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FARG‘ONA VODIYSIDA *TRIPLOPHYSA DARYOAE* VA BOSHQA *TRIPLOPHYSA* URUG‘I VAKILLARINING MORFOTAKSONOMIK TAHLILI (TELEOSTEI: NEMACHEILIDAE)

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Maqola Farg‘ona vodiysining So‘x daryosi endemigi Triplophysa daryoae ning vodiyda uchrovchi Triplophysa urug‘ining boshqa vakillari – T. elegans, T. ferganaensis va invaziv T. strauchii bilan morfotaksonomik tahliliga bag‘ishlangan. Turlarni o‘zaro solishtirish uchun ularning 32 ta morfometrik belgisi bo‘yicha Styudent t-testi (t-taqsimot) va Asosiy komponentlar tahlili (PCA) qo‘llanildi. Tahlil natijalari T. daryoae ning T. ferganaensis dan 16 ta (50%), T. elegans dan 14 ta (44%) va, ayniqsa, T. strauchii dan 24 ta (75%) belgi bo‘yicha ishonchli (P<0,01) farq qilishini ko‘rsatdi.

Kalit so‘zlar: *yalangbaliqlar, Farg‘ona vodiysi, Triplophysa, Triplophysa daryoae, morfotaksonomiya, morfometrik tahlil, Asosiy komponentlar tahlili (PCA).*

Статья посвящена морфотаксономическому анализу эндемика реки Сох (Ферганская долина) Triplophysa daryoae в сравнении с T. elegans, T. ferganaensis и инвазивным T. strauchii. На основе 32 морфометрических признаков применены t-критерий Стьюдента и метод главных компонент (PCA). Выявлены достоверные различия (P<0,01), наиболее выраженные по сравнению с T. strauchii. По результатам PCA T. daryoae формирует обособленный кластер, что подтверждает его самостоятельный таксономический статус.

Ключевые слова: *вьюны, Ферганская долина, Triplophysa, Triplophysa daryoae, морфотаксономия, морфометрический анализ, метод главных компонент (PCA)*.

KIRISH

Daryo yalangbaliqlari (Nemacheilidae) karpsimonlar turkumida (Cypriniformes) karplar (Cyprinidae) oilasidan keyingi eng yirik oila bo‘lib, bugungi kunda 900 dan ortiq turni o‘z ichiga oladi [1]. Oila vakillari Yevrosiyo bo‘ylab keng tarqalgan bo‘lib, eng katta tur xilmaxilligi Hind yarim oroli, Hindixitoy va Xitoy hududlariga to‘g‘ri keladi [2]. Oilaning faqatgina bir turi (*Afronemacheilus kaffa* Prokofiev & Golubtsov, 2013) Afrika qit’asidan – Efiopiyaning Turkana havzasidan qayd etilgan.

Markaziy Osiyo suv havzalarida Nemacheilidae oilasining shu vaqtgacha 35 taksonga oid vakili kashf etilgan, ulardan 25 tasi hozirda valid tur hisoblanadi [3]. O‘zbekistonning ichki suv havzalarida uchrovchi daryo yalangbaliqlarining aniq tur tarkibi bo‘yicha esa turli manbalarda turlicha ma’lumotlar keltirilgan. Jumladan, B.Sheraliyev, Y.Qayumova [4] O‘zbekiston yalangbaliqlari (Cobitoidei) taksonomik reviziyasida Nemacheilidae oilasining 13 turini qayd etgan. Shunga qaramay, keyingi tadqiqotlar avvalgi ro‘yxatda bo‘lmagan boshqa turlar (masalan, *Triplophysa kafirnigani*) ham o‘lkamiz suv havzalarida uchrashini ko‘rsatdi [5], ayni vaqtda *Triplophysa stolickai* (Steindachner 1866) kabi ba’zi turlarning O‘zbekistonda uchrashi esa shubha ostiga olinmoqda [6].

Farg‘ona vodiysida *Triplophysa* urug‘ining 5 turi – *Triplophysa daryoae* Sheraliev, Kayumova & Peng, 2022 (So‘x daryosining yuqori va o‘rta oqimida), *Triplophysa dorsalis* (Kessler, 1872) (Sirdaryoning asosiy o‘zanida), *Triplophysa elegans* (Kessler, 1872) (Ohangaron daryosi hamda Qoradaryoning yuqori oqimida), *Triplophysa ferganaensis* Sheraliev & Peng, 2021 (Shohimardonsoy, Isfayramsoy va Podshoota daryolarida) va *Triplophysa strauchii* (Kessler, 1874) (vodiyning tekislik qismidagi barcha suv havzalarida) qayd etilgan [6, 7]. Shulardan *Triplophysa dorsalis* ning Farg‘ona vodiysi suv havzalarida mavjudligi bahsli bo‘lib qolmoqda, zero, so‘nggi yillardagi tadqiqotlarda mazkur tur qayd etilmayapti [8].

Triplophysa daryoae So‘x daryosidan 2022-yilda tavsiflangan bo‘lib, uning tur maqomi integrativ usulda (morfologik va molekulyar) o‘rnatilgan [6]. Yaqinda

Artaev va hammualliflari [8] Tojikiston hududidagi buloqdan *Triplophysa* cf. *daryoae* ni qayd etdi. *Triplophysa* urug‘i vakillarida tur ichida va turlararo morfologik hamda morfometrik farqlarni o‘rganish ularning taksonomik maqomini aniqlash va tur ichidagi politipiyani baholash uchun muhim ahamiyatga ega [9, 10].

Shu bois mazkur maqolada So‘x daryosidan tavsiflangan *T. daryoae* ni Farg‘ona vodiysida uchrovchi boshqa *Triplophysa* urug‘i vakillari bilan morfologik hamda morfometrik jihatdan solishtirish va ular orasidagi farqlanishni asoslash maqsad qilib olingan.

MATERIAL VA USULLAR

Mazkur tadqiqot 2023–2024-yillar davomida Farg‘ona vodiysining qator daryolari – So‘x, Qoradaryo, Shohimardonsoy, Ohangaron daryolaridan tutilgan *Tripophysa* urug‘ining 4 turi – *T. daryoae*, *T. elegans*, *T. ferganaensis* va *T. strauchii* namunalariga asoslandi. Farg‘ona vodiysidan *T. dorsalis* qayd etilmaganini sababli, uning ko‘rsatkichlari J.Li va hammualliflari [11] ma’lumotlari asosida olindi. Baliq namunalari tutilgach, morfologik tadqiqotlar uchun dastlab 4% li formalin eritmasida fiksatsiya qilindi va baliqlarning hajmiga bog‘liq ravishda 3–7 kundan so‘ng doimiy saqlash uchun 70% li etil spirtiga ko‘chirib o‘tkazildi.

Baliq namunalaridan morfometrik o‘lcham olishda M.Kottelat va J.Freyhof [12] tomonidan tavsiya qilingan metodikadan foydalanildi. Meristik (sanaladigan) ko‘rsatkichlar – suzgich qanotlardagi shoxlangan va shoxlanmagan nurlar, bosh va yon chiziqdagi poralar hamda birinchi jabra ravog‘idagi qilchalar soni sanaldi. Suzgich qanotlarining shoxlangan nurlarini sanashda so‘nggi shoxlangan nur ikkiga ajralgan bo‘lsa, u bitta deb qabul qilindi, dum suzgichining shoxlangan nurlari esa R.Fricke [13] uslubiga asoslangan holda sanaldi. Suzgich qanotlarining shoxlangan nurlari va yon chiziqdagi tangachalarni sanashda stereomikroskop (SZM7045-B9L, Yuyao Dagong, Xitoy) qo‘llanildi.

Barcha statistik hisoblashlar “MS Excel” 2019 dasturida amalga oshirildi. Variatsiya va korrelyatsiya koeffitsiyentlariga oid statistik ma’lumotlar G.F.Lakin [14] qo‘llanmasida keltirilgan usullar bo‘yicha tahlil etildi. Styudent mezoni (t-test) bo‘yicha farqlarni belgilashda 1% lik ahamiyat darajasi ($P<0,01$) asos qilib olindi. Turlararo morfometrik farqlanishni test qilish uchun namunalardan o‘lchangan 32 ta morfometrik ko‘rsatkich asosida Asosiy komponentlar tahlili (Principal Component Analysis [PCA]) amalga oshirildi. PCA tahlili “OriginPro 10.1” (OriginLab Corporation; Northampton, MA, AQSh) dasturida hisoblandi.

NATIJALAR VA MUHOKAMA

Triplophysa daryoae So‘x daryosining hozircha qayd etilgan yagona endemik turi bo‘lib, uning to‘liq qayd etilgan morfometrik ko‘rsatkichlari 1-jadvalda keltirilgan.

1-jadval

***Triplophysa daryoae* (n=18) ning morfometrik ko‘rsatkichlari**

Morfometrik ko‘rsatkichlar	min	max	mean	SD	V
Umumiy uzunlik (mm)	59,7	112,4	91,0	13,2	
Standart uzunlik (SL) (mm)	49,0	94,0	75,3	11,0	
SL ga nisbatan foizda					
Bosh uzunligi (HL)	20,1	23,0	21,7	0,7	3,1
Tana balandligi (maksimum)	12,9	16,8	14,9	1,0	6,7
Tana eni (maksimum)	11,6	15,6	13,7	1,0	7,6
Predorsal uzunlik	51,3	55,0	53,5	1,0	1,9
Postdorsal uzunlik	34,7	41,0	37,5	1,3	3,6
Prepelvik uzunlik	50,7	55,5	53,0	1,3	2,4
Preanal uzunlik	69,3	73,7	71,4	1,2	1,6
Preanus uzunlik	64,3	68,7	66,7	1,2	1,8
Dorsal qanot uzunligi	14,8	18,5	16,2	0,9	5,4
Dorsal qanot asosi uzunligi	9,6	11,9	10,6	0,6	5,5

Morfometrik ko‘rsatkichlar	min	max	mean	SD	V
Anal qanot uzunligi	13,1	16,7	14,7	0,9	5,9
Anal qanot asosi uzunligi	7,2	8,3	7,8	0,3	4,3
Ko‘krak qanot uzunligi	15,4	19,7	17,3	1,1	6,6
Qorin qanot uzunligi	13,7	17,0	15,0	0,9	6,0
Dum qanot uzunligi	19,0	23,6	20,9	1,4	6,9
Dum bandi uzunligi	19,1	23,1	20,8	1,1	5,4
Dum bandi balandligi	7,6	9,2	8,2	0,4	5,5
Dum bandi eni	3,7	5,9	4,6	0,6	12,4
Ko‘krak-qorin masofasi	30,4	34,2	32,1	1,1	3,5
Qorin-anal masofasi	17,4	20,7	19,0	0,9	4,6
Anus-anal masofasi	3,7	5,8	4,8	0,6	11,7
HL ga nisbatan foizda					
Bosh balandligi (ensadan)	52,1	60,6	56,5	2,5	4,4
Bosh balandligi (ko‘zdan)	36,3	49,5	44,0	2,9	6,5
Bosh eni (maksimum)	63,2	73,2	67,8	3,5	5,2
Tumshuq uzunligi	34,9	47,3	41,3	3,0	7,3
Ko‘z diametri	12,5	17,1	14,1	1,5	10,7
Interorbital masofa	29,5	35,6	32,1	1,8	5,7
Postorbital uzunlik	41,4	47,8	44,5	1,8	4,1
Og‘iz eni	16,1	24,3	20,6	2,2	10,5
Yuqori jag‘ mo‘ylov uzunligi	22,0	37,4	30,5	4,1	13,3
Ichki og‘iz mo‘ylov uzunligi	19,8	30,2	24,2	2,7	11,1
Tashqi og‘iz mo‘ylov uzunligi	22,7	42,0	33,0	4,5	13,6

Izoh: n – tahlildagi tekshirilgan individlar soni; min – minimal; max – maksimal; mean – o‘rta arifmetik qiymat; SD – standart og‘ish; V – variatsiya koeffitsiyenti; yashil rang – o‘zgaruvchanlik past; sariq rang – o‘zgaruvchanlik o‘rtacha; qizil rang – o‘zgaruvchanlik yuqori.

Triplophysa daryoae ning morfometrik tahlili shuni ko‘rsatdiki, boshi SL ning 20,1–23,0% (21,7±0,7)ini tashkil etib, dum bandidan (19,1–23,1%; 20,8±1,1) uzun ekanligi kuzatildi. Tumshug‘ining uzunligi esa postorbital uzunlik bilan deyarli teng keldi (HL ning 34,9–47,3% vs. 41,4–47,8%). Tana balandligi o‘rtacha 14,9±1,0%, tana eni esa 13,7±1,0% atrofida qayd etildi. Bu holat turning cho‘zilgan, nisbatan yassilashgan tana shakliga egaligini ko‘rsatdi. Orqa suzgich uzunligi o‘rtacha 16,2±0,9%, anal suzgich uzunligi esa 14,7±0,9% atrofida bo‘lib, suzgich qanotlarning orqa qismi kesik yoki biroz botiq shaklda ekanligi kuzatildi.

So‘x daryosida uchrovchi *T. daryoae* ning populyatsiya ichidagi morfometrik o‘zgaruvchanlik darajasi variatsiya koeffitsiyenti (V) yordamida baholandi. Bu ko‘rsatkich asosida barcha morfometrik belgilar past (V<4,49), o‘rtacha (4,50≤V<9,49) va yuqori (V≥9,50) o‘zgaruvchanlikka ega sifatida guruhlashtirildi.

Tahlil natijalariga ko‘ra, jami 10 ta morfometrik belgilar, jumladan, bosh uzunligi (3,1), predorsal (1,9), postdorsal (3,6), prepelvik (2,4), preanal (1,6), preanus (1,8) uzunliklar, anal suzgich qanoti asosining uzunligi (4,3), ko‘krak va qorin suzgich qanotlari orasidagi masofa (3,5), boshning ensa qismidan o‘lchangan balandligi (4,4), postorbital bosh uzunligi (4,1) kabi belgilar past darajadagi o‘zgaruvchanlik bilan ajralib turdi. Bu belgilar populyatsiya ichida morfologik jihatdan barqaror va ekologik muvozanatlashgan hisoblanadi. Bularga qo‘shimcha tarzda, 15 ta morfometrik belgilar, xususan, tana balandligi va eni, dorsal suzgich qanotning uzunligi hamda asosining uzunligi, anal, ko‘krak, qorin va dum suzgich qanotlarining uzunligi, dum bandining uzunligi va eni, qorin va anal suzgich qanotlari orasidagi masofa, boshning ko‘z sohasidan o‘lchangan balandligi, boshning maksimal eni, tumshuq uzunligi hamda interorbital masofa kabi belgilar o‘rtacha darajadagi o‘zgaruvchanlik ko‘rsatdi (1-jadval).

Bunday belgilar ekologik omillarning qisman ta'siri ostida bo'lishi mumkin. Ayniqsa, 7 ta belgida yuqori darajadagi o'zgaruvchanlik kuzatildi. Jumladan, dum bandi eni (12,4), anus va anal suzgich qanot orasidagi masofa (11,7), ko'z diametri (10,7), og'iz eni (10,5), yuqori jag' mo'ylov uzunligi (13,3), ichki og'iz mo'ylov uzunligi (11,1) va, ayniqsa, tashqi og'iz mo'ylov uzunligi (13,6) kabi ko'rsatkichlar yuqori variabellikka ega bo'lib, morfologik tafovutlarning ancha kuchli ekanligini ko'rsatdi.

2-jadval

Farg'ona vodiysi *Triplophysa* urug'i vakillarining o'zaro farqlanishini ko'rsatuvchi morfologik va morfometrik belgilari

Morfologik va morfometrik ko'rsatkichlar	*T. dorsalis*	*T. daryoae*	*T. elegans*	*T. ferganaensis*	*T. staruchii*
Dorsal suzgich qanot nurlari	7	6–7	6–7	7–8	7–8
Anal suzgich qanot nurlari	5	5	5	5	5
Ko'krak suzgich qanoti nurlari	10–11	9–11	10–13	11–13	11–12
Qorin suzgich qanot nurlari	7	6	6–7	7–8	7–8
Dum suzgich qanot nurlari	16	14	16	16	16
Jabra qilchalari soni	13–16	9–10	13–14	10–11	12–16
Umurtqalar soni	38–39	39	42–43	39–40	41–42
Tana balandligi (SL %)	13,6–18,2	12,4–15,3	13,4–15,8	14,6–17,4	17,7–19,1
Dum bandi uzunligi (SL %)	19,3–20,8	19,1–23,1	21,5–24,3	18,5–23,1	18,7–23,4
Dum bandi uzunligi/balandligi	2,3–2,8	2,2–2,9	3,2–3,5	2,1–2,8	2,5–3,1
Dum bandi eni balandligidan	kichik	kichik	kichik	kichik	katta
Dum suzgich qanoti shakli	o'yiq	kesik	o'yiq	o'yiq	o'yiq
Lab burmalari	yo'q	bor	bor	bor	bor
Suzgich pufagining mavjudligi	bor	yo'q	yo'q	yo'q	bor

Triplophysa daryoae filogenetik jihatdan "*Triplophysa dorsalis* guruhi" tarkibiga kirib [152; B. 47-67], ushbu guruh vakillaridan alohida farq qiluvchi o'ziga xos unikal autapomorfik xususiyatga ega emas, barcha farqlar morfologik hamda morfometrik belgi va ko'rsatkichlar kombinatsiyasiga asoslangan. Jumladan, *T. daryoae* filogenetik va geografik jihatdan *T. ferganaensis* ga eng yaqin tur bo'lib, undan dum suzgich qanotining shakli (kesik vs. o'yilgan), dum suzgich qanotidagi shoxlangan nurlar soni (7+7 vs. 8+8); boshidagi poralar (*cephalic lateral line*) tizimidagi preoperkulomandibulyar poralarining soni (9 vs. 7–8) kabi ko'rsatkichlar bilan farqlanadi. Shu bilan birga, Farg'ona vodiysi invaziv turlaridan bo'lgan *T. strauchii* dan esa suzgich pufagining reduksiyaga uchraganligi (vs. bor); jabra qilchalarining soni (9–10 vs. 12–16), tanasidagi dog'lar (umumiy shaklga ega emas vs. dog'lari yaqqol ajralib turadi) bilan farqlanadi. Farg'ona vodiysining yana bir endemik turlaridan bo'lgan *T. elegans* dan esa umurtqalar soni (39 vs. 42–43), jabra qilchalarining soni (9–10 vs. 13–14), dum suzgich qanotidagi shoxlangan nurlar soni (14 vs. 16), dum bandi uzunligining balandligiga nisbati (2,2–2,9 vs. 3,2–3,5)ga ko'ra farq qiladi (2-jadval). *Triplophysa daryoae* guruhning boshqa turlari – *T. dorsalis* va *T. dorsonotata* lardan dum suzgich qanotining kesikligi (vs. o'yilgan); suzgich pufagining reduksiyaga uchraganligi (vs. *T. dorsalis* da bor) bilan farqlansa, *T. sewerzowi, T. tenuis* va *T. ulacholica* lardan esa orqa suzgich qanotining boshlanish nuqtasi qorin suzgich qanotining boshlanish nuqtasi bilan vertikal bir chiziqda joylashganligi (vs. orqa suzgich qanot qorin suzgich qanot boshlanish qismidan oldinroqda) bilan farqlanadi (2-jadval).

Turlarni o'zaro farqlash uchun So'x daryosidan yig'ilgan *T. daryoae* namunalari Farg'ona vodiysidagi *T. ferganaensis*, *T. strauchii* va *T. elegans* vakillari bilan 32 ta morfometrik belgi bo'yicha Styudent mezonida (t-test, P<0,01) qiyosiy tahlil etildi (3-jadval).

3-jadval

***Triplophysa daryoae* (D), *Triplophysa ferganaensis* (F), *Triplophysa strauchii* (S) hamda *Triplophysa elegans* (E) morfometrik ko‘rsatkichlarining Styudent t-test metodi asosida tahlil qilingan natijalari**

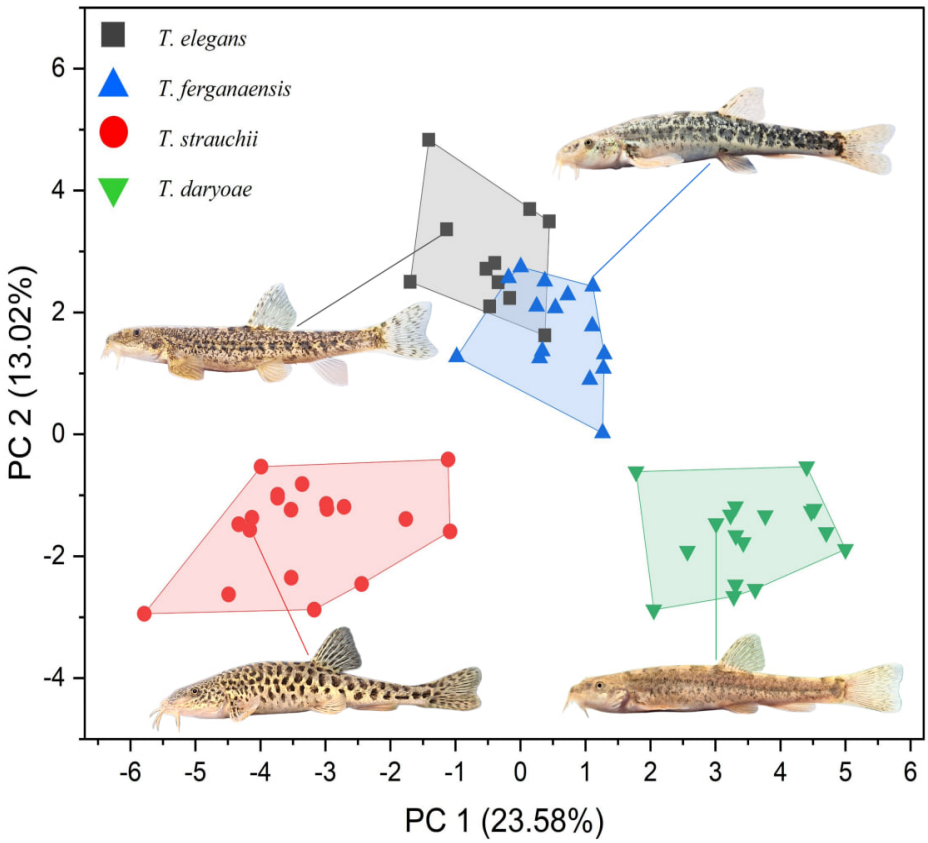
Morfometrik ko‘rsatkichlar	**D-F**	**D-S**	**D-E**
Boshning lateral uzunligi (HL)	$\mathbf{t_f > t_{st}}$	$\mathbf{t_f > t_{st}}$	$t_f < t_{st}$
Tana balandligi (dorsal qanot asosidan)	$\mathbf{t_f > t_{st}}$	$\mathbf{t_f > t_{st}}$	$\mathbf{t_f > t_{st}}$
Tana eni (dorsal qanot asosidan)	$\mathbf{t_f > t_{st}}$	$\mathbf{t_f > t_{st}}$	$\mathbf{t_f > t_{st}}$
Predorsal uzunlik	$\mathbf{t_f > t_{st}}$	$\mathbf{t_f > t_{st}}$	$\mathbf{t_f > t_{st}}$
Postdorsal uzunlik	$t_f < t_{st}$	$t_f < t_{st}$	$t_f < t_{st}$
Prepelvik uzunlik	$t_f < t_{st}$	$t_f < t_{st}$	$\mathbf{t_f > t_{st}}$
Preanal uzunlik	$t_f < t_{st}$	$\mathbf{t_f > t_{st}}$	$t_f < t_{st}$
Preanus uzunlik	$t_f < t_{st}$	$t_f < t_{st}$	$t_f < t_{st}$
Dorsal qanot uzunligi	$\mathbf{t_f > t_{st}}$	$\mathbf{t_f > t_{st}}$	$\mathbf{t_f > t_{st}}$
Dorsal qanot asosining uzunligi	$\mathbf{t_f > t_{st}}$	$\mathbf{t_f > t_{st}}$	$\mathbf{t_f > t_{st}}$
Anal qanot uzunligi	$\mathbf{t_f > t_{st}}$	$\mathbf{t_f > t_{st}}$	$\mathbf{t_f > t_{st}}$
Anal qanot asosining uzunligi	$\mathbf{t_f > t_{st}}$	$\mathbf{t_f > t_{st}}$	$t_f < t_{st}$
Ko‘krak qanot uzunligi	$\mathbf{t_f > t_{st}}$	$\mathbf{t_f > t_{st}}$	$t_f < t_{st}$
Qorin qanot uzunligi	$\mathbf{t_f > t_{st}}$	$\mathbf{t_f > t_{st}}$	$t_f < t_{st}$
Dum qanot uzunligi	$t_f < t_{st}$	$t_f < t_{st}$	$t_f < t_{st}$
Dum bandining uzunligi	$t_f < t_{st}$	$\mathbf{t_f > t_{st}}$	$t_f < t_{st}$
Dum bandining balandligi	$t_f < t_{st}$	$\mathbf{t_f > t_{st}}$	$t_f < t_{st}$
Dum bandining eni	$\mathbf{t_f > t_{st}}$	$\mathbf{t_f > t_{st}}$	$\mathbf{t_f > t_{st}}$
Ko‘krak-qorin qanotlari masofasi	$t_f < t_{st}$	$\mathbf{t_f > t_{st}}$	$t_f < t_{st}$
Qorin-anal qanotlar masofasi	$t_f < t_{st}$	$\mathbf{t_f > t_{st}}$	$t_f < t_{st}$
Anus-anal qanot masofasi	$\mathbf{t_f > t_{st}}$	$\mathbf{t_f > t_{st}}$	$\mathbf{t_f > t_{st}}$
Bosh balandligi (ensa sohasidan)	$t_f < t_{st}$	$t_f < t_{st}$	$\mathbf{t_f > t_{st}}$
Bosh balandligi (ko‘z sohasidan)	$t_f < t_{st}$	$\mathbf{t_f > t_{st}}$	$\mathbf{t_f > t_{st}}$
Bosh eni (maksimum)	$t_f < t_{st}$	$\mathbf{t_f > t_{st}}$	$t_f < t_{st}$
Tumshuq uzunligi	$t_f < t_{st}$	$t_f < t_{st}$	$t_f < t_{st}$
Ko‘z diametri	$t_f < t_{st}$	$\mathbf{t_f > t_{st}}$	$t_f < t_{st}$
Interorbital masofa	$\mathbf{t_f > t_{st}}$	$\mathbf{t_f > t_{st}}$	$\mathbf{t_f > t_{st}}$
Postorbital bosh uzunligi	$\mathbf{t_f > t_{st}}$	$\mathbf{t_f > t_{st}}$	$t_f < t_{st}$
Og‘iz eni	$\mathbf{t_f > t_{st}}$	$\mathbf{t_f > t_{st}}$	$\mathbf{t_f > t_{st}}$
Yuqori jag‘ mo‘ylov uzunligi	$t_f < t_{st}$	$t_f < t_{st}$	$t_f < t_{st}$
Ichki og‘iz mo‘ylov uzunligi	$\mathbf{t_f > t_{st}}$	$\mathbf{t_f > t_{st}}$	$\mathbf{t_f > t_{st}}$
Tashqi og‘iz mo‘ylov uzunligi	$t_f < t_{st}$	$t_f < t_{st}$	$t_f < t_{st}$
P<0,01 bo‘yicha farqlar soni	**16** ta	**24** ta	**14** ta

Natijalar *T. daryoae* va *T. ferganaensis* o‘rtasida 16 ta belgi (50%) bo‘yicha ishonchli farq borligini ($t_f > t_{st}$), aksincha, qolgan 16 ta belgi (50%) qiymatlari o‘rtasida farq kuzatilmaganligini ($t_f < t_{st}$) ko‘rsatdi. Xuddi shunday, *T. daryoae* va *T. strauchii* namunalari o‘rtasida o‘tkazilgan qiyosiy tahlilda ularning 24 ta belgisi (75%) bo‘yicha farqlar mavjudligi, biroq 8 belgisi (25%) bo‘yicha o‘xshash ko‘rsatkichlar olinganligi ma’lum bo‘ldi. Qolaversa, *T. daryoae* hamda *T. elegans* ning yig‘ilgan namunalaridagi morfometrik belgilar o‘zaro solishtirib ko‘rilganda ham farqlar sezilarli miqdorda, ya’ni 14 tani (44%) tashkil etgan bo‘lsa, qolgan 18 belgi (56%) bo‘yicha farqlar kuzatilmadi.

Triplophysa daryoae ning shu urug‘ga mansub boshqa turlar bilan bunday qiyosiy tahlili natijalari

ularning to‘g‘ri identifikatsiya qilingani yoki biror taksonomik chalkashlik yo‘qligini ifoda etadi. Chunki, ushbu turlarning kelib chiqish joyiga nazar solsak, *T. daryoae*, *T. ferganaensis* va *T. elegans* lar Sirdaryo havzasi uchun xos bo‘lgan turlar bo‘lsa [6], *T. strauchii* ning asl kelib chiqish markazi asosan Balxash ko‘li havzasi hisoblanadi [15]. Shu sababli *T. daryoae* ning *T. strauchii* bilan (24 ta farq) boshqa mahalliy turlarga (16 va 14 ta farq) qaraganda ko‘proq farqlanishi ularning turli zoogeografik havzalarga mansubligini statistik jihatdan ham isbotlaydi.

Asosiy komponentlar tahlili (**PCA**). Baliq namunalarining 32 ta morfometrik o‘lchov ko‘rsatkichlari asosida *T. daryoae* (n=17), *T. ferganaensis* (n=15), *T. elegans* (n=11) va *T. strauchii* (n=19) populyatsiyalari uchun PCA amalga oshirildi. PC1 va PC2 koordinatalarida qurilgan tarqalish diagrammasi (2-rasm) to‘rt turni alohida klasterlarga ajratdi. *T. daryoae* (yashil) va invaziv *T. strauchii* (qizil) boshqa barcha turlardan yaqqol ajralib turdi. Sirdaryo havzasining boshqa ikki turi – *T. ferganaensis* (ko‘k) va *T. elegans* (qora) esa qisman kesishgan klasterlarni hosil qildi.



2-rasm. Farg‘ona vodiysi *Triplophysa* urug‘i vakillarining morfometrik ma’lumotlari asosida tuzilgan birinchi va ikkinchi asosiy komponentlar bo‘yicha tarqalish diagrammasi.

PC1 komponentiga (umumiy o‘zgaruvchanlikning 23,58% i) asosan anus-anal masofasi (0,291), ko‘krak-qorin masofasi (0,275), preanal uzunlik (0,220), ko‘krak qanot uzunligi (0,206), postorbital uzunlik (0,193), prepelvik uzunlik (0,191), maksimum bosh eni (0,189), qorin qanot uzunligi (0,188) kabi belgilar eng katta yuklamani bergan bo‘lsa, PC2 komponentiga (13,02%) esa dum bandi eni (0,333), dum bandi balandligi (0,287), tana eni (maksimum) (0,280), anal qanot asosi uzunligi (0,248) va dorsal qanot asosi uzunligi (0,214) kabi tananing proporsional belgilari asosiy ta’sirni ko‘rsatgan (4-jadval).

4-jadval

***T. daryoae* (n=17), *T. ferganaensis* (n=15), *T. elegans* (n=11) va *T. strauchii* (n=19) populyatsiyalari uchun har bir morfometrik o‘lchov bo‘yicha dastlabki ikkita asosiy komponentlardagi yuklama (*loading*) qiymatlari**

Morfometrik ko‘rsatkichlar	PC1	PC2
Bosh uzunligi (HL)	-0.14007	-0.28543
Tana balandligi (maksimum)	-0.26009	0.18348
Tana eni (maksimum)	-0.19461	0.27987
Predorsal uzunlik	0.17466	-0.18183
Postdorsal uzunlik	-0.06143	-0.02593
Prepelvik uzunlik	0.19086	-0.02456
Preanal uzunlik	0.21984	0.0508
Preanus uzunlik	0.17605	0.08661
Dorsal qanot uzunligi	-0.18993	-0.18792
Dorsal qanot asosi uzunligi	-0.25225	0.21365
Anal qanot uzunligi	0.11331	-0.21988
Anal qanot asosi uzunligi	0.11001	0.24817
Ko‘krak qanot uzunligi	0.20577	0.04798
Qorin qanot uzunligi	0.18753	-0.01574
Dum qanot uzunligi	-0.03638	0.09817
Dum bandi uzunligi	-0.23542	-0.13459
Dum bandi balandligi	0.1489	0.28725
Dum bandi eni	-0.19752	0.33292
Ko‘krak-qorin masofasi	0.27472	0.18734
Qorin-anal masofasi	0.17308	0.15764
Anus-anal masofasi	0.29113	0.06651
Bosh balandligi (ensadan)	-0.13614	0.15089
Bosh balandligi (ko‘zdan)	-0.21836	0.10215
Bosh eni (maksimum)	0.18863	0.09142
Tumshuq uzunligi	-0.03536	0.11912
Ko‘z diametri	-0.13725	-0.22367
Interorbital masofa	0.04087	-0.23812
Postorbital uzunlik	0.19271	0.11067
Og‘iz eni	-0.20569	0.12086
Yuqori jag‘ mo‘ylov uzunligi	-0.0107	-0.14767
Ichki og‘iz mo‘ylov uzunligi	0.09904	-0.20239
Tashqi og‘iz mo‘ylov uzunligi	-0.04051	-0.17639

XULOSA

Farg‘ona vodiysining So‘x daryosi endemigi bo‘lgan *Triplophysa daryoae* ni vodiydagi boshqa *Triplophysa* urug‘i vakillari (*T. ferganaensis*, *T. elegans* va *T. strauchii*) bilan qiyosiy morfometrik tahlil qilish ularning o‘rtasida ishonchli statistik farqlar mavjudligini ko‘rsatdi. Asosiy komponentlar tahlili (PCA) ham *T. daryoae* ni boshqa turlardan aniq ajralib turuvchi mustaqil klaster sifatida namoyon qildi. Olingan natijalar *T. daryoae* ning mustaqil tur sifatidagi taksonomik maqomini statistik jihatdan mustahkamlaydi va uning Farg‘ona vodiysi ixtiofaunasidagi o‘rnini aniqlashtirishga xizmat qiladi.

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MORPHOTAXONOMIC ANALYSIS OF *TRIPLOPHYSA DARYOAE* AND OTHER *TRIPLOPHYSA* REPRESENTATIVES IN THE FERGANA VALLEY (TELEOSTEI: NEMACHEILIDAE)

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The brook loaches (Nemacheilidae) are one of the most diverse families within the order Cypriniformes, second only to Cyprinidae, with over 900 valid species described to date. Representatives of this family are distributed throughout Eurasia, with the main centers of diversity in the Indian subcontinent, Indochina, and China. In the water bodies of Central Asia, 25 valid species from 35 discovered taxa are currently recognized. However, the exact species composition of Nemacheilidae in the inland waters of Uzbekistan remains a subject of discussion, with different sources providing varying data. While some studies have revised the loaches of Uzbekistan and identified 13 species, subsequent research has revealed the presence of previously unlisted species (e.g., *Triplophysa kafirnigani*) and cast doubt on the presence of others (e.g., *Triplophysa stolickai*).

In the Fergana Valley, five species of the genus *Triplophysa* have been recorded: *Triplophysa daryoae* Sheraliev, Kayumova & Peng, 2022 (Sokh River), *Triplophysa dorsalis* (Kessler, 1872) (main channel of Syr Darya), *Triplophysa elegans* (Kessler, 1872) (Okhangaron and upper reaches of the Kara Darya), *Triplophysa ferganaensis* Sheraliev & Peng, 2021 (Shokhimardonsoy, Isfayramsoy, and Podshoota rivers), and *Triplophysa strauchii* (Kessler, 1874) (all lowland water bodies). The presence of *T. dorsalis* in the Fergana Valley is currently debated, as it has not been recorded in recent studies. *Triplophysa daryoae*, an endemic to the Sokh River, was recently described using an integrative approach (morphological and molecular). Given the importance of morphometric comparisons for resolving taxonomic status within this genus, this study aims to provide a detailed morphotaxonomic comparison of *T. daryoae* with its congeners found in the Fergana Valley.

Specimens of four species (*T. daryoae*, *T. elegans*, *T. ferganaensis*, and *T. strauchii*) were collected during 2023-2024 from the Sokh, Kara Darya, Shokhimardonsoy, and Okhangaron rivers. Fish were fixed in 4% formalin and permanently stored in 70% ethanol. A total of 32 morphometric measurements were taken following Kottelat & Freyhof (2007). Statistical analyses, including variation coefficients (V), Student's t-test (at $P<0.01$ significance level), and Principal Component Analysis (PCA), were performed using MS Excel 2019 and OriginPro 10.1.

Morphometric analysis of *T. daryoae* (n=18) revealed low variation ($V<4.49$) in 10 characters, including predorsal length (V=1.9) and preanal length (V=1.6), suggesting these traits are stable within the population. High variation ($V\geq9.50$) was observed in 7 characters, notably caudal peduncle width (V=12.4), anus-anal distance (V=11.7), and the barbels (V=10.5–13.6), indicating strong morphological variability in these traits.

Comparative statistical analysis (Student's t-test) of 32 morphometric characters demonstrated significant differentiation between the species. *T. daryoae* showed significant differences ($P<0.01$) from its closest phylogenetic relative, *T. ferganaensis*, in 16 characters (50%). It differed from *T. elegans* in 14 characters (44%). The greatest differentiation was observed against the invasive *T. strauchii* (native to the Balkhash basin), with 24 significant differences (75%), a finding consistent with their different zoogeographic origins.

Principal Component Analysis (PCA) further visually separated the species. In the scatter plot of PC1 (23.58% of variance) and PC2 (13.02%), *T. daryoae* (green cluster) formed a distinct, non-overlapping group, clearly separated from all other species.

The invasive *T. strauchii* (red cluster) also formed a well-defined, separate cluster. The two other native Syr Darya basin species, *T. ferganaensis* (blue) and *T. elegans* (black), showed partial overlap with each other but remained distinct from *T. daryoae* and *T. strauchii*. The primary drivers for separation on PC1 were length-based characters like anus-anal distance (0.29113), while PC2 was mainly influenced by body-shape characters like caudal peduncle width (0.33292).

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