

OFF

C41P4

C6/53

A

Contributions du Département des Pêcheries

Québec — N° 53

ORDER ACIPENSEROIDEI

by

Vadim D. Vladykov

and

John R. Greeley



Ministère de la Chasse et des Pêcheries

Québec

1963



Bibliothèque Nationale du Québec

Contributions du Département des Pêcheries

Québec — N° 53

ORDER ACIPENSEROIDEI

by

Vadim D. Vladykov

and

John R. Greeley

(Reprinted from Memoir Sears Foundation for Marine Research)



Ministère de la Chasse et des Pêcheries

Québec

1963

Order Acipenseroidei¹

VADIM D. VLADYKOV²

and

JOHN R. GREELEY³

Acknowledgments. We are indebted to the late Léon Bertin and to Miss Rolande Estève for their help and for their permission to examine Duméril's types of Sturgeons in the Paris Muséum National d'Histoire Naturelle. We are also grateful to Henry W. Fowler and Leonard P. Schultze for making available for study the Sturgeon collections in the Academy of Natural Sciences at Philadelphia and of the United States National Museum; to Loren P. Woods for specimens from the Chicago Natural History Museum; to Carl E. Guthe and Ralph S. Palmer for their kind offer of a rich collection of *Acipenser brevirostris* from the New York State Museum; to the late Alexander D. Bajkov, R. E. Dimick, Ivan J. Donaldson, and Charles E. Warren for collecting Sturgeons in Oregon; and to Henry B. Bigelow and William C. Schroeder for their careful editing of this manuscript and for making available their unpublished notes.

The illustrations were drawn by Paul I. Voevodine, artist of the Department of Fisheries, Quebec.

Scope of Study. In the following text we give the characters of the Order Acipenseroidei and of the family Acipenseridae; also descriptions, life histories, and geographical distributions, as well as synonyms and references, for the following Sturgeons: *Acipenser brevirostris*, *A. fulvescens*, *A. oxyrinchus oxyrinchus*, and *A. oxyrinchus*

1. Contribution No. 53, Department of Fisheries, Quebec, P. Q., Canada.

2. Present address: Department of Biology, University of Ottawa, Ontario, Canada.

3. Present address: Division of Fish and Game, Conservation Department, Albany, New York, U.S.A.

desotoi; all of these occur in the western North Atlantic or Gulf of Mexico in fresh, brackish, or salt water. Since *A. sturio* of the eastern Atlantic and Mediterranean has sometimes been considered synonymous with *A. oxyrhynchus*, the relationship of these two is discussed on p. 57.

Most of the material for our study consisted of collections made in New York (35: 45-103) and Quebec (83: 143-204; 84: 129-154). Supplementary data were obtained by examination of the material at the Paris Muséum National d'Histoire Naturelle, the United States National Museum, and the Academy of Natural Sciences of Philadelphia.

The *Descriptions* are based on the *Study Material* listed for each species. An explanation of terms, measurements, and counts is given on p. 33. The accounts of the habits and geographical distributions are based upon published records and personal observations.

Many of the earlier authors who dealt with the taxonomy of Sturgeons based their conclusions on differences associated with the age of the specimens, with the consequences that they recognized several nonexistent species. Hence, among the references, we use only those that we consider to be the most important from a taxonomic point of view, and particularly those dealing with the life histories of the species.

Characters. BODY subcylindrical. SNOUT greatly extended, blade-like and flexible in some, in others only slightly extended, if at all, and rigid. MOUTH on lower surface of head, protractile or not. CHIN BARBELS prominent in some but lacking in others. DORSAL fin situated far rearward; only one. CAUDAL fin more or less deeply forked, with fleshy axis (enclosing notochord) extending rearward to tip of upper lobe, bending upward beginning at base of fin; heterocercal, wider below than above the fleshy axis. VENTRAL fins well developed, abdominal in position. FIN RAYS much more numerous than their basal skeletal supports. PECTORALS with the first ray transformed in some into an ossified ray, the fins otherwise without spines. SKIN of trunk rearward from eyes seemingly naked in some but actually with minute scattered PLATELETS; others with five longitudinal rows of SCUTES (large bony shields), the skin roughened elsewhere with small scattered DERMAL OSSIFICATIONS.⁴ A continuous series of rhombic to lanceolate PLATES, closely set, on axis of caudal; the upper margin of caudal with a dorsal fringe of large v-shaped FULCRA (spine-like scales), each representing the fusion of a pair of opposing plates. TEETH minute, if present. BRANCHIOSTEGAL RAYS absent.

SKELETON cartilaginous for the most part, the primitive cartilaginous cranium (chondrocranium) persisting and growing throughout life; ossification chiefly representing development of membrane bones (p. 4) in regions of skull, jaws, and pectoral girdle. Upper jaw not articulating with skull either in the ethmoid region or in the sphenoid. Premaxillary bone fused with maxillary. Pectoral girdle fused with clavicle.

4. There is no definite terminology for the plates or granules found in the skin between the regular rows of bony shields; they have been variously called: stellate plates, stellate roughnesses, stellate ossifications, minute rough spinules, small prickle-like plates (43: 104-106), dermal plates, and small spinous asperities (Ryder, *The Sturgeons*, with an account of experiments bearing upon Sturgeon culture, 65: 231-328). In the present manuscript they are called "dermal ossifications."

Myodome absent. Interopercular bone absent. Radials in dorsal and anal fins cartilaginous. Vertebral centra absent, the notochord entirely unconstricted throughout its length. AIR BLADDER well developed, oval, with smooth inner surface, opening into oesophagus through a short, wide duct. INTESTINE with well-developed spiral valve (see Berg, 10: 387).

Habitat. Fresh water, or, if marine, entering fresh water to breed.

Families. Of the two living families, the Acipenseridae with four genera is much more important throughout the northern hemisphere than Polyodontidae, which is represented now by only two freshwater genera, each with a single species; *Polyodon spathula* (Walbaum), with a nonprotractile mouth, is found in eastern North America,⁵ whereas *Psephurus gladius* (Martens), with a protractile mouth, inhabits China; one family, Chondrosteidae, is extinct, being known only from fossils of the Lower Lias to Lower Cretaceous periods.

Key to Modern Families

- 1 a. Snout in front of eyes little if at all longer than remainder of head, subconical, rigid, more or less flattened in some but not blade-like in shape; a transverse series of four fleshy and conspicuous barbels close in front of mouth; mouth on lower surface of head, protrusible; jaws toothless in adult; five longitudinal rows of large bony shields (scutes) on body, the lateral row extending onto base of caudal, the skin elsewhere between them rough with small dermal ossifications; bony plates separated by evident sutures covering head; anterior edge of pectoral fins with a stout ossified ray; upper lobe of caudal much longer than lower.

Acipenseridae, below.

- 1 b. Snout in front of eyes much longer than remainder of head, blade-like in form and flexible in American species; no barbels in front of mouth; mouth lateral in position, protrusible (in *P. gladius*) or nonprotrusible (in *P. spathula*); jaws with minute teeth; no bony shields on body, the skin everywhere on trunk smooth to the touch; head not covered with bony plates; no ossified ray in pectoral fins; lower lobe of caudal at least as long as upper lobe in American species.

Polyodontidae. Paddlefishes.
Fresh water of eastern North America
and China.

Family ACIPENSERIDAE

Sturgeons

Characters. BODY elongate and fusiform. SCUTES or bony shields in five rows: one dorsal, two lateral, and two ventral; all scutes very sharp and strongly developed

5. According to Dr. R. D. Suttkus (personal communication, July 9, 1957), a specimen of *P. spathula*, 481 mm FL and weighing 354 g, was taken in the brackish water of Vermilion Bay at Cypremont Point, Louisiana, on May 15, 1954, by Antoine Carrere while trawling for penaeid shrimp.

in young individuals, but becoming progressively blunter with age or even disappearing through absorption. SKIN between scutes with small ossifications. SNOUT protruding. MOUTH inferior, protractile. TEETH absent in adults. BARBELS 4, in a crossrow in front of mouth. GILLS 4, and an accessory opercular gill. BRANCHIOSTEGALS absent. GILL RAKERS fewer than 50. OPERCLE absent. HEAD covered by bony plates separated by sutures; particularly visible in younger specimens. DERMAL SKELETON without ganoine. CAUDAL fin with typical fulcra. DORSAL and ANAL fins behind ventrals. PECTORAL fin with first ray enlarged and ossified. TAIL heterocercal. AIR BLADDER large, simple. STOMACH with numerous pyloric appendages, forming a compact and rather large gland. RECTUM with spiral valve.

Anadromous and freshwater fishes of the northern hemisphere; Upper Cretaceous to Recent.

Remarks. The cartilaginous skull has an opening under the frontal and parietal plates, usually completely roofed over by these membrane bones. Hence there is a cavity, evident in sagittal section of the head, for which we propose the name *frontal sinus*.

In young specimens of *A. oxyrhynchus* of America and *A. sturio* of Europe, there is a membranous, elongated, nonossified area on the top of the head which Ryder⁶ called the "fenestra" or "fontanelle." In specimens less than 40 inches long, this can usually be found by probing with a needle between the frontal and parietal plates; thus a probe can be passed downward into the *frontal sinus*. Adults, and in rare instances young, have the plates fully joined, closing the fontanelle.

The protractility of the mouth is made possible by movements of the jaws and palatoquadrate bone (10: 409).

The pseudobranchs are rudimentary in *Scaphirhynchus* (31: 26) and completely lacking in *Pseudoscaphirhynchus* (11: 104). The large element of the gill cover represents the subopercle, not the opercle (70: 48-50).

The appearance of the Sturgeon changes considerably with age; the snout becomes shorter and blunter and the shields smoother while the lower caudal lobe, not fully formed⁷ in very small specimens, becomes longer. Apparently the shields may be partially or completely absorbed in connection with ripening of the gonads.

Genera. The family Acipenseridae is divided into two subfamilies. Acipenserini (true Sturgeons), with spiracles present, is represented by two genera: *Huso*, Lower Pliocene to Recent, with two species; and *Acipenser*, Upper Cretaceous to Recent, with about 16 species. Scaphirhynchini (Shovelnose Sturgeons), without spiracles, also includes two genera: *Scaphirhynchus*, with two species;⁸ and *Pseudoscaphirhynchus*, with three species.

6. Ryder was probably the first American author to describe the presence of a fontanelle in *A. oxyrhynchus* (65: 233); for that in *A. sturio*, see Stannius (68: 26) and Antoniu (4: 113, 114).

7. Grote, *et al.* (36: 215, fig. 158) and Roule (62: pl. 4, fig. 7) have presented drawings of young *A. sturio* in which the lower lobe is not well grown as yet.

8. Although one of the American species has been described as a separate genus, *Parascaphirhynchus* (31: 37-44), recent studies fail to substantiate this (8: 174).

Key to Genera⁹

- 1a. Spiracles present; snout subconical; tail not depressed or completely mailed; gill rakers lanceolate.
- 2a. Gill membranes joined to isthmus. *Acipenser* Linnaeus 1758, below.
- 2b. Gill membranes free from isthmus and broadly connected between themselves.
Huso Brandt 1869.
Basins of the Adriatic, Black, and Caspian seas, and the Far East (Amur River).
- 1b. Spiracles absent; snout shovel-shaped, depressed above; tail depressed and mailed; gill rakers fan-shaped.
- 3a. Caudal peduncle completely mailed, and long, with tip of anal fin remote from caudal base; barbels fringed. *Scaphirhynchus* Heckel 1835.
Mississippi River Basin.¹⁰
- 3b. Caudal peduncle incompletely mailed, and short, with tip of anal fin reaching almost to caudal base; barbels smooth. *Pseudoscaphirhynchus* Nikolski 1900.
Turkistan (Basin of the Aral Sea).

Genus *Acipenser* Linnaeus 1758

Acipenser Linnaeus, Syst. Nat., ed. 10, 1758: 237; type species, *A. sturio* Linnaeus. Atlantic Ocean, along European coast.

Generic Synonyms:

- Ichthocolla* Geoffroy, Descr. de 719 Plantes, etc., 1767: 399 (presumably *A. huso* L.).
- Sterleta* Gldenstdt, Nov. Com. Acad. Petropol., 16, 1772: 533 (*A. ruthenus* L.).
- Sturio* Rafinesque, Indice Ittiol. Sicil., 1810: 41 (*Sturio vulgaris* Rafinesque = *A. sturio* L.).
- Sterletus* Rafinesque, Ichthyol. Ohiensis, 1820: 80 (*A. serotinus* Rafinesque = *A. fulvescens* Rafinesque).
- Helops* Brandt and Ratzeburg, Medizinische Zool., 2, 1833: 3, 349 (*A. stellatus* Pallas = *A. helops* Pallas).
- Sterletus* Brandt and Ratzeburg, Medizinische Zool., 2, 1833: 349 (*A. ruthenus* L.).
- Sturio* Mller, Vergleich. Anat. Myxinoiden, 1835: 77 (*A. sturio* L.).
- Antaceus* Heckel and Fitzinger, Ann. Wien. Mus., 1, 1836: 293 (*A. schypa* Eichwald).
- Lioniscus* Heckel and Fitzinger, Ann. Wien. Mus., 1, 1836: 370 (*A. glabra* Fitzinger).
- Sterletus* Bonaparte, Cat. Metod., 1845: 21 (*A. vultharius* L.).
- Ellops*, Gistel, Naturg. Thierreichs, 9, 1848 (*A. helops* Pallas).
- Schipa* Brandt, Bull. Acad. Sci. Petersb., 7, 1850, 113 (*A. schypa* Eichwald).

Characters. GILL MEMBRANES joined to isthmus. SPIRACLES present. SNOUT subconical. TAIL depressed and completely mailed. GILL RAKERS lanceolate. Characters otherwise those of the family.

9. Since Sturgeons change with age in such features as head proportions and characteristics of scutes, the preparation of keys applicable to both young and adult stages has involved selection of those characters that are most constant throughout life.
10. According to Dr. R. D. Suttkus (personal communication, July 9, 1957), a specimen of *S. album*, 532 mm FL and weighing 553 g, was taken in the brackish water of Vermilion Bay at Cypremont Point, Louisiana, on May 10, 1954, by Lester Boudreaux while trawling for penaeid shrimp.

Subgenera. There have been several attempts to subdivide the genus *Acipenser* as defined by Linnaeus in 1758. The preferences of earlier authors may be judged from the Generic Synonyms. Among contemporary authors, Berg (II: 66), for instance, favors three subgenera: *Lioniscus* Heckel and Fitzinger for *A. nudiventris*, *Gladostomus* Holly for *A. stellatus*, and *Acipenser* s. str. for the rest. On the other hand, Antoniu (5: 317, 318) has grouped Black-Sea Sturgeon in two subgenera: *Euacipenser* Antoniu, comprising *A. ruthenus* and *A. nudiventris*, and *Acipenser* Linnaeus, embracing *A. sturio*, *A. güldenstädti*, and *A. stellatus*. We believe that in the future any subdivision of the genus *Acipenser* should be based on meristic and anatomical characters; this is not possible yet because the anatomy of the Pacific species is completely unknown and that of Atlantic species has not been sufficiently studied.

Size. Among *Acipenser* species, the range in size is wide. The largest species is *A. transmontanus*, with occasional individuals weighing up to 1,800 pounds (21: 74), as in the case of one taken about 60 years ago at Mission, British Columbia; the smallest is no doubt *A. brevirostris*, about nine pounds (p. 38). The species of *Huso* are much larger. Berg (II: 61) has mentioned the capture of a female *H. huso* in the Volga in 1924 that weighed 2,707 pounds (1,228 kg). A still larger specimen, weighing 6,614 pounds (3,000 kg), was taken in 1827. Females grow much larger than males.

Span of Life. The species of *Acipenser* and *Huso* may have a longer life span than most fishes. For instance, through study of cross sections of the pectoral bony ray, an *A. sturio* 230 cm long was found to be 25 years old (20: 61). The age of a *Huso dauricus*, 500 cm long and weighing 1,600 pounds (655 kg), was estimated to be between 50 and 55 years (60: 199). Further information is given in the accounts of the western North Atlantic species.

Age in Sturgeons has been studied by two methods, one employing cross sections of the pectoral ossified ray, the other otoliths.¹¹

Breeding Habits and Sex. Sturgeons breed for the first time at a much more advanced age than most other fishes, and apparently the small species are more precocious than the large. For instance, the relatively small *A. ruthenus* from the Volga may mature at four years (II: 75) and *A. brevirostris* from the Hudson River at five years (35: 82-83). On the other hand, such a large species as *A. oxyrhynchus* reaches maturity in 10-12 years. According to Harkness,¹¹ *A. fulvescens* from Lake Nipissing, Ontario, spawns for the first time at 22 years of age.¹²

Apart from the period when they are sexually mature, there is practically no exterior distinction between the sexes. The cow Sturgeons, when full of ripe eggs, have a greatly swollen abdomen with rather thin walls, and the mature males have a more elongated appearance, with the walls of the abdominal cavity much thicker.

11. For schematic drawings of otoliths of *A. oxyrhynchus* and *brevirostris*, see Greeley (35: 81); and for *fulvescens*, see Harkness (38: 16-19). Harkness (38: 13-42) and Greeley (35) used otoliths for determination of age while Classen (20) and other European investigators based their findings on cross sections of the pectoral bony ray.

12. For a review of the rate of growth and of the age at spawning of different species, see Classen (20).

Among the large species, accurate determination of the sex in specimens smaller than 30 inches is difficult and often requires the use of a magnifier.

All of the species are oviparous and spawn in fresh water, and there is no adaptation for the care of eggs or young. The eggs are large, at least 2.5 mm in diameter, demersal and adhesive (prior to water-hardening), and their number varies with the species and with the size of fish; in large specimens they exceed several million, as in the case of the 2,707-pound female reported by Berg (above), which yielded an estimated 7.7 million eggs weighing 542 pounds. More details are given in the accounts of the respective species.

In all Acipenseridae¹³ the ripening gonads¹⁴ have a characteristic appearance, being thick and elongate and extending along each side of the air bladder near the dorsal surface of the body cavity. The immature gonads in both sexes are covered on the underside by a large mass of yellow fat which apparently plays a role of energy storage for the ripening gonads; in those close to spawning it is almost entirely absorbed. The fully mature ovaries are very large and make up 10–20% of the total weight of the fish. As the ripe eggs become dark,¹⁵ the whole ovary darkens. Mature testes are pale yellow to whitish.

It is a common observation that, even in the spring during the spawning season, large individuals with immature ovaries are found among fully mature females. This may be explained by the fact that the fish, after the first spawning, may spawn only at intervals of two or even three years.

Studies of gonad maturation in *A. nudiventris* from the Aral Sea found that there are two distinct "waves" in the ripening process (73: 581–584). Fish ascend the Syr Darya River for spawning around the end of July, when they have rather well developed gonads. Soon the advanced sex cells are absorbed. After about two weeks, during the second "wave," the maturation of gonads starts again and is nearly complete by mid-October. During the winter the maturing fish hibernate in the river and spawn the following April or May. However, the material at Trusov's disposal was rather limited (160 gonads) and was collected during four different years (1941, 1946–1948).

Habits and Food. Sturgeons are sluggish but strong. During the summer they often leap from four to six feet above the water. There are many known cases of Sturgeons jumping into a passing boat. About 70 years ago Ryder mentioned such a case for *A. oxyrhynchus* near Delaware City, and on August 14, 1951, the Quebec newspaper *Le Soleil* (p. 20) reported that a 35-pound *A. fulvescens* jumped into a small rowboat on the Ottawa River, near Pembroke, Ontario.

The small protractile mouth preceded by four sensitive barbels in the middle of the lower surface of the head may be considered an adaptation for bottom feeding.

13. The same phenomenon has been reported for *Polyodon* as well (46: 116–124).

14. For further details on the ripening of eastern American Sturgeons, see Ryder (65: 268–273).

15. Nikitin (56: 76) gives practical suggestions for the recognition of eggs from different species of Sturgeon made into caviar. The eggs may be distinguished by size, color, and particularly by the tint of their germinal disc ("eye" of the egg).

However, it has been observed that Sturgeon may rise to the surface to seize swimming objects (65: 265).

The main Sturgeon food consists of bottom organisms such as oligochaete worms, insects, mollusks, and crustaceans; occasionally plant material is found in their stomachs as well. Sturgeons may feed on their own eggs, at least in the case of *A. fulvescens* from Lake St. Peter, Quebec (unpublished data from Messrs. L. Philippe and J.-P. Cuerrier), and on different species of fish and birds. The gigantic *Huso huso* of the Caspian Sea may even feed on newborn seals (57: 435).

Habitat. While the majority lives in both fresh and salt water and makes most of the growth in the sea, at least two, *fulvescens* and *ruthenus*, are found typically in fresh water, although the former has been reported as occurring in brackish water.

Range. The species of *Acipenser* are spread throughout the whole northern hemisphere, being particularly numerous in the Caspian and Black Sea basins.

Commercial Importance. The fisheries for Sturgeon in North America have declined greatly in the last hundred years, and their maintenance on a sustained-yield basis constitutes a challenge to conservationists. Toward the end of the 19th century, catches for certain years were over 5,000,000 pounds for all species combined, but in 1956 only 392,000 pounds were taken in Canada and 719,000 pounds in the United States (combined value about \$386,000).¹⁶ The Lake Sturgeon (*A. fulvescens*) in Canada and the White Sturgeon (*A. transmontanus*) in the western United States yield the greater part of the commercial catch.

Most of the catch is consumed in the form of smoked Sturgeon and as caviar made by curing the eggs with salt. Over the years, production of caviar has dropped¹⁷ so that in 1951 only 2,000 pounds, made from eggs of *A. fulvescens*, were produced in Canada, worth about \$10,000 to the fishermen.

In Europe, particularly in Russia, Sturgeon fisheries are extensive. The fish are valuable not only for the flesh and eggs but for several other products; the commercial product from the spinal cord is called "vyaziga," and the inner lining of the swim bladder is used for the preparation of gelatine and glue of the best quality.¹⁸ The head of a Sturgeon, rich in gelatinous substances, is a valuable food product; in Russia it is sold separately from the flesh under the name "golovizna." In the Province of Quebec, older people use oil made from Sturgeon liver as an ointment against rheumatism.

Although angling for Sturgeon by hook-and-line is not common, it is practiced in some places, as around Montreal, Canada; there also is an important spear fishery for sport for *A. fulvescens* in several northern waters of the United States.¹⁹ The

16. A comprehensive summary of former catches of Sturgeon in North America is given by Rostlund (61: 10-12). The most recent available data for the whole continent are in "Fishery Statistics of the United States, 1956" (74) and in "Fisheries Statistics of Canada, 1956" (26).

17. According to Ryder, in 1888 fishermen from the Delaware River produced for the German market about 50 tons of caviar from eggs of *A. oxyrinchus* (65: 278).

18. For the preparation of isinglass, see Ryder (65: 278) and Classen (19: 426-428).

19. Some information on Sturgeon spearing, for instance in Lake Winnebago, has been reported (86: 29).

occurrence of Sturgeon scutes in materials excavated from prehistoric American Indian villages indicates that these large fish were utilized in aboriginal times (61: 10-12).

Hybridization. Hybrids are found in nature quite frequently, not only between different species of *Acipenser* but between *Acipenser* and *Huso*. Antipa described at least eight different types of Sturgeon hybrids (3: 270-273), and recently Antoniu added two new findings among Roumanian Sturgeon (6: 308-313). In some areas, for instance the estuary of the Lena River, Siberia, the hybrid *A. baeri* × *A. ruthenus* is much more common than either of the parent species (14: 141).

Species. At present at least 16 species are recognized, five of which are found in North America. In eastern North America there are three: *A. oxyrhynchus* Mitchill 1814, *A. brevirostris* LeSueur 1818, and *A. fulvescens* Rafinesque 1817. The two found in the Pacific coastal waters of America are *A. medirostris* Ayres 1854 and *A. transmontanus* Richardson 1836 (p. 36).

In Europe there are five species of *Acipenser*: *A. ruthenus* Linnaeus 1758, a fresh-water species inhabiting the rivers of the Black Sea and Caspian regions and the Arctic basin from the Ob to the Kolyma; *A. nudiventris* Lavetsky 1828, of the Black, Caspian, and Aral seas and their tributaries; *A. güldenstädti* Brandt 1833 and *A. stellatus* Pallas 1771, found principally in the Caspian and Black sea regions, but occasionally entering the Mediterranean; and *A. sturio* Linnaeus 1758, inhabiting both the Atlantic and Mediterranean areas. Furthermore, in his list of *Acipenser* species, Magnin recognized *A. nacarii* Bonaparte from the Adriatic Sea as a distinct species (48: 280). Chalikov has described a new species from the Caspian Sea under the name of *A. primigenius* (17: 47-50), but Berg considered it a hybrid *A. ruthenus* × *A. güldenstädti* (11: 77).

According to Professor Tamezo Mori (personal communication, December 20, 1954), seven species of *Acipenser* are represented in the waters of eastern Asia: *A. schrencki* Brandt 1869 is limited to the Amur River and Okhotsk Sea; *A. kikuchii* Jordan and Snyder 1901 and *A. multiscutatus* Tanaka 1908 are restricted to Japan; *A. dabryanus* Duméril 1868 has been reported from only the Yellow Sea basin in China and western Korea; and *A. sinensis* Gray 1834 is known from China, Korea, and Japan; the sixth, *A. medirostris* Ayres, which is found on our Pacific coast, also frequents the western Pacific coast; the seventh Asiatic species, *A. baeri* Brandt 1869, inhabits the Arctic Ocean basin along the coast of Siberia, from the River Ob to Kolyma. Some information on the taxonomic characters and distribution of Asiatic species has been given (53: 6-10; 54: 1-228; 18: 69-71; 55: 15-17; 71: 65-68).

Relationship between Species. The total number of gill rakers increases in American species in the following order: *medirostris* (18-20), *oxyrhynchus* (17-27), *brevirostris* (22-29), *fulvescens* (25-40), and *transmontanus* (34-36). The American species may be classified in order of increasing development of their bony shields in all the rows (using specimens of corresponding sizes) as follows: *brevirostris*, *fulvescens*, *transmontanus*, *oxyrhynchus*, and *medirostris*. Several small plates, with or without a weak crest, are present immediately behind the dorsal fin and in front of the anal; these plates are typically paired in the case of *oxyrhynchus* but are single in the case of the two other

western North Atlantic species. In American species, the development of the modified predorsal shield increases in the following order: *transmontanus* (not only rudimentary, but sometimes absent), *brevirostris*, *fulvescens*, *oxyrhynchus*, and *medirostris*. In the case of the enlarged fulcrum along the lower lobe of the caudal and of the dermal ossifications, the order is *brevirostris*, *fulvescens*, *transmontanus*, *oxyrhynchus*, and *medirostris*.

Explanation of Terms, Measurements, and Counts. In order to facilitate the use of the Key and *Descriptions*, a brief explanation of certain terms and methods used in measuring and counting follows.

REGULAR ROWS OF BONY SHIELDS: The dorsal row and the lateral row on each side are the most important from a taxonomic standpoint. The first shield in the dorsal row corresponds to the occipital plate or nuchale, and the last is just in front of the modified shield (see below) at the beginning of the dorsal fin. The first shield of the lateral row, called the supracleithrum, borders the posterior margin of the branchial cavity; although its size may vary, it is typically larger than the next posterior shield; its spine is usually less developed than the spines on the shields posterior to it. The last shield of the lateral row (a small one) is situated at the posterior extremity of the caudal peduncle, just anterior to the shields that continue on from the lateral row along the upper lobe of the caudal.

The elongated fulcrum at the base of the lower caudal lobe (difficult to see on large fish) is of considerable taxonomic importance when compared to the length of the anal fin base.

There are also modified shields at the beginning of both dorsal and anal fins; these, because of their respective positions, can be called predorsal and preanal. The one in front of the dorsal fin is more important from the taxonomic point of view; this modified shield is oval in shape, has no median crest or spine, and its posterior end is somewhat bent upwards to embrace the first dorsal ray; the anterior end is not forked but does have a slight indentation. There are two or more preanal shields; the nearest one to the fin is very similar in shape and structure to the predorsal shield; those farther in front, according to the species, are present in pairs or in a single file; the disposition of these preanal shields is the same as that for postdorsal shields (see below).

DERMAL OSSIFICATIONS: These small bony structures (ftn. 4), which vary in size and shape with species and with age of fish, lie in the skin between the regular rows of bony shields; they are best developed on the sides between the dorsal and lateral rows. The degree of development, according to species, corresponds closely to that of the regular bony shields.

TOTAL LENGTH (TL) is taken along the median line from the tip of the snout to the posterior of the upper lobe of the tail when the fish is lying in a natural position. **FORK LENGTH (FL)** is measured from the tip of the snout to the posterior end of the median caudal rays—that is, to the fork of the tail. [In specimens less than five inches (125 mm) FL, the lower caudal rays are still not fully developed and are therefore short. The absence of the lower caudal lobe is not only typical of young *oxyrhynchus* but of other Sturgeons as well. We observed this in *fulvescens*; and Grote, *et al.* (36:

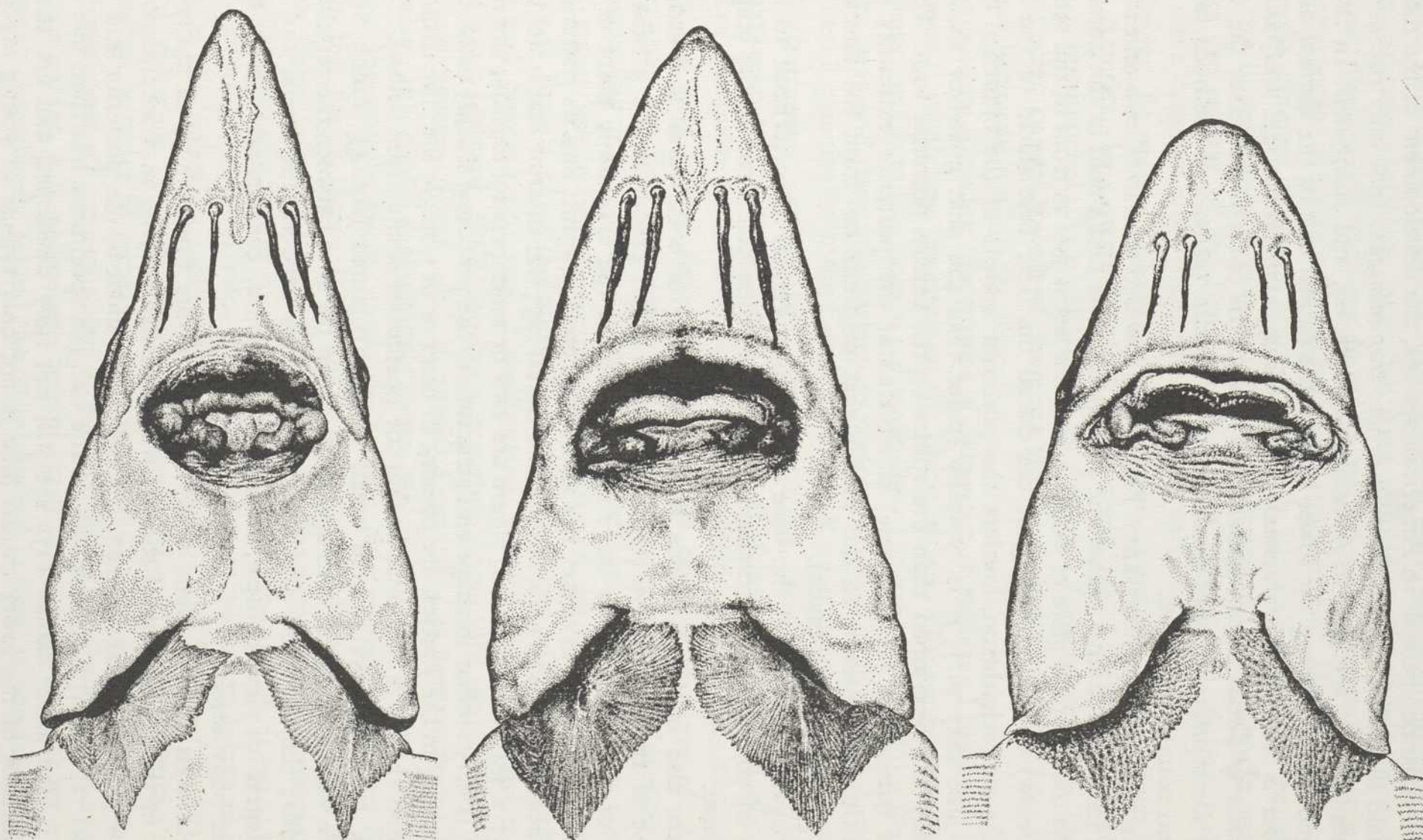


FIGURE 7. Ventral views of heads, left to right: *A. oxyrhynchus*, shown in Fig. 10; *A. fulvescens*, shown in Fig. 9; *A. brevirostris*, shown in Fig. 8.

215, fig. 158) and Roule (62: pl. 4, fig. 7) have presented drawings of young *A. sturio* in which the lower lobe is not well grown.]

HEAD LENGTH is the distance from the anterior tip of the snout to the rearmost point of the opercle, opercular membrane excluded. SNOUT LENGTH is from the anterior tip of the snout to the anterior margin of the orbit, the membranous rim included. MOUTH WIDTH is the greatest transverse distance across the mouth slit, with the thick lips excluded and the mouth closed. POSTORBITAL DISTANCE is that from the posterior edge of the orbit, membranous rim included, to the rearmost point of the opercle, membrane excluded. INTERORBITAL WIDTH is the minimum distance across the top of the head between the bony edges of the orbits. GILL RAKERS are counted on the outer surface of the first branchial arch, including the rudimentary ones; they are usually counted on the left side of the fish; in specimens smaller than eight inches (20 cm), some rakers on the upper limb are not yet developed; therefore the counts for young individuals are not given (see also 84: 149-154).

BASE OF ANAL FIN is the length from the structural base of the first ray to the point where the membrane behind the last ray contacts the body. FIN RAY counts for the dorsal and anal are sometimes given, but it is difficult to count these accurately, even after staining with alizarin and clearing in glycerin (83: 3-9); the fin membrane is very thick, and the rays are numerous, close together, and show little bifurcation; and in young individuals several rays are detached from the basal elements (radials). Since the counting of rays is not only tedious but uncertain, we omit the number of fin rays from the taxonomic characters.

Remarks on Identification. Within the same species, various characters change considerably with growth; young have much longer snouts than adults, and their scutes (shields) are sharper and closer together. Because of these natural changes it is difficult to prepare a universal key for the specific identification of young specimens as well as adults. There are, it is true, several fairly constant interspecific differences in anatomical features, such as the intestinal tract, gill arches, grinding ridges within buccal cavity, and otoliths, to mention a few. But to present these in abbreviated form seems likely to prove confusing rather than helpful, hence they are not included in the following Key to Species.

Key to American Atlantic and Pacific Species of *Acipenser*

1a. Species of the Atlantic Seaboard.

2a. Mouth width less than 55% of interorbital; average difference between TL and FL 14% of FL; gill rakers 17-27 (av. 21.6); postdorsal and preanal shields in pairs; viscera pale, unpigmented.

3a. In young specimens 50-70 cm long, head length 26-28% of FL; bony shields of dorsal row oval in shape, their longitudinal length being greater than their transverse width; carina on dorsal shields low, without a pronounced hook; dermal ossifications between dorsal and lateral rows

of shields only weakly developed; spleen short, not reaching farther back than middle loop of small intestine.

oxyrhynchus oxyrhynchus Mitchill 1814, p. 46.

- 3 b. In young specimens 50–70 cm long, head length 30–34% of FL; bony shields of dorsal rows rather square in shape, their longitudinal length much shorter than their transverse width; carina on dorsal shields high, typically with two strong hooks; dermal ossifications between dorsal and lateral rows of shields strongly developed; spleen long, reaching much farther back than middle loop of small intestine.

oxyrhynchus desotoi Vladykov 1955, p. 56.

- 2 b. Mouth width over 62% of interorbital; average difference between TL and FL less than 12% of FL; gill rakers 22–40; postdorsal and preanal shields in a single row; viscera blackish, heavily pigmented.

- 4 a. Gill rakers 22–29 (av. 25.4); interorbital width 34–40% (av. 37%) of hl; dorsal shields 8–13 (av. 10); lateral shields 25–32 (av. 28.3); dorsal and lateral shields pale, contrasting with dark background; length, so far as known, not over 100 cm.

brevirostris LeSueur 1818, below.

- 4 b. Gill rakers 25–40 (av. 33.1); interorbital width 29–35% (av. 32%) of hl; dorsal shields 9–17 (av. 13.4); lateral shields 29–42 (av. 35.4); dorsal and lateral shields brownish, of same color as background; length commonly over 100 cm. *fulvescens* Rafinesque 1817, p. 41.

- 1 b. Species of the Pacific Seaboard.

- 5 a. Caudal peduncle short; tip of anal fin reaching or even extending beyond base of lower lobe of caudal; modified shield at beginning of dorsal fin rudimentary or absent; 11–14 dorsal shields; 38–48 lateral shields; gill rakers 34–36; viscera blackish, heavily pigmented. *transmontanus* Richardson 1836.

Southern Alaska to California; enters salt water.

- 5 b. Caudal peduncle long; tip of anal fin not reaching base of lower lobe of caudal; a large modified shield at beginning of dorsal; 8–11 dorsal shields; 23–31 lateral shields; gill rakers 18–20; viscera pale, practically without pigment.

medirostris Ayres 1854.

Southern Alaska to California; enters salt water.

Acipenser brevirostris LeSueur 1818

Shortnose Sturgeon

Figures 7, 8

Study Material. A total of 109 specimens: 95, 450–900 mm TL, from the Hudson River, New York;²⁰ 1, presumably LeSueur's type, ANSP 16953;²¹ 1, from Dela-

20. For age and localities of these specimens, see Greeley (35: 89, 90).

21. This specimen, originally No. 84, was described by Ryder (65: 236) and later by Fowler (33: 604, pl. 38, fig. 1). On June 23, 1949, the specimen (stuffed) measured 746 mm FL.

ware River at Bay-at-Green Creek, Cape May County, New Jersey, in salt water, May 5, 1907, ANSP 25471; 4, from Delaware River at Torresdale, Philadelphia County, Pennsylvania, in fresh water, November 1911, ANSP 44298-44301; 3, 470-580 mm FL, from Delaware River, March 29-31, 1913, USNM 125816-125818;²² 1 young, 185 mm FL, Salmon Creek, North Carolina, USNM 64330; 1 of head, fins, and dried strips of skin with plates, from Potomac River, USNM 26273; 3 stuffed specimens in Paris Museum.²³

Distinctive Characters. *A. brevirostris* is distinguished from *A. oxyrhynchus* by blackish viscera, a wider mouth (see Key), the absence of a fontanelle, almost complete absence of the postdorsal shields, and by preanal shields arranged in a single row. Also, individuals of *A. brevirostris* assume adult proportions when they are only about two feet TL; *A. oxyrhynchus* retains juvenile characteristics even up to four feet. The most conspicuous difference between *brevirostris* and *fulvescens* is in the lateral scutes, which are much paler than the background in the former but of the same shade as the background in the latter.

Description. SCUTES in all five main rows not closely set and rather weakly developed in adults in comparison with other eastern American species, but sharp and set close together in a young specimen 7.75 inches FL (USNM 64330); in 12 specimens, 8-13 (av. 10) dorsal shields, 25-32 (av. 28) lateral shields, and 7-11 (av. 8) ventral shields; shields behind dorsal fin either in a single row or paired; elongated fulcrum at base of lower caudal lobe shorter than base of anal fin.

HEAD averaging 22% of FL in adult, 28% in a young specimen 7.75 inches FL. FONTANELLE ab-

22. According to the tag, these specimens were submitted as "young Sturgeon" (presumably as *A. oxyrhynchus*) for identification.

23. Details on these specimens are given by Bertin (12: 252). Two of these fish were sent to the Paris Museum by LeSueur, apparently as paratypes.

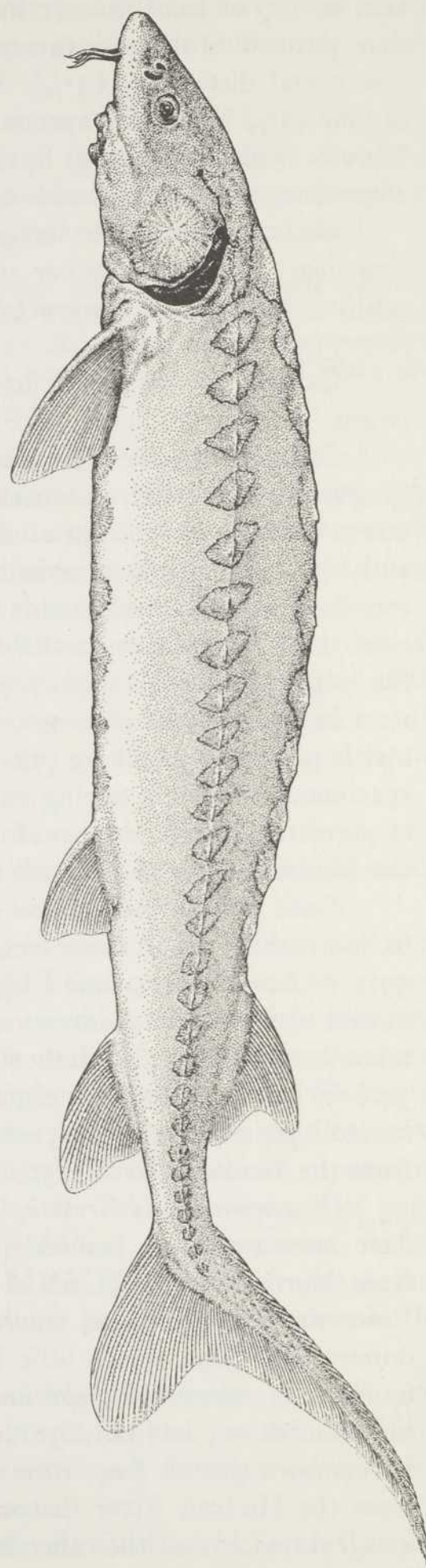


FIGURE 8. *Acipenser brevirostris*. Lateral view of spawning female, 580 mm long, from the Hudson River near Kingston, New York.

sent on top of head. SNOUT in 22 grown specimens (390–700 mm FL), much shorter than postorbital distance (av. 70% of the latter), but in a young specimen, longer than postorbital distance (183%). POSTORBITAL distance in adults 51–61% (av. 55%) of hl, but 33% in a young specimen. INTERORBITAL width 34–40% (av. 37%) of hl, and MOUTH width (excluding lips) 69–81% (av. 74%) of interorbital width, these two characters not differing with age.

GILL RAKERS rather long, triangular, in 13 specimens 22–29 (av. 25.5) on first branchial arch; in number of gill rakers, *A. brevirostris* occupies an intermediate position between *A. oxyrhynchus* with 17–27 (av. 21.5) and *A. fulvescens* with 25–40 (av. 33).

CAUDAL fin with short upper but rather long lower lobe; average difference between TL and FL, 11% of FL; no notch at tip of upper caudal lobe.

Color. In preserved specimens, general color similar to that of *A. oxyrhynchus* (p. 46). Top of head and back dark, becoming paler on sides; entire lower surface white. Central part of dorsal shields whitish, contrasting with darkly pigmented back and black skin between shields. Lateral shields pale, clearly distinguished from surrounding skin. Ventral shields of the same whitish color as lower surface of fish. Intestinal tract, air bladder, and fat surrounding gonads darkly pigmented, nearly black; the peritoneum only slightly pigmented.

In an excellent photograph of a live *brevirostris*, the similarity in color to *oxyrhynchus* is particularly striking (44: 14, 15): in addition to the details observed on preserved specimens, the white edging on the paired fins is similar; but the anal fin in *brevirostris* is pigmented while that in *A. oxyrhynchus* remains whitish. Small live specimens from the Hudson River show black pigment blotches similar to those of young *A. fulvescens*.

Size: This is the smallest species of all the Sturgeons. Apparently it never grows to more than about three feet; the largest specimen recorded thus far is a female 39.5 inches TL (899 mm FL), from the Connecticut River. The measurements submitted by Professor Andrews and two specimens sent to us (p. 40) confirm his determinations. The largest sizes encountered during the present studies were: a female 34.8 inches TL, weighing eight pounds 15 ounces, in its 13th year as determined by its otoliths; and a male 25.5 inches, weighing four pounds five ounces; both were taken from the Hudson River (35: 68–70).

Development and Growth. The early life history is unknown. Few small specimens have been recorded; probably the smallest fish is one of 7.3 inches (about 185 mm), from North Carolina (USNM 64330). The smallest specimens taken in the Hudson River were two females; one was 17 inches (about 433 mm) and weighed only 15 ounces; the other was a little less than 18 inches (about 600 mm) and weighed 19 ounces. The sizes of five specimens from the Delaware River observed by Ryder ranged between 18–23 inches. Age determinations, based on otolith readings (35: 68–70), have shown that *A. brevirostris* is a very slow-growing species. Specimens of *brevirostris* from the Hudson River that measured 17–35 inches (about 430–890 mm) TL were 4–15 years old; on the other hand, *A. oxyrhynchus* 74–100 long were 11–13 years of

age. The growth rate of the two species, however, is very similar in early life, which suggests that the subsequent divergence is due to more rapid growth by *oxyrhynchus* while at sea.

Spawning. Males may mature when they are only about 20 inches TL, and most of them do so by the time they pass 21 inches; most of the females mature at about 24 inches. The ripe eggs are dark brown. Their number is not known. Spawning takes place in rivers early in the spring. For Hudson River fish, Greeley (35: 90) stated that:

The spawning season evidently included late April during 1936. Several fish approaching spawning condition were examined from Rhinecliff during early April. A female, weighing five pounds, from Highland April 21 contained eggs which appeared ripe, while a three pound male taken at the same time was spent. Roe fish from Highland, May 1, were spent (2 pounds, 13½ ounces; 5 pounds, 8 ounces). Several others, also taken during early May had spawned.

General Habits. On account of its small size, *A. brevirostris* has attracted little attention except when taken in nets in fresh, brackish, or salt water. It is found most often in tidal rivers. But the place of capture of Gulf of Maine specimens shows that some certainly go out into the open sea and wander for some distance from the parent stream.

Food. Studies of stomach contents from Hudson River specimens showed that *A. brevirostris* feeds upon the bottom, eating small animals and plants intermingled with mud (72: 141-144, table 4). The organisms consumed were sludgeworms, chironomid larvae, small crustaceans, etc., such as are found in the stomachs of young Atlantic Sturgeon (p. 52).

Abundance and Relation to Man. Because of its scarcity and small size, *A. brevirostris* is of slight interest to commercial fishermen, hence there is little information about its abundance.

Ryder (65: 232), writing of the fishery for *oxyrhynchus* in the Delaware River, stated, "It was my good fortune to secure no less than five specimens of the *A. brevirostris* of LeSueur, which has, so far as I can learn, not been certainly recognized since that Naturalist's time," and our own *Study Material* (p. 36) marks it as at least not uncommon in the Hudson today. But while LeSueur in 1811 stated that the Shortnose Sturgeon is "more sought after and commands a higher price than the large common species" in the Delaware River (75: 383-394), it is of virtually no economic importance at present due to its small size and apparent scarcity. Its flesh, however, is of good quality, and its eggs are suitable for caviar, but they are not very numerous. A few fishermen prior to 1937 set gill nets for *brevirostris* in the Hudson River just before the yearly run of American shad (*Alosa sapidissima*). Some have also been taken in the Hudson River with hook-and-line by anglers.

Range. Atlantic seaboard of North America, from New Brunswick, Canada (47: 504, and later comments), to Florida, mostly in rivers, including the Connecticut, Hudson, Delaware, and Potomac. This range is based upon records for a period of years, and the species may now occupy a more restricted area.

Until recently the southernmost definite record was for Charleston, South Carolina

(43: 106). Smith stated, "while it doubtless ascends all suitable streams in North Carolina, actual records of its occurrence are rare" (67: 58). However, thanks to Dr. Daniel M. Cohen, we had an opportunity to examine a female *A. brevirostris* (UF 5714) 735 mm TL taken on May 11, 1949, in Big Lake George of the St. Johns River drainage, Putnam County, Florida. This is a proven record of the occurrence of the Shortnose Sturgeon in Florida. Thus the geographic range of *A. brevirostris* is almost as extensive as that of *A. oxyrinchus*.

It has been reported as being taken as far north as the St. Lawrence River (32: 70; 59: 226; 37: 44), but these records seem to be based chiefly on *A. fulvescens*, in part on *A. oxyrinchus*. The most northerly proven record of its occurrence is for the St. John River, New Brunswick (47: 504). We also obtained some specimens from this same area, thanks to the kindness of the late Dr. Leim. Collections taken at Gagetown include three heads of adults caught in 1959 (collected by J. C. Medcof, Biological Station, St. Andrews, New Brunswick); also, seven adult females (700–870 mm TL) and three adult males (740–800 mm TL) were taken in May and early June 1960 (obtained by Fishery Officer J. O. Jenkins). One female and one male of the latter sample were almost ready to spawn. In the Connecticut River, near Hadley, Massachusetts, four adults were caught in October 1951 and September 1952 (obtained by Professor T. J. Andrews, University of Massachusetts).

The breeding range of *A. brevirostris* is not clearly defined, but it is known to include the Hudson River, where the spawning areas appear to be very restricted. The Delaware River may still maintain a small local population, and it seems likely that the St. John River, N.B., has a spawning population, judging by the near-spawning condition of the above-noted male and female taken at Gagetown. If, through increased pollution or habitat changes, the population is no longer able to persist in these northern rivers, the species may become dangerously reduced.

The Shortnose Sturgeon has no close relative in Europe.

Synonyms and References:²⁴

Acipenser brevirostris LeSueur, Trans. Amer. philos. Soc., 1, 1818: 390 (descr., Delaware R.); DeKay, Zool. N.Y., 4, 1842: 345 (descr., ident. from Virginia not certain); Ryder, Bull. U.S. Fish Comm. (1888), 8, 1890: 231 (descr., Delaware R.); Jordan and Evermann,* Bull. U.S. nat. Mus., 47 (1), 1896: 106 (descr., synon., Cape Cod to Florida, specimen from Charleston, S. Carolina); Smith,* N.C. geol. econ. Surv., 2, 1907: 57 (genl. acct., doubtless occur. N. Carolina); Kendall,* Occ. Pap. Boston Soc. nat. Hist., 7 (8), 1908: 17 (New England); Fowler, Proc. Acad. nat. Sci. Philad., 1910: 604; Halkett,* Check List Fish. Canad., 1913: 44 (genl. range of distr.); Nichols and Breder,* Zoologica, N.Y., 9, 1927: 31 (genl. acct.); Hildebrand and Schroeder,* Bull. U.S. Bur. Fish., 43, 1928: 76 (Provincetown, Massachusetts); Breder,* Field Bk. Mar. Fish. Atl. Cst., 1929: 43 (genl. acct.); Truitt, Bean, and Fowler, Bull. Md. Conserv. Dep., 3, 1929: 33 (genl. acct.); Jordan,* Manual Vert. Anim. NE U.S., 1929: 33 (distr., key, and brief characteristics); Jordan, Evermann, and Clark, Rep. U.S. Comm. Fish. (1928), 2, 1930: 34 (in checklist); Jordan and Evermann, Amer. Food Game Fish., 1937: 12 (genl. acct., key); Greeley, N.Y. Biol. Surv. Lower Hudson Watershed (1936), 11, 1937: 90 (size ranges, age determ., Hudson R.); Schrenkeisen, Field Bk. Freshw. Fish. N. Amer., 1938: 14 (genl. acct.); Vladykov and Beaulieu, Nat.

24. We follow the lead of Jordan, *et al.* (45: 34) in calling this species *brevirostris*. The authors who used the spelling *brevirostrum* are marked by an asterisk (*) following their names.

Canad., 73, 1946: 43 (detail. acct. of shields and gill rakers, size); Nat. Canad., 78, 1951: 199 (detail. acct. of gill rakers for three w. Atlantic species).

Acipenser (Huso) lesueurii Valenciennes (Ms.) Duméril, Hist. Nat. Poiss., 2, 1870: 166 (descr., New York).²⁵

Acipenser (Huso) rostellum Duméril, Hist. Nat. Poiss., 2, 1870: 173 (descr., New York?).²⁵

Acipenser (Huso) sinus Valenciennes (ms.) Duméril, Hist. Nat. Poiss., 2, 1870: 175 (descr., New York?).²⁵

Acipenser fulvescens Rafinesque 1817

Lake Sturgeon,²⁶ Smoothback

Figures 7, 9

Study Material. Over 800 specimens, 6–229 cm or 2.5–90 inches TL (5.7–211 cm or 2.3–83 in. FL), from different sections of the St. Lawrence River, Quebec; also odd specimens from Lake Ontario on both the Canadian and New York sides. Specimens from a large number of interior waters not included. For details, see Vladikov and Beaulieu (83: 18).

Distinctive Characters. *A. fulvescens*, like *A. brevirostris*, is distinguishable from *A. oxyrinchus* by: the arrangement of its preanal shields in a single row, a mouth not less than 66% as wide as the interorbital width, the absence of a soft area (fontanelle, p. 27) on the top of the head, and black viscera. From *brevirostris* it differs in that its lateral shields are of the same color as the background.

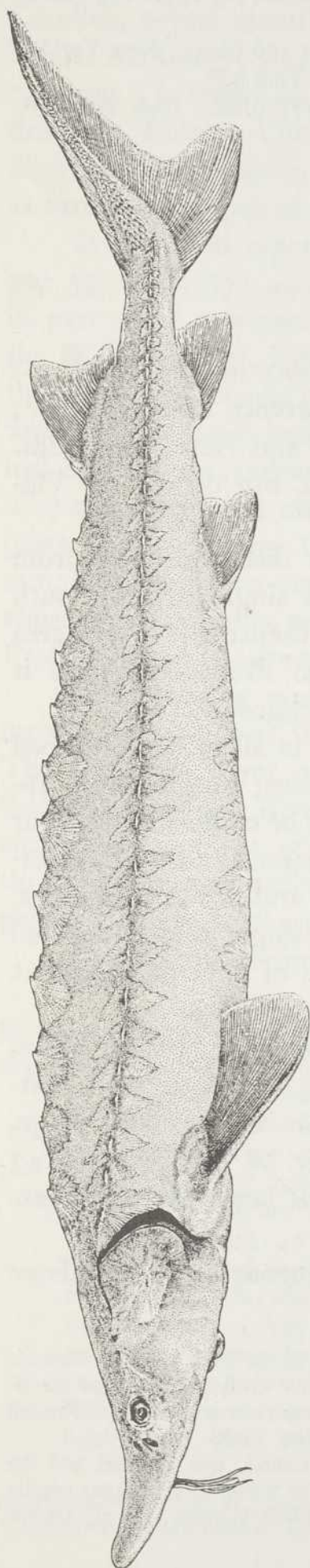
Description. SCUTES in young specimens (up to 12 in. FL), in all rows, developed even more strongly than in *A. oxyrinchus* of corresponding sizes; progressively absorbed with age, beginning with the ventral rows, until they may be completely so, near spawning time, especially in the ventral rows (hence the commercial name Smoothback); in 516 Quebec specimens, 9–17 (av. 13.4) dorsal shields, and in 242 specimens, 29–42 (av. 35.4) lateral shields; shields behind dorsal fin in a single row; elongated fulcrum at base of lower caudal lobe never longer than base of anal fin. DERMAL OSSIFICATIONS minute, but the skin much tougher than in *A. oxyrinchus*.

HEAD longer in young than in larger individuals, on the average 24% of FL in specimens 40–70 cm FL. SNOUT in specimens less than 50 cm FL longer than post-orbital distance, but shorter in older individuals. INTERORBITAL width rather large, varying; in 79 young specimens 8–36 cm FL, 21.6–31.8% (av. 28%) of hl; in 143 older specimens 40–211 cm FL, 29–40% (av. 34%). MOUTH large, its width (excluding lips) 66–93% (av. 77%) of interorbital width.

GILL RAKERS rather short and blunt, but numerous; 350 Quebec specimens above 8 inches FL with 25–40 (av. 33.1) rakers.

25. The Duméril holotypes of these three species are kept mounted in good condition at the Paris Muséum National d'Histoire Naturelle. They were examined in 1950 and identified as *A. brevirostris* by Vladikov. A similar identification was made by Bertin (12: 252). Jordan, *et al.* (45: 34) quoted two more names given by Duméril (28: 164–168), based on locality only: *microrhynchus* (New York) and *dekayi* (New York).

26. In Quebec, the French-speaking fishermen call the adults Esturgeon jaune or Camus, that is, short and flat snout; the latter name was already in use at the end of the last century (52: 188). The young specimens are usually named Escargot, or in certain sections (Nicolet) Charbonnier, on account of the black blotches (83: 32). On the New York market, this species is often called the Smoothback.



CAUDAL fin with rather short upper but long lower lobe; the average difference between TL and FL 9% of FL; no notch at tip of upper lobe.

Color. There is a pronounced difference between the young and the adult. In young below 300 mm (12 in.) FL, two pairs of large black blotches present on anterior half of upper surface of snout and on back between dorsal and lateral rows of shields, the anterior blotch the larger and immediately behind the base of pectoral fin, the smaller posterior one below the dorsal fin;²⁷ in addition, several small, irregular, black spots on top of head, on back and sides, and on lower surface of caudal peduncle. Intestinal tract darkly pigmented, nearly black. Air bladder and fat surrounding gonads, dark gray. Peritoneum pale or only slightly pigmented. In general, the dark pigmentation of the intestinal tract is similar to that of *A. brevirostris* but very distinct from that of *A. oxyrinchus*. In half-grown specimens up to about 24 inches or 610 mm FL, the large blotches have disappeared, but black spots may persist. Older individuals above 40 inches FL are uniformly dark brownish or grayish on top of head and on back and sides. In fish of all ages, dorsal and lateral shields of the same color as background; shields of ventral rows sometimes pigmented on upper part but always whitish on lower part. Lower surface of young and adults uniformly whitish. In young below 24 inches FL or about 610 mm, preserved in 4–5% formalin, lower surface and sides of head and body clear green. At all ages, fins dark brown or gray, typically without white edging.

Size and Growth. Among western North Atlantic species, *A. fulvescens* reaches a size exceeded only by *A. oxyrinchus*. The largest recorded is a female Lake Sturgeon, of approximately 275 pounds, taken in Lake Winnipeg, Manitoba, in the summer of 1941 (40: 17). The largest male, caught in Lake Erie in 1948, weighed 220 pounds (66: 7). The specimens from Quebec listed in *Study Material*, 2.5–90 inches TL, weighed 0.032 ounces–212 pounds (0.9 g–96

27. For a good illustration of these black blotches in young *A. fulvescens*, see Forbes and Richardson (31: 36); for color illustrations of an adult, see Vladikov (82: 6).

FIGURE 9. *Acipenser fulvescens*. Lateral view of immature female, 655 mm long, from the St. Lawrence River near Neuville, Quebec, P. Q., Canada.

kilo).²⁸ Data for the smallest 11 specimens from the St. Lawrence River, taken from August to November in pêches located near Quebec City, are tabulated in Table 1. Judging by their long snouts, dorsal scutes in a continuous row without separation, general coloration, and small size, we consider all of these specimens to be less than one year old. During the first year, juveniles of *A. fulvescens* (Table 1) and of *A. oxyrhynchus* grow at about the same rate.

Table 1. Growth Rate of *A. fulvescens*.

Date	Total Length		Fork Length		Weight		Place
	(mm)	(inches)	(mm)	(inches)	(g)	(oz.)	
Sept. 19, 1952...	63	2.48	57	2.24	0.9	0.032	St. Nicolas
Oct. 19, 1953...	84	3.31	82	3.23	2.0	0.071	St. Nicolas
Aug. 8, 1947...	87	3.43	79	3.11	2.5	0.088	Neuville
Nov. 19, 1947...	99	3.90	90	3.54	3.2	0.113	Neuville
Oct. 31, 1952...	106	4.17	98	3.86	4.4	0.155	Neuville
Sept. 12, 1944...	109	4.29	96	3.78	4.3	0.152	Neuville
Aug. 20, 1952...	117	4.61	107	4.21	4.8	0.169	Neuville
Sept. 30, 1947...	121	4.76	109	4.29	4.7	0.166	Neuville
Aug. 29, 1947...	121	4.76	111	4.37	7.7	0.271	St. Vallier
Aug. 25, 1952...	123	4.84	112	4.41	6.5	0.229	Neuville
Sept. 30, 1947...	123	4.84	112	4.41	6.2	0.219	Neuville
AVERAGE	104.8	4.13	95.8	3.77	4.29	0.151	

Although the ages of Lake Sturgeon in our material from the St. Lawrence River have not as yet been determined, probably their range is up to 30 years, or even more. According to Cuerrier and Roussow, who studied the growth of *fulvescens* from the upper St. Lawrence River (Lake St. Francis), fish 3–22 years old averaged 16.5–37.5 inches FL (24: 8–14). The oldest fish in their material, a female 23 years of age, was 50.5 inches FL and weighed 42 pounds.

*Spawning and Reproduction.*²⁹ The principal spawning season for *A. fulvescens* in Quebec extends from about the beginning of May to the end of June. The smallest male ready to breed, taken at St. Vallier on May 5, 1944, was 38 inches TL (35 in. FL) and weighed 11 pounds 4 ounces. The smallest mature female, taken at the same place on June 13, 1949, was 45 inches TL (41 in. FL) and weighed 17 pounds. The Lake Sturgeon from Lake Nipigon, Ontario, does not become sexually mature until it is about 22 years of age, when it is approximately three feet TL (38: 15–25).

Roussow, in studying cross sections of the first pectoral ray of *A. fulvescens*, found variations in the broad and narrow zones on this bone (64: 553–572). He concluded that "the growth retardations caused by the ripening of the gonads and the

28. For the length-weight relationship of St. Lawrence specimens from Quebec, see Vladykov (78: 57). Roussow has given some information on the rate of growth and movements of *A. fulvescens* from the St. Lawrence and Ottawa rivers (63: 1–124). Results of extensive tagging at Quebec of 1,507 *A. fulvescens* and 2,995 *A. oxyrhynchus* have been summarized by Magnin and Beaulieu (50: 237–252).

29. Additional information on spawning habits and experimental hatching of Lake Sturgeon has been given by Stone (69: 118–123) and Carter (16: 60–63).

losses at the consecutive spawnings are visible in the ray sections in the form of 'belts' of 2 to 7 narrower zones (or annuli). These indicate that the interval between spawning periods can vary from 4 to 7 years and more." It is highly desirable to corroborate these findings by observing the frequency of spawning by tagged specimens.

The principal spawning rivers in Quebec are the St. Francis for Lake St. Peter, and the Batiscan and Chaudière for the respective sections of the St. Lawrence from Three Rivers to Montmagny.

The diameter of mature but unfertilized eggs preserved in 4-5% formalin varied between 2.7-3.1 mm. Thus the ripe eggs of *A. fulvescens* are somewhat larger than those of *A. oxyrhynchus*. Table II gives data on ovaries and eggs from mature females of *A. fulvescens* from the St. Lawrence River near Quebec.

Table II. Data on Ovaries and Eggs of *A. fulvescens*.

Locality	Date	Length			Weight		Wgt. of Ovaries		Diam. of Eggs
		TL	FL	FL	(kg)	(lb.)	(kg)	(lb.)	
St. Vallier	June 5, 1944.....	136	127	50.0	17.1	37.6	3.1	6.9	2.7
St. Vallier	May 15, 1950.....	144	136	53.5	26.3	58	4.7	10.4	2.8
St. Vallier	May 15, 1950.....	142	133	52.4	19.1	42	2.9	6.4	2.9
St. Vallier	June 17, 1946.....	145	135	53.1	22.2	49	—	—	3.0
St. Vallier	May 19, 1946.....	175	170	66.9	50.3*	100*	—	—	3.0
St. Nicolas	May 8, 1949.....	170	163	64.2	37.0	81	11.2	24.6	3.1

* Approximate.

Food. In the St. Lawrence, *A. fulvescens* subsists on about the same type of food as *A. oxyrhynchus* (p. 52). In 29 stomachs of *fulvescens* we found that larvae of the burrowing May fly (*Hexagenia*) were present in 76% of the samples, amphipods in 73%, gastropod mollusks in 48%, bivalve mollusks in 35%, and fish in 24%. Indeed, *A. fulvescens* of different sizes are easily taken by hook-and-line, and the best bait is young shad, or, as second choice, banded killifish (*Fundulus diaphanus*). Harkness³⁰ found that *A. fulvescens* in Lake Nipigon, Ontario, fed principally on May fly and chironomid larvae and on mollusks.

Abundance and Commercial Importance. According to official statistics for 1951, the catches of Lake Sturgeon were (in pounds): 9,000 for Saskatchewan, 164,000 for Ontario, 194,000 for Quebec, and 13,000 for the U.S. Great Lakes; total, 380,000 pounds, with a combined monetary value of \$300,000. Late nineteenth-century yields were several times greater. From Lake Michigan alone, in 1880, the catch was 3,839,600 pounds (31: 26). Lake of the Woods (Minnesota and Canada) was formerly called "the greatest sturgeon pond in the world"; the catch there in 1893 was 1.6 million pounds (29: 121-136).

In the St. Lawrence River, from the Ontario border to Cap St. Ignace at Quebec,

30. Harkness (38: 28, 29) has given references to other authors who studied food requirements of *A. fulvescens* from various localities.

there is a regular fishery for this species; at Quebec, although present catches are less abundant than formerly, *A. fulvescens* is still taken in fair quantity; and it is reported as being still very plentiful in the Hudson Bay area. Large *A. fulvescens* are taken early in the spring or late in the fall. During the summer months, in the vicinity of Quebec City from St. Nicolas to Montmagny, *A. oxyrhynchus* is more plentiful than *fulvescens*; however, both species are taken together quite often at the beginning and end of the fishing season. The fish are caught with either gill nets (8–10 in. stretched mesh) or weirs, and a few are taken on set lines baited with fish, or in New York on unbaited set lines ("trap lines").

Relation to Man. Considering its entire range, the Lake Sturgeon is at present of much greater commercial value than both the American Atlantic Sturgeon and the Shortnose Sturgeon combined. The principal product is the meat for "smoked Sturgeon." In 1951, in Canada, 2,000 pounds of caviar were made from the eggs of this species.

Range and Occurrence in the Western North Atlantic. Larger rivers and lakes, from Hudson Bay to the Mississippi Valley; according to Hubbs and Lagler (41: 30), "from the Red River of the North, the Saskatchewan River in Alberta, and the Hudson Bay, St. Lawrence and Lake Champlain drainages of Canada (and possibly from Labrador), southward, west of the Appalachian Mountains, to the Tennessee River of Alabama, to Missouri and to eastern Nebraska." On several occasions it has been reported as being taken on the shores of Hudson Bay (75: 30 [42]).³¹ In the St. Lawrence River, where a general line of demarcation between fresh and brackish water can be drawn from Cap Brulé on the north shore to St. Jean-Port-Joli on the south shore, it is taken in commercial quantities from Lauzon to Cap St. Ignace, together with *oxyrhynchus*. Occasionally Lake Sturgeon venture even farther into brackish water. For instance, on October 10, 1954, an *A. fulvescens* weighing five pounds was taken in a pêche at St. Roches-Aulnaies; information from Mr. Alfred Pelletier, proprietor. For further details see Vladykov (79: 54–57). It should be emphasized, however, that a sea-resident stage, characterized by a rapid growth rate, has not been demonstrated for this species.

Synonyms and References:

Acipenser fulvescens Rafinesque, Amer. Mon. Mag., 1, August, 1817: 288 (descr., Great Lakes); Hubbs, Copeia, 1917: 48 (synon.); Hubbs, Misc. Publ. Mus. Zool. Univ. Mich., 15, 1926: 8 (in checklist); Dymond, Univ. Toronto Stud. Biol., 27, 1926: 33 (descr., Lake Nipigon, Ontario); Dymond, Hart, and Pritchard, Univ. Toronto Stud. Biol., 33, 1929: 13 (statist. of catches); Jordan, Manual Vert. Anim. NE U.S., 1929: 33 (distr., key, and brief characteristics); Jordan, Evermann, and Clark, Rept. U.S. Comm. Fish. (1928), 2, 1930: 35 (in checklist); Greeley, N.Y. Biol. Surv. Champlain Watershed (1929), 4, 1930: 73 (Lake Champlain); Bajkov, Trans. Amer. Fish. Soc. (1930), 60, 1931: 11 (statist. of catches, Manitoba); Greeley, N.Y. Biol. Surv. St. Lawrence Watershed (1930), 5, 1931: 81 (St. Lawrence R., New York); Bajkov, Trans. Amer. Fish. Soc. (1930), 60, 1931: 11 (Manitoba, statist. of catches); Gowanloch, Bull. La. Conserv. Dep., 23, 1933: 412 (genl. acct.); Vladykov, Contr. Canad. Biol., 8 (29), 1933: 30 (42) (Hudson Bay region); Schrenkeisen, Field Bk. Freshw. Fish. N. Amer., 1938: 13 (genl. acct.); Kuhne, Guide Fish. Tennessee, 1939: 17 (genl. acct.); Dymond, Contr. R.

31. A young specimen of *A. fulvescens* about 107 mm FL (USNM 27784) was taken by Walton Hayden at Moose Factory, James Bay (a southern extension of Hudson Bay), no doubt in brackish water.

- Ontario Mus. Zool., 15, 1939: 8 (statist. of catches, Ottawa R.); Hinks, Fish. Manitoba, 1943: 15 (Manitoba); Eddy and Surber, North. Fish. Upper Mississippi Valley, 1943: 57 (size, artif. propag., Mississippi R.); Vladykov and Beaulieu, Nat. Canad., 73, 1946: 27 (detail acct. of shields and gill rakers, size, Quebec); Hubbs and Lagler, Bull. Cranbrook Inst. Sci., 26, 1947: 30 (distr.); Dymond, Misc. Publ. R. Ontario Mus. Zool., 1, 1947: 4 (genl. distr., range); Vladykov and Beaulieu, Nat. Canad., 78, 1951: 129 (detail. acct. of gill rakers for three w. Atlantic species); Scott, Freshw. Fish. East. Canada, 1954: 7.
- Acipenser rubicundus* LeSueur, Trans. Amer. philos. Soc., 1, 1818: 38 (descr., Lakes Ontario, Erie and all upper lakes); DeKay, Zool. N.Y., 4, 1842: 344 (descr.); Jordan and Evermann, Bull. U.S. nat. Mus., 47 (1), 1896: 106 (descr., synon., distr.); Carter, Trans. Amer. Fish. Soc., 34, 1904: 60 (artif. propag. Vermont); Evermann and Goldsborough, Proc. biol. Soc. Wash., 20, 1907 (Canada); Kendall, Occ. Pap. Boston Soc. nat. Hist., 7 (8), 1908: 16 (Lake Champlain, Vermont); Nash, Vertebr. Ontario, 1908: 14 (genl. acct.); Kendall, Proc. Portland Soc. nat. Hist., 2, 1909: 219 (checklist, Labrador); Halkett, Check List Fish. Canad., 1913: 44 (Canada); Forbes and Richardson, Fish. Illinois, 1920: 24 (descr., statist. of catches); Harkness, Univ. Toronto Stud. Biol., 24, 1923: 13 (age, food); Kendall, Contr. Canad. Biol. (1923), 23, 1924: 21 (439) (between Lake Winnipeg and Hudson Bay); Breder, Field Bk. Mar. Fish. Atl. Cst., 1929: 43 (genl. acct.); Jordan and Evermann, Amer. Food Game Fish., 1937: 10 (genl. acct., key).
- Acipenser maculosus* LeSueur, Trans. Amer. philos. Soc., 1, 1818: 393 (descr., young from Ohio R.).
- Acipenser serotinus* Rafinesque, Ichthyol. Ohiensis, 1820: 80 (Ohio R.).
- Acipenser ohiensis* Rafinesque, Ichthyol. Ohiensis, 1820: 81 (Ohio R.).
- Acipenser macrostomus* Rafinesque, Ichthyol. Ohiensis, 1820: 81 (Ohio R.).
- Dinectus truncatus* Rafinesque, Ichthyol. Ohiensis, 1820: 82 (erroneous, based on drawing by Audubon).
- Acipenser rupertianus* Richardson, Fauna Boreal. Amer., 1836: 311 (specimen from Albany R., Rupert Land).
- Acipenser laevis* Agassiz, Lake Superior, 1850: 267 (Lake Superior).
- Acipenser carbonarius* Agassiz, Lake Superior, 1850: 271 (Lake Superior).
- Acipenser rhynchaesus* Agassiz, Lake Superior, 1850: 276 (Lake Superior).
- Acipenser liopeltis* Günther, Cat. Fish. Brit. Mus., 8, 1870: 341 (Mississippi).
- Nominal specific names, given by Duméril (31: 105, 220) to specimens of *A. fulvescens*, according to locality only: *copei* (supposedly upper Missouri), *rauchi* (Osage R., Missouri), *richardsoni* (upper Mississippi), *anasimos* (Missouri R.), *paranasimos* (Huntsville, Alabama), *anthracinus* (Lake Erie), *megalaspis* (Lake Champlain), *lamarii* (supposedly Lake Erie), *atelaspi* (Saskatchewan R.), *rafinesquii* (Ohio R.), *rosarium* (supposedly Lake Erie), *platyrhinus* (supposedly upper Mississippi), *kirtlandi* (Lake Erie), *nertinianus* (Michigan), *cincinnati* (Ohio R.), and *buffalo* (Lake Erie).

Acipenser oxyrhynchus oxyrhynchus Mitchill 1814

Atlantic Sturgeon, Sea Sturgeon, Common Sturgeon³²

Figures 3, 7, 10

Study Material. Over 3,000 specimens: 1, ca. 485 mm (19 in.) FL, New Britain, Florida, Jan. 6, 1900, CNHM 35376 (received through kindness of Loren P. Woods); 42, 200–2,490 mm TL, Hudson River, New York³³; the remainder, 65–

32. According to the List of Common and Scientific Names (1: 7), *oxyrhynchus* should be called the Atlantic Sturgeon, but the name Sea Sturgeon is more generally used. In the Hudson River adults are known as the Big Sturgeon and small ones as Sharpnose Sturgeon or Pelican (35: 89). In Quebec, French-speaking fishermen commonly call the larger ones Esturgeon noir, or Esturgeon d'eau salée, while the young are known as Escargots or Ecailles (83: 43).

33. For age and size of these specimens, see Greeley (35: 68, 139).

2,670 mm TL (60–2,500 mm FL), St. Lawrence River, Quebec, between Three Rivers and Rivière-aux-Outardes.³⁴

Distinctive Characters. *A. oxyrhynchus oxyrhynchus* is readily distinguishable from both *brevirostris* (Shortnose Sturgeon) and *fulvescens* (Lake Sturgeon) by the arrangement of its preanal shields in a double row, by its pale unpigmented viscera, by a mouth less than 55% as wide as the space between the orbits, and by the presence of a soft area (fontanelle) on the top of its head. It differs from *A. oxyrhynchus desotoi* (p. 56) in that its bony shields are oval and longer than broad, and that the carina on its dorsal shields do not have a conspicuous hook. Among western Atlantic species, furthermore, *A. oxyrhynchus* has much the longest upper caudal lobe but a rather short lower one. In *A. oxyrhynchus* the average difference between TL and FL is 14% of FL, in *A. brevirostris* 11%, and in *A. fulvescens* 9%. For a discussion of the differences between *oxyrhynchus* and *sturio* of the eastern Atlantic, see p. 57.

*Description.*³⁵ SCUTES strongly developed in all longitudinal rows; in 1,814 Quebec specimens, 7–13 (av. 9.8) dorsal shields, and in 692 specimens, 24–35 (av. 28.7) lateral shields; shields behind dorsal fin in pairs; elongated fulcrum at base of lower caudal lobe decidedly longer than base of anal fin. DERMAL OSSIFICATIONS also well developed on skin between dorsal and lateral rows.

HEAD elongate. A membranous FONTANELLE between frontal and parietal plates in young individuals, and a sinus at all ages. SNOUT longer than postorbital distance in individuals up to 95 cm, but in older specimens shorter than postorbital distance. INTERORBITAL width rather narrow, varying; in 239 young specimens (6–49 cm), 22.4–28.4% (av. 26%) of hl, in 439 older specimens (50–231 cm), 25–35.6% (av. 29%). MOUTH narrow, its width (excluding lips) less than 55% of interorbital width.

GILL RAKERS among specimens from the St. Lawrence River, Quebec (studied by Vladykov and Beaulieu, 83: 43–

34. For origin, size, and method of fishing, see Vladykov and Beaulieu (83: 43–47).

35. In part from Vladykov and Beaulieu (83: 43–47), but mainly from an unpublished manuscript by the same authors on the morphometric studies on Quebec Sturgeons.

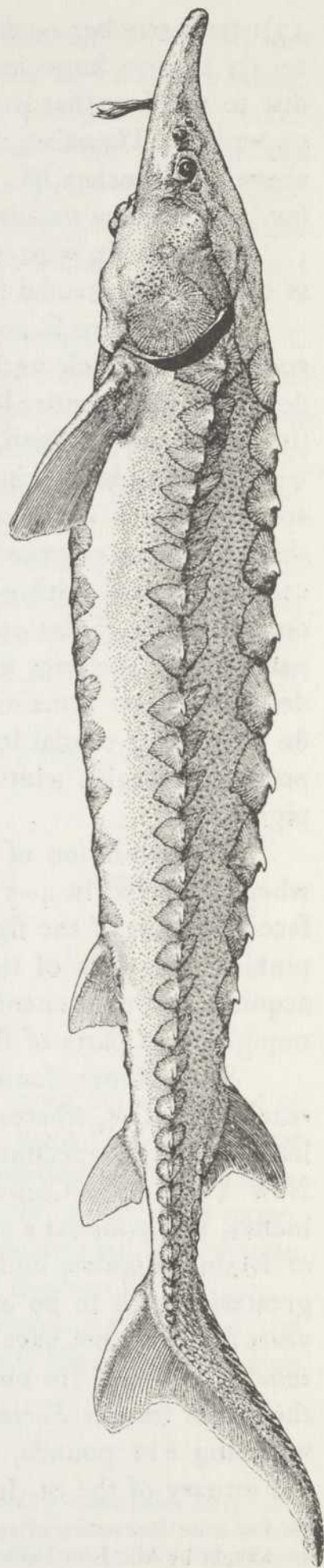


FIGURE 10. *Acipenser oxyrhynchus*. Lateral view of immature male, 581 mm long, from the St. Lawrence River near St. Vallier, Quebec, P. Q., Canada.

47): total number on first branchial arch in 70 young below eight inches, 15-24 (av. 20.4); in 800 large individuals 8-91 inches, 16-27 (av. 21.5). This difference was due to the fact that in young specimens not all rakers were developed as yet on the upper limb. Therefore, for purposes of comparison of gill raker counts, only individuals above eight inches FL should be used. In 70 large specimens of *A. oxyrhynchus*, 9-14 (av. 11.5) rakers on lower limb and 7-13 (av. 9.8) on upper limb.

CAUDAL fin with average difference between TL and FL, 14% of FL; a notch at tip of upper caudal lobe in undamaged specimens.

Color. There is no significant difference in coloration between young specimens and adults.³⁶ Back and top of the head bluish-black, becoming progressively paler down the sides; entire lower surface whitish. Median carina and spine on dorsal shields (in dorsal row) whitish, contrasting strongly with darkly pigmented back, particularly with the jet-black skin covering the extremities of each shield, the dorsal row thus appearing as a series of whitish spots on a dark background. Upper half of lateral shields of same color as background, but central and lower part of these shields whitish, contrasting well with pigmented sides of fish, but not as sharply as in the case of the dorsal shields. Sides of head and body, including ventral row of shields, white. Iris pale golden. Anterior edge of pectorals, ventrals, and lower caudal lobe white, clearly defined against remaining dark grey part of these fins; anal fin entirely white; dorsal fin and upper caudal lobe dark grey or blue-black in the central portion, their broad posterior margins whitish. Intestinal tract and peritoneum nearly white, never darkly pigmented.

The coloration of the three species that occur on the Atlantic coast of America, when preserved in 4-5% formalin, is characteristic. In *A. oxyrhynchus*, the ventral surface and sides of the fish, even after a long period in preservative, are whitish or faintly pinkish. The skin of the two other species (*brevirostris* and *fulvescens*), however, soon acquires and permanently retains a green color that is particularly pronounced on the unpigmented parts of the body, such as the ventral surface, sides of the head, etc.

Size. Ryder found that females averaged about 8 feet TL, and sometimes reached 10 feet, whereas males ranged between 6-7 feet (65:268). Weights and total lengths of two specimens taken in the Hudson River in 1936 and recorded by the New York State Conservation Department were as follows: unspent male 7 feet 4 inches, 176 pounds; a spent male 8 feet 4 inches, 199 pounds 15 ounces. For the Gulf of Maine, Bigelow and Schroeder (13: 82) stated that "about 12 feet is perhaps the greatest length to be expected today. But 18 feet, reported for New England many years ago, may not have been an exaggeration.... The heaviest Gulf of Maine Sturgeon reliably reported (to our knowledge), was one of 600 pounds, landed in Portland by the steam trawler *Fabia* from Georges Bank, December 21, 1932." A 14-foot female, weighing 811 pounds, was caught at Middle Island Maguerville, about 64 miles off the estuary of the St. John River, New Brunswick, in July 1924.³⁷

36. For color illustrations of an adult Atlantic Sturgeon, see Vladykov (82: 7).

37. Caught by Mr. John Neilson of Moncton. This information was kindly furnished by Mr. J. Raymond Tippet, Moncton, New Brunswick, a Sturgeon fisherman himself.

The St. Lawrence River specimens noted in the *Study Material*, 65–2,670 mm TL, weighed 0.0015–352 pounds (0.7–160 kg). Every year in the St. Lawrence River, Quebec, some Atlantic Sturgeons weighing between 200 and 300 pounds are taken by local fishermen. The two largest specimens at our disposal were taken in the brackish section of the St. Lawrence River at Ile-aux-Patins in a fascine weir.³⁸ A spent female³⁹ 8 feet 3 inches TL (7 ft. 7 in. FL) and weighing 203 pounds was taken July 5, 1946. Another female, almost ready to spawn, 8 feet 9 inches TL (8 ft. 2.5 in. FL) and weighing 352 pounds, was caught June 23, 1954.

Development and Growth. Eggs hatch in about one week at a temperature of 17.8° C (64° F). In one of the New York hatcheries where some fry were kept until they were about an inch long, the yolksac apparently lasted for about six days.⁴⁰ Unfortunately, the temperatures were not recorded. The newly hatched fry are about 11 mm (0.4 in.) long. The later growth of young *oxyrhynchus* has not been followed, but in Europe *A. sturio* reach a length of 4–5.5 inches in two months.

Little is known about the early stages of *oxyrhynchus* in nature, but it appears that yearlings grow rather rapidly, for in freshwater sections of the St. Lawrence River in Quebec we collected some young specimens ranging between 60–96 mm FL that we consider to be less than one year of age (see Table III). The smallest of

Table III. Data for the Five Smallest Specimens from Fresh Water, St. Lawrence River.

Date	Place	TL (mm)	FL (mm)	Weight (g)
Aug. 8, 1945	Berthier-en-Bas, fresh water	65	60	0.7
Aug. 24, 1950	St. Vallier, fresh water	96	87	3.4
Sept. 26, 1944	Berthier-en-Bas, fresh water.....	103	89	4.3
Sept. 26, 1944	Berthier-en-Bas, fresh water.....	102	91	4.0
Sept. 22, 1944	Rivière Ouelle	110	96	4.2

these was tangled in one corner of a net with 8-inch stretched mesh, set in 60 feet of water. The others were taken in pêches, that is, weirs made from chicken wire or fascines. Berthier-en-Bas and St. Vallier are on the freshwater section of the St. Lawrence River. Rivière Ouelle is situated at the estuary of the river of the same name, which empties into the brackish section of the St. Lawrence. Additional information about the growth of young fish that we consider to be yearlings is given in Table IV.

Determinations of the apparent growth rates of *A. oxyrhynchus* tagged in the St. Lawrence are made difficult because of damage to their tails.⁴¹ However, instances

38. Taken by Mr. Maurice Ouellet, Kamouraska, Quebec, a Sturgeon fisherman.

39. The ovaries of this fish weighed 30 pounds.

40. Eighth Annu. Rep. Comm. Fish., New York (1875), 1876: 12–14.

41. In Quebec, fishermen who catch Sturgeon in a pêche built in salt water at St. André de Kamouraska carry them alive in a horse-drawn cart ("tombereau" locally) for about 30 minutes and dump them in a freshwater brook. But if one of them is a tagged fish, it is measured and weighed and returned to the sea by horse-cart after a sojourn of a few hours to one or two days in the brook. On a hot summer day, fish in the cart thrash so

Table IV. Sizes and Weights of Young Taken during 1944 in a Pêche at Ste. Famille Ile d'Orléans, near Quebec City.

Date	No. of Specimens	Fork Length (mm)		Weight (g)	
		Range	Average	Range	Average
August 31	25	130-144	122.8	6.8-17.4	10.7
Sept. 6-28	43	100-205	150.6	5.6-35.1	21.1
Oct. 11-26	40	125-201	168.5	9.9-47.7	28.0

of good growth are afforded in four specimens, 27.8-33.3 inches FL and weighing 4.8-8.8 pounds; the indicated annual increases were 6.3-14.4% in length, corresponding to 28.8-47.0% in weight (for further details, see Vladykov, 78).

Sturgeon 11-34 inches long from the Hudson River were 2-8 winters old, as indicated by their otoliths (35: 68, tab. 10). Otolith studies, though based on few specimens, also indicate a greatly accelerated growth following the seaward migration of the immature Sturgeon, if estimated ages of 11 years for a 75-inch fish and of 12 years for two others of 88 and 100 inches are approximately correct. The maximum age, as indicated by the winter marks on the otoliths, is at least 18 winters in the case of a female 8 feet 8.5 inches and weighing about 225 pounds, taken from the Hudson River, Malden, N.Y., April 30, 1937.⁴² Vladykov (78) has given a graph for the length-weight relationship for a series of 1,592 Atlantic Sturgeon from the lower St. Lawrence River, Quebec.

Spawning and Migrations. The Atlantic Sturgeon is an anadromous species, invariably spawning in fresh water but making its growth in salt water. Adults migrate from the sea to fresh water in advance of the spawning season. The spawning migration begins during February in the St. Marys River, Georgia, typically during April in Chesapeake Bay (39: 73-76), at the end of April and in May in the Hudson River, and during May and June in the Gulf of Maine (13: 82). The exact movements of mature Sturgeon in the St. Lawrence River have not been reported, but they probably begin to ascend the current in May (fishing during this month is prohibited) and continue to run upstream through June and sometimes in early July.

In the Delaware River in 1925, the spawning migration started on April 23; a few fish were taken during the last of April and the first part of May, with the largest catches between May 12 and 22 inclusive (15: 184). During the last week of May and the first ten days of June the catch was scarcely one fish per day, and on June 10 the Sturgeon fishing ceased. The gill nets (13-in. stretched mesh) were set in a narrow arm of the river between Pea-Patch Island and the New Jersey shore opposite Delaware City, where the channel is about 2.5 miles long, 6-7 fms. deep, and the current strong. The Sturgeon gathered for spawning in the upper part of the river near the eastern shore, where the bottom is hard clay. Spawning took place

hard with their tails that the posterior ends of the caudal rays are broken, and only by slow regeneration do they regain their original length. Thus some fish, after repeated recaptures within the same season, seem to have grown somewhat shorter.

42. Age determination by Greeley, not previously published.

at water temperatures ranging between 56°–64° F. Among 63 adult females, three were "pasters"; i. e. with the roe in the form of a slimy, grayish white paste consisting of squeezed eggs, white yolks, and ruptured membranes. Between the 10th and 22nd of May, seven females with running roe and three males with ripe milt were taken during the act of spawning.

Little is known about the breeding grounds or spawning behavior along the rest of the Atlantic coast. Apparently the sexually mature individuals ascend the St. Lawrence River through deep channels that are kept free of nets because of navigation, and it is probable that spawning takes place in pools below waterfalls of certain St. Lawrence tributaries, for instance the Batiscan River along the southern shore. Moreover, there are several rivers along the northern shore (Rivière-aux-Outardes, for instance) where *A. oxyrhynchus* spawn. It is probable that the spent fish return gradually to salt water.

The eggs when laid are light to dark brown. The outside membrane of ripe eggs readily imbibes water and becomes glutinous and sticky. Being demersal and adhesive, they become attached to weeds, stones, and so forth, and it is believed that the eggs are scattered over a wide area. There is no evidence of prenatal care, such as preparation of a nest area (65: 267–268; 39: 73).

The diameter of ripe eggs is 2.5 or 2.6 mm; using this size as a basis for estimates, there would then be 168,000 eggs per gallon (U.S.) and 800,000–2,400,000 eggs per fish (65: 268; 15: 186).

The largest ripe female examined by us, caught on June 23, 1954, in the St. Lawrence River at Ile-aux-Patins, Quebec, was 8 feet 9 inches TL (8 ft. 2.5 in. FL), weighed 352 pounds, and would have spawned in about a week; its ovary weighed 91 pounds and contained an estimated total of 3,755,745 eggs. No female *A. oxyrhynchus* have been reported as being ready to spawn before reaching at least 150 pounds and an age of about 10 years. The testes of the smallest ripe male encountered during this study, a fish of 69 inches TL (60 in. FL) and 70 pounds, taken in the St. Lawrence River at St. André de Kamouraska on June 2, 1949, weighed 3 pounds 13 ounces.

General Habits. Sturgeon are bottom fish and are seldom seen except when taken in nets or when jumping. It is of interest that this relatively sluggish species is capable of making powerful jumps (p. 30). In the opinion of fishermen, at least in Quebec, Sturgeon jump to rid themselves of attached lampreys.

Very little appears to be known about the behavior of the Sturgeon in salt water. It is astonishing how easily these fish can adapt to a sudden change from salt to fresh water, or vice versa. Some tagged specimens were forced to abruptly change habitats at least twice during the same season, apparently without harmful results, because they were recaptured again alive.

Thus far the actual movements of *A. oxyrhynchus* have been studied by means of tagging in Quebec only.⁴³ During five years, 1945–1949, a total of 1,948 was liberated

43. For details, including a photograph of a tagged Sturgeon, see Vladykov (80: 65–69; 76: 47). Recently in Oregon several White Sturgeon (*A. transmontanus*) were marked with Peterson modified tags (58: 4–5).

at different localities in the St. Lawrence River, in both fresh and salt water. Up to December 31, 1952, a total of 47 fish was recovered. Several of them were recaptured as many as four and five times each and were subsequently reliberated. The majority of the recaptures showed definite mass movements toward fresh water in spring (May–June) and back to salt water in the fall (Sept.–Nov.). There were four recaptures of tagged Atlantic Sturgeon of unusual interest: three liberated at Kamouraska and one at Ile aux Coudres, Quebec. After periods varying between 307–705 days, three of them were recaptured not far from Halifax, Nova Scotia, having traveled a minimum of 900 miles. The fourth fish was retaken near the Strait of Canso. The weights of these fish when recaptured, according to the fishermen, ranged between 6–24 pounds.

Food and Feeding. The large Sturgeon feeds on mollusks and other bottom organisms. The fish roots in the sand or mud with its snout, like a pig (the barbels serving as organs of touch), as it noses up the worms and mollusks on which it feeds and which it sucks into its toothless mouth with considerable amounts of mud (65: 265). The Sturgeon also eats small fishes, particularly launce (*Ammodytes*) (13: 83). The mature Sturgeon, like the salmon, eats little or nothing while it travels up the river to spawn.

The digestive tracts of 26 young *oxyrhynchus* weighing 1–7 pounds, from the Hudson River, contained bottom mud along with plant and animal matter, including sludgeworms (*Limnodrilus*), chironomid larvae, isopods, amphipods, and small bivalve mollusks (*Pisidium*) (72: 141–144, tab. 5). The food of *A. oxyrhynchus* varies with the type of habitat, as in the St. Lawrence River, Quebec. In 27 half-grown Sturgeon taken in salt water, polychaete worms (*Nereis virens*) were found—265 on the average; the maximum number in a single stomach was 1,221. In addition, the Sturgeon fed on marine gastropods, shrimps (*Crago*), amphipods, and isopods, in that order. In fresh water, the bulk of the food consisted of aquatic insects, amphipods, and oligochaete worms; in 88% of 178 Sturgeon examined, larvae of the burrowing May fly (*Hexagenia*) were present.⁴⁴

Abundance and Commercial Importance. The present Sturgeon fishery along the western Atlantic coast is very small. In 1956, according to statistics (in pounds), the following catches of *A. oxyrhynchus* were made: Quebec 57,000, New Brunswick 800, Nova Scotia 1,000, New England 9,000, Middle Atlantic, U.S., 15,000, Chesapeake Bay 23,000, South Atlantic, U.S., 129,000, and Gulf of Mexico 15,000; the total was 249,800 pounds.

Former catches were manifold greater: the catch in North Carolina in 1880 was 437,000 pounds (67: 56), in Chesapeake Bay in 1890 over 900,000 pounds (39: 75), and in the Delaware River that year, 5,000,000 pounds (22: 372). Seven years later, however, the Delaware catch was only 2,428,616 pounds, about half as large as in 1880. By 1920 the catch had declined to 22,886 pounds in Chesapeake Bay, by 1950 to about 1,200 pounds in and at the mouth of Delaware Bay, and to 18,900 pounds in Chesapeake Bay (see also *Details of Occurrence*, p. 54).⁴⁵

44. For further details on the food of *A. oxyrhynchus* in Quebec, see Vladykov (77: 53–55).

45. For the abundance of Sturgeon in New England waters in Colonial days, see Bigelow and Schroeder (13: 83).

At the turn of the century, when Sturgeon were caught in very large numbers and when mature individuals were the mainstay, fishing was so intensive that very few fish were able to reach the upper waters to spawn. This was probably one of the reasons for their great decrease in subsequent years. Also, the building of dams in many important rivers (e. g. the Susquehanna, Maryland) deprived Atlantic Sturgeon of their favorite spawning areas, and pollution by wastes of all kinds from the factories and by municipal sewage from the towns and cities along the Atlantic shore aided in reducing still further the local populations.

Laws prohibiting the capture of Atlantic Sturgeon below a minimum size or during certain periods of fishing (39: 76) were helpful in protecting and maintaining the species. However, even at its lowest ebb the Atlantic Sturgeon in North America never was close to complete extermination, as some authors⁴⁶ were inclined to believe (in 1950). There are indications, along the Atlantic seaboard, that this Sturgeon is coming back. The small number of large fish taken during recent years is partially due to a reduction in the quantity of appropriate fishing gear. In New York, for instance, the 10-inch mesh nets, legally specified for taking this species, are not used in the Hudson River because fishermen do not consider it likely that enough fish could be taken to justify the expense of gear and license (35: 139).

In Quebec, the Atlantic Sturgeon is perhaps as plentiful now as it used to be in bygone years. For instance, at our request a fisherman of St. Vallier counted all the young *A. oxyrhynchus* that he liberated alive from his pêche; during the night of October 2, 1944, he freed 1,000 young 6–15 inches long.

The principal Quebec catches are made with weirs situated along the southern shore of the St. Lawrence River, from Rivière Ouelle to St. Nicolas. Some fish are also taken regularly with gill nets in the same area. Along the northern shore of the St. Lawrence, some large fish are caught in either weirs or in salmon nets, particularly in the estuaries of Rivière-aux-Outardes and Rivière Manicouagan, and occasionally large fish are taken at Sept Îles.

Relation to Man. The Atlantic Sturgeon is a good quality foodfish, but less so than the Lake Sturgeon (*fulvescens*), which reaches maturity at around 20 pounds and is more generally appreciated for "smoking" purposes. The flesh of the young or half-grown Atlantic Sturgeon, which make up the great bulk of the catch of this species, is coarse, contains many ligaments, and has only a small amount of fat; it is only the large adult that furnishes a tender and rich flesh. Some years ago the price paid to Quebec fishermen for a fish weighing 30 pounds when dressed was 35 cents a pound for an Atlantic Sturgeon as compared with 80 cents or even one dollar per pound for a Lake Sturgeon of the same dressed weight; the male fish brings a better price than the female. Moreover, the Atlantic Sturgeon carries heavier scutes, thus there is a greater loss of weight during preparation of the meat. Dressing for the United States market consists

46. Darlet and Prioux (25: 6), in their review of the Atlantic Sturgeon supply in different countries, said that there were no more left in America ("aux Ameriques il n'y en a plus").

of removing the head, collar bone (cleithrum), tail, all fins, and the viscera.⁴⁷ Thus the weight of prepared meat, which varies with size of fish, sex, stage of maturity, and condition of fatness, is only about 50% or even 40% of the entire Sturgeon. The roe from Atlantic Sturgeon is as good for making caviar as that from Lake Sturgeon, and being mature at a larger size, the Atlantic Sturgeon furnishes a larger quantity of eggs. In early Colonial days, around 1709 in North Carolina, the rough Atlantic Sturgeon scutes were considered "good nutmeg graters" (67: 56).

The value of the Atlantic Sturgeon for angling purposes is negligible. Nevertheless, occasional captures of large ones with hook-and-line stir public interest. It is worthwhile to mention the capture of a 6-foot Sturgeon, foul-hooked, by a skilled woman angler at Wasque Point, Martha's Vineyard, Nantucket Sound (13: 84).

General Range. The regular range of *A. oxyrhynchus* is limited to the Atlantic coast of North America and the Gulf of Mexico. The northern subspecies, *A. oxyrhynchus oxyrhynchus*, occurs from Hamilton Inlet on the Atlantic coast of Labrador (7: 290) and the Gulf of St. Lawrence to eastern Florida. In the Gulf of Mexico is found the southern subspecies *A. oxyrhynchus desotoi* (p. 56) (34: 408, 409, 411). Occasional captures of Atlantic Sturgeon have been reported for Bermuda⁴⁸ and even for French Guiana,⁴⁹ but these southern stragglers probably are of the subspecies *desotoi*. And a large Sturgeon, taken near the mouth of the Mississippi River, the photograph of which has been published (34), can be identified as *desotoi* by its broad and strongly developed scutes.

There are early reports of the presence of *A. sturio* (equals *A. oxyrhynchus*) in Hudson Bay, but from the descriptions it is evident that the specimens in question were *A. fulvescens* (see also 75: 30 [42]).

Details of Occurrence. Hamilton Inlet on the Atlantic coast of Labrador is the most northerly point where *A. oxyrhynchus* has been reported (7: 290). Blanc Sablon, on the Quebec side of the Strait of Belle Isle, is the next most northerly point (some specimens from this locality are in our collections). Atlantic Sturgeon are found regularly throughout the Gulf of St. Lawrence and in the St. Lawrence River up to Three Rivers, and odd specimens are taken even in Lake St. Peter, near Sorel, Quebec (23: 19). They are found also in small numbers on the Newfoundland side of the Gulf of St. Lawrence, are well known in Nova Scotian waters, especially near estuaries (85: 58), and are caught regularly in the St. John River, New Brunswick, as well as at the head of the Bay of Fundy (42: [10] 58).

To the south, Atlantic Sturgeon are (or were) well known in the Penobscot, Kennebec, and Merrimack rivers; indeed, they entered nearly every stream of any size

47. Ryder (65: 276) and Hildebrand and Schroeder (39: 75) have given details on the methods of preparing Sturgeon for the market.

48. According to Beebe and Tee-Van, two records of *A. oxyrhynchus* were mentioned in early Bermuda lists, one for 1876 and the other for 1887 (9: 32).

49. In 1867 Duméril (27: 161) described a new Sturgeon, as *A. cayennensis*, from French Guiana "de la riviére Oyapock dite la Cayenne." Bertin (12: 248-249), after examining the holotype (No. 3493, 740 mm, stuffed, in good condition) in the Paris Museum, considered it as a possible hybrid *A. sturio* × *A. brevirostris*, but Vladykov, who re-examined it in 1950, identified it as *A. oxyrhynchus*.

that empties into the Gulf of Maine. There are also definite records of Sturgeon taken off the open coast from the Bay of Fundy southward to Cape Cod (13: 83), and along the coasts of southern New York. Along the Middle and South Atlantic seaboard of the United States there are several rivers that formerly maintained important fisheries: the Hudson, Delaware, Susquehanna, Potomac, York, James, St. Marys (Georgia), and St. Johns (Florida).⁵⁰

At Quebec, it seems that young *A. oxyrhynchus* pass their entire growth in the fresh and brackish water of the St. Lawrence River, for Sturgeons of all sizes are taken there—from a few inches long up to nine feet or longer (78: 53–56). Why it was that some half-grown tagged fish were recaptured several hundred miles from the place of release is not known (pp. 51, 52). But the small number of these stragglers does not appreciably change the impression that the majority of the Atlantic Sturgeon produced in the St. Lawrence River does not venture far from the estuary, for they are taken there in some numbers throughout the entire fishing season.

In the Hudson River, where gill nets used for shad and other species accidentally capture Sturgeon 11–34 inches long and 2–8 winters old (age determinations based on otoliths), there is abundant evidence from both winter and summer catches that these immature Sturgeon inhabit the freshwater areas of the river throughout the year. But there is a wide gap in the Hudson River collections between these and the adults; since immature Sturgeon are frequently encountered in salt water in the general vicinity, it seems likely that all of them go to sea sooner or later to complete their growth. This rule seems to apply also to the rivers of the Gulf of Maine. However, some of the Delaware River Sturgeon seeking salt water may remain within the lower reaches of Delaware Bay while others go to sea, as proven by catch records of fish taken in the pound nets near Ocean City, Maryland. In Chesapeake Bay, fish of all sizes are taken in both the upper and lower parts of the Bay throughout that portion of the year when the pound nets are in operation (39: 73). But it is not known how many Sturgeon stray beyond the outer headlands, from Chesapeake Bay, the sounds of North Carolina, or the rivers farther southward.

Published reports of Sturgeon taken at sea are mostly for waters close to shore, but landings of 3,700 pounds in 1950 and 3,900 pounds in 1952 in New York and New Jersey by otter trawlers show that some wander out on the Continental Shelf; and to the east, some even stray to the offshore fishing banks. Thirty Sturgeon, for example, were landed in Boston and Portland from Brown Bank, Georges Bank, the South Channel, and Nantucket Shoals by otter trawlers during the years 1927–1934; and landings of 5,300 pounds in 1940 and 6,600 pounds in 1947 in New England ports from these offshore grounds correspond to about 50 and 70 fish, respectively, if an average weight no greater than 100 pounds is assumed.⁵¹

50. We believe that the specimens from South Carolina and Florida, referred to as *A. brevirostris* by Jordan and Evermann (43: 106) and by several subsequent authors, were *oxyrhynchus*.

51. From data collected by the late Walter H. Rich, U.S. Bureau of Fisheries, and from notices in the daily press.

Synonyms and American References:⁵²

Acipenser oxyrhynchus Mitchill, Trans. Lit. philos. Soc. N.Y., 1, 1814: 462 (descr., New York); DeKay, Zool. N.Y., 4, 1842: 346 (descr.); Provancher, Nat. Canad., 8, 1876: 226 (genl. acct.); Smith, N.C. geol. econ. Surv., 2, 1907: 57 (Albemarle Sd.); Hildebrand and Schroeder, Bull. U.S. Bur. Fish., 43, 1928: 72 (Chesapeake Bay); Breder, Field Bk. Mar. Fish. Atl. Cst., 1929: 42 (genl. acct.); Jordan, Manual Vert. Anim. NE U.S., 1929: 32 (distr., key, brief descr.); Jordan, Evermann, and Clark, Rep. U.S. Comm. Fish. (1928), 2, 1930: 34 (in checklist); Gowanloch, Fish. Fishing Louisiana, Bull. La. Conserv. Dept., 23, 1933: 411 (mouth of Mississippi R.); Schrenkeisen, Field Bk. Freshw. Fish. N. Amer., 1938: 12 (genl. acct.); Vladykov and Beaulieu, Nat. Canad., 73, 1946: 43 (detail. acct. of shields and gill rakers, size, Quebec); Vladykov and Beaulieu, Nat. Canad., 78, 1951: 129 (detail. acct. of gill rakers for three w. Atlantic species); Rostlund, Univ. Calif. Publ. Geogr., 9, 1952: 248 (import. to native Indians).

Acipenser sturio Linnaeus,⁵³ Syst. Nat., ed. 10, 1758, 237 (descr., European seas); Ryder, Bull. U.S. Fish Comm. (1888), 8, 1890: 232 (descr., Atlant. cst.); Jordan and Evermann, Bull. U.S. nat. Mus., 47 (1), 1896: 105 (descr., Atlant. cst.); Kendall, Occ. Pap. Boston Soc. nat. Hist., 7 (8), 1908: 16 (New England); Kendall, Proc. Portland Soc. nat. Hist., 3 (1), 1914: 13 (Maine); Huntsman, Contr. Canad. Biol. (1921), 3, 1922: 10 (58) (St. John R., head of Bay of Fundy); Bigelow and Welsh, Bull. U.S. Bur. Fish., 40 (1), 1925: 74 (descr., habits, Gulf of Maine); Borodin, Trans. Amer. Fish. Soc., 55, 1925: 184 (biol. observ.); Nichols and Breder, Zoologica, N.Y., 9, 1927: 30 (size, distr. New England, New York); Truitt, Bean, and Fowler, Bull. Md. Conserv. Dep., 3, 1929: 33 (Chesapeake Bay); Beebe and Tee-Van, Field Bk. Shore Fish. Bermuda, 1933: 32 (2 recs. for Bermuda cited); Vladykov and McKenzie, Proc. N.S. Inst. Sci., 19 (1), 1935: 53 (genl. acct.); Jordan and Evermann, Amer. Food Game Fish., 1937: 8 (genl. acct., key); Bigelow and Schroeder, Fish. Bull. (74) U.S. Fish Wildl. Serv., 53, 1953: 81 (descr., habits, Gulf of Maine).

Acipenser sturio oxyrhynchus, Smith, Bull. U.S. Fish Comm. (1891), 1893: 190 (N. Carolina rivers: Pasquotank, Edenton, and Roanoke); Halkett, Check List Fish. Canad., 1913: 44 (distr.); Greeley, N.Y. Biol. Surv. Lower Hudson Watershed (1936), 11, 1937: 89 (age determ., size ranges, Hudson R.); Bailey, Biol. Surv. Merrimack Watershed, New Hampshire Fish Game Dept., 1938: 155 (former abund. Merrimack R.).

Acipenser cayennensis, Duméril, Nouv. Arch. Mus. Hist. nat. Paris, 3, 1867: 161 (descr., River Oyapock known as Cayenne, French Guiana; see fn. 49).

To the above Synonyms should be added several nominal specific names, which were given by Duméril (27: 161-177; 28: 116-228) to specimens of *A. oxyrhynchus* according to locality only: *mitchilli* (New York), *kennicotti* (James R.), *girardi* (Maryland), *macrohinus* (New York), *milberti* (New York), *bairdi* (Maryland), *storeri* (Boston), *holbrooki* (Charleston), and *lecontei* (New York).

Acipenser oxyrhynchus desotoi Vladykov 1955

Gulf of Mexico Sturgeon, Common Sturgeon

Figure 3

Study Material. Two specimens, 50 and 60 cm FL, obtained by T. Dawson between Twin and Rabbit islands at the mouth of Singing River, off Gautier, Mississippi, November 30, 1953, CNHM 59803, 59804;⁵⁴ 3 specimens (seen by V.D.V.), from western coast of Florida (two from Cedar Keys, the other from Suwannee River), UF collections.

52. Among the references, we have omitted some early authors whose incomplete or erroneous descriptions of the species are of little scientific value.

53. European authors in general, such as d'Ancona (2), Berg (11: 94), and others, consider the American form identical to the European *A. sturio*.

54. Kindness of Loren P. Woods. These specimens served as the basis for the original description (81: 2, pls. 1, 3, 5, 7).

Distinctive Characters and Description. The subspecies *desotoi* is distinguishable from typical *oxyrhynchus* of comparable size by the following differences, the most striking and characteristic difference being the length of the spleen. Head, pectoral, and spleen given in per cent of fork length. For other details, see Vladykov (81).

Character	<i>desotoi</i>	<i>oxyrhynchus</i>
Scutes — dorsal row ...	squarish, with length much shorter than width; carina (keel) typically with two strong hooks	oval, with length greater than width;* carina (keel) low, without a pronounced hook
Head	30.9–33.6%	26.5–27.6%
Pectoral fins	15.5–16.3%	11.5–15.1%
Spleen length	16–19%	3–9%

* Specimens from eastern Florida and Quebec.

† Two specimens.

Habits. The subspecies *desotoi* is anadromous, as is the northern subspecies *oxyrhynchus*. Further than this there is no detailed information on its habits, except that Louisiana fishermen occasionally capture large Sturgeon around the mouth of the Mississippi River and in the Sound, where they have been reported as "Common Sturgeon" (34: 411–412). Adults probably visit several rivers on the northern and eastern shore of the Gulf of Mexico for spawning purposes.

Range. Apparently its occurrence is limited to the Gulf of Mexico, the northern coast of South America, and Bermuda (p. 54).

Synonyms and References:

Acipenser oxyrhynchus de sotoi Vladykov, J. Fish. Res. Bd. Canada, 12 (5), 1955: 2 (orig. descr.).

Acipenser oxyrhynchus Gowanloch, Bull. La. Conserv. Dep., 1933: 411 (mouth of Mississippi R.).

Acipenser sturio Rivas, Bull. U.S. Fish Wildl. Serv., 55 (89), 1954: 504 (n. and e. shore, Gulf of Mexico).

Acipenser (oxyrhynchus) de sotoi Springer and Bullis, Spec. Sci. Rep., U.S. Bur. Comm. Fish., 196, 1956: 46 (Mississippi Sd.).

Relationship of *A. oxyrhynchus* to *A. sturio*

Some authors (see Synonyms and References, p. 56), following Ryder (65: 234–238), have considered the Atlantic Sturgeon of America to be the same species as the Common Sturgeon of Europe, *A. sturio* Linnaeus; the two species resemble each other very closely in certain features, as is shown in Table v.

D'Ancona, in a summary of the characters of *A. sturio*, presumably from the Mediterranean Sea,

Table V. Comparative Counts of *A. sturio* and *A. oxyrhynchus*.

Species	<i>A. sturio</i>	<i>A. oxyrhynchus</i>
Authority	Berg (11: 93–95)	Vladykov and Beaulieu (83: 44–57)
Dorsal shields ...	9–13	7–13
Lateral shields ..	24–35	24–35
Gill rakers	18–25	17–27

has quoted somewhat higher figures than those given in Table v for the shields: 10-14 in the dorsal row (excluding the nuchale) and 25-36 in the lateral row (2). Antoniu, for *A. sturio* from the Black Sea, mentioned the presence of pairs of postdorsal shields and of a frontal sinus in the cartilaginous skull; both of these characters are found in *A. oxyrhynchus* (4: 109-116).

Of two specimens obtained by Cope nearly a century ago in Adige (Verona), Italy, and labeled *A. sturio*, one is probably *A. güldenstädti* (ANSP 646) and the other is definitely an *A. sturio* (ANSP 645), 15 inches long (380 mm) FL. The latter has a fontanelle, 10 shields (including nuchale) in the dorsal row, and 30 shields (including supracleithrum) in the lateral rows. On the first branchial arch we counted 20 gill rakers. The body proportions are also very similar to those of *A. oxyrhynchus* of corresponding size, and its color, or what remains of it, corresponds very closely to that of American specimens.

In a drawing of *A. sturio* by d'Ancona, the coloration is also very similar to that of the western Atlantic Sturgeon (2: fig. 1); on the other hand, the mouth of d'Ancona's *A. sturio* is larger than that of *A. oxyrhynchus* (2: fig. 2), the shape of its lower lip is very different, and there are other differences as well. According to Berg, the adult of *A. sturio* has several (up to 10-12) dense, oblique series of rhombic plates (dermal ossifications) between the dorsal and lateral rows of shields (11: 97); in western Atlantic specimens these ossifications are much less developed and are rather irregular in shape. Moreover, Classen (20: 88-102) has mentioned several ripe females of *sturio* from the Gulf of Cadiz, Spain, 63 inches TL (145 cm FL) and weighing as little as 62 pounds (28 kg); *oxyrhynchus* apparently attains sexual maturity at a larger size than *sturio*, the males of *oxyrhynchus* being approximately six feet TL and 70 pounds in weight, the females not less than 150 pounds (p. 51).

In Europe, probably because of a general scarcity of *A. sturio* (25: 5-13), little work has been done to elucidate the problem of local races. Nevertheless, there are observations by Marti that *A. sturio* from the Black Sea are similar to those from the Mediterranean region but differ from those of the Baltic (51: 435-442, Russ.); the Black Sea specimens have on the average higher numbers of dorsal and lateral scutes and dorsal rays. Magnin, by studying cross sections of the pectoral ray, found that the rate of growth of the European Sturgeon varies according to geographical region (49: 152-159). The growth observed was fastest in Italy (Tiber and Po rivers), intermediate in Spain (Guadalquivir River), and slowest in France (Gironde River).

In conclusion, until an adequate comparison of anatomical and meristic characters of these two species is made, it is preferable to retain separate specific rank for *A. sturio* and *oxyrhynchus*.

TEXT AND FOOTNOTE REFERENCES

1. AMERICAN Fisheries Society, List of Common and Scientific Names... Fish... U.S. and Canada, Publ. 1, 1948.
2. d'Ancona in Faune Ichthyol. d'Atl. nord, 2, 1929.
3. Antipa, Fauna Ichthyol. Romaniei (Buch.), 1909.
4. Antoniu, Ann. Sci. Univ. Jassy, 23 (2), 1937.
5. Antoniu, Ann. Sci. Univ. Jassy, 28 (2), 1942.
6. Antoniu, Bull. Acad. Roumaine, 29 (5), 1946.
7. BACKUS, Copeia, 1951.
8. Bailey, Pap. Mich. Acad. Sci., 39, 1954.
9. Beebe and Tee-Van, Field Bk. Shore Fish. Bermuda, 1933.
10. Berg, Class. Fish., Trav. Inst. zool. Acad. Sci. URSS, 5 (2), 1940; reprinted by J. W. Edwards, Ann Arbor, Mich., 1947.
11. Berg, Poiss. des eaux douces... U.R.S.S., 1, 1948.
12. Bertin, Bull. Mus. Hist. nat. Paris, (2) 12 (6), 1940.
13. Bigelow and Schroeder, Fish. Bull. (74) U.S. Fish Wild. Serv., 53, 1953.
14. Borisov, Trav. Comm. Rép. Jakoute, 9, 1928.
15. Borodin, Trans. Amer. Fish. Soc., 55, 1925.
16. CARTER, Trans. Amer. Fish. Soc. (1904), 1905.
17. Chalikov, Zool. J., 23, 1944.
18. Cheng, Fukien Univ. Sci. J., 1, 1938.
19. Classen, Tech. Fish. Prod., 1925 (Russ.).
20. Classen, Trab. Inst. esp. Oceanogr., 19, 1944.
21. Clemens and Wilby, Bull. Fish. Res. Bd. Canad., 48, 1946.
22. Cobb, Rep. U.S. Comm. Fish. (1899), 1900.
23. Cuerrier, Fry, and Prefontaine, Nat. canad., 73, 1946.
24. Cuerrier and Roussow, Canad. Fish Cult., 10, 1951.
25. DARLET and Prioux, Bull. franc. Piscic., 158, 1950.
26. Dominion Bureau of Statistics, 1956.
27. Duméril, Nouv. Arch. Mus. Hist. nat., Paris, 3, 1867.
28. Duméril, Hist. Nat. Poiss., 2, 1870.
29. EVERMANN and Latimer, Proc. U.S. nat. Mus., 39, 1911.
30. FORBES and Richardson, Bull. Ill. Lab. nat. Hist., 7, 1905.
31. Forbes and Richardson, Bull. Ill. nat. Hist. Surv., ed. 2, 3 (3), 1920.
32. Fortin, Ann. Rep. Fish. (1863), Append., 1864.
33. Fowler, Proc. Acad. nat. Sci. Philad., 1910.
34. GOWANLOCH, Bull. La. Conserv. Dep., 23, 1933.
35. Greeley, 26th Rep. N.Y. St. Conserv. Dep., Suppl., 1937.
36. Grote, Vogt, and Hofer, Süßwasserfische von Mittel-Europa, 1 (text), 11 (Atlas), 1909, 1908.
37. HALKETT, Check List Fish. Canad., 1913.
38. Harkness, Publ. Ont. Fish. Res. Lab., Biol., 24 (18), 1923.

39. Hildebrand and Schroeder, Bull. U.S. Bur. Fish., 43, 1928.
40. Hinks, Fish. Manitoba, 1943.
41. Hubbs and Lagler, Bull. Cranbrook Inst. Sci., 26, 1947.
42. Huntsman, Contr. Canad. Biol. (1921), 3, 1922.
43. JORDAN and Evermann, Bull. U.S. nat. Mus., 47 (1), 1896.
44. Jordan and Evermann, Amer. Food Game Fish., 2nd ed., 1937.
45. Jordan, Evermann, and Clark, Rep. U.S. Comm. Fish. (1928), 2, 1930.
46. LARIMORE, Copeia, 2, 1950.
47. Leim and Day, J. Fish. Res. Bd. Canad., 16 (4), 1959.
48. MAGNIN, Rev. Trav. Inst. Pêches marit., 23, 1959.
49. Magnin, Bull. franc. Piscic., 193, 1959.
50. Magnin and Beaulieu, Nat. canad., 87, 1960.
51. Marti, Zool. J., 18, 1939.
52. Montpetit, Poiss. d'eau douce Canad., 1897.
53. Mori, J. Chosen nat. Hist. Soc., 16, 1933.
54. Mori, Mem. Hyogo Univ. Agr., 1 (3), 1952.
55. NICHOLS, Nat. Hist. Centr. Asia, 9, 1943.
56. Nikitin, Fish Products, 1949 (Russ.).
57. Nikolski, Rept. Amph., Fish., 1906 (Russ.).
58. OREGON State Game Commission, Bull., 1950.
59. PROVANCHER, Nat. canad., 8, 1876.
60. Putschkov, Phys. Fish., 1941 (Russ.).
61. ROSTLUND, Univ. Calif. Publ. Geogr., No. 9, 1952.
62. Roule, Poiss. des eaux douces Fr., 1925.
63. Roussow, Off. Biol. Min., Chasse Pêches, Quebec, 1955.
64. Roussow, J. Fish. Res. Bd. Canada, 14, 1957.
65. Ryder, Bull. U.S. Fish Comm. (1888), 8, 1890.
66. SCOTT, Freshw. Fish. east. Canad., 1954.
67. Smith, N. C. geol. econ. Surv., 2, 1907.
68. Stannius, Handb. Zool. Fische, ed. 2, 1854.
69. Stone, Trans. Amer. Fish. Soc., 29, 1900.
70. TATARKO, Trav. Mus. zool. Acad. Sci. Ukr., 10, 1936.
71. Ting, Copeia, 1949.
72. Townes, 26th Rep. N.Y. St. Conserv. Dep., Suppl., 1937.
73. Trusov, Doklady Acad. Sci. USSR, 67 (3), 1949.
74. U. S. Fish Wildl. Serv., Statist. Digest., 1956.
75. VLADYKOV, Contr. Canad. Biol., 8 (29), 1933.
76. Vladykov, Rapp. Gén. Dép. Pêch. Quebec (1945-1946), 1946.
77. Vladykov, Rapp. Gén. Dép. Pêch. Quebec (1947-1948), 1948.
78. Vladykov, Rapp. Gén. Dép. Pêch. Quebec (1948-1949), 1950.
79. Vladykov, Rapp. Gén. Dép. Pêch. Quebec (1950-1951), 1951.
80. Vladykov, Rapp. Gén. Dép. Pêch. Quebec (1952-1953), 1953.
81. Vladykov, J. Fish. Res. Bd. Can., 12 (5), 1955.
82. Vladykov, Fish. Quebec, Alb. 5, 1955.
83. Vladykov and Beaulieu, Nat. canad., 73, 1946.
84. Vladykov and Beaulieu, Nat. canad., 78, 1951.
85. Vladykov and McKenzie, Proc. N.S. Inst. Sci., 19 (1), 1935.
86. WISCONSIN Conserv. Bull., August 1954.

3,
7,
0,
7,
7,
1),
66
3.
ec
ec
ec
55,
33,
88,
ci.

THE HISTORY OF THE CITY OF BOSTON, FROM THE FIRST SETTLEMENT TO THE PRESENT TIME.

1. The first settlement was made in 1630 by a group of Puritan ministers and laymen, who came to the city from England. They were led by John Winthrop, who gave the city the name of Boston.

2. The city grew rapidly, and by 1639 it had a population of about 1,000. It was the center of the Massachusetts Bay Colony, and its government was based on the principles of self-government.

3. In 1689, the city was the scene of a revolution, when the people overthrew the royal government and established a new one. This was the first time that a colony had successfully rebelled against the crown.

4. The city was the center of the American Revolution, and it was here that the Declaration of Independence was signed in 1776.

5. The city was the scene of many important events, including the Boston Tea Party in 1773, the Battle of the Clouds in 1780, and the capture of the city by the British in 1774.

6. The city was the center of the abolition movement, and it was here that many of the leading abolitionists lived and worked.

7. The city was the scene of the Civil War, and it was here that many of the soldiers fought and died.

8. The city was the center of the industrial revolution, and it was here that many of the great factories were built.

9. The city was the scene of the Great Fire of 1872, which destroyed much of the city and its harbor.

10. The city was the center of the Progressive movement, and it was here that many of the reforms were introduced.

11. The city was the scene of the World War I, and it was here that many of the soldiers fought and died.

12. The city was the center of the New Deal movement, and it was here that many of the reforms were introduced.

13. The city was the scene of the World War II, and it was here that many of the soldiers fought and died.

14. The city was the center of the Cold War, and it was here that many of the reforms were introduced.

15. The city was the scene of the Vietnam War, and it was here that many of the soldiers fought and died.

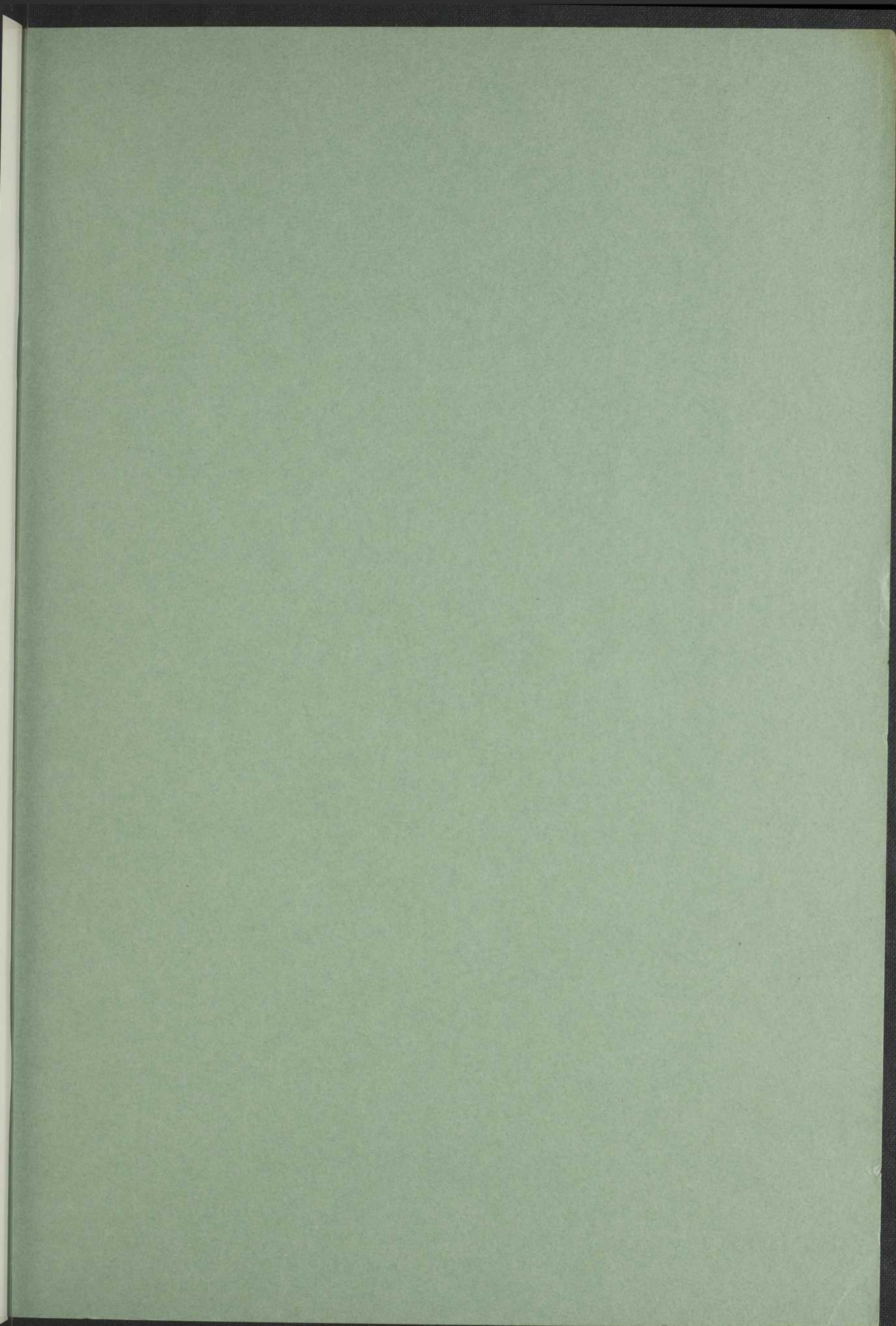
16. The city was the center of the Civil Rights movement, and it was here that many of the reforms were introduced.

17. The city was the scene of the Watergate scandal, and it was here that many of the reforms were introduced.

18. The city was the center of the AIDS crisis, and it was here that many of the reforms were introduced.

19. The city was the scene of the 9/11 attacks, and it was here that many of the reforms were introduced.

20. The city was the center of the 2008 financial crisis, and it was here that many of the reforms were introduced.



BNQ



000 176 776