrostoma nasus*.
8. *Tinca tinca*. Tench.
9. *Rutilus rutilus*. Roach.
10. *Abramis brama*. Bream.
11. *Notropis cornutus*. Redfin.
12. *Leuciscus dobula*. Chub.

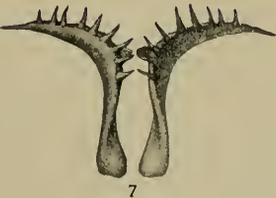
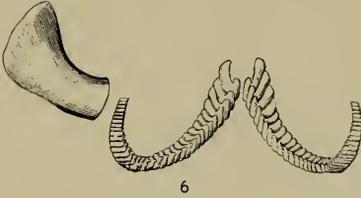
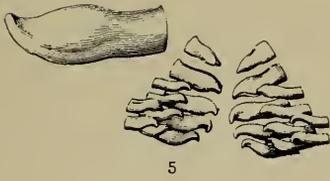
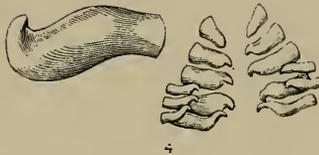
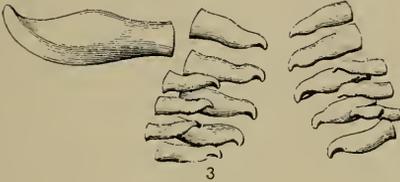
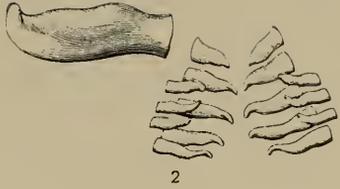
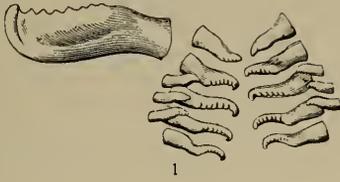


TEETH (AFTER HECKEL)

PLATE LI

1-6, teeth of Cyprinoid genera according to Heckel.

- FIG. 1. *Scardinius erythrophthalmus*. Red eye.
2. *Idus idus*. Ide.
3. *Aspius aspius*. Asp.
4. *Gobio gobio*. Gudgeon.
5. *Danio alburnus*.
6. *Catostomus commersonii*. Sucker.
7. *Nemachilus barbatulus*. After Fatio.
8. *Nemachilus barbatulus*. Side view. After Fatio.



PHARYNGEAL TEETH

PLATE LII

Carp stones of various European species showing free surfaces and profiles according to Fatio.

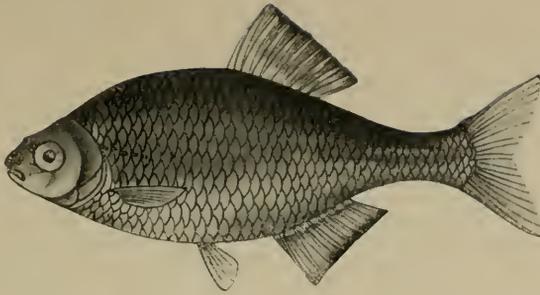
- FIGS. 1, 2. *Cyprinus carpio*. Carp.
3, 4. *Tinca tinca*. Tench.
5. *Barbus barbus*. Barbel.
6, 7, 8. *Gobio gobio*. Gudgeon.
9, 10, 11. *Rhodcus amarus*. Bitterling.
12, 13. *Abramis brama*. Bream.
14, 15. *Abramis (Blicca) bjoerkna*.
16, 17. Hybrid between *Scardinius erythrophthalmus* and *Blicca bjoerkna*.
18, 19. *Spiralinus bipunctatus*.
20, 33. *Alburnus lucidus*. Bleak.
21, 22. *Alburnus lucidus*. Bleak variety.
23, 24. *Scardinius erythrophthalmus*. Red eye.
25, 26. *Rutilus rutilus*. Roach.
27, 28. *Rutilus pigus*.
29, 30. *Rutilus aula*.
31, 32. *Leuciscus cephalus*. Chub.
34. *Leuciscus leuciscus*.
35, 36. *Phoxinus phoxinus*. Minnow.
37, 38. *Chondrostoma nasus*.
39, 40. Hybrid between *Leuciscus cephalus* and *Chondrostoma nasus*.



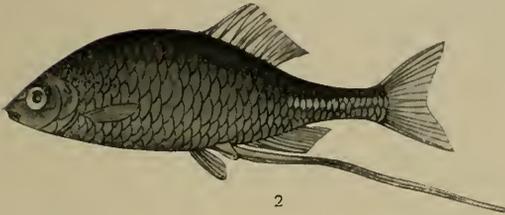
CARPSTONES (AFTER FATIO)

PLATE LIII

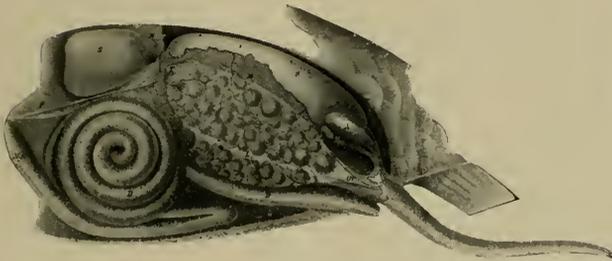
- FIG. 1. The Bitterling (*Rhodeus amarus*). Male in breeding season.—After Siebold.
2. The Bitterling (*Rhodeus amarus*). Female with long ovipositor.—After Siebold.
3. Section of Mussel gill with embryoes of Bitterling intervening between lamellæ.
4. Abdomen of female Bitterling. *o*, ovary; *t*, anterior extension of ovary; *l*, line free from follicles; *ov*, oviduct; *AA*, glands; *R*, oviducal tube; *M*, mesoarium; *S*, swim-bladder; *P*, pneumatic duct between air-bladder and stomach; *D*, intestinal canal.—After Olt.
5. Mussel showing gill and directions of water currents. *a*, course of branchial flow; *b*, meeting place of currents from branchiæ; *c*, inhalent respiratory current; *d*, exhalent current; *e*, mouth.



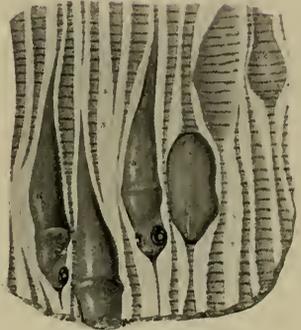
1



2



4

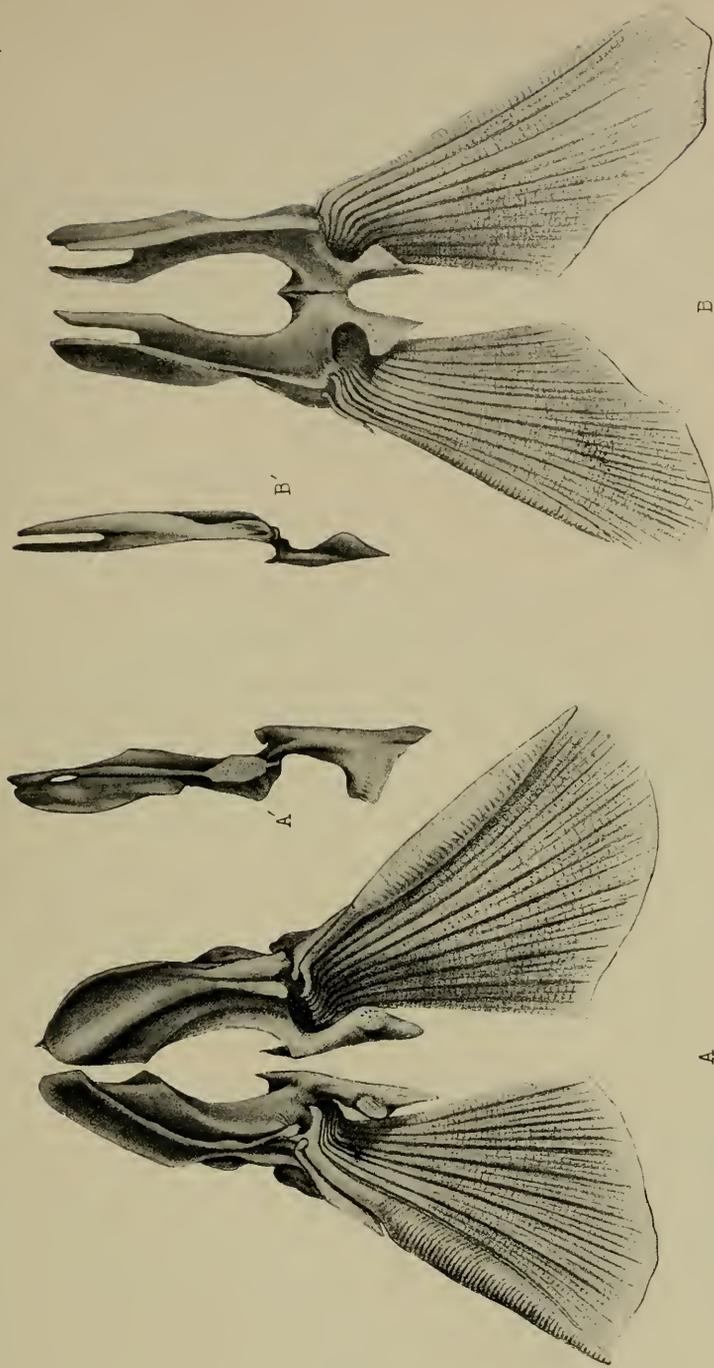


3

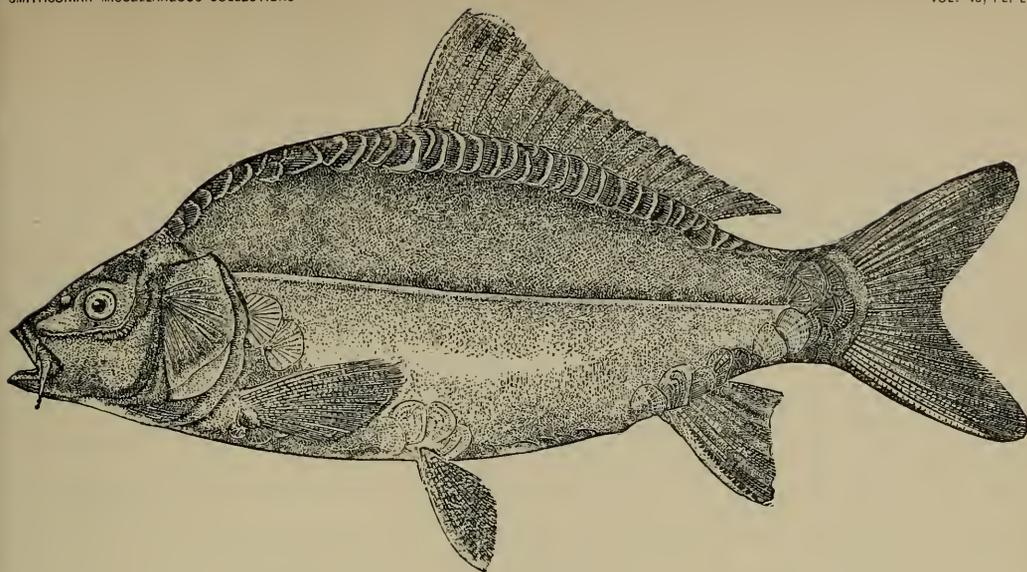


5

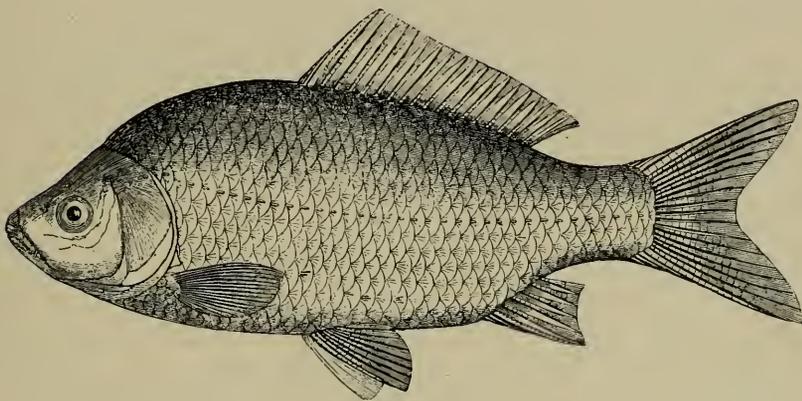
SEXUAL DIFFERENTIATION OF THE BITTERLING



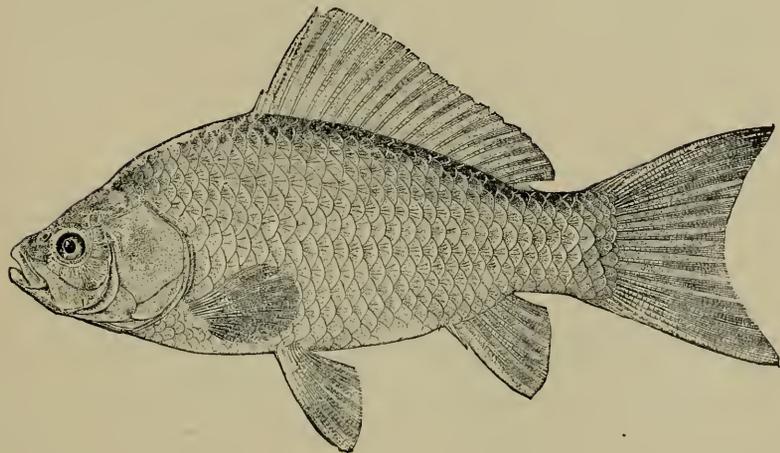
SEXUAL PECULIARITIES OF TENCH
A. Male. *B.* Female. (After Günther.)



1

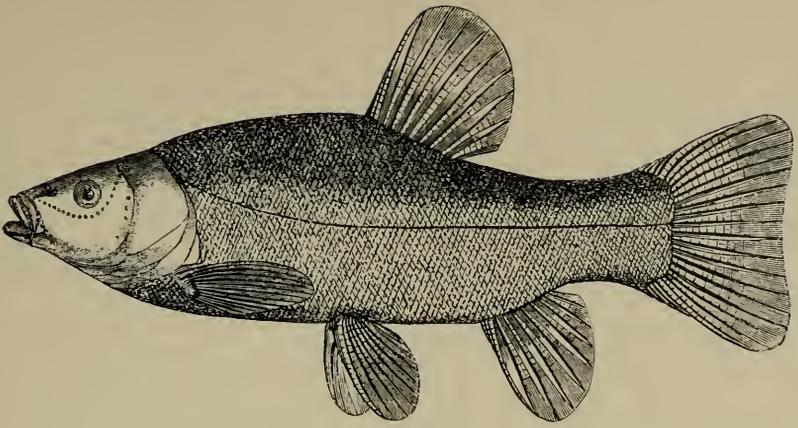


2

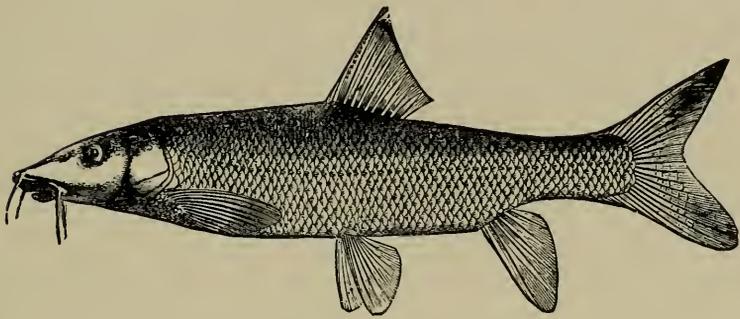


3

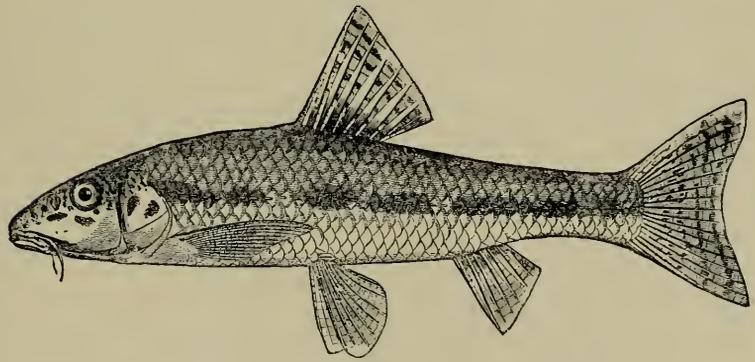
1. CARP. 2. HYBRID BETWEEN CARP AND CARASS OR GOLDFISH. 3. GOLDFISH



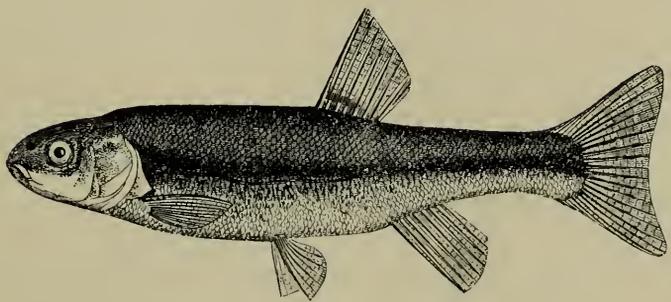
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2

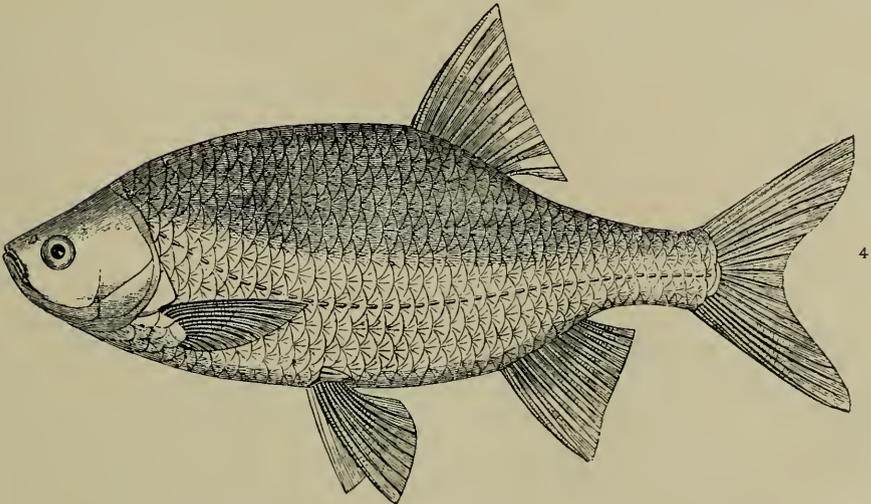
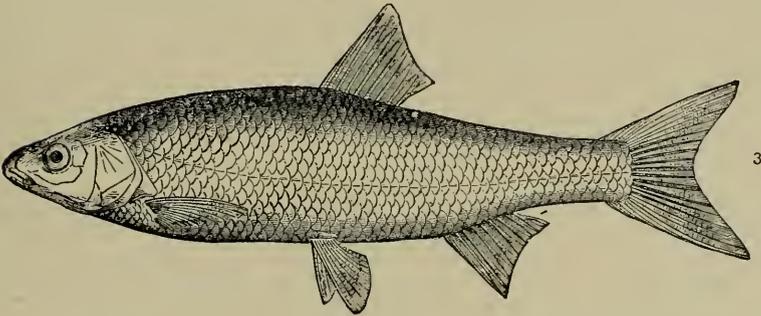
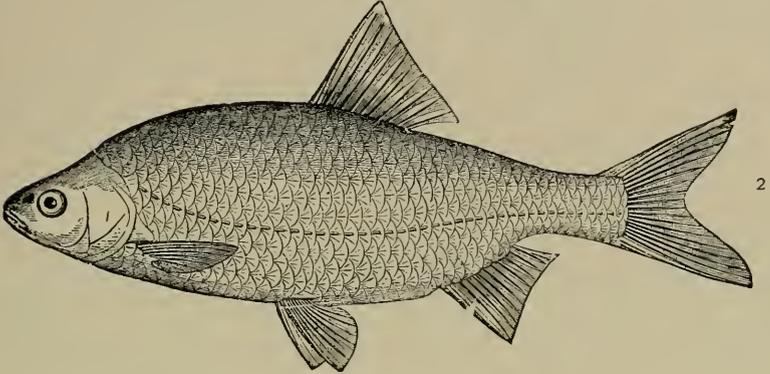
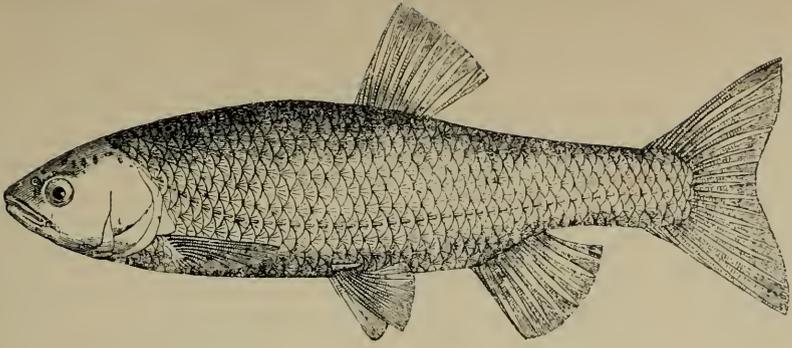


3

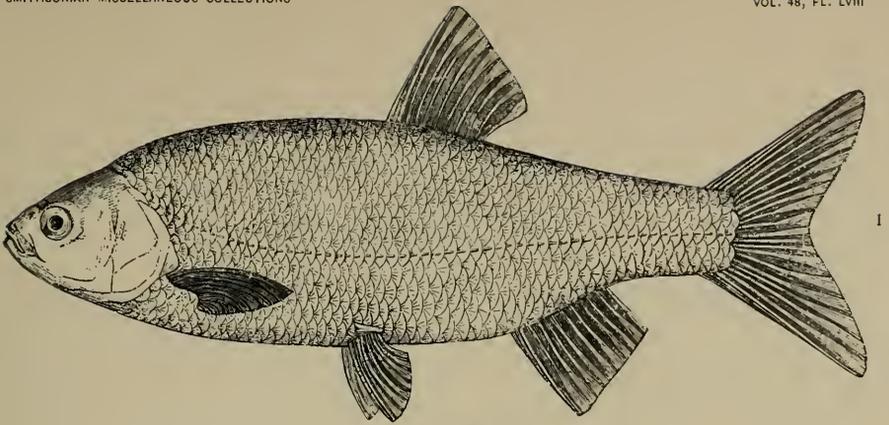


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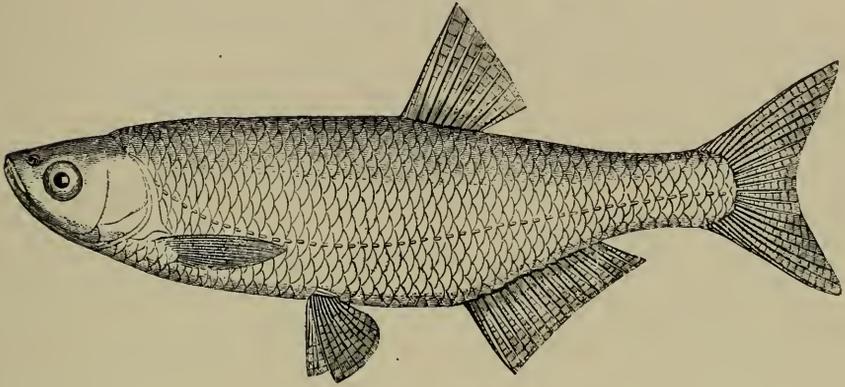
1. TENCH. 2. BARBEL. 3. GUDGEON. 4. MINNOW. (AFTER HECKEL AND KNER.)



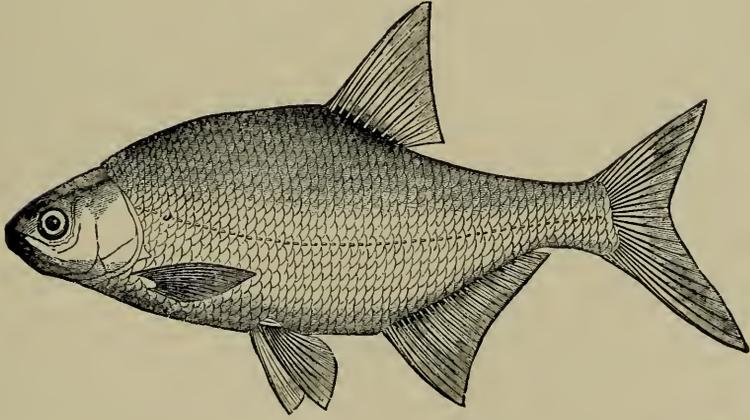
1. CHUB. 2. ROACH. 3. DACE. 4. RUDD. (AFTER HECKEL AND KNER.)



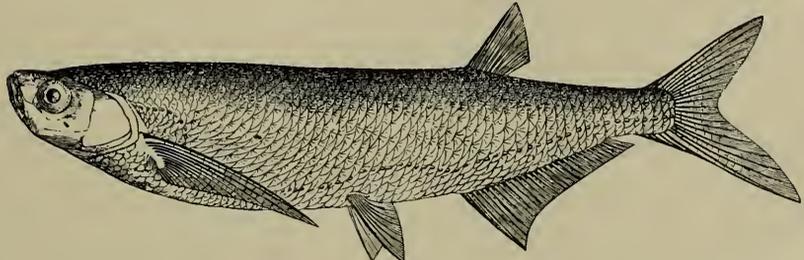
1



2



3



4

1. IDE. 2. BLEAK. 3. BREAM. 4. SICHLING. (AFTER HECKEL AND KNER.)

