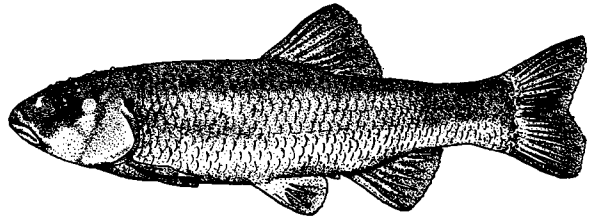


FEMALE HORNHEAD CHUB



MALE HORNHEAD CHUB

Minnows

By E. LAURENCE PALMER

This is the eighty-sixth in NATURE MAGAZINE'S series of educational inserts.

THE POET John D. Wells, in "A Damper on Discipline," a poem about his son who had run away from the farm chores to go fishing, and who worried his father because he had not returned, says;

"Where's my boy? I whined, an' then
As if in answer there he come
Down the pastcher lane again,
An' headin' straight for us and home—
Steppin' high an' straight an' sta'nch
An' proud as Grant, as like as not—
An' draggin' from a willer branch
The first horndays he ever caught!

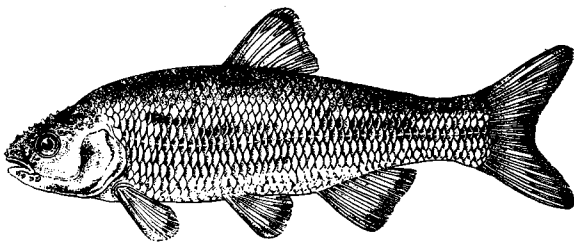
"Where you been? I says, an' looks
Right in his eyes an' there I saw
Pitchers of the fields an' brooks
An' things a young 'un loves! My law,
All my temper left my head,
I throwed the beech gad good an' strong—
Stead o' what I'd planned, I said:
Why don't y' take your pa along?"

This may illustrate well the ability of minnows to bring together human beings of widely divergent ages and interests. In my own case my father and I agreed much more on the joys of fishing than we did on many other things. Minnows surely are, in many parts of the land, the small boy's fish, although it must be recognized that many boys exceed their elders when it comes to the taking of fishes rated more highly than minnows.

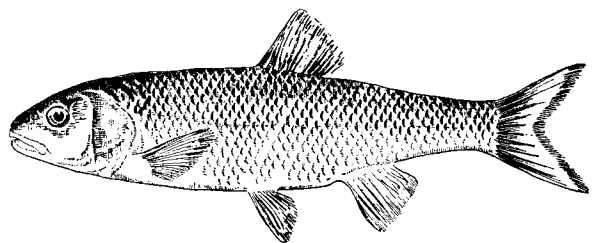
In the third act of *Coriolanus*, Shakespeare elects to disparage minnows, or to belittle one of his characters, when he says; "Hear you this, Triton of the minnows," implying that it is not much to be a demigod to relatively insignificant fish. But if Shakespeare belittles our minnows, that famous fisherman, Izaak Walton, in his *The Compleate Angler*, gives them much more credit than I, for one, would give them, at least so far as fishing for sport is concerned.

If you have not read your Walton recently, take it along with you some time and glance through it again. I am sure that you will enjoy his dry humor, even though he never used a dry fly. Speaking of the apparent recovery of some minnows that had been frozen in the ice, Walton says that it gave him surprise that would equal that of witnessing the resurrection of an atheist. Apparently he repeats "old wives' tales" when he writes about the tench, a minnow, and says that it bears two "little stones" in its head that foreign physicians feel have exceptional medicinal values. Again he tells us of "certain Jews in Rome" who effected a "great cure" of a "very sick man" simply by applying a tench to his feet. I am sure that the famous angler writes much more authoritatively about experiences in catching fishes than when he discusses mystic powers of the finny tribe in the field of medicine.

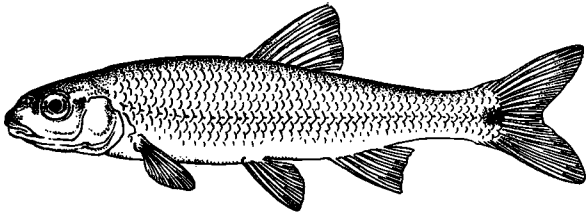
Byron W. Dalrymple is, in a way, a modern Izaak Walton when he writes, in his generally unappreciated *Panfish*, of the art and enjoyment of light tackle fishing for the common fishes of the United States. In these days, when it is becoming almost impossible to catch



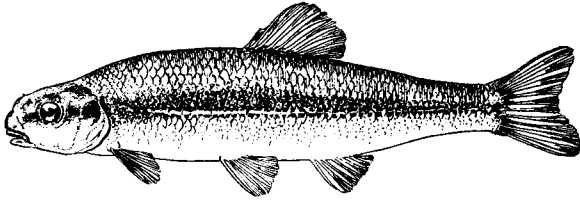
COMMON SHINER



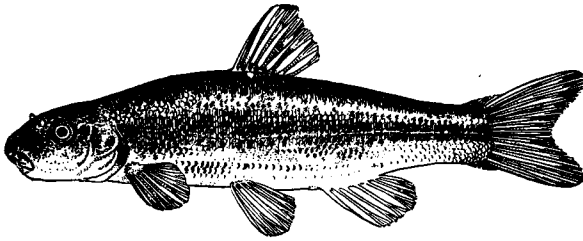
SILVER CHUB, OR FALLFISH



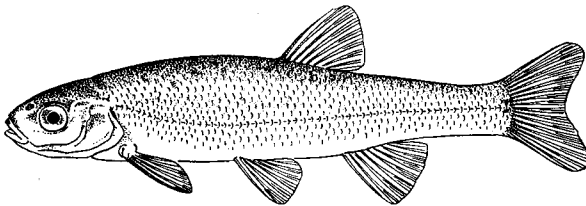
SPOTTAIL SHINER



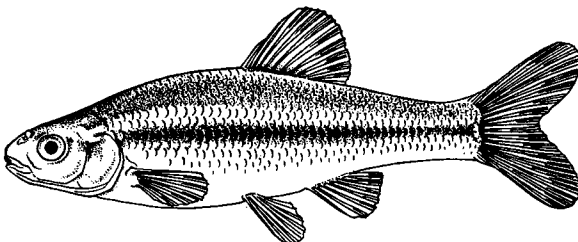
BLUNTNOSE MINNOW



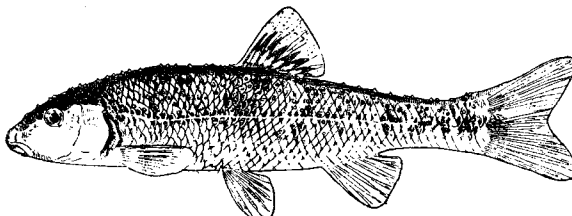
CUTLIPS MINNOW



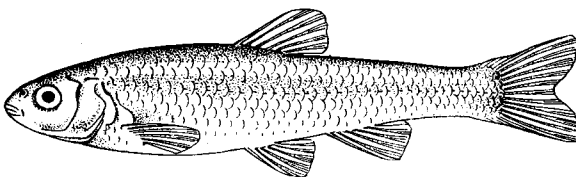
PEARL DACE



FATHEAD MINNOW



STONEROLLER MINNOW



BRASSY MINNOW

many large game fishes, Dalrymple wisely proposes that if we cannot get large fishes with standard tackle we may well take weight from our tackle and thus add stature to our smaller fishes. What's wrong with the idea? If you are interested in having fun in catching fish do not pass up the minnows. Read Dalrymple's chapters on "Our Fresh-water Heritage," "Orphans of the Sporting Angle," and "Midget Department." It may give you a new lease on your fishing life. Surely it will help you have more fun catching more fishes than is otherwise likely through more orthodox procedures.

Many writers have suggested the possibilities associated with catching by various means members of the minnow family. Dalrymple says: "If you want to get some good practice in handling heavy fish on light tackle then carp will give it to you." He, as well as others, point to the new horizon in fishing opened by the revived use of archery in the sporting field, and shows how the shooting of tethered arrows into carp has great possibilities, and may well result in the reduction of the numbers of obviously inferior fishes.

We cannot honestly conclude that the popular conception of minnows as being just small fishes is well taken. Common fallfish are minnows that sometimes reach a weight of three pounds. One of these minnows, a foot or more long, can give a fisherman using light tackle in swift water some real excitement. The white salmon of the Colorado River Basin is really a minnow, yet it may reach a length of more than five feet and a weight in excess of seventy pounds. The rod and reel record for carp in America is forty-two pounds, which exceeds in size the recognized brown trout, cutthroat trout, brook trout and our commoner fresh water basses. Of course there is more fun in catching a two-pound, small-mouthed bass than there is in catching a ten-pound carp. But if we are fair we have to recognize that the minnows are not all characterized by being small.

As is usually the case with any group of organisms represented by a great number of species, it is dangerous to generalize about minnows. One text implies that since the respiration of one minnow is normally at the rate of about 140 a minute, and of a fish in another group is only about 12 to the minute, it can be implied that respiration is more rapid in minnows than in other groups. Respiration, of course, varies with the activity of the animal, with the amount of oxygen available in the water, with the temperature of the animal and of the water, and with other factors. The speed of your own respiration varies greatly, as you know, and a little experimentation with the goldfish in your nearest goldfish globe will show you how, by changing temperature and activity, the rate of respiration may be changed.

Ecologists speak of niches occupied by different kinds of animals. Certainly we cannot generalize and say that all minnows occupy the same niche because they seem to occupy, in one form or another, almost any kind of niche. Some, like our black-nose dace, are found over stony bottoms in swift waters. Others, like our carp, are found over muddy bottoms in still warm waters.

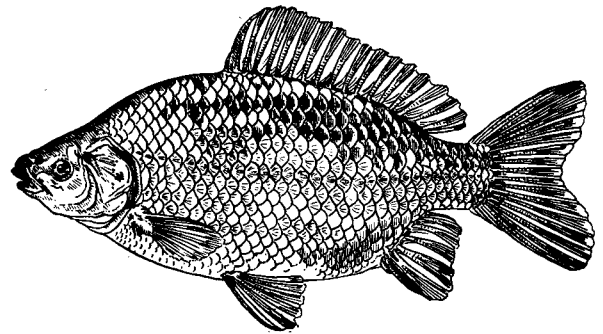
Some are found only in the smaller, shallower brooks; others are found in the open waters of large lakes. A few are found in the brackish waters of streams that flow into the seas. Some favor waters that are heavily limed, while others are found in waters that come from bogs and the like.

Through the year the habitat occupied by members of any one kind of minnow will vary greatly. During the breeding season most of these fishes but not all, will make their ways to shallower, cooler waters than those in which they spend much of their lives. In winter many make their ways to the depths of larger bodies of water, where they remain practically in a state of hibernation.

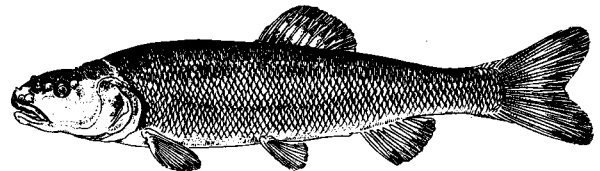
Some idea of the variation temperature may have on the activities of minnows may be found in what happens with carp, one of our larger minnows. When the temperature of water rises in spring to about 50° F., carp begin to move about freely. However, they do not feed or digest their food readily at this temperature. At 59° F., feeding and digestion begins. Breeding normally takes place at about the time the rising temperature reaches 68° F. When the temperature goes above 77° F., a new period of inactivity begins. As the temperature drops, feeding and digestion practically stop at 59° F. Other species have patterns of their own, of course, and much of the success of fishing may well depend on the fisherman's ability to fit his activities into the activities of the fishes he seeks to take.

Minnows differ greatly in their means of reproduction, as is shown in the life history charts. Some swim in great schools, depositing their eggs over plants, over mud, or over sand. Sometimes the eggs are nonadhesive, while others stick quickly to almost anything with which they come in contact. Some of the minnows place their eggs under protective stones or boards, and frequently these are protected by one of the parents. Sometimes elaborate nests are built by a male, and sometimes a nest is shared by a number of males. Most frequently females lay their eggs in a nest ruled by one male. Many times the species making the nest may be identified by the kind of materials used in the nest. An understanding of the nesting habits of these fishes is most important to those who wish to raise minnows, possibly for sale as bait. Those minnows that need protection for their eggs must be able to find suitable nesting sites. Many of the minnows that require water flowing over a particular kind of bottom cannot be reared economically simply because these conditions cannot be reproduced easily in a breeding pond. The eggs of many kinds of minnows frequently are eaten by other fishes and protection by an adult may be necessary. Protection against the silting in of the nest may be more important than protection against fish enemies.

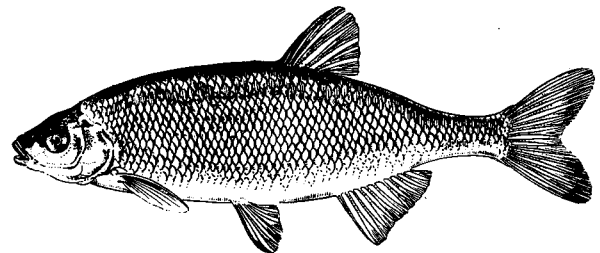
Variations in food needs may be critical in the lives of minnows. As the charts show, some minnows feed largely on small animals. This means that these creatures must be present in sufficient numbers to support the highest population. Minnows (*continued on page 256*)



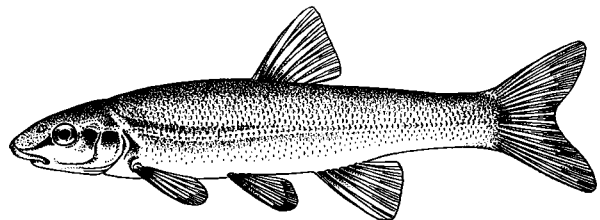
GOLDFISH



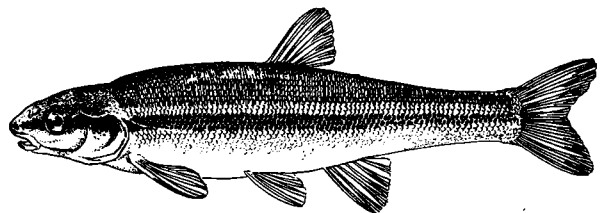
CREEK CHUB, OR HORNED DACE



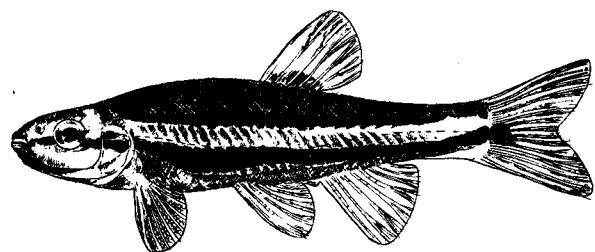
GOLDEN SHINER



LONGNOSE DACE



BLACKNOSE DACE



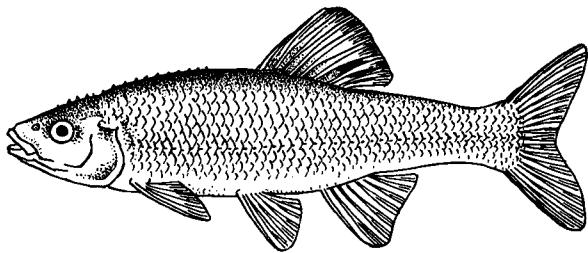
REDBELLIED DACE

COMMON NAME SCIENTIFIC NAME	CARP <i>Cyprinus carpio</i>	GOLDFISH <i>Carassius auratus</i>	HORNYHEAD CHUB <i>Nocomis biguttatus</i>	BLACKNOSE DACE <i>Rhinichthys atratulus</i>
DESCRIPTION	Record carp in Switzerland, taken in 1825, weighed 90 lbs.; S. African record, 83 lbs. Rod-reel American record, 42 lbs., in 1930, from Virginia. Carp have 2 barbels at corner of jaw on each side, and first ray of dorsal and anal fins are spine-like. Mostly coarse scaled, soft-fleshed and sluggish. Black above; golden beneath.	Usual maximum length to 15 inches. Weight to more than 4 pounds. Under 30 scales in lateral line. No barbels at corners of mouth. Black, brown, red or white with infinite variations. Great variation in size and shape of fins, shape of body and in type of eyes, some being raised above normal surface of face.	Length to 10 inches. Head large and broad. Dusky to black above and silvery beneath, with large oblique mouth and, in breeding males, with a red spot behind the eye. General sex differences are indicated in the sketches. There are 41 to 47 scales in the lateral line and 18 rows behind the dorsal.	Length to 3 inches. Blackish above, with dark speckles. Black band through eye from snout back along sides. Belly silvery with lower margin of lateral stripe well defined. Scales about 64 in lateral line. Jaws about equal in length. Adult male with little red along black band but with orange pectoral fins.
RANGE AND RELATIONSHIP	Order Eventognathi. Family Cyprinidae. Native of Asia. Introduced into Europe 1227 from China, and successfully into America in 1877. Widely distributed from Washington, D.C., in 1879. Now in all States, except possibly Maine and Florida. Leather carp is scaleless; mirror carp has few large scales. Typical carp well-scaled.	Order Eventognathi. Family Cyprinidae. Native of Asia, but introduced on a world-wide basis for aquarium use. Established in waters of Great Lakes and their tributaries to the south, particularly in Lake Erie. Favors areas with weeds over mud bottoms. Closely related to carp with which may cross.	Order Eventognathi. Family Cyprinidae. Ranges from North Dakota and Colorado east to the Hudson River and south to Oklahoma. It favors large creeks or small rivers with swift water flowing over bottoms of gravel. In some literature, it appears under the genus <i>Hypobopsis</i> .	Order Eventognathi. Family Cyprinidae. Ranges from New Brunswick and the St. Lawrence River system south to Georgia and west through Alabama, Iowa and North Dakota. At best in small, clear brooks with stony bottoms and swift water, where it may be found among the stones in riffles.
REPRODUCTION	In latitude of New York breeds May and June in schools in shallows, a 16-lb. fish laying to 2,000,000 adhesive eggs, which are unprotected. Hatch in 5-12 days depending on temperature, may reach 9 inches in one year and mature in 2-3 years. During breeding antics may leap from water repeatedly and roil water.	In April and May when water temperature reaches to 70°F. pairs may mate in early morning to early afternoon with female laying 10-20 amber eggs at a time. These adhere to plants. Female may lay to 500 eggs, which hatch at 70°F. in 3-7 days. Good breeder has to 2-inch body, breeds at age 2-9 years. Life span to 25 years.	Spawns in April and May in water to 2 feet deep at 65°F., or warmer, at the head of gravelly riffles. Males build a pebble nest, and eggs and pebbles become mixed. Nest may be to 6 inches deep and cover a number of square feet. A number of females and some shiners may lay eggs in nest. Several years to maturity.	Spawn in April and May, when dark stripes of male may become orange or tan and pectoral fins similarly colored. Male builds nest over sand and gravel and squeezes eggs from visiting female, although this may be off the nest. Water temperature 75°F. at breeding time. Eggs about 1/16-inch in diameter, quickly swelling to 1/8-inch.
ECOLOGY	Food primarily any organic stuff, plant or animal, including fresh fish eggs. Migrates to shallows in May and July. An average 10-inch fish weighs 1/2 lb.; 12-inch, 1 lb.; 16-in., 2 lbs.; 18-in., 3 lbs.; 20-in., 4 lbs.; 24-in., 8-lbs., 2 years old; 26-in., 10 lbs.; 32-in., 15 lbs., 8 years old.	Thrive best in water containing lime, with best development between 55-70°F. Female may lay to 14,000 eggs in a lifetime after maturing at about 4 to 5-inch length. An 11-inch fish may weigh to 9 ounces, and an 18-inch fish may weigh to 3 pounds. May lose color if living in natural habitat.	Food mostly insect larvae and other small animals. About 30% midge larvae; 14% algae; 12% mayflies and 24% aquatic beetles. Only a small percent is of mud and silt so it is obvious that it may be difficult to rear this species in artificial rearing ponds. Slow growth also makes it unpopular in this respect.	Food chiefly small animals, as 70% midge larvae and 17% mayfly nymphs, or sometimes fish eggs where available. A good forage fish for trout, but a direct competitor for food and sometimes an enemy of eggs in nests. July young average 17 1/2 mm. and weigh .09 grams; one-year young average 35 mm. and weigh .7 grams.
ECONOMY	Destroyer of nests and eggs of more valuable species. 250 tons harvested annually in New York State as cheap food and to protect more valuable species, but ineffective. Considered pest. Makes good bait minnow but use prohibited in many States to limit spread. Cooked properly is considered edible by some. Good fighter on line.	Popular aquarium fish of the hardiest type. Essentially a scavenger, eating almost any organic material. Of little value except as an aquarium animal. May be used successfully as bait minnow but danger of escape should be avoided in waters supporting valuable game fishes. Reared profitably in ponds heavily fertilized 2/3 sheep manure, 1/3 superphosphate.	One of the best bait minnows because it is hardy on the hooks and in storage tanks where the loss is remarkably small. It is particularly popular as a bait for catching bass, catfish and walleyed pike. It is quite significant that data on rearing costs and practices in rearing ponds are meager or lacking.	Used as bait for trout by fishermen. Caught in traps or seines. Useful primarily as a forage fish for trout in spite of competition offered. Makes a most interesting aquarium fish because of great activity, but requires a high oxygen content in the water and relatively low temperature to succeed.

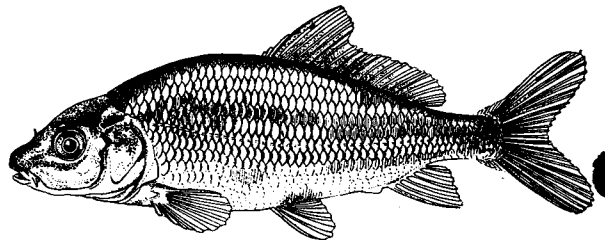
<p>LONGNOSE DACE <i>Rhinichthys cataractae</i></p>	<p>SILVER CHUB, FALLFISH <i>Semotilus corporalis</i></p>	<p>CREEK CHUB, HORNED DACE <i>Semotilus atromaculatus</i></p>	<p>PEARL DACE <i>Semotilus margarita</i></p>	<p>REDBELLIED DACE <i>Chrosomus erythrogaster</i></p>
<p>Length to 4 inches, but usually not more than 3. Upper jaw much longer than lower, and mouth horizontal and "shark-like." Eye nearer center than upper part of head. Olive above with numerous dusky areas on sides, and whiter below with margins of dark areas fading gradually. About 65 scales in the lateral line.</p>	<p>Length to 18 inches for males. Brown above to olive on sides and lighter beneath. Dorsal with 8 rays and no dark spot, set slightly behind mid-body and directly above pelvic fins. Anal fins with 8 rays. Scales silvery and about 48 or less in lateral line, which is almost straight. About 22 in front of dorsal fin.</p>	<p>Length to about 11 inches. Body stout. Mouth large. Dorsal inserted behind pelvic fins. with dark spot at base. Dusky blue above. Sides with vague dusky band. Belly cream. Head blunt, with 4 large tubercles on top in breeding season. Scales crowded before dorsal, with 55-65 in lateral line, which curves up forward</p>	<p>Length to 7 inches, but usually about half that length. Heavy body, short head, blunt snout. Dusky olive above with faint lateral stripe darker. Lighter on sides and lightest beneath. Mottled with darker scales. Scales small but visible.</p>	<p>Rarely more than 3 inches long. Brown with 2 horizontal stripes on sides. These join before tail. Silvery between stripes. Fins canary-yellow, with dorsal with scarlet band. Scales fine. Eyes large. Mouth small. Body cavity lining black. Intestine from 2 to 4 times length of body.</p>
<p>Order Eventognathi. Family Cyprinidae. Related, of course, to Blacknose Dace. Found in fast water and along cool lake shores. Ranges from coast to coast in North America in the general latitudes of the Great Lakes. Extends south to South Carolina and northern New Mexico.</p>	<p>Order Eventognathi. Family Cyprinidae. Ranges from northern tributaries of James Bay and the Maritime Provinces south to eastern Alleghanies into mountains of Virginia. Definitely prefers clear lakes and streams. Is closely related to the Creek Chub or Horned Dace.</p>	<p>Order Eventognathi. Family Cyprinidae. Ranges from Red River of North country and Manitoba east to Gaspé Peninsula in Canada, and south to South Carolina, Georgia, the Ozarks and New Mexico. Usually in clear, cool, head-water streams, commonly associated with Brook Trout, White Suckers and Black-nose Dace.</p>	<p>Order Eventognathi. Family Cyprinidae. Has been included in genus <i>Margariscus</i>. Northern pearl dace found from Rocky Mountains to Maine and north into the tundra. Best known in United States probably in Dakotas, Minnesota, Wisconsin. Not reported in the tributaries of Lake Superior. South to Virginia in East.</p>	<p>Order Eventognathi. Family Cyprinidae. 3 species, closely related, range from British Columbia to New Brunswick and south to Colorado, the Dakotas, Minnesota and Maryland. Southern forms are longer and have more horizontal mouth. Prefer cool gravelly creeks</p>
<p>Breeds May and June, when body of breeders becomes covered with small tubercles, and fins of males become suffused with red. Males also show crimson on lips, cheeks and lower fins. At 1 year males are to 2.4 inches long; at 2, 2.9; at 3, 3.2; at 4, 3.6 inches. Females at 1, 2.3; at 2, 3.; at 3, 3.3; at 4, 3.7; at 5, 4.2 inches.</p>	<p>Breeding males develop reddish fins and in season select nest site in a stream and build a somewhat circular pile, which may be 6 feet across and 3 feet high, using small stones as material and taking a week for construction. Spawn on downstream side of nest and eggs may be partly covered in building act.</p>	<p>Breed April-July in swift water in riffles where purplish and rosy male digs a pit above a riffle, dropping sand and gravel upstream in ridge to 15 inches long. Fights other males. Spawns in pit. At 10 weeks may be 2 inches long; at 12, 3; at 18, 4; at 1 year, 5, and at 2 years, 7 inches long.</p>	<p>In breeding season in early spring male has red band along under side but no black on fins and no tubercles. May be highly colored from February but this fades by fall. Eggs usually laid in fine sand or gravel, usually in running water. One female 4½ inches long yielded 1686 eggs and young may reach 3½ inches first year.</p>	<p>Spawn from May to August, breeding in lakes, ponds and forested swamps in shallow water among plants in North and on sand in South. Female lays 5-30 nonadhesive eggs, which, at 70-80°F., hatch in 8-10 days. Female breeds 2 times a year with early young maturing 1st season and late the next.</p>
<p>Food is almost wholly animal matter, particularly insects, so the species is a direct competitor with game species for food. However, it is a valuable forage fish for larger game fish, although it would be better if it fed on non-competitive plant materials. It occupies territory similar to many game species' favorites.</p>	<p>Food is primarily insects, crayfish, worms and small fishes so may serve as a competitor for food with more valuable game species, such as trout that are found in similar waters. May take an artificial fly and may provide a good fight to the fisherman who hooks one. Mouth is usually rather tough.</p>	<p>Food commonly insects, crayfish and small fishes so is direct competitor with game species. Usual food over 50% insects and 26% surface drift. Heavily stocked ponds may yield 2¼-inch fish in 14 weeks if food problem can be met. 2-inch fish number 300 per pound; 3-inch, 90 per pound, and 4¼-inch, 18 per pound.</p>	<p>Favors small brooks, lakes and bogs where water is clear and cool. Feeds mostly on insects, but known to eat plankton, small mollusks, water mites and surface organic material. Its food undoubtedly varies with the nature of its environment, which may vary considerably.</p>	<p>Food is plants and small animals, but by far the greater proportion of the food comes from algae and diatoms gleaned from the surface of submerged stones. At best in cool waters such as are inhabited by Brook Trout, which frequently feed in turn on Redbelly Dace.</p>
<p>Makes a good bait minnow and an excellent small aquarium fish, but it does not survive well in the crowded conditions found in a bait bucket, or in a rearing pool, nor does it yield well to artificial breeding ponds.</p>	<p>In the Delaware and Susquehanna River systems in New York and Pennsylvania these fish may be a nuisance to fly fishermen, who naturally prefer other species. Fallfish are good bait minnows, and are hardy in the bait bucket and on the hook. Popular with bass and pike fishermen within range. Not easily raised in pools.</p>	<p>Pools may yield 134,772 fishes per acre where raised as bait. Brings top price as bait minnow because of hardness on hook and in bucket. Normal mortality in ponds may be 25-50%, largely because of food problem. The ideal fish for small boys with cheap tackle. Edible but decidedly bony.</p>	<p>Excellent forage fish providing food for larger game species. Excellent bait. Hardy in crowded pails and can survive low oxygen content of 1/5 of 17 parts per million. 4 gallons were carried 2 hours in 5-gallon container at 40°F. without loss of a fish. Recommended to dealers with little working capital. Bait size in a summer.</p>	<p>Under cultivation in ponds may be made to yield 125,000 fish per acre. Not a competitor for food with associated game species. Hardy in bait buckets and generally considered as a fair bait minnow among all the kinds commonly reared for sale as bait. Usually used as bait for the common small panfish.</p>

COMMON NAME SCIENTIFIC NAME	GOLDEN SHINER, ROACH <i>Notemigonus chrysoleucus</i>	SPOTTAIL SHINER <i>Notropis hudsonius</i>	COMMON SHINER REDFIN SHINER, <i>Notropis cornutus</i>	SATINFIN SHINER, SILVERFIN <i>Notropis analostanus</i>
DESCRIPTION	Length, to 12 inches. Lateral line rather conspicuously parallels lower profile of body. Belly behind pelvic fins with 11-15 rays. Head small and pointed. Clear green above, with sides silvery, with golden reflections. Fins yellowish. Young silvery.	Length to 6 inches. Pale with broad silvery band along sides and faint or dark spot at base of tail, and a dark spot at base of dorsal. Anal fin usually with 8 rays. Eyes large. Scales not crowded between head and base of dorsal. With about 59 scales in the lateral line. 18 scales between dorsal and head. Muzzle blunt.	Length of males to 8 inches. Dark steel-blue above, with a gilt line along back and gilt lines along sides. Silvery on sides and belly. Male larger than female. Scales deeper than long with more than 20 between head and dorsal and 37-40 in lateral line. No barbel. Body strongly compressed. 9 rays in anal.	Length to 4 inches. Male bluish but female silvery. Paired fins white. Edges of scales dusky with 34-33 scales in lateral line. With a large dark spot on the upper rear portion of the dorsal fin. 9 rays in anal fin. Head about as long as body is deep and depth of body about 1/2 the length.
RANGE AND RELATIONSHIP	Order Eventognathi. Family Cyprinidae. Ranges from New Brunswick to Manitoba and south to Texas, Tennessee and Florida. Found often abundantly in ponds and slow streams where there is abundant vegetation. Common name of Bream is applicable to these fishes. Formerly considered in the genus <i>Abramis</i> .	Order Eventagnathi. Family Cyprinidae. About 100 species in the genus. This one ranges from James Bay in Canada to the upper Great Lakes, and south to upper Mississippi and the Hudson and Susquehanna systems. Often found congregating in large schools near shores of lakes and rivers.	Order Eventognathi. Family Cyprinidae. Ranges through most of continent east of Rockies, except in Texas and along Atlantic south of Neuse River. Northern limit in Saskatchewan and southern limit the Gulf of Mexico. One of commonest minnows in most creeks of eastern North America, where it seeks open sunny areas.	Order Eventognathi. Family Cyprinidae. Found abundantly locally in clear streams from Lake Ontario south to North Carolina, and in closely related forms west to Oregon. Related Spotfin has 8 rays in anal fin and 39-42 scales in lateral line.
REPRODUCTION	Breed May to August, when males develop red abdomens. Female lays 5-30 nonadhesive eggs at a time on roots, plants or algae, which, at 70-80° F., hatch in 8-10 days. Probably 2 spawning periods. Silvery young may reach 3 inches in 5 months under ideal conditions. Normally 1 inch, 5 months; 1 1/2-2, in 1 year, 9-inch fish, 9 years.	Spawn in May and June along sandy lake shores, usually near mouths of tributary streams, or even up the streams a way. Grow 1/2 mm. a day for 1st month. By July may be more than 1/5-in. long, 1st year become to 1 3/4 inches long; 2nd year, to 2 1/4 inches; 3rd year, to 3 inches. Young left to shift for selves without any parental care.	Breeding males from May to August may have salmon-pink bellies, and lower fins and tuberculate bodies forward. Eggs laid at 73° F. in swift water, usually in pebble nest built by males and over shallow gravel. Male protects eggs and nest. Young with dark band along sides. In ponds fish may breed near intake.	Breeds in late spring, such as May and June, in shallow waters of lakes or near the mouths of streams, usually in considerable numbers. Relatively little known about early stages, or about breeding habits. At least, information not to be found in most literature.
ECOLOGY	Normally 90-95% of food is plants, but 35% may be insects; 28% plankton; 14% algae and 12% crustaceans. 14 known parasites. Young of year have dusky lateral stripe. 4-inch fish weighs 1/4 ounce; 6-inch, 1; 8-inch, 2 1/2, and 9-inch, 4 ounces. Non competitors for food with common game fishes and a valuable forage fish for them.	In winter goes to deeper waters of lakes. Food is primarily small, free-swimming crustacea and other minute animals. May include some plant material as well, but most of the food is taken from open water rather than from the bottoms or from the surface, as is the case with some minnows.	Food mostly insects but may average 40% plants, 37% insects; 12% plankton; 7% other fish. 3 known parasites. In pond may reach 2 inches, 1st year; 2-4, in 2nd; 3-5, in 3rd, reaching maturity in 2-3 years. Grows 1/2 mm. a day for 1st month. Not as prolific in ponds as some other bait minnows.	In winter may make way into deeper waters as is common with many other minnows. This species may be found in the tide-water areas of some of the larger rivers flowing into the sea, and since it is a good bait minnow may be collected for that purpose.
ECONOMY	One of best bait minnows, hardy on hook and in pail. May be used as panfish, but flesh soft. 1/2-acre pond fertilized with 464 pounds cottonseed meal at cost of \$8 yielded 204,082 fish at cost of \$.018 per pound. 1 acre stocked with 200 fish yielded 65,000. Breeding ponds may support 250,000 golden shiners per acre.	A most important forage fish providing food for larger and more valuable game and food species. Makes a good bait minnow, particularly for Muskellunge, Pike, Pickerel and for Yellow Perch. Is not too hardy in the bait bucket or in storage tanks. Named originally by Gov. DeWitt Clinton of New York State.	Popular small boy's fish. Difficult to raise in ponds because of food problems, but because of brightness and activity makes high priced and excellent bait minnow. Also makes a good aquarium fish. May take artificial flies as do trout. Flesh is good to eat but is bony.	This species is widely used in Virginia as a superior bait minnow. Of course, it serves the basic function of converting small organic materials into suitable food for the larger fishes that use this species as food.

BRASSY MINNOW <i>Hybognathus hankinsoni</i>	FATHEAD MINNOW <i>Pimephales promelas</i>	BLUNTNOSE MINNOW <i>Hyborhynchus notatus</i>	CUTLIPS MINNOW, NIGGER CHUB <i>Exoglossum maxillingua</i>	STONEROLLER, DOUGHBELLY, ROTGUT <i>Campostoma anomalum</i>
Length to 6 inches. Large scales that rub off easily, with many weak radii. Scales crowded behind the head. Head blunt. Fins rounded, short, with free edges. Mouth small. General color silvery or brassy, as distinguished from the brilliant silver of Silver Minnow, which may be more slender.	Length to 3 inches. Body short and relatively deep. Dark olive above and coppery or purplish forward. Dorsal fin with dusky crossbar at middle, or over lower 2/3 in breeding males. Mouth terminal and oblique. Anal fin with 7 rays. Lateral line incomplete, with 43-47 scales. Intestine 2-3 times body length.	Length to 4 inches. 1st dorsal fin ray thickened. Broad head. Inferior mouth. Small scales crowded in front of dorsal. Dark spots on body in front, at middle of dorsal and at base of tail. Body cavity lining black. Intestine 2 times length of body. Breeding male dark with black band through dorsal fin.	Length to 8 inches. Dark compact body. Olive above, with purplish reflections on the sides and lighter beneath. Breeding male may appear to be excessively dark. Lower lip is characteristically 3-lobed and relatively short, and on under side of head, also considerably shorter than upper lip. Fins plain.	Length to 8 inches. Females usually less than 5 inches. Stout-bodied. Brassy above. Sides blotched or mottled with black. Scales long, may be black-flecked, with 55 in lateral line. Belly white. Breeding male with black bar through middle of dorsal. Abdominal cavity black-lined. Long intestine coiled around air bladder.
Order Eventognathi. Family Cyprinidae. Ranges from Montana east through Great Lakes area to Lake Champlain and south to Colorado, Kansas and New York. Also reported from many tributaries of the Mississippi. Most close relative is the Silvery Minnow, <i>H. nuchalis</i> , which has about the same range.	Order Eventognathi. Family Cyprinidae. Ranges over eastern North America from Hudson Bay and the Maritime Provinces south to Maine, New York, Ohio, Tennessee, Kentucky, Kansas and Colorado. Known sometimes as Blackhead Minnow because of dark forward parts.	Order Eventognathi. Family Cyprinidae. Ranges from Winnipeg through Great Lakes area to Quebec and south to Virginia and the Gulf States, west to Nebraska. In Michigan area this may be the commonest of the minnows. Dorsal fin with 9 rays; anal with 7. Lateral line with 45 scales.	Order Eventognathi. Family Cyprinidae. Ranges from the St. Lawrence River system south to Virginia usually east of the Appalachian Highlands. Not a widely distributed species as compared with most other minnows. Not much if any west of Lake Ontario. May be locally abundant.	Order Eventognathi. Family Cyprinidae. Found in streams and lakes, commonly over mud in weeds close to shore, ranging from the St. Lawrence system through the Great Lakes to Minnesota south through upper Mississippi River valley and into Mexico. A number of subspecies recognized in range area.
Breeds from April through July, with the female laying adhesive eggs that are scattered over mud, twigs and debris at temperatures of 50-55° F. Growth is slow and it may take 2 years to develop a fish from 2½-3 inches long. The breeding habitat varies with the region occupied.	Breeds in May to mid-August in shallow waters of lakes, ponds and swamps, usually over shingle of fine gravel at 64° F. Eggs laid on under side of objects, guarded by male with 36-1200 eggs in a single nest. One female produced 4144 young in 11 weeks in 11 spawnings. Eggs hatch in 4-6 days. 1 inch, in 1 month; 2, in 3.	Spawns May to August, with males almost black. Breeds at 70° F. in water to 8 feet deep to 6 feet over shingle, in nests under stones or boards, with average nest containing to 2500 eggs. Female breeds twice in a season. Young at 1 year, 2¼ inches; at 2, 3 inches. Maximum age to 4 years. Less prolific than Fathead Minnow.	Breeds May and June, when males build pebble nest in water 3 to 30 inches deep and 8-12 inches across in or at head of riffle. Male guards nest, which may be visited by many females. Male has no breeding tubercles. Avoid competition with interlopers but fights other males. Eggs 1/10-inch, yellow, glossy; hatch in 4 days.	In breeding from April through mid-June, male digs cup-like depression above riffles in water usually less than 3 feet deep. In breeding season male has tubercles on head, bright brassy color on body, dark and orange bars across the dorsal, orange eye and orange on pelvic fins. Young reach maturity in 2-3 years.
Found in bogs, creeks and lakes and small streams. Food may average 32% plant plankton; 30% animal plankton; 21% insects; 16% surface debris; 3% plant materials and 2% silt. The mud-eating habit is reflected in the intestine, which is 2-3 times the length of the air bladder and coiled like a watch spring.	Largely a mud-eater favoring plant foods, but sometimes eating fish eggs. Tolerates muddy water more than many species. Known to have 2 parasites. Food may average 35% plant plankton; 12% sand and silt; 12% surface food and 6% crustaceans, with rest miscellaneous.	Favors lakes and rivers with firm bottoms and some rough material. Food primarily plants, crustacea and insects; 35% plankton; 12% silt; 11% surface drift; 16% insects; 9% plants. May be an important food for larger fishes. Known to support at least 9 parasites. Male builds nest and guards the eggs at breeding time.	Normally found in small, swift streams over gravel bottoms. Essentially a bottom feeder but has been taken on a fly. Food largely insects, snails, worms, crayfish. Lower lip used in removing food from stones that have been rasped by upper lip. Nest abandoned in 6 days when young leave after 4-day incubation at 70° F.	At best in clear gravel bottomed brooks. Can withstand relatively warm water. Food largely plants with to 60% algae and diatoms gleaned from stone surfaces, 30% mud and sand and to 10% insects possibly taken incidentally with mud and sand. Obviously largely a mud-eater.
Makes a good forage plant for larger and more valuable food and game fishes. Makes an excellent bait minnow and is frequently reared in artificial ponds. An acre of well-managed pond may in a year yield to 35,200 of these popular bait minnows.	Good forage fish and food for trout. Used as bait but not too hardy in containers. 1 acre of managed pond may yield 200,000 minnows weighing 328 pounds with number varying largely with fertilization and food available. Stands crowding in ponds remarkably well. Brush sunken in breeding ponds supply supports for the eggs.	An excellent bait minnow but does not withstand too much crowding in containers. Can best be propagated as a slow grower but ponds may yield to 100,000 fishes a year and as high as 473,350 per acre have been raised in Ohio. Pond fertilized at rate of 640 pounds cottonseed meal per acre yielded 580 pounds of minnows.	Sometimes considered an important bait minnow but does not yield to raising in ponds because of nesting requirements. Hardy on hook and in containers. Serves general purpose of being food for larger game species and may also serve as enemy of the species in the destruction of nests.	An excellent forage fish for larger game species of habitat, with which it does not compete for food. Has no food value to man. Is of minor importance as a bait minnow but may be favored by Black Bass. Is hardy as aquarium fish, but does not breed well in artificial ponds because of need of running water over nest.



SATINFISH SHINER



CARP

(continued from page 251)

that feed on plants are much more likely to survive overcrowding since plants are usually more abundant than are animals. Those minnows that feed largely on algae and the diatoms, such as those that form slimes on submerged rocks, find an almost inexhaustible supply of food. It is relatively simple to raise these fishes. This is particularly true if the abundance of these plants may be increased by the use of suitable fertilizers. The charts show the specific food needs of some of our minnows.

When this insert first appears in print it is quite probable that one of the chief points of public interest will be the food problem, nationally and internationally. Our mid-West food belt has tremendous political influence, and both of the major political parties, soon to select candidates for the fall elections, will be courting support from that area. Of course, we do not eat farmers, but without farmers we do not eat. Farmers are able to process the sun, rain and soil into corn and wheat, and to process the corn and wheat into dairy products, and into pork and beef. The product of the farmer is, in turn, processed at the will of the labor leaders into food products that reach the dealers who supply most of us with what we put on our tables and, eventually, into our mouths. Somehow in this chain of events many of the farmers have not been able to prosper. This is particularly true of those who have relied on antiquated methods associated with their labors. The major farm organizations have recognized merit in the private enterprise system and seem to resent manipulations of their economy that may limit their earning power in many ways. Logic makes it difficult to justify the expenditure of public funds for the erection of huge dams to produce food, the profitable sale of which depends on fixed price supports. Somehow a solution will be found, of course.

If our national and international food problem is a complicated one, the same holds for the food economy of our waterways, where our minnows may play an important role. We cannot consider all minnows as having similar problems and similar potentials any more than we can consider all farmers as being alike.

Our minnows are, like farmers, largely early processors in the whole food chain. Basically, of course, the water plants process air and water into plants. These plants, either suspended in the water, possibly as plankton, or anchored to the bottom, are eaten by fishes, many of which are minnows. These fishes process the

plant material into food acceptable to many of the more valuable food and game fishes. The successful management of a body of water may depend on using fishes that can, with a minimum use of time and space, produce a maximum of flesh acceptable to the more valuable fishes as food. This means that minnows that compete with the larger fishes for food are not so valuable as minnows whose food is not favored by the food and game species. Our chart section will give many details supporting this idea, particularly in the last sections where problems associated with rearing minnows are given emphasis.

Other problems associated with the food chain of which minnows are a part take into consideration such things as temperature, water turbidity, light, chemical nature of water, parasites, pollution and presence and abundance of enemies. Conditions suitable for the prosperity of a fish must be present during its life time, even though these conditions will vary from time to time during the day, or from time to time during the year or during the years necessary for the fish to reach reproductive maturity. As suggested for the carp, many fishes are able to meet these changing conditions by suspending their activities, including their digestive needs. Our waterway economy could no more do without minnows, or similar fishes, than our national economy can do without farmers. The minnows in many areas produce a major portion of the bulk of food used by the most important fishes.

The management of this minnow supply in a waterway system sometimes calls for more care than might seem necessary. If we have a lake that yields a valuable fish resource the chances are good that those fishes are dependent largely on the minnows and similar fish that start their lives in the shallows, or in the tributary streams. If we seine these areas consistently we remove the natural food supply from the lake and our desirable fish population becomes reduced. Under these circumstances we must either control the seining activities or rear fishes under controlled conditions. As a matter of fact, we do both. In many parts of the country it is illegal to take bait minnows from natural areas. In more parts of the country we are learning how to use farm ponds for the production of superior bait minnows that cost little to produce, are hardy in containers and on hooks, and remain attractive when put on a hook. Usually this is most easily done with minnows whose food supply can be produced cheaply and abundantly.