

Goldfish Breeds and other Aquarium Fishes

Their Care and Propagation

A Guide to Freshwater and Marine Aquaria,
Their Fauna, Flora and Management.
With 280 Explanatory Illustrations,
printed with the Text.



By

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AUTHOR'S PREFACE

TO the lover of Nature all forms of life are interesting and there is nothing of greater charm, more diverting or restful to the mind than observations of the natural phenomena of the world about us. The habits of land animals and plants are easily observed but the fascinating study of the ever-varying beauty of aquatic life presents greater difficulty, as the denizens of the water can only be kept alive for convenient observation when the natural conditions of their existence are understood and simulated; and to those not satisfied with the dried mummy forms of the specimen cabinet or of others in preserving fluids, the aquarium and terrarium offer the best aid to that liberal education which is acquired only by personal observation.

There is, however, probably no pursuit in the natural sciences more abused by false statements, crass ignorance of the subject, trickery of trade and wilful withholding of the truth, than the care and maintenance of the aquarium, the breeding of aquarium fishes, and the cure of their diseases. Let it be here stated that these are only troublesome when not correctly understood, and the laws governing the existence of the plants and animals violated, either from lack of information or by misleading counsel.

A simple and full elucidation of the correct governing principles is greatly to be desired, as technical zoological and botanical treatment would not accomplish the purpose, nor would books of that nature reach the general public. There are a number of good American and foreign publications which severally treat of the aquarium and its inhabitants, the culture of the goldfish, and the descriptions of freshwater and marine fauna and flora, for the use of the collector, but there is none of sufficiently wide scope to cover the entire field, and by concise, up-to-date, easily comprehensible descriptions and abundant illustrations to fully familiarize the subject to all readers, the novice, the amateur and the adept.

The author's interest in aquaria and the breeding of fine goldfishes first led him to make the drawings and later prepare the accompanying

text, as an interesting study and pleasant diversion, apart from any motives of profit. He has nothing to sell, nothing to conceal, nothing to withhold. It has been his earnest effort to give as complete an insight of the subject as is possible in a book of the present dimensions. He desires to bring statements of facts before the reader in simple, practical and readable form, to incorporate all obtainable accurate information and useful precept in easily understood terms, without enthusiasm; and where possible, impart explanations of the often puzzling phenomena which tend to mislead and discourage both the novice and the expert fancier.

Though the discussions of Aquarium Societies are unquestionably the best means of acquiring information and of removing difficulties, these are usually not accessible to the masses and are patronized more especially by adepts, novices not realizing that it is inexperience which leads to their many annoyances, and so losing confidence give up a recreation which should only animate to constantly increasing effort.

It is freely admitted that the herein contained information pertaining to the breeding and care of the goldfish, aquarium hints and kindred subjects, is the consensus of opinion and the recognized best practice of the members of the Aquarium Society of Philadelphia, as elucidated by the discussions and official transactions of the past eight years. The classifications and descriptions of the goldfish breeds and varieties are those recognized as its criterion upon which awards in competitions are made; and the drawings, with but few exceptions, accurate portraits of living fishes owned by members and attested to over their signatures. The classifications of the plants are those of Britton and Brown and other recognized American authorities.

Written on a flyleaf of a book which was probably the first American publication on the aquarium and its inhabitants is the following memorandum:—

August 7, 1858.

Completed the Aquarium.

Stock,

4 Goldfish

2 Carp

1 Crawfish

1 Turtle

Mit Gott.

Though much has been learned in the fifty years since the above was written, pertaining to the physiological principals governing aquatic existence, the properly conditioned aquarium, the marvelous toy breeds of the goldfish and other aquarium fishes, there still remains much which is unexplained and which may prevent the aquarium and terrarium becoming as much a feature of almost every household as potted plants,

the canary bird, the dog and the cat; and why the same success is usually not attained with fishes as with other domesticated animals. It is hoped that this book will remove some of these difficulties and enable all to indulge in this enjoyment to whatever extent they may be inclined.

In the preparation of this volume the author has made use of every available source for information, and is personally indebted for aid in various ways to Dr. Herman Burgin, Dr. Robert Formad, Dr. Henry Skinner, Dr. J. Percy Moore, Mr. Stuartson Brown, Mr. E. G. Vanatta, Mr. Henry W. Fowler, Mr. Wm. H. Hetzel, and Mr. Rudolph H. Wolf.

THE AUTHOR



CHAPTER I.



**History and Anatomy of
the Goldfish**

THE GOLDFISH

The beauty and hardiness of the goldfish has made it a household pet for centuries, and until comparatively recently it was the only domesticated fish. Its history and origin are lost in dim and distant ages, though from the earliest descriptions to those of the present day authorities agree that the fish was derived from the golden carp or a similar member of the Cyprinidæ, and originated in a lake near a high mountain named Tsiencing, near the city of Tchanghou, in the province of Tche-Kiang; and thence distributed to other provinces of the Chinese realm. It was transplanted to Japan, and then brought to Europe, in the year 1611, where it was well-known in 1728. Later it was brought to the United States, where its propagation has become an industry of considerable magnitude.

Dr. S. Watase states that the goldfish was first introduced into Japan from China at the beginning of the sixteenth century; and subsequently, at frequent intervals, from China, Loo-choo and Corea. This first imported goldfish was what is now known in Japan as the "Japanese breed" or the "Wakin," having a slender body closely resembling that of the carp and probably like the common American and European goldfish. The Loo-choo goldfish, known as the "Riukin" has a short body, rounded abdomen, and a tail longer than the rest of the fish. The Corean goldfish, known as the "Maruko" or the "Ranchiu," is characterized by a very short body, which is often almost globular, and the absence of the dorsal fin. There exist various intermediate forms; and the Japanese goldfish breeders can freely produce the "Riukin" and "Maruko" from the "Wakin"; indicating that the latter is the primitive form.

Of the European authorities Pennant, in the tenth edition of *Systema Natural*, 1751, published drawings of several breeds, descriptions of which resemble those given by Linnæus; and show individuals with double anal and bifurcated and trifurcated caudal fins, which he designated as *C. pinna ani gemina, cauda transversa bifurca*. M. Baster, in 1765, on Plate IX, Vol. II, of *Opusculus subsiciva*, also illustrated six varieties of goldfishes which he had living in basins.

George Edwards, of the Royal College of Physicians of London, in 1756, mentioned on the subject of the Goldfish that "His Grace, the late Duke of Richmond, had a large Chinese earthen vessel full of these fishes brought to England. I drew some of them for his Grace with leave to make the drawings public. The first account of these fishes being brought to England may be found in Petiver's Works, published about 1691, though

they were not generally known till 1728, when a large number were brought over in the *Houghton Indiaman*, Captain Philip Worth, and presented by him to Sir Mathew Decker; since when they have been propagated in ponds in the neighborhood of London. They may now be esteemed a domestic fish."

Edward's colored engravings show five fishes having the general conformation of the ordinary goldfish but with double anal fins; one of blue color on the back and red sides; one all red with a "spiked" dorsal fin of four rays; one red and white with a distinctly "webbed" tail; and one having a brown back, white sides and red abdomen. All have the relative length of body, head and eyes of the common goldfish.

Dr. Elieser Bloch, in *Ichthiologie*, edition of 1784, describes the goldfish and mentions some kept alive by him in Germany. Three illustrations accompany the article. In a later volume there is one other illustration of which both the description and the appearance would lead to the inference that it was a native Chinese fish and the probable progenitor of the Chinese Telescope goldfish and its kindred varieties. His is an interesting description, part fact, part fancy, but worthy of reproduction here. Of the first-named three fishes, No. 1 is described as follows:—

"The head is of moderate length, the nostrils near the eyes, which have a dark star in a golden ring, the rest of the head being of a golden color; and the operculæ consist of two blades. The back is rounded and several black spots are noticeable. On the sides it is red with gold, and the abdomen reddish mixed with silver. Large scales cover the body. The sides are narrow and straight. The fins of the sides are carmine and the tail forked. I know of no fish of which the fins are more varied, as I have one which has a small dorsal of nine spines, others with it entirely absent; another has in place of the dorsal only a hump and a third two of these humps. One of these fishes has a double anal fin and a forked tail; with another the tail is unusually long and all the other fins relatively very much longer than usual. The double anal fins stand side by side, and the superfluous lobe of the tail grows in the centre. It would appear that the tendency of the absence of one fin occasions the duplication of another, which may have given rise to the culture of the fish. Remarkable is the fact that its color changes with age. In the first year it is usually black, a color which Nature often produces in minerals and quadrupeds, more seldom in insects, birds and plants, and never with fishes except these. After the first year silver spots usually appear which gradually extend in size until the fish assumes a silver grey appearance, after which it becomes red and more beautiful the older it grows; though it sometimes happens that after the red it assumes a permanent silver color. Occasionally it is red from infancy..... The fish possesses a brilliancy which is astonishing, as it throws a lustre from the glass of water wherein I kept it, like that of a glowing coal in the dark; but my pleasure did not last long, for after death, it was in spirits but a few days before the color disappeared, a circumstance which would indicate that the color is produced by a delicate mucus (slime) which covers the fish, as the spirits assume a red color as the fish lost it; a similar occurrence to what I noticed with the Schlampitzger, which lost its fine orange color on the abdomen as in holding it the mucus came off on my hand. What further induced me to adhere to this opinion is that the fish retains its color when dried or mounted, as the mucus dries on the surface and is preserved by the varnish."

This is a strange combination of correct and of faulty observations, interesting both on account of their antiquity and of the information which they contain.

The researches of both the author and of his friends leads to the belief that all the descriptions of the toy varieties of the goldfish, subsequent to 1780, and many of those which still pass current, are based upon a monograph and series of colored plates published in Paris in 1780. The constant recurrence of allusions and reference to this work and the almost identical phraseology in describing the fishes, would indicate that the first and probably only authentic information of the goldfishes of China was this monograph which the *Manual du Libraire* mentioned as the "Histoire Naturelle des Dorades de la Chine, par de Sauvigny; gravée par M. F. N. Martinet, accompagnée d'observations. Paris, 1780, gr. in-fol. col." and briefly states "There appeared but 24 pages with the frontispiece and 48 colored plates." These represent seven distinct breeds and eighty-eight varieties of Chinese goldfishes painted from nature by Panzy-Missionnaire and sent to the French Minister of State, N. Bertin, in 1772. Most diligent search and extensive inquiry failed to produce any further information of these most important documents, of which no copy then existed in any library in the United States, nor are they mentioned in the catalogues of the libraries of Europe; but in March 1904, through the instrumentality of the author, probably the only known copy was acquired by the Academy of Natural Science of Philadelphia.

In *Historie Naturelle des Poissons*, 1803, de Lacépède describes and illustrates three goldfishes. One of these he named *Cyprin Anne-caroline*. It has the head and body of the common goldfish, a long, low, 17-spined dorsal fin, extending over the back almost to the base of the tail, narrow paired fins, a single anal fin and the short caudal fin of the common goldfish, but deeply bifurcated. It has a brilliant gold and silver color on the head, back and side and yellow fins. The back is overlaid with streaks and spots of metallic black. The second illustration shows a scaled, slightly telescopic-eyed fish, with rather long body, fins like the common goldfish, but having a distinctly double tail, deeply bifurcated. This he calls *Cyprin Gros-yeux*. The third illustration shows a fish similar to the second, with a shorter dorsal fin and a broader double tail. The eyes are like those of the common goldfish. This he calls *Cyprin Quatre-lobes*.

In the *Histoire Naturelle des Poissons*, 1842, by M. le B. Cuvier and M. A. Valenciennes, the following descriptions of Chinese goldfishes are given, which appear to be largely taken from the writings of de Sauvigny and de Lacépède:—

The Ya-Tan-Yu or Duck Eggs, so called because of their shortened form and swollen middle. It appears from the drawings that the most of the individuals lack a dorsal fin, have two anals and four-lobed caudal fins. This variety usually remains on the bottom of the water

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in an overturned position, the back down and the belly upwards; but can turn readily when they wish to swim, or can move about as well in the overturned position. It seems that this is also the most richly colored fish.

The Long-Tsing-Yu or Dragon Eyes correspond with the "Telescope" and "Gros-yeux" of M. de Lacépède, a variety remarkable for the enormous development of the eyes. I have dissected them and have not found any difference in internal or external structure, the eye only is much larger. Their right or oblique muscles were very weak, but the oblique nerves did not appear smaller. This fish often holds itself overturned like the preceding. The Chinese have a singular belief as to the origin of this species, regarding it as a cross between the ordinary Kin-yu, or common goldfish, fecundated by a frog. It is however one of the rarest breeds, and are sold in Pekin for as much as twenty thalers a piece.

The Choui-Yu or Sleepers are a variety which keep themselves at the bottom of the water without motion. It would appear that to come to the surface of the vessel is a fatigue for the fish because it goes back very promptly to the sand.

The Kin-Teon-Yu or Leapers have the habit of frequently obliquely jumping out of the water, like some species of our carp.

The Kin-Eubb-Yu of Nymphs are less brilliant in gold or silver than the others; but the delicate lustre, the rich shades and the iridescence of their colorings and the quickness of their movements, make this variety highly appreciated.

The Quen-Yu or Lettered. In conclusion the missionaries mention the Quen-yu or lettered goldfish, the colors of which are so placed that one seems to find Chinese characters along their sides. The dealers in Pekin pretend that they obtained this result by a secret method. The fathers of the missions learned, but without verification from trustworthy source, that the Chinese by a method similar to tattooing cause the sides of the fish to appear as though covered by written characters. They believe that a paste is employed to leave these tracings on the fish, made of arsenic mixed with the urine of the tortoise, as skin preparations usually contain this metal; which has a very active effect; and it is natural to suppose that this metallic agent would leave marks on the horny scales of the fish.

The above constitutes the basis for probably all the more recent descriptions of the Chinese goldfish breeds; the differences being principally in the wording, errors of translation, or unfamiliarity with the toy varieties of this fish.

In the *Nouveau Memoirs de la Societé Imperial des Naturists de Moscow*, 1855, M. Basilewsky depicted five goldfishes, which he designated *cyprini aurati*, all having elongated bodies, either "tripod" tails, "web" tails or double tails; and two having "spiked" dorsal fins of three and five rays. All have larger eyes than the common goldfish but not protruding from the head.

Dr. P. Bleeker in the *Atlas Ichthologique des Indes Néerlandisis* 1863, describes nine breeds of goldfishes, four from Sarakarta, Java, and five from Jedo, Japan. Two of these are new, the others are based upon the descriptions and nomenclature of Bloch, Valenciennes, de Lacépède and Basilewsky.

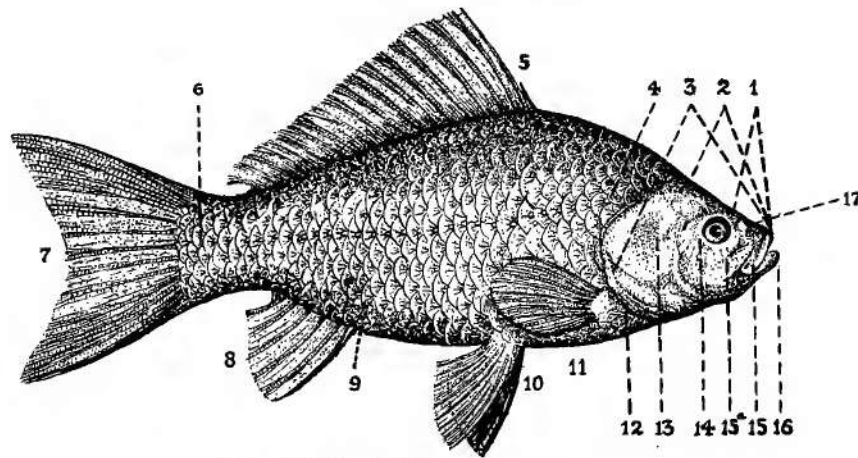
FISHES IN GENERAL

The Pisces or fishes belong to the Vertebrata and may be defined as gilled and generally scaled cold-blooded vertebrate animals having a heart consisting of a single auricle and ventricle, limbs in the form of fins,

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and a body adapted to rapid locomotion in water, and shaped to offer the least resistance and friction in swimming. The goldfish is a member of the carp family, and has been variously known as *Cyprinus auratus* and *Carassius auratus*, the latter designation being more recently preferred as more distinctive of the ornamental fish as there is a species of food carp which bears the name *Cyprinus aureus*.

ANATOMY OF THE COMMON GOLDFISH. Fig. 1. As one of the bony fishes, it has the vertebræ hollow at the ends, united by ligaments, and having the cavities filled with a gelatinous substance in order to give to the spine the mobile flexibility requisite to existence in a fluid medium.



COMMON AMERICAN GOLDFISH

Carassius auratus americanus.

FIG. 1.—Parts referred to in descriptions.

- | | |
|---|--|
| 1 Snout. | 9 Anus. |
| 2 Distance from snout to nape, or occiput. | 10 Ventral fin. |
| 3 Head. | 11 Pectoral fin. |
| 4 Lateral line. | 12 Branchiostegals. |
| 5 Dorsal fin. | 13 Operculum. |
| 6 Base of caudal fin. | 14 Eye. |
| 1 to 6 Distance from snout to base of caudal fin. | 15 Upper jaw, or maxillary. 15A. Preorbital. |
| 7 Caudal fin. | 16 Lower jaw, or mandible. |
| 8 Anal fin | 17 Nostril |

The spinal column is divided into an abdominal and a caudal region, the bones forming the arch through which the spinal cord passes. There are also transverse processes and an inferior arch below, which carries the lower caudal spine and the interspinous bones of the anal fin. The ribs are slender, curved bones each attached to a vertebra and imbedded in the muscles of the sides and abdomen. The interspinous bones in the middle line of the back between the lateral muscles, are connected with the vertebræ by ligaments, their outer ends being interspaced with the median or dorsal fin. The skull is a complicated structure consisting principally of the cranial, the maxillary and inter-maxillary, the præ-operculum, sub-operculum, and inter-operculum, mandible and other smaller intermediary bones.

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The ordinary goldfish has two sets of horizontal paired fins, the anterior paired or *pectoral* fins, Fig. 2, connected with the clavicles and the skull immediately behind the gills, and the posterior paired or *ventral* fins inserted on the abdominal surface below and to the rear of the pectorals

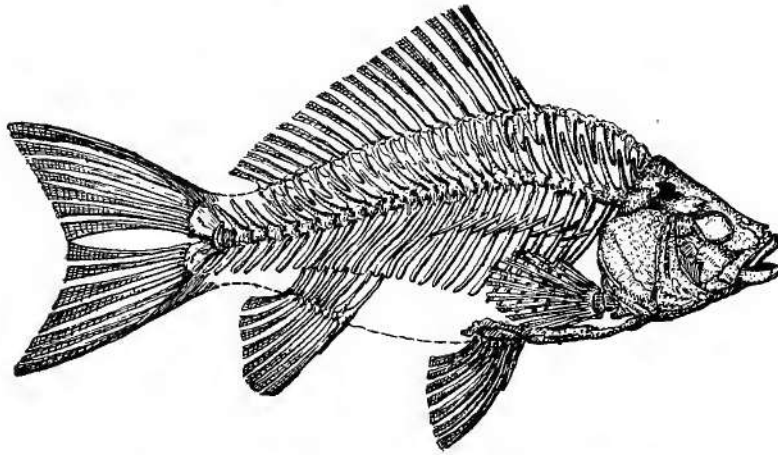


FIG. 2.—Skeleton of the Common Goldfish

and articulated to the posterior visceral arches and the pubic bone. The single median or *dorsal* fin is interspaced with the upper interspinous bones; the single *anal* fin with the lower interspinous bones, and the tail or *caudal* fin set vertically at the extremity of the spine, articulated so that it is flexible in all directions. The rays of all the fins are branched, increasing in number towards their extremities. The spinous and soft rays of the paired fins correspond with the bones of the limbs of other animals, one of their functions being to maintain the balance of the fish. Retrograde motion is principally affected by the pectoral fins which also direct the course of the fish by acting as propellers, further serving as adjuncts to the respiratory system in changing the water at the gills. The ventral fins act as a break in checking the forward motion in addition to aiding in the retrograde movement. The dorsal and anal fins balance the body, and as rudders prevent zigzag or rocking motion, while the caudal fin is the principal means of locomotion, and also, together with the anal fin, aids in steering the fish.

All the fins are organs of motion, but it is by the caudal fin that the fish is impelled forward. If the movement is to be swift, it is strongly bent to the right and left, while a gentle forward motion is effected by an undulating movement, the lobes and rays of the caudal fin, acting like the blades of a screw or an oar in sculling. If the fish wishes to move towards the left, it gives a stroke of the tail to the right, the right pectoral

fin acting simultaneously while the left remains pressed to the body; if the motion is to be checked, the ventral fins are erected and expanded vertically; if the motion is to be retrograde, a backward stroke is made with all the paired fins and the dorsal and anal fins held rigidly upright, the caudal fin being either held on a line with the body or slightly relaxed; and should the retrograde movement be in either direction, the caudal fin is flexed to the opposite side.

By observing injured fishes the purpose of the fins will be manifested. If a pectoral fin is useless or both a pectoral and a ventral fin on the same side, loss of balance will ensue, the fish falling on the opposite side; without both the pectorals, the head sinks; without the ventrals, the motion is unsteady; without the dorsal and anal fins the motion is zigzag; without the caudal fin, forward movement is labored and slow; and without any of the horizontal and vertical fins, the fish floats helplessly on its back, this being the heaviest part of the body.

The head and fins of the goldfish are naked, that is, devoid of scales; but the body is covered with an even layer of cycloidal scales which consist of thin, flexible, horny discs, almost circular in form and evenly imbricated, or overlapping each other like tiles, with the posterior parts extended and free, the anterior parts being embedded in the epidermis and muscular tissue. Fig. 3. They have an enameled surface, showing a fine striation concentric to the margin with stiffening ribs radiating from the rear. Their arrangement is in an oblique transverse section across the body. On each side, reaching from the head to the caudal fin, there is a row of scales different from these in structure, which constitute the *lateral line*. Each of these scales is perforated by a tube leading to a duct connected with a sac in the head; their function being the excretion of mucus which covers the body to lessen the friction of scales and water, and to make it impervious thereto. This mucilaginous system is also provided with nerves and is the seat of a peculiar sense which corresponds to the organs of touch and hearing.

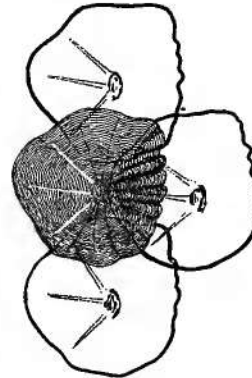


FIG. 3—Greatly enlarged scale of the Goldfish and diagram of imbrication.

The digestive system of the goldfish is simple and adapted to its natural mixed diet. Fig. 4. Devoid of teeth, a limited mastication only takes place in the throat, which, for this purpose, is provided with a number of bony protuberances. The mouth is formed of the maxillary and the mandible bones, having labial folds or lips. The œsophagus is

capacious and opens into a well-defined stomach furnished with a valve, behind which are a number of enlargements or appendages, the pyloric cæca, which probably serve as the pancreas. The intestinal canal is a convoluted tube lined by a mucus membrane which winds in easy turns from

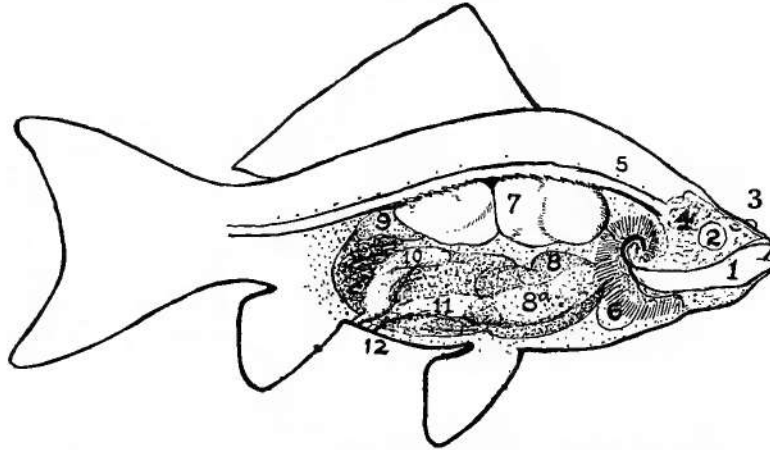


FIG. 4.—Interior anatomy of the Goldfish, showing parts referred to in descriptions.

- | | | |
|---------------------|---------------------|----------------|
| 1 Gullet and gills. | 5 Vertebræ. | 9 Kidney. |
| 2 Eye socket. | 6 Heart. | 10 Milt. |
| 3 Nasal passage. | 7 Swimming-bladder. | 11 Intestines. |
| 4 Brain. | 8 Liver. | 8A Stomach. |
| | | 12 Anus. |

the pylorus to the anus. The liver is large, the gall-bladder distinct, and the kidneys, situated outside of the peritoneal cavity, form two elongated organs below the spine.

The swimming bladder is large and consists of a constricted sac divided into an anterior and a posterior portion which contains air. It is placed above the alimentary canal and communicates with the gullet by a duct. It serves to maintain the specific gravity and to change the centre of gravity of the fish and is enlarged or contracted by muscular action, whereby the air is expanded or compressed. When this bladder is ruptured, malformed or diseased the fish loses all power of changing its position except in limited motion over the bottom of the tank, or is helpless on the surface of the water.

The reproductive system of the goldfish is oviparous, the ovaries of the female being known as the roe and the testes of the male as the milt. The ovaries are placed below the spinal column on each side of the swimming bladder and posteriorly united with a Fallopian tube or oviduct which leads to an opening behind the anus. The milt of the male are similarly located, and contain a thick white fluid in which are the spermatozoa. The eggs or spawn when laid, are slightly compressed globules, about the size of the head of a pin, of semi-transparent, white or yellowish color. Fecunda-

tion takes place after the eggs are discharged, their outline then assuming a more spherical form, whereby the spermatozoa are drawn into the ova through minute orifices and the egg fertilized.

The circulation of the blood is induced by a branchial or respiratory heart consisting of two cavities, an auricle and a ventricle. Fig. 5. The venous blood, coming from the liver and the body generally, is taken

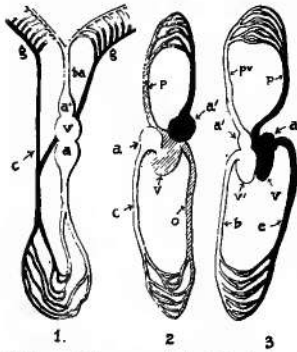


FIG. 5—Diagram of the Blood circulatory systems of Fishes, Reptiles and Mammals.

No. 1.—Diagram of a fish.

a' Auricle, receiving venous blood from the body.

v Ventricle.

a Bulbus arteriosus, at the base of the branchial artery.

ba Branchial artery, carrying the venous blood to the gills.

r Aorta, carrying the arterial blood to all parts of the body.

g Gills

No. 2.—Diagram of a Reptile.

a Right auricle, receiving venous blood from the body.

a' Left auricle, receiving arterial blood from the lungs.

v Arterio-venous ventricle, containing mixed blood, which is driven by the pulmonary artery (*p*) to the lungs, and by the aorta (*o*) to the body.

The venous system is left light, the arterial system is black, and vessels containing mixed blood are cross-shaded.

No. 3.—Diagram of a Mammal.

a Right auricle.

v Right ventricle.

p Pulmonary artery, carrying venous blood to the lungs.

pv Pulmonary veins, carrying arterial blood from the lungs.

a' Left auricle.

v' Left ventricle.

b Aorta, carrying arterial blood to the body.

c Vena cava, carrying venous blood to the heart.

The arterial system is left white and the venous system is black.

through the vena cava into the auricle and propelled into the ventricle, from which arises an aortic arch, dilated at the base into a cavity, the bulbus arteriosus, which has transverse rows of valves, and is covered with muscular fibres for rhythmical contraction. The blood is driven by the ventricle through the branchial artery to the gills where it is distributed by means of the branchial laminae and subjected to the action of the aerated water and thereby oxygenated. The water is taken in at the mouth, forced to the branchia by muscular action, passed over the gills, deoxydized and then emitted from the gill slits, or opercular apertures, on each side of the neck. These gill slits are closed in front and covered by the operculum bones connected by bony spines with the hyoid arch supporting the branchiostegal membrane. The aerated blood is not returned to the heart, as in higher forms of animals, but is driven from the branchia through all parts of the body by the action both of the heart and the contractions of the voluntary muscles; that is, the arterial blood returned from the gills is propelled through the systemic vessels of the body without being first sent back to the heart. The oxygen thus consumed is not that which forms the chemical constituent of water (H_2O) but that contained in the air which is dissolved or in suspension in the water. Fishes transferred to water devoid of air are speedily suffocated, but goldfishes are of low vitality and their absorption of oxygen is comparatively small, as compared with others; this, however, being also characteristic of all stillwater fishes in greater or lesser degree.

The nervous system of the goldfish is well developed but of somewhat inferior type. The brain is small and appears to consist mainly of ganglia devoted to the special senses. The eyes are large, brilliant and well developed, devoid of eyelids, and have a considerable range of vision, and probably some magnifying power as compared with the human sight. The interorbital space is wide, the eyes being placed at the sides of the head, directed somewhat forward, the angles of vision being both to the front and to the sides. The pupils are nearly round with flattened, slightly convex cornea, and are enveloped in a layer of gelatinous substance which covers the cavity of the orbit and permits of considerable movement of the bulbus. They have brilliant dark centres and white, yellowish or reddish borders.

Goldfishes are voiceless, having no lungs nor any of the auditory organs present in some species of fishes.

The nose has two erect nasal appendages below the infraorbital space with tubes leading to sacs lined with a folded olfactory membrane. Anteriorly the water is admitted into the sacs, but posteriorly they are closed and do not connect with the pharynx; the sense of smell apparently not being very acute.

The sense of taste is located in the sensory nerves of the palate, in a thick cushion of soft contractile substance supplied with nerves.

The essential portions of the organs of hearing are present but not fully developed, and consist of rudimentary organs located at the base of the cranial cavity, a labyrinth with vestibule and semicircular canals, but the tympanum and the external parts are entirely absent, though the bones in the temporal region are thin and may partially serve the purpose of conducting soundwaves.

The sense of touch is very well developed and it would appear that sensations of sound are communicated by vibrations in the water, which act on the sensory nerves of the scales, more especially those of the lateral line. On this account the fish probably feels, rather than hears, sounds.

The nerves on the surface of the fish, both of the scales and of the fins, are well developed.

The fish has a well-organized muscular system in all parts of the body. There are sets of muscles that cover the sides of the trunk, the back and the tail, composed of many tendons branching from the large lateral muscles, these being divided into dorsal and ventral halves. Each fin possesses a separate system of muscles which governs every movement. Internally, the muscles are greatly ramified and control all the organs.

The goldfish has no fixed period for slumber, apparently sleeping whenever desirable, by day or by night. It remains motionless on the bottom of the tank or rests on the plants, breathing slowly and regularly, the eyes slightly withdrawn, vacant and of a glassy stare. All the fins but the pectorals are motionless, and these have only sufficient movement to change the water at the gills. If undisturbed this rest may be for hours, but usually it is only for a few minutes at frequent intervals.

The diet of the goldfish is omnifarious, its food consisting of the minute vegetal, insectile and animal organisms found in its natural habitation, and the young shoots and tender leaves of aquatic plants, as well as smaller fishes and its own spawn and young.

The excrement, when the fish is in a healthy condition, is dark brown or black, and usually appends for some time, as a long vermicelli-like thread. From its appearance illness of the fish or constipation, may often be first detected.

