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AGING A POPULATION OF THE WHITE SUCKER, *Catostomus commersoni*, BY THE FIN-RAY METHOD

by

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ABSTRACT

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A population of the white sucker, Catostomus commersoni, studied from 1975 until 1982, was aged by the fin-ray method. Problems encountered in age determinations of fish by the fin-ray method were discussed. The following guidelines for the use of the fin-ray method for aging the white sucker were recommended: 1) examination of fin rays from several young fish and comparison of these ages with ages derived from length-frequency histograms to determine the position and shape of the first annulus; 2) determination of the type of fin being aged, that is, pectoral or pelvic, and the differences in position of the first annulus; 3) awareness of the potential underaging due to time of year fish are captured; 4) recognition of false annuli in fast-growing fish; 5) comparisons of age of tagged fish at release and at recapture to validate older age-classes; and 6) compilation of reference photographs of fish of all ages, especially of young fish. The fin-ray method was successfully used to age white suckers up to the age of 11 years in this population and was generally applicable to white sucker populations in other lakes in the same area.

Key words: Aging; sucker, white; pectoral fin; pelvic fin.

RESUME

Chalanchuk, S.M. 1984. Aging a population of the white sucker, Catostomus commersoni, by the fin-ray method. Can. Tech. Rep. Fish. Aquat. Sci. 1321: iv + 16 p.

Lors d'une étude menée de 1975 à 1982, on a déterminé l'âge d'une population de meuniers noirs, Catostomus commersoni, grâce à la méthode des rayons de nageoires. Après avoir discuté des problèmes soulevés dans la détermination de l'âge par cette méthode, nous recommandons les lignes de conduite suivantes: 1) examen des rayons de nageoires de plusieurs jeunes poissons et comparaison de l'âge ainsi établi avec les âges déterminés par un diagramme en bâtons de la longueur en fonction de la fréquence, afin de déterminer la position et la forme du premier annulus; 2) identification du type de nageoire étudié (pectorale ou pelvienne), et établissement des différences dans la position du premier annulus; 3) prise de conscience du risque de sous-estimer l'âge réel du poisson en raison de la période de l'année où s'effectue la capture; 4) reconnaître les faux anneaux des poissons à croissance rapide; 5) comparaison de l'âge des poissons marqués à leur libération à l'âge de ces mêmes poissons à leur nouvelle capture, cela afin de vérifier les vieilles classes d'âge de poissons; et 6) compilation de photographies de référence de poissons de tous les âges, particulièrement de jeunes poissons. L'étude de poissons par la méthode des rayons de nageoires a permis d'établir l'âge des meuniers noirs de cette population jusqu'à l'âge de 11 ans, et cette méthode pouvait généralement s'appliquer aux populations de meuniers noirs des autres lacs de cette région.

Mots-clés: détermination de l'âge; meunier noir; nageoire pectorale; nageoire pelvienne.

INTRODUCTION

The purpose of this study was to examine the fin-ray method of aging the white sucker, Catostomus commersoni, in an effort to resolve some of the problems associated with its use in age studies of fish.

Determining the position and shape of the first annulus in fin rays is of prime importance in assigning reliable ages to the white sucker (Beamish 1973). However, it has not always been clear in pictures previously published (Beamish and Harvey 1969; Beamish 1973; Beamish and McFarlane 1983) exactly what the first annulus looks like in fins of variously aged fish. Inconsistencies in designation of the first annulus could result in misleading information; to circumvent misinterpretation problems, representative photographs of fin rays from fish of several ages were included in this report as a means of illustrating various aspects of the fin-ray method of aging the white sucker.

The determination of fish age is very important in understanding various aspects of fish biology and population dynamics. Determination of growth, age at maturity, fecundity, population structure and production are all dependent on accurate ages. Fin rays and scales are commonly used for obtaining fish ages because their removal from a fish's body does not necessitate killing the fish. The advantages of using the fin-ray method rather than the scale method for aging other species of fish have been demonstrated by several authors (Beamish and Chilton 1977; Mills and Beamish 1980; Beamish 1981). However, there is still some controversy about which is the more reliable method for aging white suckers and the use of fin rays for determining ages has not been completely accepted.

Traditionally, scales have been used for aging the white sucker (Stewart 1926; Spoor 1938). More recently, the fin-ray method has become more popular (Beamish and Harvey 1969). Scidmore and Glass (1953) stated that fin rays showed more sharply defined growth patterns and more easily distinguishable first annuli than scales. Beamish and Harvey (1969) tested the validity of the scale method of aging by comparing scale ages to pectoral fin ray ages which had been previously validated by tagging fish and aging them again one year later. They found that the scale method of aging was reliable only up to five years of age and that the fin-ray method was more reliable for determining the ages of white suckers in the population they studied. MacCrimmon (1979) compared ages determined from six bony structures (scales, pectoral fin rays, dermethoid, frontal, lacrimal and rib bones) of 25 fish and found complete agreement among all structures up to the age of 12 years with the exception of scales which were in agreement with the other structures only up to the age of three years. Quinn and Ross (1982) studied a population of white suckers with intermediate growth rates and found agreement between scale ages and pectoral fin ray ages was less than 50% for fish older than five years of age. Using mark-recapture data and the capture of fish aged 0+ and 1+ to confirm the validity of the pectoral fin ray method, they concluded that the fin-ray method was more reliable than the scale method for fish up to seven years of age but they had difficulty in reading rays over the age of seven years and recommended caution when aging older suckers.

The previously mentioned studies illustrate the importance of age validation of all age-classes in age determination studies of fish. Beamish and McFarlane (1983) defined validation of an aging technique as proving its accuracy and emphasized its essentiality in understanding life-history traits. They stated that analyses of length-frequency distributions enabled validation of younger fish but that mark-recapture studies or capture of known age fish were necessary for validation of all age classes in a population. A long-term mark-recapture study of white suckers in Lake 223, in the Experimental Lakes Area, northwestern Ontario, provided an opportunity for examining the fin-ray method of aging fish of all age-classes and for validating all ages-classes in the population. Age data obtained during this study were essential to understanding the growth, age at maturity and other parameters of the white sucker population's response to the experimental acidification of Lake 223, which will be discussed in a later paper. This report presents data and photographs illustrating the use of the fin-ray method in age determination of the white sucker in Lake 223.

MATERIALS AND METHODS

Lake 223 is a small oligotrophic lake (area = 27.3 ha, mean depth = 7.2 m) in the Experimental Lakes Area of northwestern Ontario (Johnson and Vallentyne 1971). This lake has been undergoing experimental acidification since 1976. Information on the chemistry of Lake 223 and additional responses to acidification can be found in Schindler (1980); Schindler et al. (1980); Schindler and Turner (1982); Mills (1984).

Fin rays were collected from 1975 until 1982. Fish were captured by Beamish trap nets (Beamish 1972) or by small mesh multifilament gillnets (bar mesh = 25-45 mm). The fork length, weight, and previous capture history were recorded for each fish. All fish were marked by systematically scarring fin rays (Welch and Mills 1981) and fish with fork lengths greater than 280 mm were tagged with modified Carlin tags (White and Beamish 1972). Two or three fin rays of a pectoral fin were removed from each fish captured for the first time; recaptured fish had 2-3 rays removed from an unclipped pectoral or pelvic fin if the elapsed time since last sampling was greater than one year. The use of both pectoral and pelvic fins allowed for multiple recaptures of individually marked fish as a validation check of the fin-ray method at several year intervals.

After removal from the fish, fin rays were prepared by air-drying in envelopes. They were then fixed in epoxy on a parafilm strip, sectioned with a jeweller's saw using fine-toothed blades sized 6/0-8/0, cleared with toluene, and mounted on microscope slides with Permount®.

Further details about the preparation of fin rays for aging can be found in Beamish (1973). Four or five sections (<0.5 mm thick) per fin were cut as close as possible to the base of the fin ray and were examined under transmitted light using a compound microscope equipped with a screen at ≈ 160x power. Annuli (rings representing annual growth) appeared as narrow translucent zones surrounded by a dark matrix.

Three techniques for validating the ages of fish were used. Fin rays from several of the smallest fish captured each season (fork lengths of 75-105 mm) were collected to determine the shape and position of the first annulus in relation to the center of the ray. Length-frequency distributions, based on fork lengths, were constructed for each sampling period. The separation of fork lengths into discrete modes and the progression of these modes throughout the years is a commonly used technique of age determination as discussed by Weatherley (1972) and Bagenal and Tesch (1978). Ages determined from fin rays were compared with those derived from length-frequency distributions to verify ages of 0+ - age 2 fish. Older age-classes were validated by mark-recapture techniques, that is, capture of tagged fish and comparison of ages at time of initial release and times of subsequent recaptures.

RESULTS AND DISCUSSION

Any of the four or five sections cut close to the base of each fin could be used for aging. This was well within the 0.25 inch (6 mm) limit beyond which Scidmore and Glass (1953) found that the first annulus was absent or difficult to discern, and no differences in ages were found between sections. Each ray consisted of an upper and a lower half (Fig. 1). Both halves yielded the same age despite differences in shape and one half of the ray was useful for verifying the age determined from the other half. The position and shape of the first annulus in relation to the centre of the ray for pectoral fins is shown in Fig. 2a-c. The centre of the ray is the dense white material around which the annuli form. The shape of the first annulus remained consistent in fins from older fish also (Fig. 3). The shapes of the annuli in a pelvic fin ray were more semi-circular than those of annuli in a pectoral fin ray which were crescent-shaped. Also, the first annulus was usually more closely associated with the centre of the ray in the pelvic fin than in the pectoral fin (Fig. 4a-b). Often, because of its close association to the centre of the ray, the first annulus in a pelvic fin could not be easily distinguished from the centre of the ray; this could result in underaging a fish by one year if a reader was unaware of whether a pectoral or pelvic fin was being aged.

Fork lengths of age 0+ - age 2 fish were determined by following the progression of modes in the length-frequency histograms from the spring of 1978 until the spring of 1981 (Fig. 5). Because the majority of fish were captured during the spring sampling period each year the modes were more distinct in histograms for spring than for fall. Fork lengths of fish aged 0+ - 2 by this method when compared with fork lengths of fish aged 0+ - 2 by the fin-ray method were in agreement, indicating the validity of the pectoral fin-ray method for these young age-classes of suckers. Validation was similarly possible for pelvic fins. As shown clearly in the spring 1980 and spring 1981 histograms (Fig. 5), the most common fork length for age one fish in the spring was ≈100 mm and for age two fish was ≈200 mm.

Comparison of age at release and age at recapture of tagged fish indicated that the fin-ray method of aging Lake 223 white suckers was valid at least up to the age of 11 years (Fig. 6). Fins from fish recaptured 1-4 years after initial release were aged correspondingly 1-4 years older. For example, when initially released in June, 1977, the fish with tag #3738 was aged 5+ and was aged seven when recaptured in June, 1979 (Fig. 7a-b). Ages determined from both pelvic and pectoral fins were validated in this manner. Occasionally, a fin ray did not show the "correct" number of annuli; this was usually due to a poor quality fin section, caused by cutting at an angle or an extremely thick section. Sections that were cut too thickly did not allow for optimal contrast between light and dark zones and could not be read accurately. Sections cut at oblique angles rather than perpendicular to the longitudinal axis of the fin had inconsistent or poor alignment of annuli.

The time of capture of fish was a potential source of aging error. It has been generally established that annuli (the narrow translucent zones) are formed during the winter when growth stops and that the wider opaque zones between annuli are formed during active growth in the spring, summer and early fall. Fin rays from fish captured very early in the spring showed no growth at the edge of the ray (Fig. 8a) beyond the last annulus. By late May or early June, new growth was evident at the edge of the ray (Fig. 8b) and from early July until the end of the fall season, growth was usually obvious and fish were reliably aged. Quinn and Ross (1982) discussed a potential bias in age-growth studies due to differences in time of annulus formation. They found that annuli appeared on pectoral fin rays of young suckers earlier than on older fish because growth was inhibited until completion of spawning. Fish 4-7 years old only occasionally showed new growth at the edge of the fin ray by mid-July in the population they studied. Although young suckers in Lake 223 showed greater growth in the spring than did older suckers (Fig. 9a-b), there was no difficulty in distinguishing growth in fish 4-7 years old. Fish older than 10 years showed very little growth on their fin rays until late fall (Fig. 9b). Because the weight-length relationship of fish is a power function, a change in weight for larger (older) fish is reflected in less change in length than a comparable change in weight for smaller (younger) fish and consequently less growth on the rays is discernable for older fish than for younger fish at the same time of year. A higher growth rate in Lake 223 compared with that of the white sucker population studied by Quinn and Ross (1982) could account for the appearance of new growth on the fin rays of fish in the 4-7 year age-classes of Lake 223 suckers in addition to the normally fast growth seen on fins of young suckers.

Another problem encountered in the fin-ray method of aging Lake 223 white suckers was the occurrence of "false" annuli. Beamish (1973) discussed the complications in determining the first annulus due to a "false" annulus between the center of the ray and the first annulus in fins from fast-growing populations of white suckers. Fin rays from fast-growing Lake 223 fish showed several "false" annuli not associated with the center of the ray but interspersed between several annuli (Fig. 10). Similar occurrences of false annuli in the fins of fast-growing lake whitefish were observed by K.H. Mills (Freshwater Institute, Winnipeg, personal communication) and in fins of walleye pollock by Beamish (1981). These "false" annuli were probably due to cessation of growth during temporary adverse weather conditions or food shortages throughout the growing season. Criteria used to distinguish "false" annuli from real annuli were whether or not the annuli completely encircled the center of the ray or disappeared at some point along the circumference and how distinct the annuli were in comparison with the other annuli in the section. "False" annuli were much fainter than real annuli and were usually discontinuous.

The fin-ray method was found to be a very successful method for determining the ages of the white sucker population in Lake 223. Necessary steps in the successful execution of this method included establishment of the shape and position of the first annulus by comparison of fin ages of very young fish with ages derived from length frequencies, and validation of the technique for older fish by comparisons of age at release and age at recapture of individually marked fish. Occurrences of false annuli, differences in shapes between pectoral and pelvic fins and differences in growth due to season of capture were characteristics also common to fin rays of white suckers from other populations in northwestern Ontario (Experimental Lakes Area staff, Freshwater Institute, Winnipeg, personal communication). When used in conjunction with a series of photographs of fin rays of suckers of all ages, the fin-ray method, as outlined in this report, is recommended as the preferred method for aging all lake populations of the white sucker.

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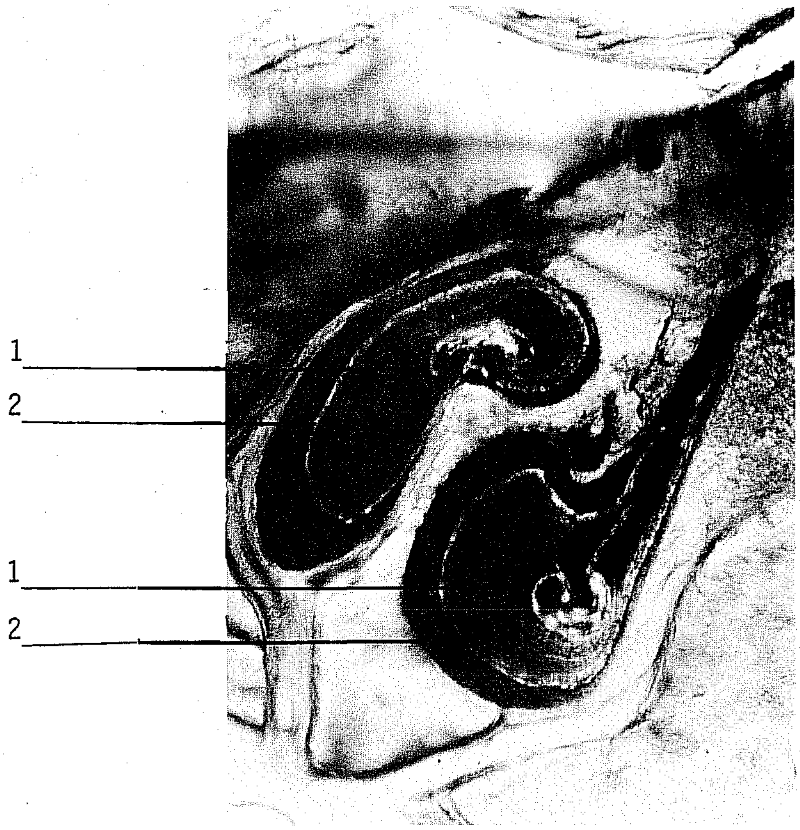

Fig. 1. Pectoral fin ray from fish aged 2+ on June 30, 1980, showing upper and lower halves. Note difference in shape of each half.

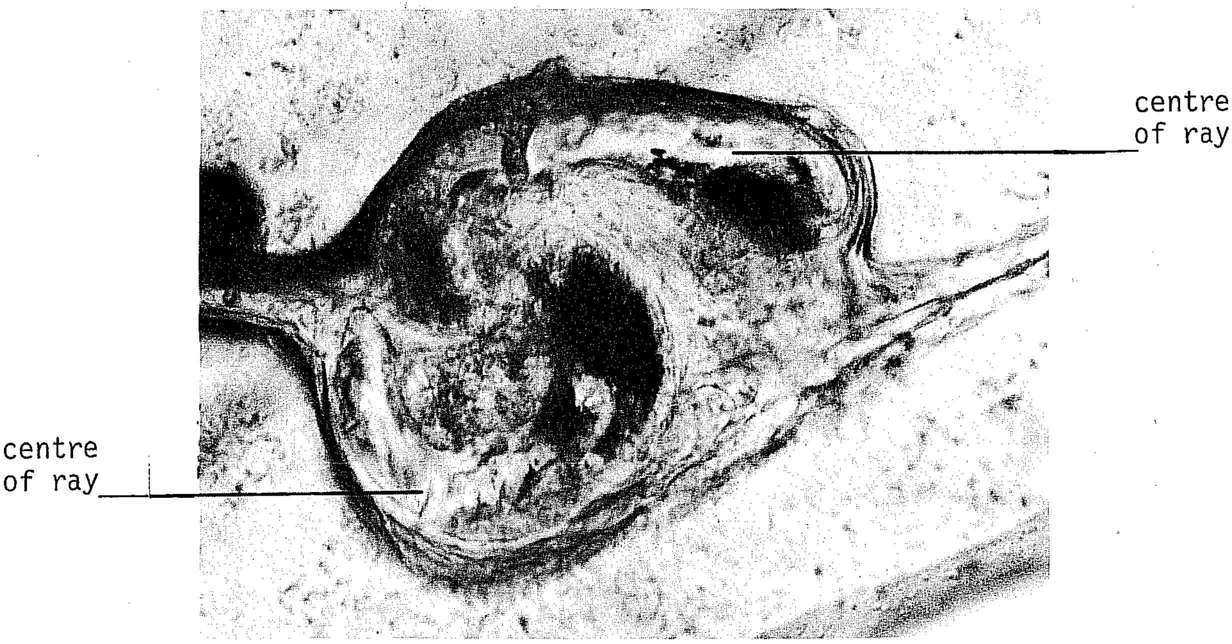

Fig. 2a. Pectoral fin ray from fish aged 0+ (fork length = 101 mm, wt ∿15 g, caught Oct. 4, 1978). Black material surrounding centre of ray is material laid down during the time from hatching in June until time of capture.

Fig. 2b. Pectoral fin ray from fish aged 1+ (fork length = 175 mm, wt = 65 g, caught Oct. 8, 1979). Black material from first annulus to edge of ray represents growth since spring.

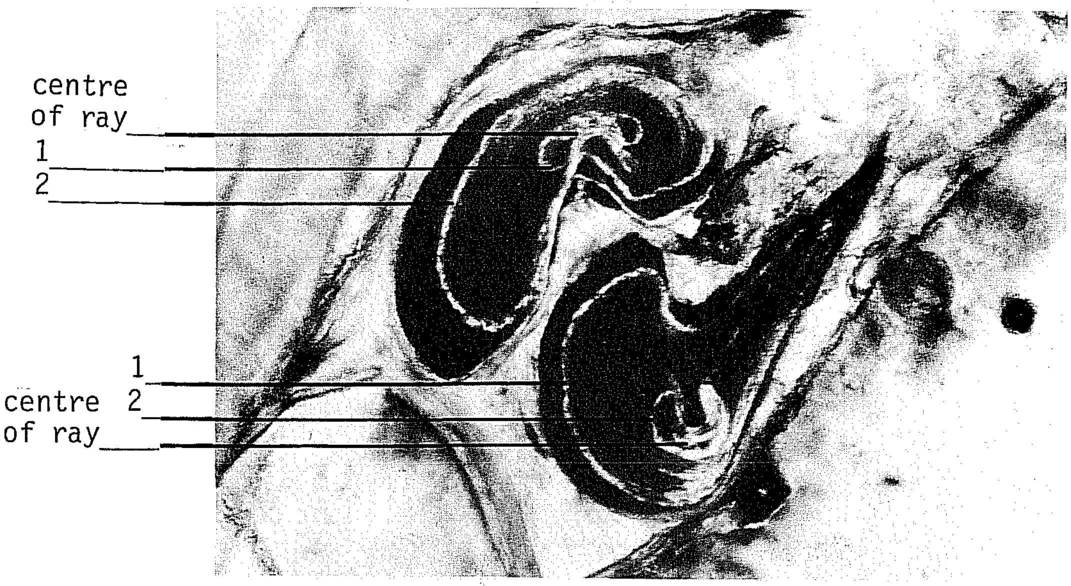

Fig. 2c. Pectoral fin ray from fish aged 2+ (fork length = 232 mm, weight = 150 g, caught July 30, 1980.

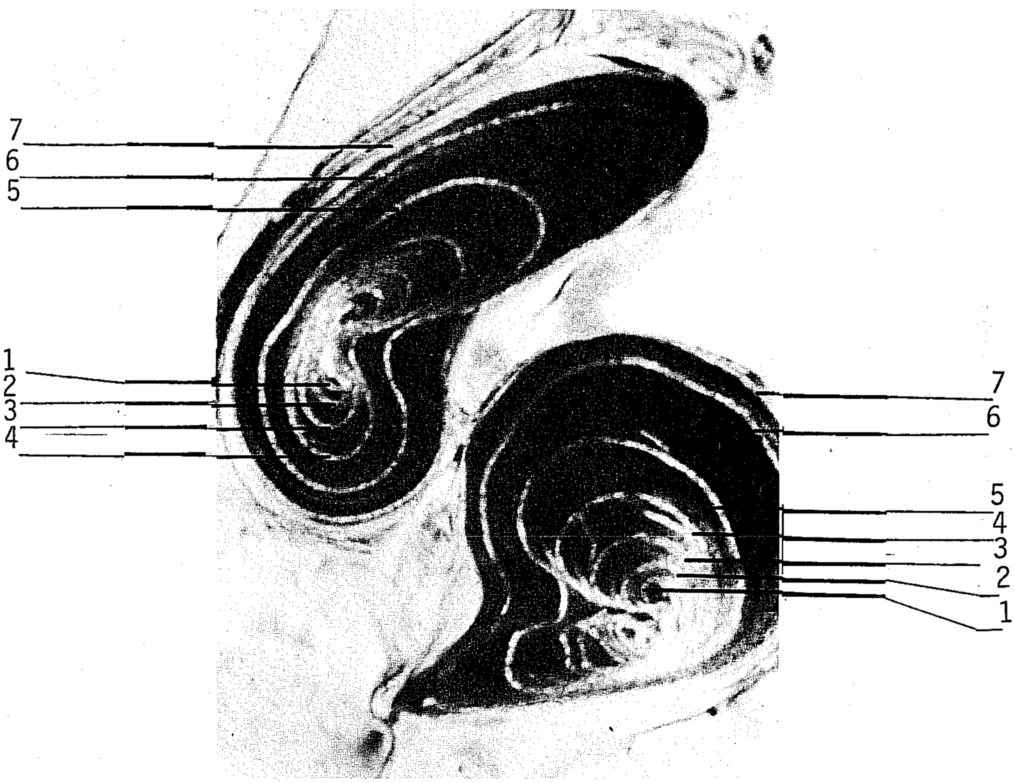

Fig. 3. Pectoral fin ray from fish aged 7 (fork length = 428 mm, weight = 1 124 g, caught May 22, 1980). Fish has not yet started to grow in 1980, so last annulus is at edge of ray.

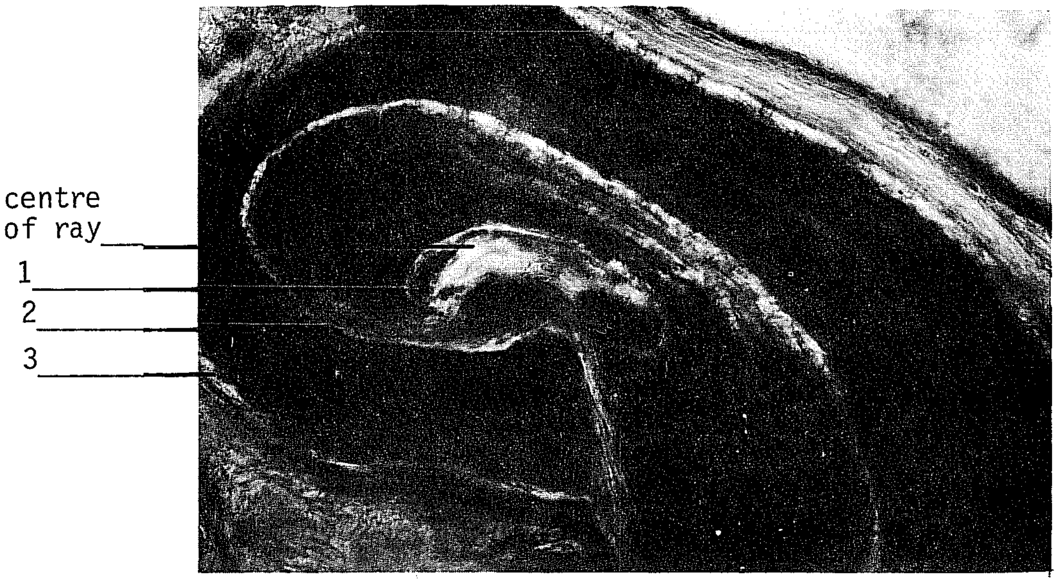

Fig. 4a. Pectoral fin ray from fish aged 3+ (fork length = 281 mm, weight = 297 g, caught June 4, 1980). New growth is just barely visible at edge of ray. Note crescent shape of annuli and separation of centre of ray and first annulus by dark material.

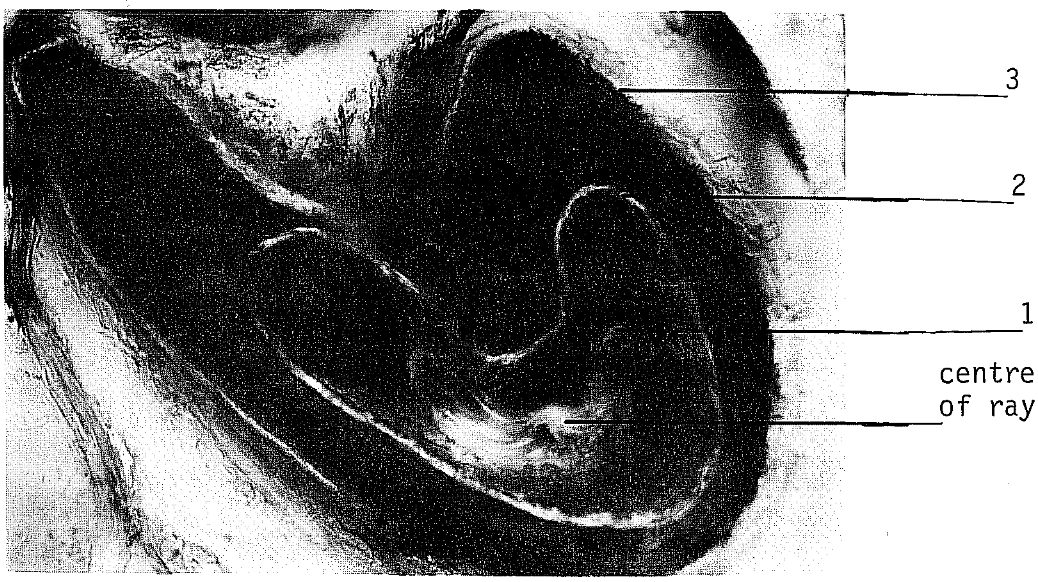

Fig. 4b. Pelvic fin ray from fish aged 3 (fork length = 317 mm, weight = 446 g, caught May 4, 1981). No new growth has occurred, so last annulus is at edge of ray. Note the semi-circular shape of annuli and the lack of separation of centre of ray and first annulus.

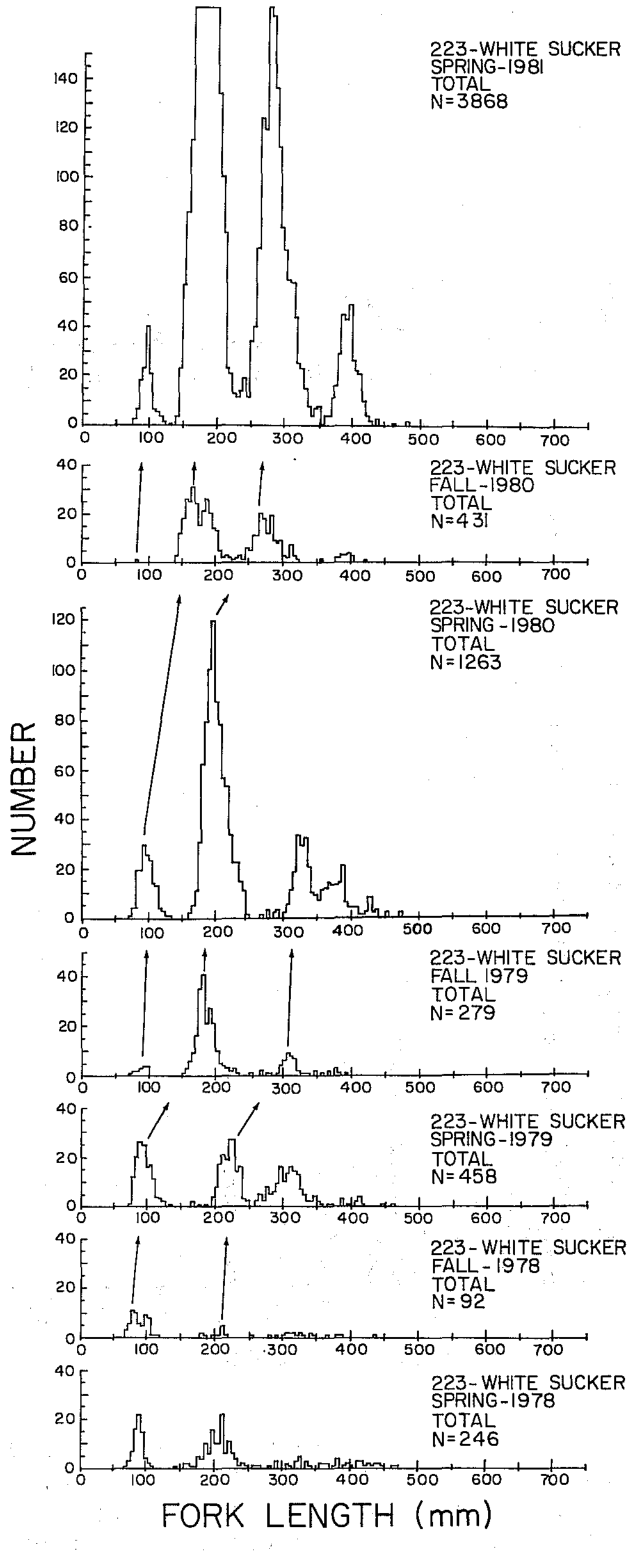

Fig. 5. Length-frequency histograms from spring 1978-1981. Lines connecting histograms suggest progression of age-classes through population.

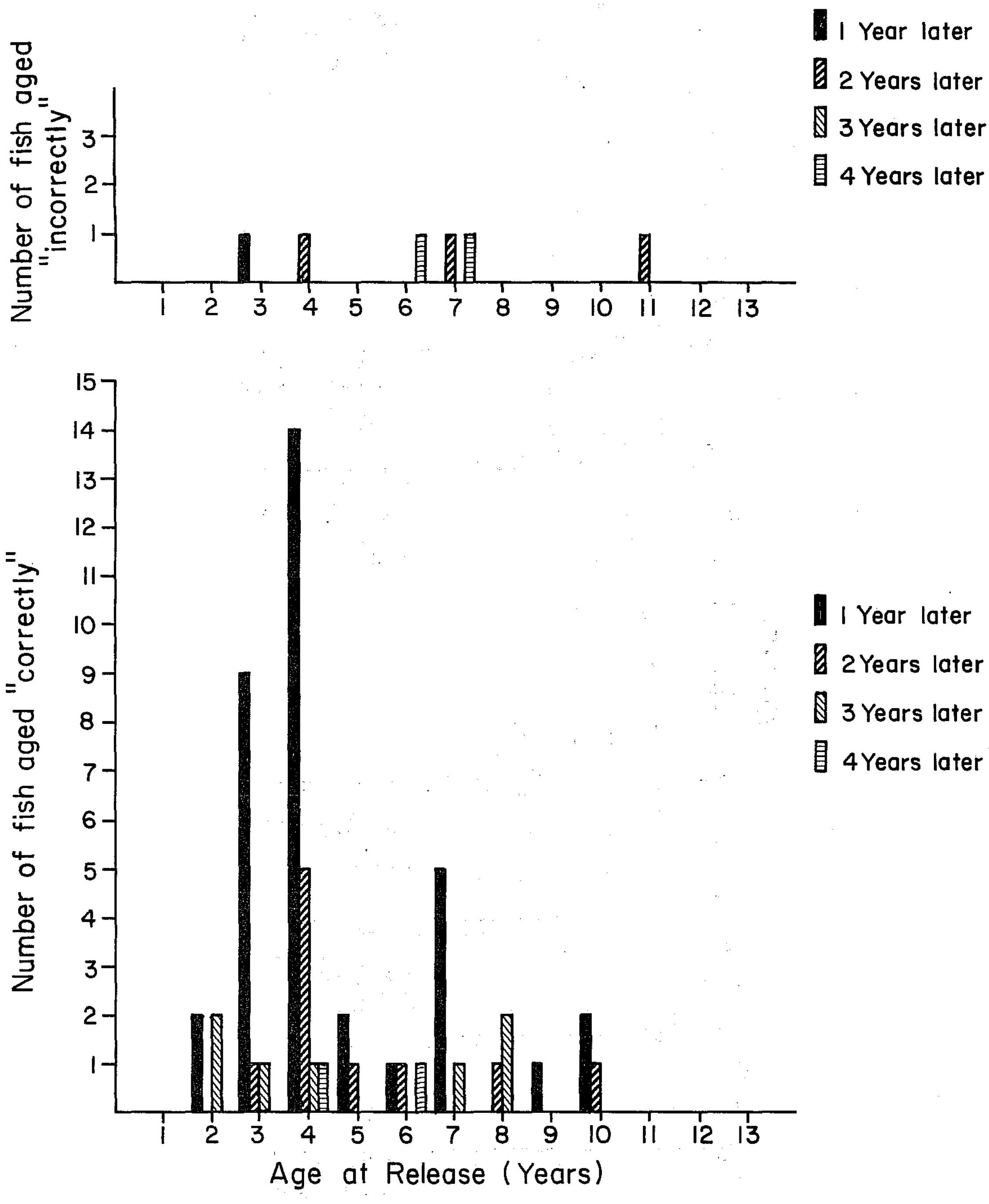

Fig. 6. Comparison of age at initial release and age at subsequent recapture of 61 individually marked fish. Bars indicate number of fish aged "correctly" at recapture intervals of 1-4 years after initial release. All fish aged "incorrectly" were aged one year greater than the "correct" age at recapture. A total of 55 of the 61 fish were aged "correctly".

Fig. 7a. Pectoral fin ray from fish tagged #3738, aged 5+ (fork length = 325 mm, weight = 490 g, caught June 7, 1977). Note new growth at edge of ray.

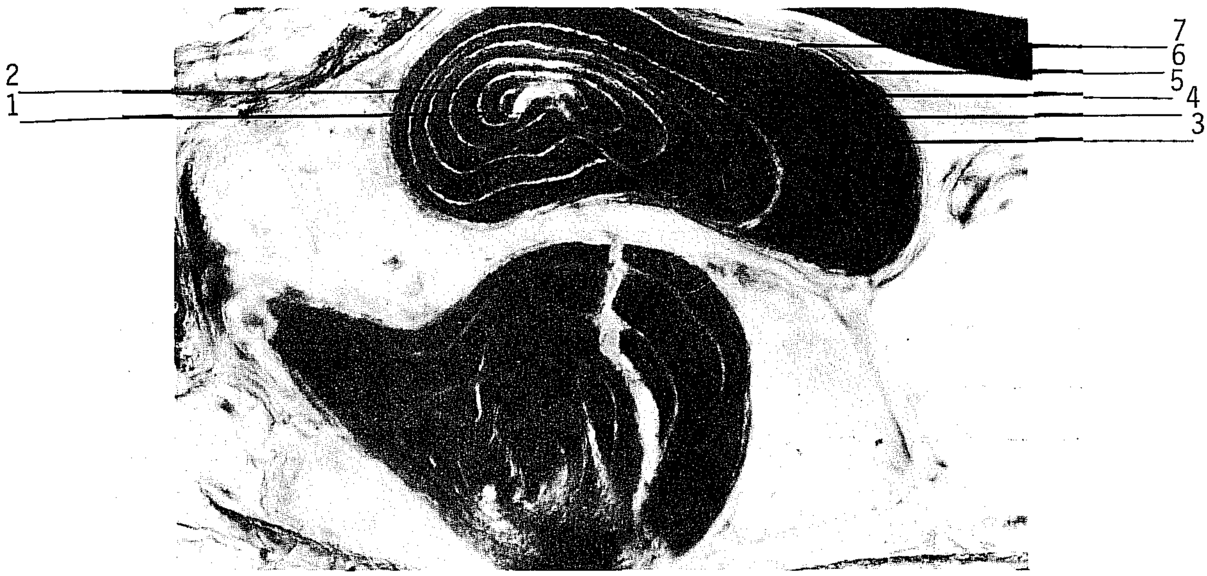

Fig. 7b. Pectoral fin ray from fish tagged #3738, aged 7+ (fork length = 412 g, weight = 1 109 m, caught June 1, 1979. Jagged line in lower half of ray is due to a crack in section. Annuli can be seen more clearly in upper half of ray.

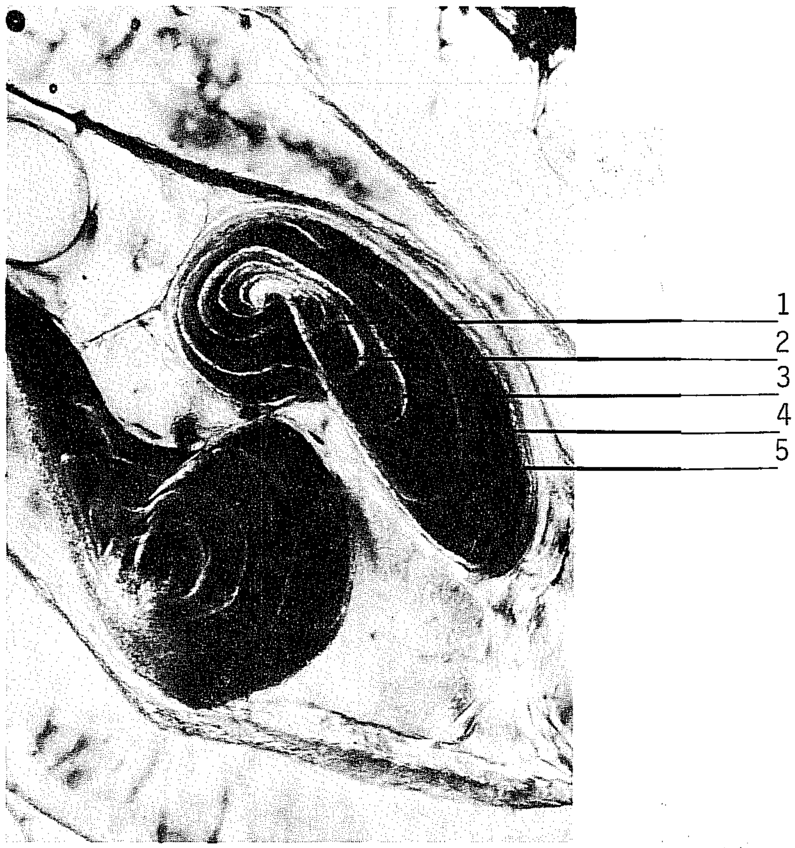

Fig. 8a. Pectoral fin ray from fish aged 5 (fork length = 313 mm, weight = 440 g, caught May 16, 1977). Fifth annulus is at edge of ray; no new growth is visible.

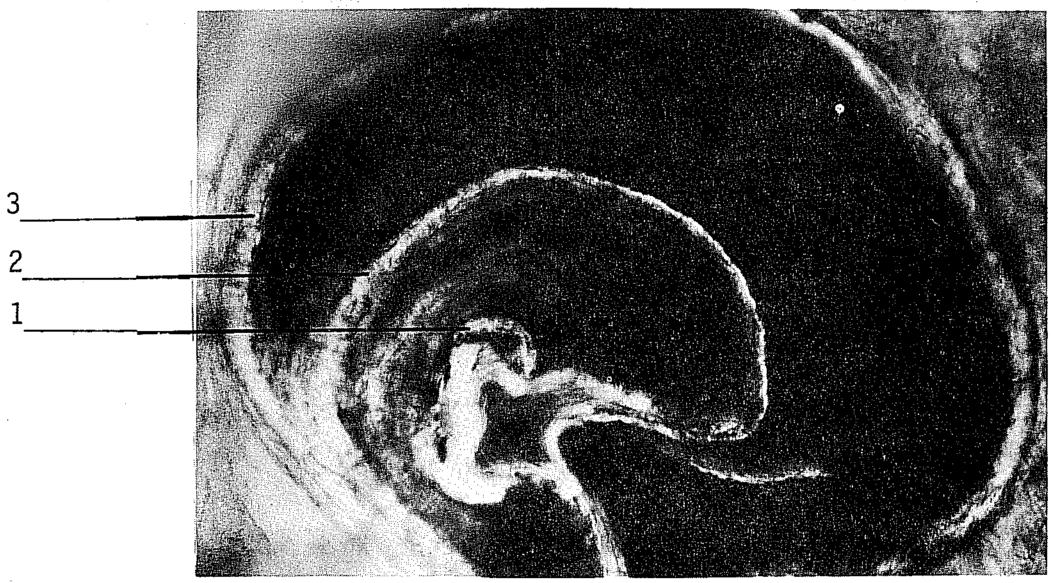

Fig. 8b. Pelvic fin ray from fish aged 3+ (fork length = 280 mm, weight = 276 g, caught June 9, 1981). New growth is visible at edge of ray beyond third annulus.

Fig. 9a. Pectoral fin ray from fish aged 2+ (fork length = 187 mm, weight = 86 g, caught June 9, 1981). New growth is quite obvious beyond the second annulus.

Fig. 9b. Pectoral fin ray from fish aged 10 (fork length = 330 mm, weight = 547 g, caught May 19, 1977). No new growth is visible beyond edge of ray. Some of the annuli are obscured on the lower half of the ray (left side of picture) and at edge of upper half of the ray (right side of picture) by extraneous matrix material.

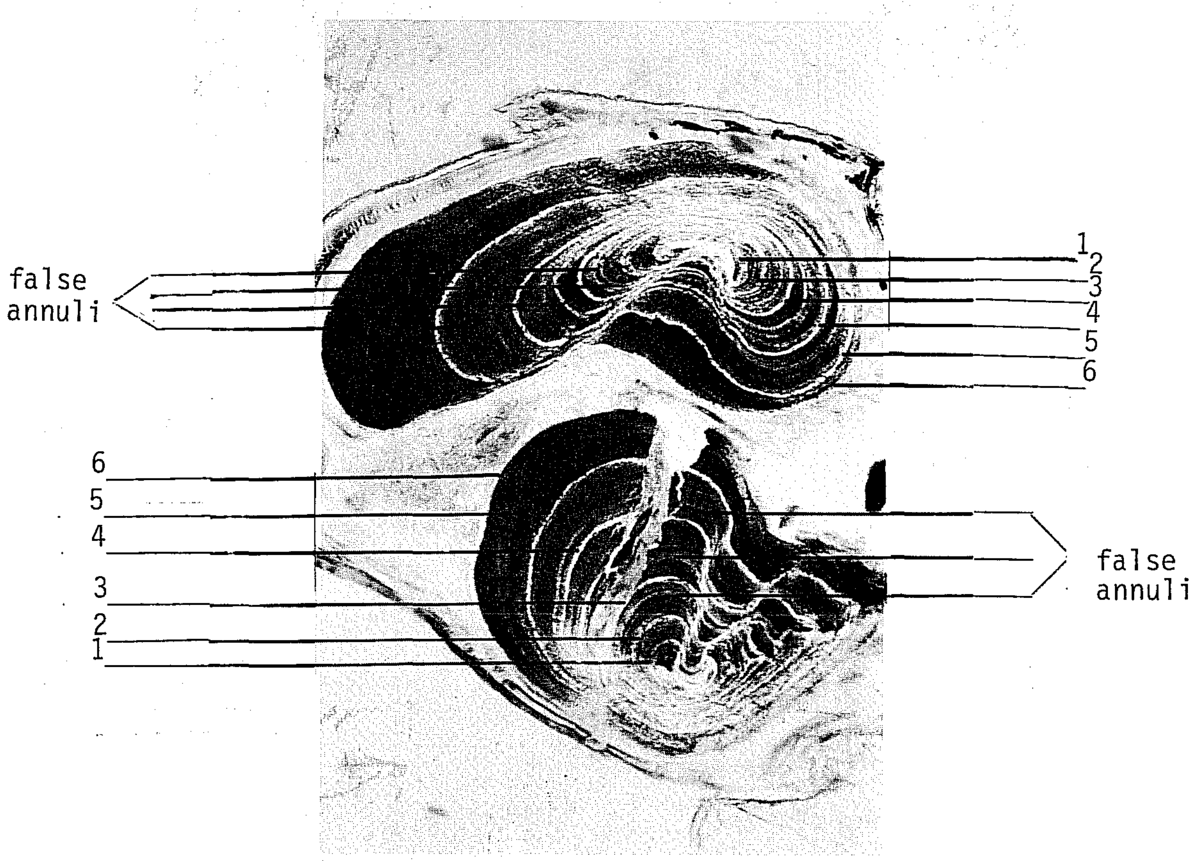

Fig. 10. Pectoral fin ray from fish aged 6 (fork length = 388 mm, weight = 971 g, caught May 28, 1979). Several "false" annuli are seen interspersed among the annuli. Part of the lower half of the ray is cracked and missing. "False" annuli are lighter in color than real annuli and often fade out at some point along their circumference.