PHENETIC DIVERSITY AND TAXONOMY OF STONE LOACHES SUBGENUS DEUTEROPHYSA (COBITIDAE) *

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Subgenus *Deuterophysa* (=*Triplophysa*) only four species are included. Gray stone loach *N. dorsalis* (Kessler, 1872) is the most widely distributed among them. Areas of spotted stone loach *N. strauchi* (Kessler, 1874) and plane stone loach *N. labiatus* (Kessler, 1874) are overlap and almost inside the area of gray stone loach. The fourth species – Severtzov's stone loach *N. sewerzowi,* G.Nikolsky, 1937 has very small area in the lower riches of the Ily River. In spite of areas overlapping these species don't have joint habitat. This occurs to preference of each species to own type of water bodies. Gray stone loach prefers small swamps, ponds and streams between it. Plane stone loach usually likes big and/or small rivers with turbulence and rapid flowing. Spotted stone loach habitat in lakes, big and small ponds, river's backwaters. Severtzov's stone loach was found in small rivers and creeks. But such preference is not absolute. So we find gray stone loach in reservoir and in mountain river, spotted stone loach in small river in the semi-desert and in rivers with rapid flowing and so on. It is obvious, that stone loaches are adapted according to changes of water bodies with human activity and habitat in not usual biotopes.

For species identification usually several key-characters are used: ratio of height and thickness of caudal peduncle, placement of nostrils, relative size of fins. More over, Severtzov's stone loach distinct by small body size; it become mature at 25 *mm* and the maximum body size is only 45 *mm*. Also there are differences in many other morphological characteristics. But we don't detect any differences in counting (meristic) characteristics: number of gill rakers, number of soft-branched rays in fins, number of vertebra. It seems number of vertebra is higher in plane stone loach (Fig. 1). Some times different population within species differ from each other more than different species.

We try to compare measured characteristics of species using the factorial analyses, the method of principal components. In space of the First and the Second Principal Components gray stone loach is distinct well from spotted and plane stone loach. In the space of the First and the Third Principal Components plane stone loach is well distinct from spotted loach and from gray stone loach. In the space of the Second and the Third Principal Components each of this three widely distributed species has their own area with small overlapping others. This means, that each of the species – gray stone loach, spotted stone loach, plane stone loach has their own phenotypic outlook, well distinct from each other. The case with Severtzov's loach is more complicated. It always overlaps with all three other species! It means, that this species join many distinct characters of three other species in one phenotype. We have no doubts in

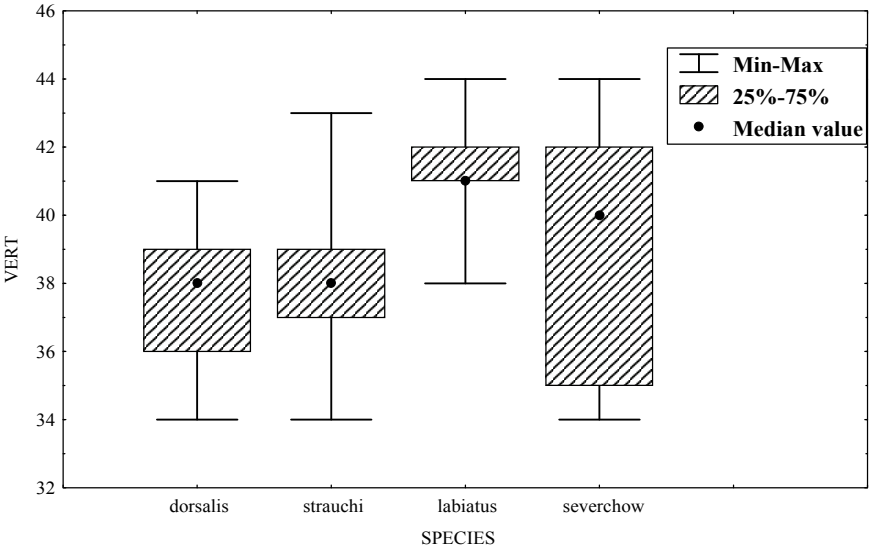

Fig. 1. Number of vertebra in different stone loach species

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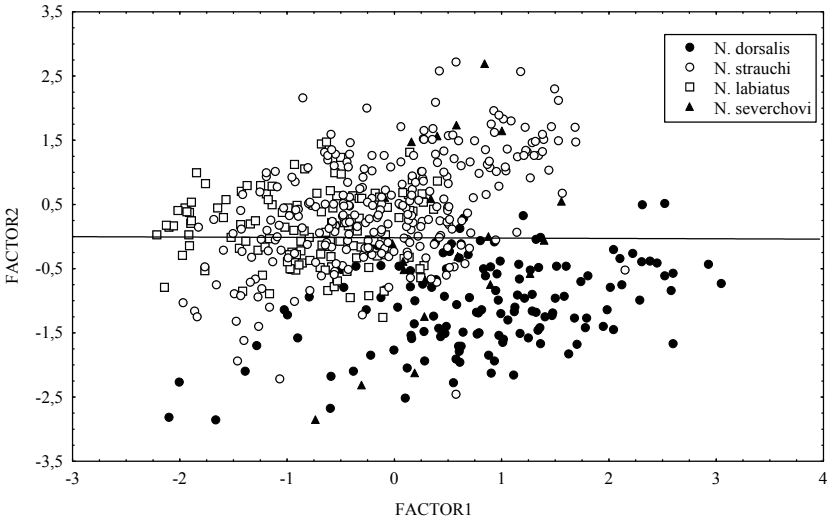

Fig. 2. Loach species (measurement characters and indices) in space of Principal Components

validity of Severtzov's loach as a species. It has several biological characteristics distinct it from other species (first of all small size and rapid maturation). More over, area of its distribution in space of Principal Components never included in the area of one of other species, but all the times overlap areas of all three species. This is true as for mutual habitat of species in one water body, and for distinct habitat in different water bodies. This can mean that phenotype of Severtzov's stone loach is more "primitive" and phenotypes of other stone loaches are more "specialized". It wonders, why the species with the most "primitive" phenotype has the smallest area. We think the area of Severtzov's stone loach is much wider, that it has been published. We have found this species in the rivers where it is not listed before. May be other investigators have taken Severtzov's loach as a youngers of other species and don't look on it closely and don't listed it in their publications.

Comparing of 138 specimens of gray stone loach from 8 water bodies shows some differences between populations from different rivers. Population from River Naryn differs by the smallest pectroventral and ventroanal spaces. Population from River Bolshaya Almatinka differs by the shortest fins (*hD, lV, lP, lCs, lCi, lCm*), smallest length of the head (*lc*), small ante-dorsal space (*aD*) and the smallest height of caudal peduncle (*h*). As a result this population is well distinct from all other in space of the First and the Second Principal Components. According to peculiarities of these characteristics population from the River Bolshaya Almatinka can be described as a special subspecies – *N. dorsalis valerii.* But we prefer to obtain more data and fulfill repeated measurements in order to be sure, that these peculiarities don't appear occasionally and are stable during generations. More over, the spotted stone loach from the same location has shortened pelvic and pectoral fins.

129 specimens of plane stone loach from 7 rivers were compared. Population from the River Kurty has smaller head and accordingly smaller ante-dorsal space than usual. Fishes from this river also have smaller eye's diameter. Fishes from the River Chue also have smaller eye than it is usual and in addition they have the smallest height of caudal peduncle. Population from the River Akkeshke has the smallest thickness of the body among other populations. In the space of the First the Second Principal Components no one population distinct from others, but each population has own area overlapping many others. It means that all populations of plane stone loach have very similar

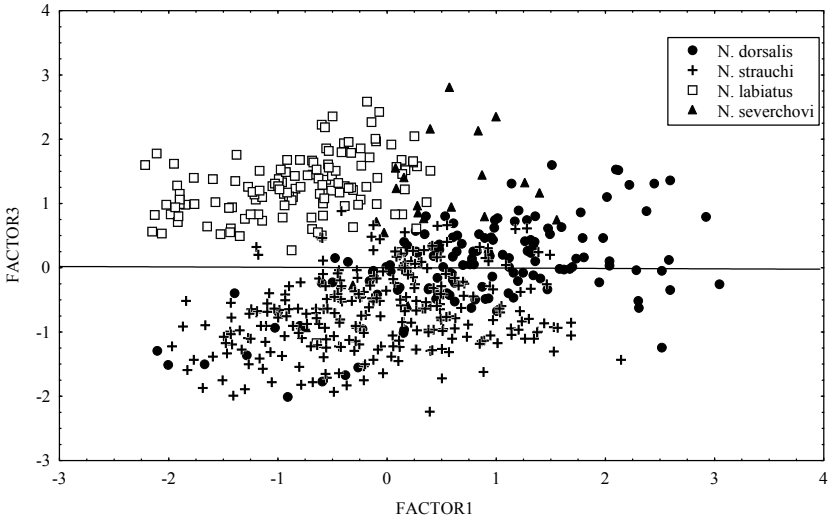

Fig. 3. Loach species (measurement characters) in space of Principal Components

phenotypes and no taxonomic subdivision could be divided within the species of plane stone loach.

Comparison of 12 populations of spotted stone loach (271 specimens) shows a big diversity of this species. So population from the River Bolshaya Almatinka has the shortest pectoral and pelvic fins, and the population from the River Lavar on the contrary has the longest pelvic fins. Fishes from the River Bugaz have the highest caudal peduncle among all.

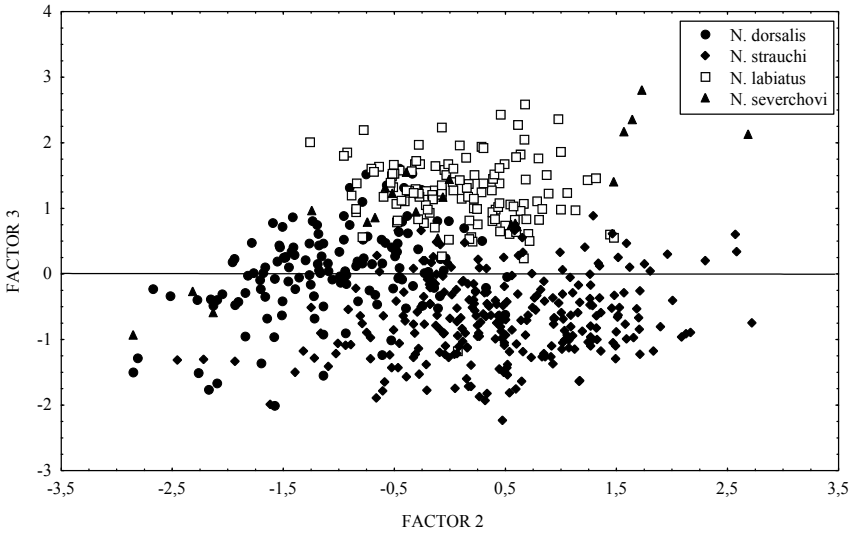

Fig. 4. Loach species (measurement characters) in space of Principal Components

Population from the River Naryn is very special. These fishes have the longest barbells, the biggest eye's diameter, and short pelvic fins. More over, there are small spines in the skin. This is not usual for spotted loach and for the whole subgenera *Deuterophysa*. But small scales and spines were found in other loaches species – *N. barbatulus, N. amudarjensis, N. malapterurus, N. cristus.* We want to point out that fishes from the River Bugaz (Irtysh basin) have been described as a valid subspecies *N. strauchi zaisanicus* Meinschikov, 1937. But we don't find many differences of these fishes from all others. It seems this subspecies is an artificial one, described only on the base of distribution in the Irtysh basin. Penetration of stone loaches to Irtysh basin has been found by us for gray stone loach too (the River Shagan). We also don't find any significant differences of this population from other population of gray stone loach. So, it seems that habitat in the Irtysh basin is not enough for describing a special subspecies within spotted loach. Unfortunately we don't have a chance to analyze spotted loaches from big lakes, which have been described as another subspecies *N. strauchi ruzskyi*, Nekraschewitsch, 1948. Nowadays, after introduction of sander (*Stizostedion lucioperca*) and other fish species, stone loaches become very rare in the lake Alakol and almost disappear in the Balkhash Lake. We can suppose, that inhabit in a big lakes can influence to their phenotypes, but it is difficult to say anything now. We have only six big specimens from the Lake Alakol and they have no differences with fishes from the rivers. So, it seems to us, that two subspecies described previously don't have enough peculiarities to be a valid subspecies. On the other hand, population from the River Naryn is very special and can be a new subspecies or even a new species. Repeated investigations of loaches from the River Naryn confirm stability of founded peculiarities in generation. In the space of the First and the Second Principal Components only fishes from the River Naryn distinct well from all others. So, a new subspecies *N. strauchi jimbeyi* can be described.

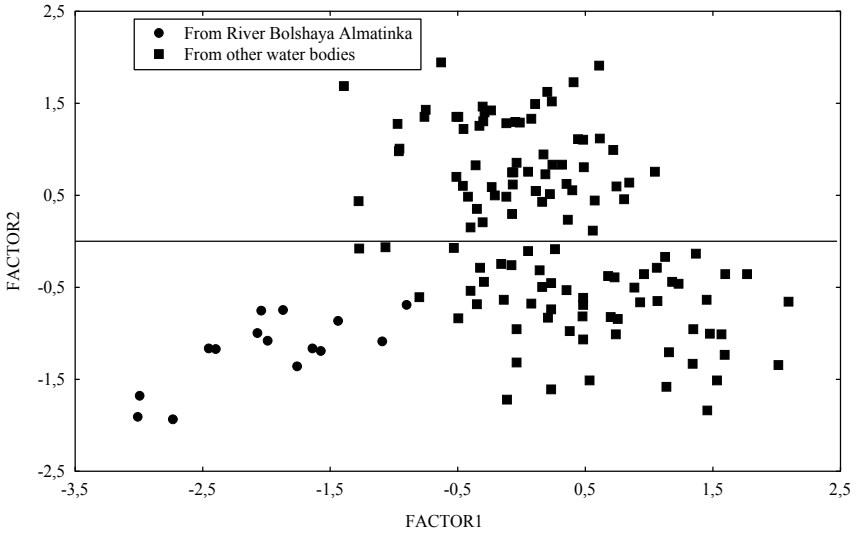

Fig. 5. N. dorsalis (measurement characters) in space of Principal Components

A few words about some morphological abnormalities founded in stone loaches. First of all it is "hump-nose" specimens.

Table. Distribution of color variations within four species of stone loach in different water bodies (%)

		Shagan 1	Uzun-bulak 2	Shagan reserv. 3	Akkeshke 4	Byzhe 5	Lavar 6	Bolshaya Almatinka 7	Malaya Almatinka 8	Chue 9	Kurty 10	Tentek 11	Bakanas 12	Baskan 13	Bugaz 14	Ily 15	Naryn 16	Ayaguz 17
colorless	dorsalis	14					17											
	strauchi							25		12		20	17	50				
	labiatus							50	13	100	30		12					
	sewerzowi				100													
small spots	dorsalis	4															100	
	strauchi							25		12			14					
	labiatus				100				80		15		10					
	sewerzowi							100								92		
mix spots	dorsalis				100		75											
	strauchi							35		7			17		100			4
	labiatus																	
	sewerzowi																	
big spots	dorsalis	64		88		100	8											
	strauchi					100	100	15	100	69	100	80	40	50			37	95
	labiatus							50			15		13					46
	sewerzowi															8		
tigris	dorsalis																	
	strauchi												12					1
	labiatus										30							
	sewerzowi																	
marbel	dorsalis	16		6				100										
	strauchi																	
	labiatus								7		10							27
	sewerzowi																	
nigra	dorsalis	2	100	6														
	strauchi																63	
	labiatus												65					27
	sewerzowi																	

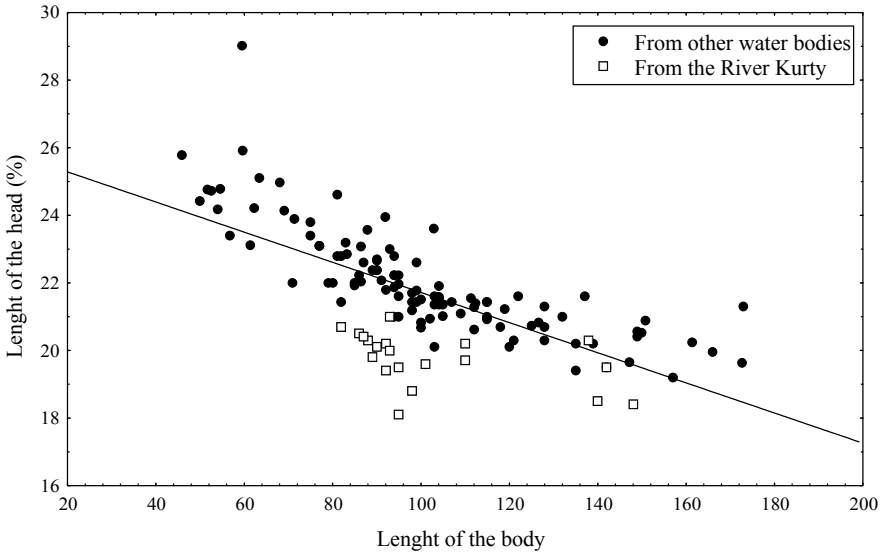

Fig. 6. Ration of the head length in plane stone loach

No other differences were found except shape of the head. "Hump-nose" specimens were found in different water bodies among different species. For example, spotted stone loach from rivers Malaya Almatinka, Ayaguz, Chue; gray stone loach from rivers Shagan and Uzunbulak; plane stone loach from the River Kurty, thibet loach (*N. stoliczkai*) from the River Charyn. Usually "harm-nose" specimens are rare (single specimens). and only once we found a lot – 26 specimens from the River Malaya Almatinka. Once a specimen with very thin barbells was found. These abnormalities are described by Valery Mitrofanov in his monograph "Fishes of Kazakhstan" volume 4. In the river Uzunbulak we found a lot of loaches with very short barbells. Sometimes barbells are reducing to size of small knobs.

During analyses several variation of coloration were detected. We describe it as follow:

I. **Colorless**. The main color is pale gray. Usually it is darker on the dorsal side. No spots are on the dorsal side. Sometimes several spots or a strip can appear along lateral line. In this case spots and/or strip are not dark, small, pausteries. There are only a few ones and distance between spots bigger than their diameter. Usually spots almost absent. No small spots on the fins.

II. **Small spots**. The main color is yellowish gray, darker on the dorsal side. There are a lot of small spots on the lateral and dorsal side without any grouping. Distance between spots is equal to their diameter and is about the size of the eye. No stripes along the lateral line or on the dorsal side. The head is covered by very small dark spots – points.

III. **Mix spots**. The main color is yellowish. On the dorsal and lateral sides there are very dark spots. Spots are not big, distance between them is equal to their diameter. In the caudal and central part of the body diameter of spots is about the size of eye's diameter or a little bigger. On the head part of the body spots become smaller and become only a dark points on the head. On the fins very small spots grouping into the transversal stripes.

IV. **Big spots**. The main color is grayish yellow, the same as on the stomach side. On the dorsal and lateral sides there are rounded brownish black spots. Big spots on the dorsal and caudal fins continue the picture on the body. On the pectoral, and sometimes on the pelvic and anal fins too there are smaller sports without grouping in the stripes. Size of the spots covered the body is usually much bigger than eye's diameter. Distance between spots is about the size of the spots. The head is covered by smaller spots.

V. **Tigris**. The main color is yellowish gray. Spots are dark brown or black, very contrast. Size of spots is three-five times bigger than size of the eye. Distance between spots is bigger than their diameter. On the dorsal and sometimes on the lateral sides spots are grouping in the transversal stripes. At the beginning and at the end of the base of dorsal fin there are black spots. On the dorsal, caudal and pectoral fins and on the head there are big spots as on the body.

VI. **Marble**. The main color is gray. A lot of big and small spots cover dorsal and lateral sides. Their color vary from dark gray to brown and almost black on the same fish. Distance between spots is small, sometimes it is only a thin line and single spot is not distinct. Combination of big and small spots, pale areas and light lines creates on the lateral side "marble texture". On the dorsal, caudal and pectoral

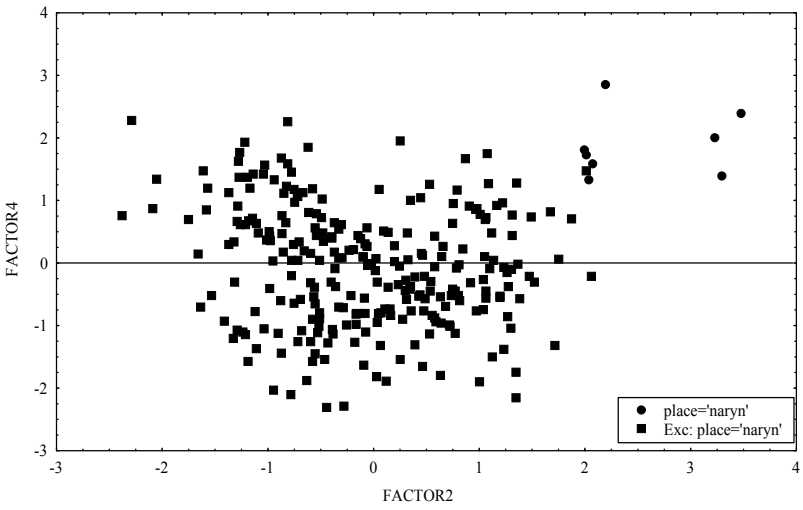

Fig. 7. Populations of *N. strauchi* in space of Principal Components

fins there are big dark spots. At the beginning of dorsal fin is a black spot. The head is dark and single spots are not distinct.

VII **Nigra**. On the dorsal, anal, pectoral, and pelvic fins there are small black spots grouping in the stripes. On the caudal fin there are big rounded spots. The body is covered by big dark spots. Distance between them is very small and spots very often join each other creating a view of uniform black coloration. The ventral side is gray without yellow color.

Similar color variation can be found in figures of L. Berg (1949) and S. Herzenstein (1888). The last author described some of such variation as a single species (*N. kungessanus, N. microphtalmus, N. intermedius,* etc.). L. Berg join all variation in three species. *N. dorsalis, N. strauchi,* and *N. labiatus.* But for the Issyk-Kul lake L. Berg described *N. strauchi ulacholicus* var. *pedaschenkoi* with plane coloration (colorless in our classification) and for River Charyn *N. labiatus* var. *herzensteini* with coloration as *N. strauchi* (big spots in our classification). The maximum diversity of color variations were detected for gray stone loach from the River Shagan (5 variations), for plane stone loach from the River Bakanas (4 variations) and River Kurty (5 variations), for spotted stone loach from the River Bakanas (5 variations). Coloration doesn't depend from sex and age of fishes. Distribution and frequency of color variation in different population is shown in the table. For spotted loach 6 variations are founded ("marble" variation isn't found). For gray stone loach 6 color variations are found ("tigris" variation isn't found). For plane stone loach 6 color variations are found ("mix spots" isn't found). For Severtzov's stone loach only 3 color variations are found. For each species there is a predominant variation. It is "big spots" for spotted stone loach, "colorless" for plane stone loach, "mix spots" and "big spots" for gray stone loach and "small spots" for Severtzov's stone loach. Some of those color variations are predominant for other loach species. For example "tigris" is the predominant for *N. kessleri* and *N. tigris*. We found significant differences between color variations within each species from the same location. But at the moment we are not sure these differences have any taxonomic sense. That is a question for future.

SUMMARY

Митрофанов И. В. **Таксономия гольцов подрода *Deuterophysa* (Balitoridae)**

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Были исследованы несколько сотен особей четырех видов гольцов подрода *Deuterophysa* . Обнаружено семь вариаций окраски. Colorless - бледный серый цвет, почти без пятен. Small spots - мелкие пятна покрывают спину и бока, диаметр пятен примерно равен диаметру глаза, расстояние между пятнами намного большее, чем их диаметр. Big spots - спина и бока покрыты большими пятнами, диаметр пятен намного больше, чем диаметр глаза, расстояние между пятнами равно их диаметру. Mixed spots - спина и бока покрыты большими пятнами, но в передней части тела пятна много меньше, и их диаметр равен диаметру глаза. Tigris - поперечные полосы покрывают спину, особенно в задней части и продолжаются на бока. Между полосами на боках есть небольшое количество пятен средней величины. Marble - много пятен, полос и линий густо покрывают спину и бока, создавая мраморный рисунок. Расстояние между пятнами намного меньшее чем диаметр глаза или диаметр пятен. Nigra - большие темные пятна фактически объединяются друг с другом и создают почти черную окраску спины и боков. Все вариации окраски обнаружены у трех широко распространенных видов (*N. strauchi, N. dorsalis, N. labiatus*). До пяти различных вариаций окраски были найдены в одной реке. Имеются значимые различия между рыбами с различным типом окраски из одной реки по ряду морфологических признаков.