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SIMILARITIES AMONG ELEVEN SPECIES OF CYPRINIDS (TELEOSTEI) AS INDICATED BY THEIR COUNTS OF GILLRAKERS, MERISTICS AND MORPHOMETRY

A. B. Kotalawala
Museum Curator,

Department of Zoology
University of Sri Jayewardenepura, Nugegoda
Sri Lanka.

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Abstract

The numbers of gill rakers, 12 meristic characters and 20 morphometric ratios were studied in 11 species of Sri Lankan cyprinids by using digested stained specimens and preserved specimens. The statistical analysis of characters showed that the counts of gill rakers, vertebrae, lateral line scales, pectoral fin rays and most of the morphometric ratios made significant differences among the species studied. In the analysis of results of ANOVA tests using matrices showed that the 11 species of cyprinids fall in to 4 clusters : *Danio malabaricus* (Jerdon) and *Chela laubuca* (Hamilton - Buchanan) in cluster one, *Rasbora vaterifloris* (Deraniyagala) and *Horadandiya athukorali* (Deraniyagala) in cluster two, *Rasbora daniconius* (Hamilton-Buchanan), *Amblypharyngodon melettinus* (Valenciennes), *Rasbora caveri* (Hora), and *Esomus danrica thermoicos* (Valenciennes) in cluster three, *Tor khudree longispinis* (Gunther), *Labeo dussumieri* (Valenciennes) and *Garra ceylonensis* (Bleeker) in cluster four. This separation indicate that, *Danio malabaricus* of the subfamily Rasborinae is more related to *Chela laubuca of* Abraminae than to the other species of Rasborinae. The two smallest rasboranines, *Rasbora vaterifloris* and *Horadandiya athukorali* were 80% similar to each other and tend to separate from other species of Rasborinae.

Key Words : morphometry, meristics, statistical analysis, dendogram, degree of similarity.

Introduction

Morphometry, counts of gill rakers and meristics were used in most taxonomical studies of fish to show the interrelationships among the species and in the separation of species (Turner *et. al.*, 1989, Collette & Russo 1978, Collette & Chao 1975, Henault & Fortin 1989, Omaoileidigh *et. al.*, 1988, Nizinski *et. al.*, 1990, Ben Tuvia 1990, Gardener *et. al.*, 1988, Kotalawala & Jinadasa 1992). In earlier studies of Sri Lankan cyprinids, although some

meristics were used to describe the species they were not statistically analysed to show the degree of similarities among the species (Deraniyagala 1952, Munro 1955, Mendis & Fernando 1962). The important meristic characters such as numbers of vertebrae, gill rakers, predorsals, dorsal fin pterygeophores and the morphometry were not studied in Sri Lankan cyprinids. In the present study, similarities among the 11 species of Sri Lankan cyprinids are investigated using the counts of gill rakers, vertebrae, pterigeophores, predorsals and morphometry which were not studied in earlier investigations. When such a broader view of all species of genera are obtained, the status of each genera can be easily understood.

Materials and Methods

Eleven species of cyprinids collected from Labugama - Kalatuwawa area of Western Province were identified according to Deraniyagala (1952), Munro (1955), and Pethiyagoda (1990). The specimens preserved in 10% formalin were used for counts of gillrakers, lateral line scales and for the measurement of different body lengths. Twenty simple body measurements were made on each fish using a caliper to the points indicated in the Fig 1. For the meristic counts other than lateral line scale counts, digested stained specimens were used. The specimens preserved in 10% formalin were digested in 2% KOH stained in alizarin red and were kept in glycerol. All counts were taken using a stereomicroscope under reflected light.

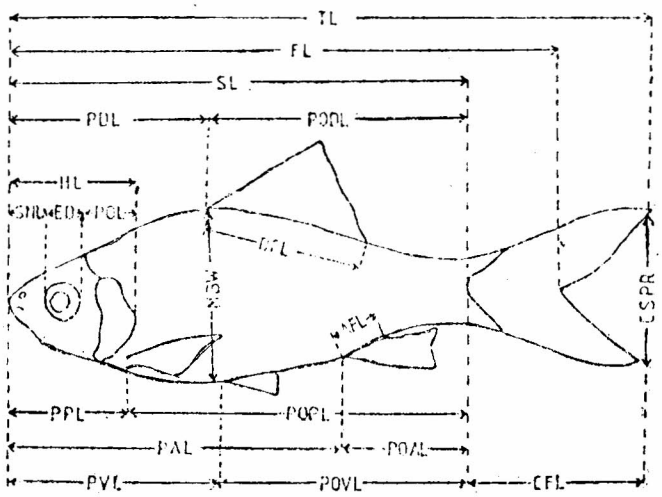

Fig. 1 Different body measurements used in the study of fish TL=total length, SL=Standard length, FL=forked length, MBW=Maximum body width, HL=head length, ED=Eye diameter, POL=post orbital length, DFL=dorsal fin length, PDL=predorsal length, PODL=postdorsal length, AFL=anal fin length, PAL=preanal length, POAL=postanal length, PVL=preventral length, POVL=postventral length, PPL=prepectoral length, POPL=postpectoral length, CFL=caudal fin length, CSPR=caudal spread.

Mean, standard deviation and range of all characters were determined by using a LOTUS softwere package. The morphometric data were transformed into a series of ratios dividing them by the standard length, maximum body width and head length. The data of 20 ratios, three meristic characters and the counts of gill rakers were initially analysed for analysis of variance using Scheffe's Range Test (SAS package) to indicate which species were significantly different. The remaining meristic characters without variation among the individuals of a species were compared using means and modes.

Results of ANOVA tests and the comparisons of means and modes were transformed into two state primary data matrices. A similarity matrix was prepared using all the primary data matrices (Goto 1982, Kotalawala & Jinadasa 1993). The similarity matrix was transformed into a percntage similarity matrix by converting coefficient of similarities into percenttages, The percentage similarity matrix was rearranged so as to obtain maximum relationships among the species.

RESULTS

Gillrakers

F — value obtained from the ANOVA test on counts of gill rakers for the 11 species shows that this character makes significant differences among the species studied (Table 1). *Danio malabaricus* contained the lowest numbes of gill rakers while *Labeo dussumieri* contained the highest number of gillrakers. The range and mean values of gillrakers of species were shown in Fig. 2

Meristic characters

Table 1. F—values obtained from Sheffe's Range Test of morphometric ratios, meristic characters and the counts of gill rakers.

Character	F—value	Character	F—value
TL/SL	7.04	PGAL/SL	33.32
PPL/SL	26.46	ED HL	32.59
HL/SL	51.23	SNL/HL	27.53
PODL/SL	74.73	PCL/HL	18.07
MBW/SL	19.0	SL/MBW	16.66
PDL/SL	103.4	HL/MBW	33.95
DFL/SL	76.81	PODL/MBW	40.87
AFL/SL	388.47	PDL/MBW	65.19
PVL/SL	76.96	L.I. Scale counts	644.8
POVL/SL	17.61	Pectoral rays	65.7
POPL/SL	12.65	Gill rakers	281.9
PAL/SL	78.01	Vertebral counts	274.9

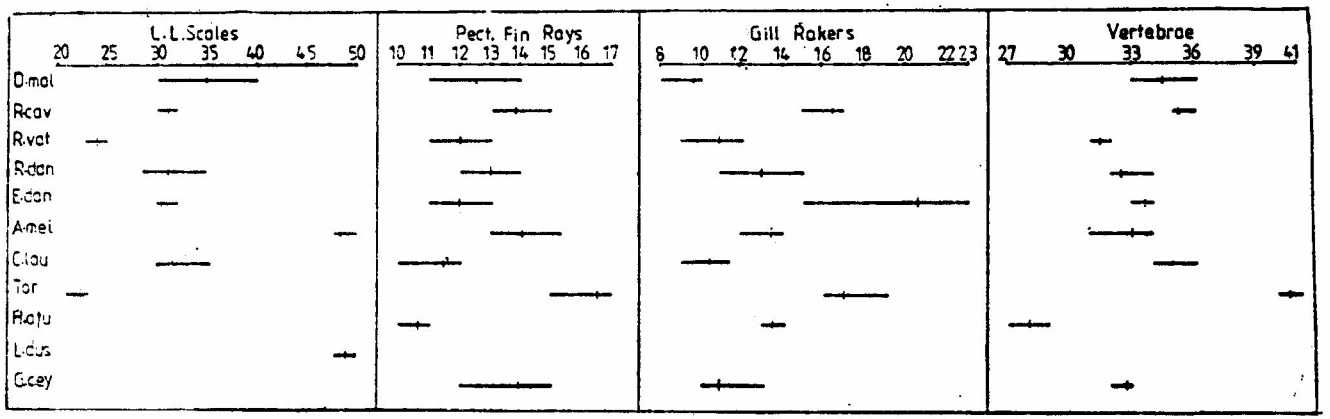

Fig. 2 Range and mean of lateral line scales, pectoral fin rays, first arch gill rakers and vertebrae of 11 species of cyprinids. The horizontal bar indicate the range and the cross line indicate the mean value. Hence the mean number of gill rakers of Labeo dussumieri is 46.5 and vary from 46 to 47 it was unable to represent in this diagram. R. dan=Rasbra *daniconius*, R. cav=*Rashora caveri*, R. vat=*Rasbora vaterifloris*, D. mal=*Danio malabaricus*, E.dan=*Esomus danrica*, A. mel=*Amblypharingodon melettinus*, *C.* lau=*Chela laubuca*, Tor=*Tor khudree longispinis*, G. cey=*Garra ceylonesis*, L. dus=*Labeo dussumieri*, H. atu=*Horadandiya athukorali.*

Out of 12 meristic characters studied only the counts of pelvic spines were constant among the species studied (Table 2). In all species one spine was present in the pelvic fin. There were no spines in the pectoral fin of any species studied. Out of 12 meristic characters studied only 3 varied among the individuals of species These characters were counts of vertebrae, pectoral rays and lateral line scales.

The largest species *Tor khudree longispinis* contained the highest number of vertebrae (40.85 $\pm$ 0.37) while the smallest species *Horadandiya athukorali* contained the lowest number of vertebrae (28.3 $\pm$ 0.77). The mean values and the range of counts of vertebrae of species studied are shown in Fig. 2. The variation of range and mean of pectoral fin rays of species were shown in Fig. 2. *Horadandiya athukorali* contained the lowest number of pectoral fin rays while the species *Labeo dussumieri* contained the highest number of pectoral fin rays. All the species studied contained one unbranched hardened ray in the pectoral fin. All species except *Horadandiya athukorali* have lateral lines. The mean and range of lateral line scales of species are shown in Fig. 2. *Tor khudree logispinis* shows the lowest value while *Labeo dussnmieri* shows the highest value for the number of lateral line scales.

Out of 11 species studied three species contained no spines, three species contained 1 spine, two species contained 2 spines, two species contained three spines and one species contained four spines in the dorsal fin (Table 2). Generally most of the species studied contained 8 or 9 dorsal fin rays while the two species *Danio malabaricus* and *Labeo dussumieri* contained 12-14 dorsal fin rays (Table 2). Out of 11 cyprinids *Danio malabaricus* and *Chela laubuca* which have longer anal fins than others, contained 17-20 while the others contained 6 or 7 rays in the anal fin. All species contained 1 or 2 anal spines in the anal fin (Table 2). The pelvic fin of species studied contianed 1 spine and 6 to 9 rays (Table 2). The number of predorsal bones vary from 3 to 10 among the species studied. In *Danio malabaricus*, *Esomus danrica thermoicos* and *Chela laubuca*, the number of predorsals vary from 8 to 10 while in others it vary between 3 to 7 (Table 2). The counts of dorsal fin pterygiophores depend upon the length of the dorsal fin. *Danio malabaricus*, *Chela laubuca*, *Tor khudree longispsnis*, *Labeo dussumieri* and *Garra ceylonensis* which have longer dorsal fins than others contained 10-15 dorsal fin pterygiophors while the others contained 8 or 9 dorsal fin pterygiophores (Table 2).

Morphometric characters

The mean value and the standard deviation of twenty simple body measurements of 11 species studied was shown in Table 3. Based on the total length, forked length, standard length and the maximum body width, *Tor khudree longispinus* is the largest while the *Horadandiya athukorali* is the smallest among the species studied.

Table 2. **Mean values, standard deviation and range of some meristic characters of eleven species of cyprinids, R. dan=*Rasbora daniconicus*, R. cav=*Rasbora carveri*, R. vat=*Rasbora vaterifloris*, D. mal=*Danio malabaricus*, E. dan=*Esomus danrica*, A. mel=*Amblypharingodon melettinus*, C. lau=*Chela laubuca*, Tor=*Tor khudree longispinis*, G. cey=*Garra ceylonensis*, L. dus=*Labeo dussumieri*, H. atu=*Horadandiya athukorali*. The numbers within brackets represent the standard deviation. N=sample size.**

Character	species										
	D.mal N=28	R.cav N=16	R.vat N=6	R.dan N=16	E.dan N=16	A.mel N=19	C.lau N=18	Tor N=5	L.dus N=11	G.cey N=16	H.atu N=15
Dorsal Spines	1	1	2	0	0	1	0	4	3	3	2
Dorsal rays	12.9 (0.84)	8	8	9	8	9	10	9	14	9	8
Anal rays	17.08 (0.86)	6	7	6	7	7	19.8 (0.81)	6	6	6	6
Anal spines	1	2	2	2	1	1	1.44 (0.58)	2	2	2	2
Pelvic rays	8	9	8	8.5 (0.72)	8	9	6	9	9	9	7
Pelvic spines	1	1	1	1	1	1	0.48	1	1	1	1
Predorsals	9-10	7	5	7	8-9	6	8-9	6	3	5	4
Dosal fin pterigiophores	12-13	9	9	9	8	9	10	11	15	10	9

Table 3. **Mean value and standard deviation of 20 body measurements of eleven species of cyprinids. R. dan.** = *Rasbora daniconius*, **R. cav.** = *Rasbora caveri*, *R* **vat** = *Rasbora vaterifloris*, **D. mal** = *Danio malabaricus*, **E. dan** = *Esomus danrica*, **A. mel** = *Ambiypharingodon melettinus*, **C. lau** = *Chela laubca* **Tor** = *Tor khudree longispinis*, **G. cey** = *Garra ceylonensis*, **L. dus** = *Labeo dussumieri*, **H. atu** = *Horadandiya athukorali.*
N = *Samlpe Size*

Character	species										
	R.dan N=16	R.cav N=16	R.vat N=6	D.mal N=28	E.dan N=16	A.mel N=19	C.lau N=16	Tor N=11	G. cey N=16	L.dus N=4	H.atu N=12
TL	78.8±4	84.8±6.4	31.3±1.8	69.2±6.4	79.5±6.3	80.6±3.9	57.6±7.1	238±69	99.4±18	173±8.1	23.9±1.54
FL	70.7±3.6	76.4±6.8	26.9±1.8	63.2±5.8	72.3±6	712.3±3.5	52.8±6.6	210±60.2	91.8±1.7	153.5±4.9	21.35±1.4
SL	62.6±3.1	66.5±5.9	23.1±1.7	54.9±5.2	62.6±4.8	63.8±3.9	45.6±5.3	186±55.6	77.9±1.3	138.7±7	19.3±1.3
MBW	17.8±0.9	16.9±1.9	7.8±0.6	16.8±2.1	15.7±1.4	17.6±0.9	12.5±1.6	5 1±19.3	19.3±3.5	42.8±2.3	5.6±0.6
HL	17.5±1.1	2.0±1.6	6.8±0.3	13.9±1.2	16.3±1.2	20.5±1.1	10.8±1.3	5.6±15.8	20.8±3	37.5±0.9	5.6±0.5
SNL	4.9±0.4	5.6±0.6	1.7±0.2	3.8±0.5	3.8±0.37	4.8±0.3	2.5±0.35	17.1±4.5	8.0±2.1	12.5±1.1	1.7±0.2
ED	5.0±0.3	5.5±0.5	3±0.2	4.7±0.3	4.36±0.47	5.7±0.3	3.15±0.34	11.8±0.9	5.4±0.4	8.2±0.4	1.8±0.1
POL	7.5±0.7	8.5±1.4	2±0.2	5.2±0.9	8.0±1.0	9.9±1.0	5.0±0.89	2.7±11.3	7.2±1.3	16.7±1.6	2.0±0.4
DFL	7.2±0.6	7.8±1.0	3.8±0·3	11.6±1.6	6.0±0.6	7.5±0.5	6.5±1.1	28.5±8.7	15.3±3.9	36.8±2.1	2.6±0.4
PDL	3.5±2.3	4.0±3.8	12.8±1.4	32.5±3.2	41.7±3.4	35.1±1.7	31.3±4.0	94.1±29.7	37.4±5.8	62.6±2.2	9.9±0.8
PODL	27.7±1.4	27.3±4.8	10.5±1.5	22.3±2.4	20.9±2.0	28.3±2.3	14.2±1.4	9.2±23.4	40.5±8.0	75.3±5.0	9.4±0.8
AFL	6.4±0.4	6.7±0.9	4.0±0	12.5±1.5	6.0±0.7	7.2±0.5	11.8±1.8	16.1±5.6	7.9±1.7	11.0±1.0	2.0±0.2
PAI	46.0±3.0	48.2±3.5	14.8±1.1	34.9±3.4	45.0±3.6	43.2±2.1	28.5±3.3	14.0±41.4	60.7±1.0	10.7±7.2	12.6±1.0
POAL	16.6±1.1	18.5±2.6	8.3±0.7	20.0±2.3	17.4±1.5	20.1±1.6	17.0±2.2	46.5±14.9	17.1±3.5	30.7±1.7	6.6±0.5
PVL	23.6±2.2	34.6±3.4	11.4±0.8	25.0±2.3	32.9±2.6	32.6±1.3	18.7±2.2	9.8±29.9	41.5±7.5	73.5±4.9	10.0±0.9
POVL	29.3±2.1	31.9±3.1	11.7±1.1	29.9±3.0	29.6±2.5	30.7±2.2	26.9±3.2	87.1±26.5	36.4±6.2	64.5±2.2	9.3±0.7
PPL	17.2±1.1	18.7±1.9	6.9±0.3	13.8±1.0	16.2±1.2	18.7±1.01	11.5±1.2	50.7±14.6	17.3±3.0	34.0±1.8	6.0±0.6
PPL	45.6±2.6	47.7±6.3	16.3±1.4	41.1±4.3	66.8±3.9	44.2±2.6	34.0±4.3	13.5±42.2	60.5±1.1	104.0±5.3	13.3±1.1
CFL	16.3±1.5	18.1±1.4	8.1±0.9	14.2±2.0	16.9±1.8	17.4±1.6	12.3±2.2	53.7±14.4	20.4±6.0	35.7±2.6	4.5±0.4
CSPR	10.8±7.5	12.7±2.0	7.4±1.0	11.1±1.8	11.3±1.5	13.4±2.6	9.5±2.0	11.2±1.7	11.3±1.5	7.6±0.9	5.2±0.4

Table 4. **The mean values of body proportions of species of cyprinids in thousands, R. dan**=*Rasbora daniconius*, **R. cav**=*Rasbora caveri*, **R. vat**=*Rasbora vaterifioris*, **D. mal**=*Danio malabaricus*, **E. dan**=*Esoms danrica*, **A. mel**=*Amblypharingodon melettinus*, **C. lau**=*Chela laubuca*, **Tor**=*Tor khudree longispinis*, **G. cey**=*Garra ceylonensis*, **L. dus**=*Labeo dussumieri*, **H. atu**=*Horandandiya athukorali*. *N=Sample Size.*

Ratio	species										
	R.dan N=16	R.cav N=16	R.vat N=6	D.mal N=28	E.dan N=16	A.mel N=19	C.lau N=16	Tor N=11	G.cey N=16	L.dus N=4	H.atu N=12
TL/SL	1257	1275	1354	1260	1269	1265	1262	1283	1274	1259	1234
FL/SL	1129	1148	1162	1150	1154	1119	1157	1133	1177	1106	1102
MBW/SL	274	255	338	306	251	276	273	275	248	310	292
HL/SL	279	302	294	253	260	322	237	303	268	272	290
SNL/SL	79	85	75	70	61	75	56	94	103	90	88
ED/SL	79	83	129	86	69	89	69	68	71	59	97
POL/SL	120	128	90	95	127	156	110	140	93	121	105
DFL/SL	115	117	166	211	97	118	143	153	192	267	136
PDL/SL	558	601	553	592	665	551	685	503	451	454	513
PODL/SL	442	410	453	406	335	443	313	496	518	545	486
AFL/SL	102	100	173	228	97	113	259	86	101	79	106
PAL/SL	734	725	640	635	721	677	625	758	779	776	654
POAL/SL	266	276	359	364	278	314	373	243	220	223	345
PVL/SL	536	519	493	456	526	511	411	525	532	532	515
POVL/SL	467	479	506	543	473	481	589	469	467	467	484
PPL/SL	275	281	298	251	259	293	253	274	224	246	309
POPL/SL	728	716	703	746	747	694	746	725	775	753	690
CFL/SL	260	273	354	260	269	273	269	293	258	259	236
CSPR/SL	174	191	319	203	180	209	210	65	148	55	273
SNL/HL	283	283	256	277	234	235	238	310	382	333	304

Table 4. The mean values of body proportions of species of cyprinids in thousands, R. dan=*Rasbora daniconius*, R. cav=*Rasbora caveri*, R. vat=*Rasbora vaterifioris*, D. mal=*Danio malabaricus*, E. dan=*Esoms danrica*. A. mel=*Amblypharingodon melettimus*, C. lau=*Chela laubuca*, Tor=*Tor khudree longispinis*, G. cey=*Garra ceylonensis* L. dus=*Labeo dussumieri*, H. atu=*Horandandiya athukorali* N=*Sample size*

Ratio	species										
	R,dan N=16	R.cav N=16	R.vat N=6	D.mal N=28	E.dan N=16	A.mel N=19	C.lau N=16	Tor N=11	G.cey N=16	L.dus N=4	H.atu N=12
ED/HL	286	275	439	347	268	279	294	225	264	220	334
POL/HL	431	425	306	374	443	484	462	2253	3498	446	359
TL/MBW	4591	5041	4006	4147	5071	4585	4621	4707	5156	4053	4244
FL/MBW	4124	4541	3439	3788	4613	4057	4235	4158	4763	3561	3793
SL/MBW	3653	3958	2959	3292	2995	3626	3661	3668	4048	3219	3440
HL/MBW	1018	1192	872	834	1041	1166	870	1116	1088	876	1000
SNL/MBW	289	338	224	231	244	275	208	347	416	292	301
ED/MBW	291	329	382	286	279	325	255	252	288	192	333
POL/MBW	439	506	266	311	509	566	403	513	379	390	363
DFL/MBW	420	467	492	698	388	429	524	563	775	861	467
PDL/MBW	2040	2378	1636	1946	2685	1998	2508	1843	1948	1462	1765
PODL/MBW	1616	1613	1347	1339	1336	1610	1148	1827	2100	1756	1675
AFL/MBW	375	399	513	750	387	412	949	314	412	256	367
PAL/MBW	2684	2863	1893	2089	2881	2456	2288	2782	3152	2500	2249
POAL/MBW	972	1102	1066	1203	1114	1142	1368	891	895	718	1190
PVL/MBW	1958	2052	1458	1500	2103	1854	1505	1930	2157	1713	1775
POVL/MBW	1709	1901	1501	1791	1889	1745	2159	1719	1892	1506	1664
PPL/MBW	1006	1110	883	827	1035	1063	927	1009	908	792	1067
POPL/MBW	2661	2832	2083	2460	2992	2515	2734	2658	3139	2426	2373
CFL/MBW	948	1675	1046	854	1078	988	985	1076	1047	824	813
CSPR/MBW	634	759	944	669	716	760	771	241	600	177	938

In relation to the ratios such as PDL/SL, PODL/SL, PAL/SL, POAL/SL in thousands, the dorsal fin originate more posteriorly and the anal fin originate more anteriorly in *Chela laubuca* than that of all the other species (Table 4). The anal fin of *Chela laubuca* is longer than that of all the other species while the dorsal fin of *Danio malabaricus* and *Labeo dussu mieri* are longer than that of all the other species. In relation to the head length *Labeo dussumieri* has the longest snoute while *Rasbora vaterifloris* has the the largest eye. The postorbitol length of *Amblypharyngodon melettinus* is higher than that of all the other species (Table 4).

The F—values indicate that most of the body ratio variables producee significant differences among the species studied (Table 1). The ratio such as AFL/SL, PDL/SL, DFL/SL, PVL/SL, PAL/SL are highly significant than that of other ratios (Table 1).

The rearranged similarity matrix which based on primary data matrices of all morphometric and meristic characters and counts of gill rakers studied shown in Fig 3. The eleven species studied were separated into four clusters. The first cluster included *Danio malabaricus* and *Chela laubuca* and they were 63% similar to each other. The second cluster included *Rasbora vaterifloris* and *Horadandiya athukorali* and their similarity is 78%. The third cluster included 4 species. They were *Rasbora daniconius, Amblypharyngodon melettinns, Rasbora caveri* and *Esomus danrica thermoicos.* Their similarity within the cluster vary from 53%-84% and the minimum similarity is 53%. The three species, *Tor khudree longipinis, Labeo dussumieri* and *Garra ceylonensis* included in the fourth cluster and they were 66% similar to each other. The species included in all four clusters are 25% similar to each other.

Discussion

In the Actinopterygii there are two types of fin rays ; the soft rays or segmented rays and hard rays or spines. The soft rays are divided into jointed segments and also branched so as to form fans : their branches more or less extended across the entire fin membrane, and strengthen it, specially when the fin is spread out. Soft rays are always bilaterally arranged. Sometimes unbranched soft rays also occur. In contrast hard rays or spines are not jointed. but the entire structure from the base on are fused to form a single solid element (Harder 1975, Larglar 1962). In the comparison of results of present study with that of previous studies, there are some anomalies of counts of spines and rays of fins (Table 5). According to the previous studies there is a spine in the pectoral fin of all species studied. However, the present study shows that there are no spines but a hardened unbranched ray in the pectoral fin of all these species. The difference of results is due to the wrong iidentification of hardened rays as spines which is in turn is due the use of undigested specimens in previous studies. In the present study all specimens used to count spines and rays were digested stained specimens.

	Dmal	C.lau	R.vat	H.atu	Amel	R.dan	R.cav	E.dan	Tor	L.dus	G.cey
Dmal	100	63	56	31	22	38	38	31	28	47	34
C.lau	63	100	31	31	31	38	34	59	25	34	28
R.vat	56	31	100	78	63	59	56	34	56	50	40
H.atu	31	31	78	100	59	69	56	25	66	63	53
Amel	22	31	63	59	100	72	78	53	53	41	47
R.dan	38	38	59	69	72	100	84	75	63	63	56
R.cav	38	34	56	56	78	84	100	63	72	47	47
E.dan	31	59	34	25	53	75	63	100	50	47	44
Tor	28	25	56	66	53	63	72	50	100	81	66
L.dus	47	34	50	63	41	63	47	47	81	100	78
G.cey	34	28	41	53	47	56	47	44	66	78	100

Fig. 3 The separation of clusters of rearranged percentage similarity matrix of 11 species of cyprinids. R. dan=Rasbora *daniconius*, R.cav=*Rasbra caveri*, R. vat=*Rasbora vaterifloris*, D. mal=*Danio malabaricus*, E. dan=*Esomus danrica*, A. mel =*Amblypharingodon melettinus*, C. lau=*Chela laubuca*, *Tor*=Tor *khudree longispinis*, *G.* cey=*Garra ceylonensis*, L. dus=*Labeo dussumieri*, H-atu=*Horandiya athukorali.*

Based on the previous studies, there are two spines in the dorsal fin of *Chela laubuca, Rasbora daniconius* and *Esomus danrica thermoicos.* However, the present study shows that there are no spines but hardened unbranched rays in the dorsal fin of these species. Previous studies of *Danio malabaricus* and *Amblypharyngodon melettinus* indicate the presence of two spines in the dorsal fin. However, the present study shows that there is only one spine in the dorsal fin of these species. Based on the results of the present study, there is a reduction of the number of spines of the anal fin of most of the species (Table 5). As the number of spines of the anal fin reduce, the number of rays of the anal fin of these species increase. The difference of number of spines and rays of fins is mainly due to the wrong identification of unbranched hardened rays as spines.

In earlier Sri Lankan works on cyprinids the researchers have used undigested specimens for meristic counts. However, in the present study in most occasions a sample of more than 10 digested stained specimens were used for each species. Therefore the identification and counts of spines and rays is more dependable than that of previous studies and the counts of spines and rays obtained in the present study is acceptable.

Table 5. Differences of species discribing formulae of fish in previous studies and present study,D= dorsal fin, A=anal fin, P=pectoral fin, V=ventral fin, L=lateral line scales. The Roman neumarals indicate the number of spines in the fins while the Arabian indicate the number of rays.

Species	formulae of previous studies	formulae of present study
Danio malabaricus	D II 10-12, A III 13-16, P I 11, L 37-40	D I 10-12, A I 15-18, P. 11-13, V I 8, L 30-35
Chela laubuca	D II 7-8, A III 17-19, P. I 9-11, L 33-35	D 10, A I-II 19-20, P 10-12, V I 8-9. L 30-34
Rasbora vaterifloris	D II 8, A II 6, P I 11, L 25	D II 8, A II 7, P 11-13, V I 8-9, L 24-25
Horadandiya athukorali	D II 6, A III 5, P 10, L 22	D II 8, A II 6, P 9-11, V 1 7,
Rasbora daniconius	D II 6-7, A II 5, P I 13-14, L 30-34	D 9, A II 6, P 12-14, V I 8-10, L 29-34
Amblypharyngodon melettinus	D II 7, A III 5, P I 13-14, L 45-50	D I 9, A I 7, P 13-15, V I 9, L 48-50
Rasbora caveri		D I 8, A II 6, P 13-15, V I 9, L 30-32
Esomus danrica	D II 6, A II 5, P I 10-12, L 31-34	D 8, A I 7, P 11-13, V I 8, L 30-32
Tor khudree longispinis	D IV 9, A III 5, P I 15-17, L 23-24	D IV 9, A II 6, P 15-17, V I 9, L 22-24
Labeo dussumieri	D III 12-13, A III 5, P I 15, L 48-53	D III 14, A II 6, P 17, V I 9, L 48-50
Garra ceylonensis	D III 8-9, A II 5, P I 9-12 L 33-35	D III 9, A II 6, P 12-15, V I 9, L 33-35

In previous studies, the statistical analysis of morphometry and meristics were not used in the identification and in the comparison of species. In the present study, the use of large number of statistically analysed characters, increased the reliability of the study.

Hence the ANOVA tests on counts of gill rakers, vertebrae, lateral line scales and pectoral fin rays produced significant differences among the species studied these characters can be used successfully in the separation of species. The other meristic characters used were less effective in the separation species.

The ratios of body measurements eliminate the effects of size and therefore the ratios are better than the raw variables in the comparison of species (Turner *et. al.*, 1989). However, no ratio is entirely diagnostic of any species in this study. The ANOVA tests of body ratios used showed that most of the ratios produced significant differences among the species studied.

The use of matrices in the combination of results of morphometric data with that of meristic data is more simple than the complex statistical methods. As the number of characters increased the separation of clusters is more clear (Goto 1982). In this study out of 33 characters used 24 were statistically analysed. Therefore the similarities among the species reflected by this study is reliable.

Based on the informations of the rearranged percentage similarity matrix, the degree of similarities among the 11 species of cyprinids is as shown in the dendogram is evident (Fig. 4). The species within a cluster and the clusters with close affinities were linked together by horizontal lines placed at the appropriate height in relation to the vertical scale representing the degree of similarity. The dendogram shows that the species *Danio malabaricus* which included in the subfamily Rasbirinae is more related to *Chela laubuca* of the subfamily Abraminae. The two smallest rasboranines, *Rasbora vaterifloris* and *Horadandiya athukorali* tend to separate from other species of the sub family. The three cyprinides, *Tor khudree longispinus*, *Labeo dussumeiri* and *Garra ceylonensis* from a separate cluster as usually.

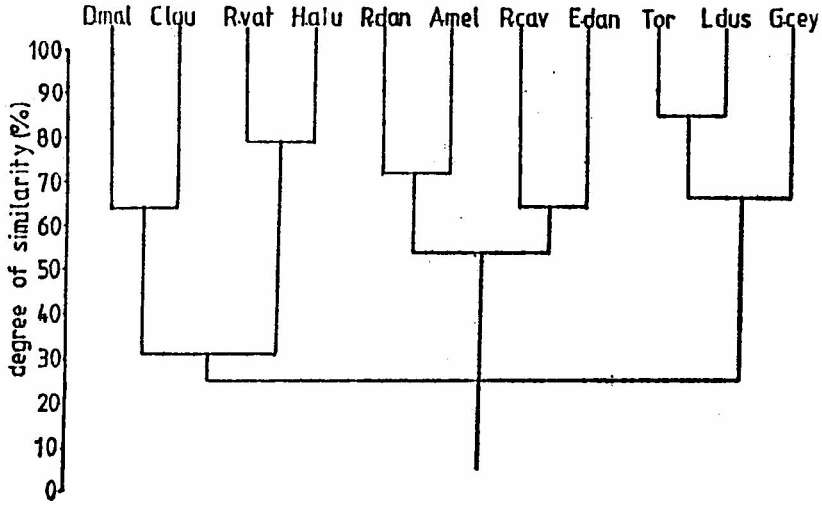

Fig. 4 The dendogram of 11 species of cyprinids. Similar species and clusters with close affinities were linked together by horizontal lines in appropriate height in relation to the vertical axis representing the degree of similarity as a percentage, R. dan=*Rasbora daniconius*, R. cav=*Rasbora caveri* R. vat=*Rasbora vaterifloris*, D. mal=*Danio malabaricus*, E. dan=*Esomus danrica* A. mel=*Amblypharingodon melettinus*. C. lau=*Chela laubuca*, Tor=*Tor khuree longispinis* G. cey=*Garra ceylonensis*, L. dus=*Labeo dussumieri*, H.atu=*Horadandiya athukorali*.

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