

Morphometric analysis of fish

Objective: To learn the circuit of fish measuring and learn how to conduct morphometric analysis.

Materials and equipment: Set of fresh or fixed fish – 10–15 species. Tools: ruler, dimensional board, calipers, measuring tape, dissecting needles

Basic theoretical information

Complete morphometric analysis involves the study of a large number of plastic and meristic features, which are recorded in protocols of experiments

Plastic features are the features that may vary with age of fish or can be influenced by environmental conditions. For example, the length of the head, body, tail stalk, weight, the largest and the smallest height of the body and so on

Meristic features are species-specific steel signs which are characteristic for some populations and species. They are determined by calculation. For example, the number of scales in the lateral line, the number of gill rakers, rays in the fins, vertebrae, pyloric appendages, etc

As an example, the measurement scheme of carp fish (Cyprinidae) and pumpkinseed sunfish (Centrarchidae) fish is considered (Fig. 6, 7

:Plastic features

ab (L) – the absolute length of the fish. The distance from the top of the snout to the vertical lowered from the end of the longer blade of caudal fin straightened in the normal condition

ac – length by Smith. The distance from the front edge of the snout to the end of the middle caudal fin rays

ad(l) – industrial or ichthyological length. The distance from the top of the snout to the end of scaly cover, or to the base of middle caudal fin rays if fish has naked body

od (lcor) – trunk length. The distance from the most remote point of the gill cover to the .base of middle caudal fin rays

an (lr) – snout length. It is measured from the top of the snout to the front edge of the ;eye

;np(do) – eye diameter. The horizontal diameter of the eye is typically determined

po (po) – behindeye distance. The distance from the rear edge of the eye to the most ;remote point of the gill cover

ao (lc) – the length of the head. The distance from the top of the snout to the most remote ;point of the gill cover

lm – the height of the head near the nape. It is measured as a vertical length held by the rear ;edge of the eye

gh (H) – the maximum height of the body. The vertical distance from the highest point of the ;(back to the belly (the height of the fins is not accounted

ik (h) – the lowest height of the body or height of the tail stem. It is measured as well the ;distance between the nearest points of the dorsal and ventral edges of the tail stalk

aq (aD) – anterodorsal distance. Distance in a straight line from the top of the snout to the ;front edge of the dorsal fin bases

sd (pD) – postdorsal distance. It is measured from a vertical, down from the end of the dorsal ;(fin to conventional axle of body, by the end of scaly cover (or base of the caudal fin

y1d (pl) – length of the tail stem. The distance from the vertical edge of the rear bases of the anal fin to the conditional axis of the body by the end of scaly cover

qs (ID) – length of dorsal fin D. It is measured from the base of the first ray to the base of the ;last

tu (hD) – maximum height of dorsal fin D. The height of the biggest ray of this fin is ;measured

yy1 (IA) – length of basis of anal fin A. The distance from the base of the first to the base and ;the last ray

;ej(hD) – maximum height of anal fin A. The length of the biggest ray of this fin is measured

vx (IP) – length of pectoral fin P. Distance from the anterior point of basis of fin to the ;farthest point of its blade

zz1 (IV) – length of pelvic fin V. The distance from the anterior point of basis of ventral fin to  
;its farthest point

vz (PV) – pectoventral distance. It is measured the distance from the anterior point of bases  
;pectoral fins to the anterior point of bases of ventral fin

zy(VA) – ventroanal distance. It is measured the distance from the anterior point of basis of  
ventral fin to the front point of the anal fin basis

:Meristic features

l.l. – the number of scales in the lateral line. The number of scales permeated by lateral line  
;canals is counted

D – the number of rays in the dorsal fin. Branched and unbranched rays are counted  
separately. Content of dorsal fin formula, for example, might be: D III 9 (where, III – number  
;(of unbranched rays 9 – of branched

A – the number of rays in the anal fin. It is determined the same way as in the dorsal  
;fin

P – the number of rays in the pectoral fins. Accounting of rays is conducted with a  
;magnifying glass, as the lower unbranched rays of pectoral fins are very small

V – the number of rays in the ventral fin. Unbranched rays must be separated from each  
.other by dissecting needle

C – the number of rays in the caudal fin. The longest top unbranched ray, the number of  
.branched rays and the longest lower unbranched ray is pointed. For example, C I 12 I

The most important component of the morphometric analysis of fish is a statistical analysis  
of the results. The arithmetic mean (M) is determined by dividing the sum of the values of  
.option (xi) on the number (n):  $M = \sum x_i / n$

Besides the arithmetic mean value (M) the standard deviation ( $\sigma$ ), the average error of  
measurement ( $\pm m$ ) and the differences coefficient of Mayr (CD) is calculated. To compare  
the variability of different traits relative measure of variation or the coefficient of variation is  
calculated (CV):  $CV = \sigma / M \times 100\%$ . If the value of the received CV is less than 20%, the  
sample can be considered as representative in case of large values of CV more researches  
are conducted. The reality of differences of morphometric parameters of various fish  
samples are determined by Student t-test:  $t = (M_1 - M_2) / \sqrt{m_1 + m_2}$ , where M1, M2 are  
.the arithmetic mean and the m1, m2 are the average errors of two samples

Figure 6. Scheme of measurement of main features of carp fish (Cyprinidae) on the example of common roach (*Rutilus rutilus*). Shaded rows explain calculation of the scales in the lateral line, above and below it. Under the main picture it is shown the measuring of width of forehead

Figure 7. Scheme of measurements of the pumpkinseed sunfish: ab (L) – total body length; ad (l) – body length to the end of the scale cover; gh (H) – maximum body depth; ik (h) – minimum body depth; l caud – length of caudal peduncle; lv – length of ventral fin; aq (aD) – antedorsal distance; sd (pD) – postdorsal distance; qs (lD) – length of dorsal fin base; gu (hD) – height of dorsal fin at the level of the fourth unbranched ray; vz (PV) – distance between pectoral fin base and ventral fin base; vx (lP) – length of pectoral fin base; ao (lc) – length of head; np (do) – horizontal diameter of eye; po (po) – postorbital distance [8

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Progress of work

To examine carefully the external structure of the fish. 2. Place the fish on the right side of the measuring board. Head of fish should lie to the side of the mechanical measuring boards and snout should touch zero. 3. The work requires two performers: one holds dimensions other registers data. All linear dimensions are indicated in millimeters. Morphometric analysis of small fish, as well as its individual parts (diameter of the eye, body height, the length of the snout) should be conducted using calipers. During the measurements it is necessary to observe the correct position of the fish, do not squeeze it with hand or instrument. 4. Conduct a statistical analysis of the results. 5. To make a special table for each type of fish (Table 1

Table 1. Morphometric analysis of fish

Species of fish	Feature №	sample	Statistical figures №
			M±m σ CV 3 2 1

::Plastic features

(ab (L .1

ac .2

(ad(l .3

(od (lcor .4

.....

(zy(VA .22

Meristic features

.l.l .1

D .2

.....

C .6

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Questions for individual work

What parameters of the fish are necessary to be measured? 2. Which method is carried out in morphometric study? 3. How many fish should be investigated? Which part? 4. What is plastic and meristic features of fish? 5. How the statistical study of material should be conducted?