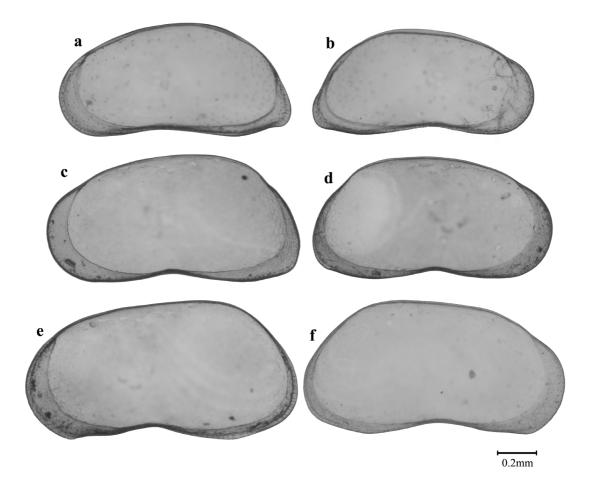
Comparison of *Fabaeformiscandona caudata* (Kaufmann) and *Fabaeformiscandona lozeki* (Absolon) from the sublittoral of Lake Mondsee

Anika Stracke¹, Dan L. Danielopol², Laurent Picot³

¹Heinrichstrasse 55, A-8010 Graz (E-Mail: anika_boriss@yahoo.com).
²Commission for the Stratigraphical & Palaeontological Research of Austria, Austrian Academy of Sciences. c/o Institute of Earth Sciences (Geology & Palaeontology), University of Graz, Heinrichstrasse 26, A-8010 Graz (E-Mail: dan.danielopol@oeaw.ac.at).
³Avenue des Vendeens 71, F-50400 Grandville (E-Mail: laurent.picot@lavache.com).



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.

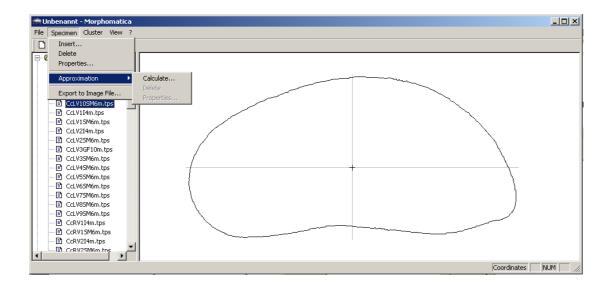
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The pictures are transformed to a bitmap in a program such as Adobe Photoshop, to enable digitalizing with tps.dig. Collect the specimen you want to compare in one folder, this is not obligatory, but will help keep things organised.

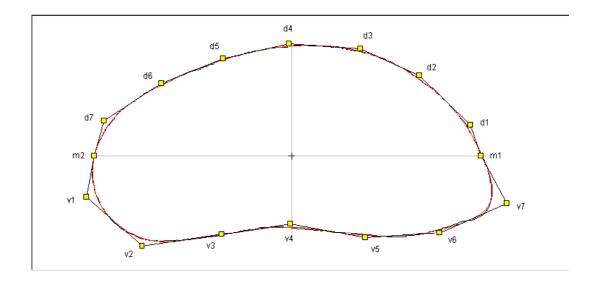
Open MORPHOMATICA, click on *Specimen* in the menubar and choose *Insert*. A dialog field opens where the samples that you want to compare are selected.

File Specimen Cluster View ? Cluster View ? ? ?		
 E-Cost Specimen Cluster 	Open 2 × Look in: • example 3 tps • You c • Caud 9 ZW8m-vd-f.tps • Caud Absolon-f-vg.TPS • CcLV15M6m.tps • Caud-Absolon-f-vg.TPS • CcLV2SM6m.tps • Caud-Asolon-f-vg.TPS • CcLV2SM6m.tps • Caud-Scharf-f-vg.TPS • CcLV2SM6m.tps • Caud-Scharf-f-vg.TPS • CcLV3SM6m.tps • CcLV0SM6m.tps • CcLV3SM6m.tps • CcLV10Mom.tps • CcLV3SM6m.tps • CcLV10Mom.tps • CcLV3SM6m.tps • CcLV10Mom.tps • CcLV3SM6m.tps • CcLV10Mom.tps • CcLV3SM6m.tps • CcLV114m.tps • CcLV4SM6m.tps • CcLV114m.tps • CcLV4SM6m.tps • Claude • Claude • File name: • Dpen • Files of type: All Specimen Files (*.tps;*.msd) Cancel	
Ready	Coordinates NUP	1 //.

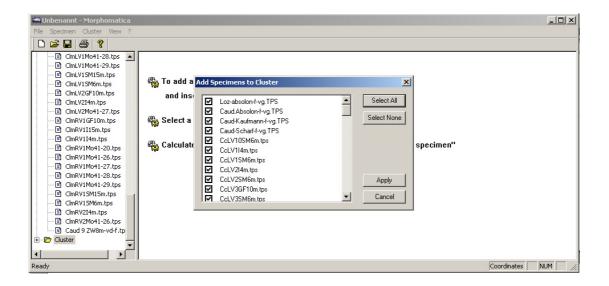
To see the fit of the calculated outline select *Approximation* under *Specimen* in the menubar.



It might be useful to change the number of control points to get a better resemblance between the calculated and the real shape.



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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		Cluster View ?		L								
ונ	🖻 🖬	Insert										
-	- 🖻 ClmR	Delete		en	Area total	Area dorsal	Area ventral	Mean Delta-Square	Mean Delta	Max Delta	Sum Delta	Surr
-	🖻 ClmR	Properties		solon-f-vg.TPS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
	- 🖻 ClmR	Select		ZW8m-vd-f.tps	54.53	18.16	36.37	26.78	22.00	71.38	351.95	
	- 🖻 ClmR	Calculate Mean 9		Absolon-f-vg.TPS	54.82	19.62	35.20	27.35	24.70	45.69	395.21	
	ClmR			aufmann-f-vg.TPS	74.87	23.12	51.75	34.63	29.72	78.26	475.56	
	- 🖹 ClmR -	Mark as Referen	ce	icharf-f-vg.TPS	41.59	13.09	28.50	23.23	18.91	58.92	302.60	
-		piedes cardon		4m.tps	44.92	18.96	25.97	20.72	18.05	39.90	288.73	
-0	Cluster	Display Specimer		iM6m.tps	42.91	17.45	25.46	22.96	19.59	46.74	313.43	
ľ		🖌 Display Coordina		4m.tps	37.36	15.74	21.62	20.79	16.53	49.53	264.45	
-	- 🖻 Caud	Display Difference	ies 🕨	iM6m.tps	30.39	11.79	18.60	15.46	13.31	33.06	213.00	
-	🗈 Caud -			= 5F10m.tps	39.85	15.59	24.26	21.29	18.43	49.07	294.83	
	- 🖻 Caud	Export to Data F	ile	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	
	- 🗈 Calvii	4m tos - 5		55M6m.tps	36.09	16.42	19.67	17.67	15.53	32.73	248.41	
		M6m.tps - 6		6SM6m.tps	34.96	14.27	20.70	17.93	14.79	43.83	236.68	
				7SM6m.tps	37.84	14.65	23.19	19.75	16.41	46.17	262.59	
	🖹 CcLV2I			85M6m.tps	42.03	16.11	25.92	23.66	19.17	56.80	306.71	
		M6m.tps - 8		95M6m.tps	36.17	12.99	23.17	18.50	15.87	36.98	253.92	
-		GF10m.tps - 9		10SM6m.tps	40.75	17.59	23.16	21.38	17.76	52.95	284.10	
-	🖹 CcLV39	M6m.tps - 10		/1I4m.tps	41.19	16.39	24.80	22.72	19.19	58.72	307.10	
	- 🖹 CalV49	M6m.tps - 11		1SM6m.tps	51.27	19.06	32.21	25.76	21.45	64.15	343.27	
	- 🗈 Cri V59	M6m.tps - 12		/2I4m.tps	43.40	16.86	26.54	25.67	21.72	62.43	347.49	
		M6m.tps - 13		/2SM6m.tps	32.55	13.02	19.54	18.85	15.90	41.36	254.38	
		M6m.tps - 14		/35M6m.tps	39.92	17.02	22.91	23.44	19.23	62.42	307.72	
ſ	_			4SM6m.tps	37.05	13.10	23.95	21.01	18.04	37.78	288.58	
ľ	_	M6m.tps - 15		/SSM6m.tps	41.32	17.00	24.32	22.06	18.84	51.86	301.46	
-	_	M6m.tps - 16		65M6m.tps	34.55	15.09	19.45	19.42	16.87	42.67	269.99	
-	_)SM6m.tps - 17		7SM6m.tps	44.50	13.77	30.73	21.52	18.55	46.53	296.83	
-	🖹 CcRV1)	(4m.tps - 18		/8SM6m.tps	46.30	17.46	28.84	25.65	21.12	67.67	337.89	
	- 🖻 CcRV19	5M6m.tps - 19		1GF10m.tps	41.41	10.05	31.36	22.28	18.23	46.93	291.75	
	- 🖹 CcRV21	(4m.tps - 20		1I4m.tps	42.44	7.73	34.71	20.13	16.40	42.73	262.33	
		5M6m.tps - 21		1Mo41-23.tps	45.41	12.97	32.44	20.74	17.24	51.05	275.78	
		5M6m.tps - 22		1Mo41-26.tps	38.52	11.75	26.77	17.85	15.34	42.59	245.36	
1				1Mo41-27.tps	45.04	14.82	30.22	22.25	18.85	57.08	301.55	
1	-	5M6m.tps - 23		1Mo41-28.tps	48.00	9.08	38.92	23.94	18.52	62.76	296.37	
-		5M6m.tps - 24 🖵		1Mo41-29.tps	41.54	15.52	26.02	20.70	16.61	52.46	265.78	
÷	B course		35 CI£LV	1Mo41-30.tos	35.97	8.47	27.50	16.54	12.92	42.22	206.75	

To export the pairwise area deviation of the whole outline select *Display Differences* – *Area total*.

		Morphomatica 1	.6																_1	
File	Specimen	Cluster View ?		L																
	🖻 🖬 🛛	Insert Delete																		
	ClmR	Properties			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	<u></u> ▲
	- ClmR			-f-vg.TPS	0.00	54.53	54.82	74.87	41.59	44.92	42.91	37.36	30.39	39.85	40.04	44.06	36.09	34.96	37.84	4
	🖹 ClmR	Select		m-vd-f.tps on-f-va.TPS	54.53 54.82	0.00 34.84	34.84 0.00	41.30 36.67	22.75 21.84	45.90 42.30	31.67 25.58	35.43 35.37	28.43 31.74	27.42 25.75	23.51 32.72	19.98 29.28	37.57 38.91	21.63 33.50	28.03 27.95	2
	ClmR	Calculate 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
	ClmR	Mark as Reference	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
	🖹 ClmR 🖹 ClmR	Display 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
	⊡ ClmR ⊡ ClmR			.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
		Display Coordinal		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
	🗈 ClmR 🗈 ClmR	Display Differenc	es 🕨	🖌 Area total		43	31.74 25.75	55.43 50.60	17.53	28.12 27.13	17.63	18.14 16.07	0.00	15.84 0.00	14.09 12.25	16.43 12.36	17.82 17.94	9.54 12.78	12.81 7.46	1
	⊡ ClmR ⊡ ClmR	Export to Data Fi	ile	Area dorsal		42	32.72	55.67	15.77	27.13	15.19	12.78	15.84	12.25	0.00	12.36	17.94	12.78	10.08	-
	⊡ ClmR ■ ClmR	Export to Image		Area ventra		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
4.6		Export to Image	CULVODINION	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
e		bsolon-f-va.TPS	CcLV6SM6n		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
		9 ZW8m-vd-f.tp	CcLV7SM6n		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
		Absolon-f-vg.TF	CcLV8SM6n		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	0
		Kaufmann-f-vg.	CcLV95M6n CcLV105M6		36.17 40.75	34.69 27.73	27.21 26.46	54.48 51.64	18.12 12.81	24.31 26.17	13.04 10.81	15.86 14.61	11.32 16.33	12.70 7.29	16.82 13.61	18.91 13.75	16.03 17.83	15.63 13.49	10.84 9.20	1
	_	-Scharf-f-vg.TPS	CcRV105Me		41.19	17.20	31.52	51.64	16.65	32.68	20.96	20.93	16.02	16.38	11.96	10.70	23.75	9.83	9.20	r i
		I4m.tps - 5	CcRV15M6r		51.27	13.48	42.47	52.32	25.71	37.66	30.93	27.63	28.30	26.79	18.15	18.30	30.67	19.74	26.83	2
		SM6m.tps - 6	CcRV2I4m.		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
		214m.tps - 7	CcRV2SM6r		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
		29m.cps - 7 25M6m.tps - 8	CcRV3SM6r		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
		GF10m.tps - 9	CcRV4SM6r		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
			CcRV55M6r		41.32	17.47 26.44	29.35 32.70	49.73 59.98	15.91 20.16	33.28 25.72	19.96 17.81	21.59 15.80	14.66 13.37	17.08 15.72	12.02 12.09	10.17	24.13 17.56	9.26 10.44	16.44 14.37	2
		ISM6m.tps - 10 ISM6m.tps - 11	CcRV65M6r CcRV75M6r		34.55 44.50	26.44	36.17	45.55	20.16	44.89	32.39	33.23	22.28	28.87	23.32	20.79	36.15	19.66	28.54	3
		5M6m.tps - 11 55M6m.tps - 12	CcRV85M6r		46.30	15.50	36.52	50.03	18.04	32.51	24.31	21.92	22.20	19.93	12.49	12.03	25.93	13.97	20.00	2
			CIFLV1GF10		41.41	76.51	58.48	83.09	57.45	47.23	48.88	51.23	49.59	53.49	59.52	61.90	49.15	57.46	51.81	5
		5M6m.tps - 13 75M6m.tps - 14	ClfLV1I4m.	tps	42.44	80.29	74.19	104.06	65.89	45.22	54.35	49.46	54.41	59.14	59.90	67.98	48.09	59.37	54.42	5
		SM6m.tps - 15	ClfLV1Mo41		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
	_		ClfLV1Mo41		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
		SM6m.tps - 16	ClfLV1Mo41		45.04	80.23 82.17	63.50 71.49	90.52 100.74	62.20 65.59	49.98 49.24	53.22 55.38	53.15 54.16	54.21 54.97	55.35 59.09	61.92 63.19	63.41 68.18	49.68 51.32	61.09 62.19	55.06 56.59	5
		.05M6m.tps - 17 1I4m.tps - 18	ClfLV1Mo41 ClfLV1Mo41		48.00 41.54	82.17	71.49	100.74	57.29	49.24	48.55	54.16 50.13	54.97	59.09	63.19 58.55	68.18 59.28	51.32 47.29	62.19 57.44	56.59	4
		114m.tps - 18 15M6m.tps - 19	ClfLV1Mo41		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
	I=1 CCRV	1 DIVIOM. CDS - 19			50177	1	30101	37172	57100	1100	JEIEO	30177	50172	50.20	30107	51100	10100	50102	55170	F
																[Coordina	tor	NUM	2
																1	coordina	ices	NOM	

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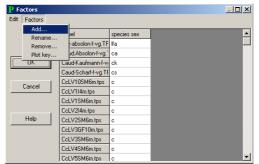
The resulting sheet is a classical matrix that can easily be exported to Excel. Right click the sheet and choose *Copy Sheet*, open a new Excel table and paste the sheet into the field A3. Into field A1 write a title, copy the names of the specimen and paste it with *Paste Special – Transform* into field B2. Save the Excel file.

Microsoft Excel - Example1(01070	8).xls [Schreibge	eschützt]											_ 🗆 ×
Datei Bearbeiten Ansicht Einfügen	Forma <u>t</u> E <u>x</u> tras	Daten Eenster	2										_ 8 ×
0 🗃 🖬 🔗 🖨 🗟 🖤 👗 🖣	b 🛍 ダ 🗠 -	· C4 - 🍓 Σ	f≈ 2↓ Z↓	100%	Calibri		11 - F A	: ⊻ ≡ ≡	≣ 🗟 😵 €	% 000 % 4	3 🗊 💷 🔛	• 👌 • <u>A</u> • ,	-
A1 = Examp	ole 1(010708)												
A	В	С	D	E	F	G	Н	1	J	K	L	M	N 🗖
1 Example 1(010708)	1												
2	Loz-absolon-	Caud 9 ZW8r	Caud Absolo	Caud-Kaufm:	Caud-Scharf-	CcLV1I4m.tp	CcLV1SM8m	CcLV2l4m.tp	CcLV2SM8m	CcLV3GF10r	CcLV3SM6m	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		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		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			0	15.84			1
12 Ccl V3GE10m tos	39.85 elle3 /	77 47	25 75	50.6	11.79	77.13	11.67	16.07	15.84	n	12.25	12.36	٦٢
Bereit							1_1_					NF	

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.

Example 1(01)	0708)										
Dissimilarity (0											
	, 10 , 00)										
	Loz-absolon-1	Caud 9 ZVV8m	Caud.Absolon	Caud-Kaufma	Caud-Scharf-	CcLV1I4m.tps	CcLV1SM6m.t	CcLV2l4m.tps	CcLV2SM6m.t	cLV3GF10m	CLV39
.oz-absolon-f-vg.TF											
Caud 9 ZVV8m-vd-f.t	54.53										
Caud.Absolon-f-vg.	54.82	34.84									
aud-Kaufmann-f-v	74.87	41.3	36.67								
aud-Scharf-f-vg.TR	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			
cLV3GF10m.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	

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



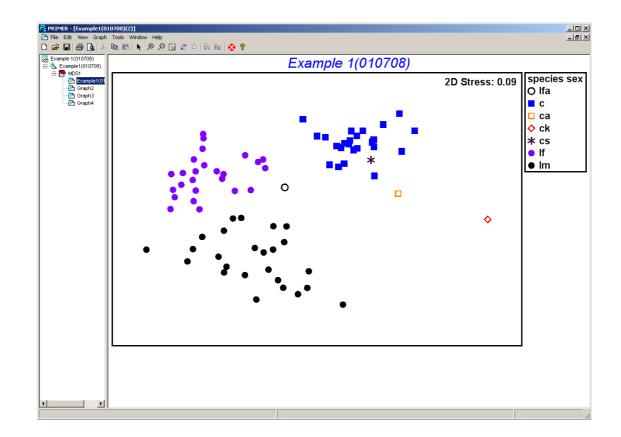
You are now asked to give a name for the factor you are about to make, the name for the factor is important if you give the samples several factors (e.g. species and sex/species, sex plus individual identifier/species, sex plus origin, etc.).

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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