Comparison of *Fabaeformiscandona caudata* (Kaufmann) and *Fabaeformiscandona lozeki* (Absolon) from the sublittoral of Lake Mondsee

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Fabaeformiscandona caudata: left valve (a), right valve (b); *Fabaeformiscandona* lozeki: female left valve (c), right valve (d), male left valve (e), right valve (f).

Above, you see microphotographs representing typical specimen of the two species.

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The pictures are transformed to a bitmap in a program such as Adobe Photoshop, to enable digitalizing with tps.dig. Collect the specimen you want to compare in one folder, this is not obligatory, but will help keep things organised.

Open MORPHOMATICA, click on *Specimen* in the menubar and choose *Insert*. A dialog field opens where the samples that you want to compare are selected.

Subenannt - Morphomatica File Specimen Cluster View ?		_ 🗆 ×
File Specimen Cluster View ?	Open ? × Look in: example 3 tps •	
Ready	Coordinates	

To see the fit of the calculated outline select *Approximation* under *Specimen* in the menubar.



It might be useful to change the number of control points to get a better resemblance between the calculated and the real shape. Ber. Inst. Erdwiss. K.-F.-Univ. Graz ISSN 1608-8166 Band 13 Graz 2008



Mark the Cluster folder, select the specimen you want to compare and click Apply.



Set the control points to the value that you determined earlier (usually 8 control points on each half of the valve give a good result).

To see the coordinates of the vectors and the differences between the control points, mark one valve as reference and select *Display Coordinates*.

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File	Specimen	Cluster View ?										
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				_ SOION-F-VG. TPS	0.00 E4 E2	10.00	26.27	24 79	0.00	71.29	251.05	
		Select		Abcolon-f-val TPS	54.55	10.10	30.37	20.70	22.00	45.60	205 21	
		Calculate Mean S	pecimen	aufmann-f-vg TPS	74.87	23.12	51.75	27.55	29.72	78.26	475 56	
		Mark as Reference	e	icharf-f-yg, TPS	41.59	13.09	28.50	23.23	18.91	58.92	302.60	
	⊡ ClmR			4m.tps	44.92	18.96	25.97	20.72	18.05	39,90	288.73	
.	Cluster	Display Specimen	s	6M6m.tps	42.91	17.45	25,46	22.96	19.59	46.74	313.43	
L .	🙀 Loz-a	🗸 Display Coordinal	tes	4m.tps	37.36	15.74	21.62	20.79	16.53	49.53	264.45	
	🖹 Caud	Display Differenc	es I	M6m.tps	30.39	11.79	18.60	15.46	13.31	33.06	213.00	
	🖹 Caud			F10m.tps	39.85	15.59	24.26	21.29	18.43	49.07	294.83	
L .	🗈 Caud	Export to Data Fi	le	iM6m.tps	40.04	16.76	23.28	21.38	17.41	48.68	278.50	
	🖹 Caud	Export to Image	File	iM6m.tps	44.06	18.52	25.54	21.02	18.26	47.93	292.08	
	B Cd VI	I4m tos - 5	12 CULV	a5M6m.tps	36.09	16.42	19.67	17.67	15.53	32.73	248.41	
L .		SM6m toc - 6	13 CcLV	6SM6m.tps	34.96	14.27	20.70	17.93	14.79	43.83	236.68	
		Marchan 7	14 CcLV	7SM6m.tps	37.84	14.65	23.19	19.75	16.41	46.17	262.59	
		214m.tps - 7	15 CcLV	85M6m.tps	42.03	16.11	25.92	23.66	19.17	56.80	306.71	
	CCLV2	25M6m.tps - 8	16 CcLV	95M6m.tps	36.17	12.99	23.17	18.50	15.87	36.98	253.92	
	CcLV3	GF10m.tps - 9	17 CcLV	10SM6m.tps	40.75	17.59	23.16	21.38	17.76	52.95	284.10	
	CcLV3	SM6m.tps - 10	18 CcRV	/1I4m.tps	41.19	16.39	24.80	22.72	19.19	58.72	307.10	
	CcLV4	ISM6m.tps - 11	19 CcRV	/1SM6m.tps	51.27	19.06	32.21	25.76	21.45	64.15	343.27	
	Callys	SM6m.tps - 12	20 CcRV	/2I4m.tps	43.40	16.86	26.54	25.67	21.72	62.43	347.49	
	CaLV6	SM6m.tps - 13	21 CCRV	25M6m.tps	32.55	13.02	19.54	18.85	15.90	41.36	254.38	
	Cd V7	SM6m tos - 14	22 CCRV	COSM6m.tps	39.92	17.02	22.91	23.44	19.23	62.42	307.72	
		SM6m toc - 15	23 CCRV	45M6m.tps	37.05	13.10	23.95	21.01	18.04	37.78	288.58	
		SMGm key 10	24 CCRY	r55M6m.cps	41.32	17.00	24.32	22,06	18.84	51.86	301.46	
		SMom.cps - 16	25 CCR	roomom.cps	34.55	15.09	19,45	19.42	10.07	42.67	269.99	
	CCLV1	.05M6m.tps - 17	20 CCR	PSM6m kps	44.50	13.77	30.73	21,52	10.55	40.53	290.03	
	CcRV1	1I4m.tps - 18	27 CUR	ICE10m kpc	40.30	17.40	20.04	20.00	10.22	46.02	201.75	
	🖹 CcRV1	15M6m.tps - 19	20 CIEV	14From.cps	42.44	7 72	24.71	22.20	16.23	42.72	291.75	
	🖻 CcRV2	2I4m.tps - 20	30 CIELS	11Mo41-23 toe	45 41	12.97	32.44	20.13	17.24	51.05	275 78	
L .	CcRV2	25M6m.tps - 21	31 CIELS	1Mo41-26 tos	38.52	11.75	26.77	17.85	15.34	42.59	245.36	
	CcRV3	35M6m.tps - 22	32 CIELS	1Mo41-27 tos	45.04	14.82	30.22	22.25	18.85	57.08	301.55	
1		45M6m.tps - 23	33 CIELS	1Mo41-28.tps	48.00	9,08	38,92	23.94	18.52	62.76	296.37	
		55M6m tos - 24	34 CIFLV	1Mo41-29.tps	41.54	15.52	26.02	20,70	16.61	52.46	265.78	
			35 CIELV	1Mo41-30.tos	35.97	8.47	27.50	16.54	12.92	42.22	206.75	-
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To export the pairwise area deviation of the whole outline select *Display Differences* – *Area total*.

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File	Speci	men	Cluster 1	View ?																		
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		ClmP				-r-vg. IPS	0.00	59.53	54.82	74.87	41.59	44.92	42.91	37.35	30.39	39.85	40.04	44.06	35.09	34.96	37.84	4
		ClmP	Select.			nn-f-ya.TPS	54.82	34.84	0.00	36.67	21.84	42.30	25.58	35.37	31.74	25.75	32.72	29.28	38.91	33.50	27.95	2
		ClmD	Calcula	ite Mean S	ipecimen	ann-f-vg.TPS	74.87	41.30	36.67	0.00	42.62	74,99	56.53	65.58	55.43	50.60	55.67	47.29	68.20	54.00	55.52	5
		ClmP	Mark a:	s Referenc	se	-f-vg.TPS	41.59	22.75	21.84	42.62	0.00	33.69	17.36	23.48	17.53	11.29	15.77	13.62	26.17	15.01	13.31	1
		ClmD	Dicolou	Specimen		ps	44.92	45.90	42.30	74.99	33.69	0.00	19.78	13.82	28.12	27.13	23.29	33.63	11.76	28.49	21.99	2
		ClmD	Display	Coordinat	19111 La -	.tps	42.91	31.67	25.58	56.53	17.36	19.78	0.00	12.72	17.63	11.67	15.19	17.28	16.23	15.97	7.97	9
		Close	Display	Coordinal	tes	hs	37.36	35,43	35.37	65.58	23.48	13.82	12.72	0.00	18.14	16.07	12.78	22.34	8.26	16.44	11.61	1
		Clasp	Display	Differenc	es 🕨	 Area total 		43	31.74	55.43	17.53	28.12	17.63	16.07	15.94	15.84	14.09	10.43	17.82	9.54	12.81	
		Club	Export	to Data Fi	ile	Area dorsa	I	51	20.70	55.67	15.77	27.13	15.19	12.78	14.09	12.25	12.25	11.30	15.15	8 95	10.08	
		Climit	Export	to Image	File	Area ventra	al	98	29.28	47.29	13.62	33.63	17.28	22.34	16.43	12.36	11.30	0.00	24.45	10.72	15.59	1
LL .		CIMR	Export	co mago	I CLEVODINO/	Mean delta	quadrat	57	38.91	68.20	26.17	11.76	16.23	8.26	17.82	17.94	15.15	24.45	0.00	18.49	13.35	1
1 = ···		ster			CcLV6SM6m	n.tps	34.96	21.63	33.50	54.00	15.01	28.49	15.97	16.44	9.54	12.78	8.95	10.72	18.49	0.00	11.29	1
L		LOZ-a	DSOION-F-VQ	g. 1P5	CcLV7SM6m	n.tps	37.84	28.03	27.95	55.52	13.31	21.99	7.97	11.61	12.81	7.46	10.08	15.59	13.35	11.29	0.00	9
L		Caud	9 ZW8m-V	a-r.tp	CcLV8SM6m	n.tps	42.03	29.48	24.93	51.21	13.78	26.18	9.16	16.56	16.92	6.69	15.19	15.76	19.16	16.32	9.25	
L		Caud	Absolon-r-	-vg.1F	CcLV9SM6m	n.tps	36.17	34.69	27.21	54.48	18.12	24.31	13.04	15.86	11.32	12.70	16.82	18.91	16.03	15.63	10.84	1
L		Caud	-Kaurmann	-r-vg.	CcLV105M6	m.tps	40.75	17.00	26.46	51.64	12.81	26.17	10.81	14.61	16.33	7.29	13.61	13.75	17.83	13.49	9.20	2
L		Caud	-Schart-t-v	g.TPS	CcRV114m.	ups mitos	41.19 51.27	13.49	42.47	50.21	25.71	32,00	20.96	20.93	28.30	26.79	18.15	18.30	20.75	9.03	26.83	2
L	E	CcLV1	.14m.tps - 5	5	CcRV2I4m.	Incps	43.40	23.34	29.12	53.70	14.20	25.07	17.93	17.63	19.80	12.58	11.47	16.14	20.18	14.71	13.46	1
L	- E	CcLV1	SM6m.tps	-6	CcRV2SM6r	n.tos	32.55	28.05	28.31	53.89	17.50	28.01	17.06	18.18	9.57	16.13	13.83	17.04	19.02	10.92	14.89	1
L	🖻	CcLV2	214m.tps - 1	7	CcRV3SM6r	n.tps	39.92	26.11	32.71	56.98	15.55	22.61	15.34	12.18	17.01	11.35	8.54	14.65	15.15	12.84	10.88	1
L	···· 🖻	CcLV2	SM6m.tps	- 8	CcRV4SM6r	n.tps	37.05	23.89	26.32	48.56	17.12	38.50	26.75	30.08	16.21	24.54	20.84	20.25	30.63	17.29	24.15	2
L	···· 🗈	CcLV3	GF10m.tps	s-9	CcRV5SM6r	n.tps	41.32	17.47	29.35	49.73	15.91	33.28	19.96	21.59	14.66	17.08	12.02	10.17	24.13	9.26	16.44	2
L	🖻	CcLV3	SM6m.tps	- 10	CcRV6SM6r	n.tps	34.55	26.44	32.70	59.98	20.16	25.72	17.81	15.80	13.37	15.72	12.09	16.18	17.56	10.44	14.37	1
L	🗈	CcLV4	ISM6m.tps	- 11	CcRV7SM6r	n.tps	44.50	14.15	36.17	45.55	23.79	44.89	32.39	33.23	22.28	28.87	23.32	20.79	36.15	19.66	28.54	3
L	···· 🖻	CcLV5	SM6m.tps	- 12	CRV85M6F	n.tps	46.30	15.50	35.52	50.03	18.04	32.51	24.31	21.92	22.10	19.93	12.49	12.03	25.93	13.97	20.00	2
L	···· 🗈	CcLV6	SM6m.tps	- 13	CIELVIGETO	initips for	42.44	20.51	74 10	104.06	65.89	45.22	40.00 54 35	49.46	49.59 54 41	50.49	59.52	67.98	49.15	59.37	54.42	2
L	···· 🖻	CcLV7	'SM6m.tps	- 14	Clft V1Mo41	-23.tns	45.41	86.08	68.38	90.92	66.93	55.01	58.66	59.37	58.79	62.57	68.14	70.78	56.67	66.54	60.91	6
L	····· 🗈	CcLV8	SM6m.tps	- 15	ClfLV1Mo41	-26.tps	38.52	74.98	61.66	89.51	57.28	45.45	49.36	47.65	48.63	51.40	56.38	59.47	43.94	55.59	50.07	5
1	🗈	CcLV9	9SM6m.tps	- 16	ClfLV1Mo41	l-27.tps	45.04	80.23	63.50	90.52	62.20	49.98	53.22	53.15	54.21	55.35	61.92	63.41	49.68	61.09	55.06	5
	🗈	CcLV1	.0SM6m.tp	s - 17	ClfLV1Mo41	l-28.tps	48.00	82.17	71.49	100.74	65.59	49.24	55.38	54.16	54.97	59.09	63.19	68.18	51.32	62.19	56.59	5
1	···· 🗈	CcRV	1I4m.tps -	18	ClfLV1Mo41	-29.tps	41.54	76.32	57.17	80.40	57.29	47.88	48.55	50.13	50.34	51.58	58.55	59.28	47.29	57.44	51.11	4
	🖻	CcRV	1SM6m.ţos	- 19 🔳	CIFLV1Mo41	1-30.tps	35.97	79.00	63.01	87.72	59.80	47.56	52.23	50.97	50.72	56.20	60.67	64.68	48.96	58.62	53.76	5-
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The resulting sheet is a classical matrix that can easily be exported to Excel. Right click the sheet and choose *Copy Sheet*, open a new Excel table and paste the sheet into the field A3. Into field A1 write a title, copy the names of the specimen and paste it with *Paste Special – Transform* into field B2. Save the Excel file.

M	crosoft Excel - Example1(010708	8).xls [Schreibg	eschützt]											- 🗆 ×
1	🖲 Datel Bearbeiten Ansicht Einfügen Format Extras Daten Eenster 2													
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	A1 - Examp	ole 1(010708)												
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1	Example 1(010708)]												
2		Loz-absolon-	Caud 9 ZW8r	Caud Absolo	Caud-Kaufm	Caud-Scharf-	CcLV1I4m.tp	CcLV1SM6m	CcLV2l4m.tp	CcLV2SM6m	CcLV3GF10r	CcLV3SM8m	CcLV4SM8m	CcLV5Si
3	Loz-absolon-f-vg.TPS	0	54.53	54.82	74.87	41.59	44.92	42.91	37.36	30.39	39.85	40.04	44.06	31
4	Caud 9 ZVV8m-vd-f.tps	54.53	0	34.84	41.3	22.75	45.9	31.67	35.43	28.43	27.42	23.51	19.98	3
5	Caud.Absolon-f-vg.TPS	54.82	34.84	0	36.67	21.84	42.3	25.58	35.37	31.74	25.75	32.72	29.28	31
6	Caud-Kaufmann-f-vg.TPS	74.87	41.3	36.67	0	42.62	74.99	56.53	65.58	55.43	50.6	55.67	47.29	
7	Caud-Scharf-f-vg.TPS	41.59	22.75	21.84	42.62	0	33.69	17.36	23.48	17.53	11.29	15.77	13.62	20
8	CcLV1I4m.tps	44.92	45.9	42.3	74.99	33.69	0	19.78	13.82	28.12	27.13	23.29	33.63	1
9	CcLV1SM6m.tps	42.91	31.67	25.58	56.53	17.36	19.78	0	12.72	17.63	11.67	15.19	17.28	11
10	CcLV2l4m.tps	37.36	35.43	35.37	65.58	23.48	13.82	12.72	0	18.14	16.07	12.78	22.34	
11	CcLV2SM6m.tps	30.39	28.43	31.74	55.43	17.53	28.12	17.63	18.14	0	15.84	14.09	16.43	1
12	Cel V3GE10m tos	39.85	27.42	25.75	50.6	11.29	27.13	11.67	16.07	15.84	n	12.25	12 36	17
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Start Primer, select *Open* and choose your Excel table; in the pop up dialog field click *Similarities*, on the second surface, *Dissimilarities*, check that the right number of lines is imported, if not most likely a labelling mistake occurred. If everything is correct, click OK. The matrix is displayed.

🐁 Example1(010708	3)										_ 🗆 🗵
Example 1(01	0708)										
Dissimilarity (0	0 to 100)										
	Loz-absolon-1	Caud 9 ZVV8m	Caud.Absolon	Caud-Kaufma	Caud-Scharf-	CcLV1I4m.tps	CcLV1SM6m.t	CcLV2l4m.tps	CcLV2SM6m.t	CcLV3GF10m	CcLV3SM 📥
Loz-absolon-f-vg.TF											
Caud 9 ZVV8m-vd-f.t	54.53										
Caud.Absolon-f-vg.	54.82	34.84									
Caud-Kaufmann-f-v	74.87	41.3	36.67								
Caud-Scharf-f-vg.TF	41.59	22.75	21.84	42.62							
CcLV1I4m.tps	44.92	45.9	42.3	74.99	33.69						
CcLV1SM6m.tps	42.91	31.67	25.58	56.53	17.36	19.78					
CcLV2l4m.tps	37.36	35.43	35.37	65.58	23.48	13.82	12.72				
CcLV2SM6m.tps	30.39	28.43	31.74	55.43	17.53	28.12	17.63	18.14			
CcLV3GF10m.tps	39.85	27.42	25.75	50.6	11.29	27.13	11.67	16.07	15.84		
CcLV3SM6m.tps	40.04	23.51	32.72	55.67	15.77	23.29	15.19	12.78	14.09	12.25	
	44.00	40.00	20.20	47.00	40.00	22.02	47.00	22.24	40.40	40.00	Þ

Under the header *Edit* choose *Factors*, a list of the specimen is displayed, click *Factors* and select *Add*.



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You are now asked to give a name for the factor you are about to make, the name for the factor is important if you give the samples several factors (e.g. species and sex/species, sex plus individual identifier/species, sex plus origin, etc.).

The same factors are used for the statistical methods, such as Anosim or Cluster. It is possible to produce the factor lists in Excel and copy/paste them into Primer (paste only works with the menu or the keys and not the right mouse button); this is helpful since it might speed up the process of labelling. In the Factors menu you can also define a plot key plus you can move the given factors up and down, which makes the legend easier to interpret.

To produce a MDS plot of your matrix click on Analyse and select MDS.



The program asks for the number of restarts and starts calculating. The more restarts you have the more reliable the results are, but the longer the calculation takes, ten restarts are usually sufficient. The MDS will be displayed in a new window, go to *Graph* and select *Properties*. Choose the factor and whether you want labels and/or factors displayed. The graph can be rotated in order to give the best display of the data.



ca	F.caudata det. A. Absolon (Absolon 1973)
ck	F. caudata det. A. Kaufmann (Kaufmann 1900)
CS	F. caudata, det. B. Scharf (Scharf and Keyser 1993)
с	F. caudata, lake Mondsee (det. D. Danielopol)
lf	F. lozeki female, lake Mondsee (det. D. Danielopol)
lm	F. lozeki male, lake Mondsee (det. D. Danielopol)
lfa	F. lozeki female, det A. Absolon (Absolon 1973)

Further calculations such as Cluster or ANOSIM can be performed using "Primer" as well.

References

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