

iso-electric point of bovine albumin is 4.7. The iso-electric points of the fractions studied in this case ranged from 5.41 to 5.81 (table 12) and molecular weights ranged from 55,500 to 89,100 (excluding fractions 18 from L. capensis and L. umbratus). These figures can not be equated with any other data available but it is quite possible that some of the fractions studied could be albumins. (The similarities observed between the titration curves of fraction 13 and albumin (fig. 16) would strengthen this concept). Fractions 13 from the two mudfish species had low pI but high molecular weights. These fractions always contained the greatest percentage protein and could therefore serve as an albumin (human nomenclature). The naming of these fractions must however, await more detailed investigations and results.

The results obtained on the fractions in 0.1% S.D.S. gels indicate two things. In the first place, the proteins studied from L. capensis (fractions 13 and 15) are two distinct proteins and in the second place, the form usually seen in the gel pattern is probably a dimer (molecular weight measurements bear this out). If bands 13 and 15 were the same protein, the one a monomer and the other a dimer, only one identical band would have been seen on gel electrophoresis with S.D.S. (Gordon, 1969). This was not the case and it is therefore concluded that fractions 13 and 15 are separate proteins with similar molecular weights, different iso-electric points and existing in a dimeric form.

According to Lepkovsky (1930) and others (see table 1) the A/G ratio of fish is low compared to that of the mammal. From the presented results it is not possible to agree with this statement

as to reject it, seeing that it could not be shown whether any of the fractions studied were albumins or globulins. From the precipitation results it is definitely not clear what is precipitated and what is not (albumin or globulin). It is therefore at present not possible to give values for the A/G ratio of the species studied. It is wiser to agree with Mulcahy (1970) who doubts the value of the human nomenclature when applied to fish patterns.

An aspect of the plasma protein pattern which has not been mentioned as yet, is the presence of hemoglobin in plasma. Hattingh (1973) and Du Toit et al (1933) have shown that in normal healthy fish of all four species the plasma hemoglobin content ranges from 1,4 to 10,75 mg %. The gel electrophoresis system used is sensitive enough to show these bands. The bands which in all probability contain minute amounts of hemoglobin are no. 6 and 13 in L. capensis; bands 8 and 13 in L. umbratus; band 20 in C. gariepinus and bands 8 and 12 in B. holubi. In all cases these correspond to major plasma protein bands, but the iso-electric points of the hemoglobin are all above 6 (Hattingh, 1973). It is not implied here that these bands contain only hemoglobin; the relative mobilities of certain plasma protein bands correspond. In the case of B. holubi, fraction 8 was shown to absorb strongly at 410 nm (p38). All other fractions studied showed no absorption at this wavelength and were therefore devoid of hemoglobin. These points are important and should be borne in mind in the isolation and study of fish plasma proteins.

Finally, it is suggested that for future work on the plasma proteins of these species, blood from 8 $\pm$ 10 animals should be pooled after preliminary gel electrophoresis. Blood from animals having identical patterns (number and position of bands) is then used and the amount of protein obtained would then be workable (biochemical analyses).

The influence of age, pollution, diet, stage of life cycle and sexual activity must also be investigated to obtain a comprehensive picture of the influence of environmental and other factors on the patterns and only then it would be possible to give an accurate account of the plasma proteins of these fish.

6. CONCLUSIONS

From the presented results the following is concluded:

- (a) Characteristic protein patterns can be obtained on cellulose-acetate and polyacrylamide-gel electrophoresis from the plasma of L. capensis, L. umbratus, C. gariepinus and B. holubi: These patterns have certain features in common but are sufficiently distinct for species identification.
- (b) Variations occur within a given framework for any one species and these are not related to body, weight, body length, sex or sexual activity within the range of animals studied. Unidentified environmental and other factors probably influence the patterns obtained.
- (c) The application of the human nomenclature to the patterns

of fish plasma proteins is not a recommendable technique and the various fish fractions should only be named after extensive biochemical analyses.

- (d) The proteins isolated from plasma have approximate molecular weights ranging from 55,000 to above 120,000 and isoelectric points ranging from 5.81 to 3.8. At least some of these proteins exist in dimeric form.
- (e) Care should be exercised in regarding all fractions obtained on plasma electrophoresis as purely plasma proteins. Plasma hemoglobin fractions are present and can cause incorrect deductions.

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8. APPENDICS.

FIGURES AND TABLES.

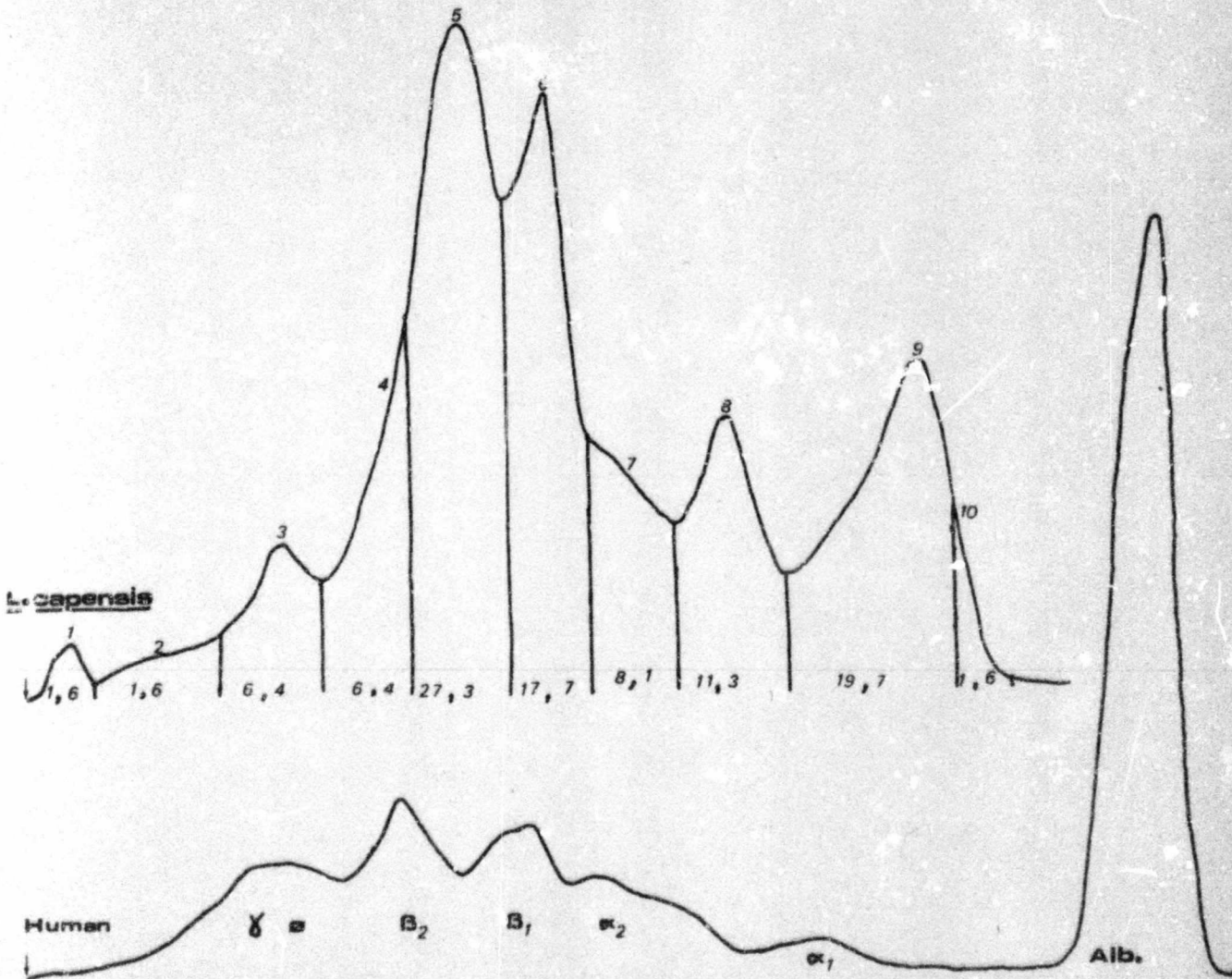


Fig. 1. Typical paper electrophoretogram of *L. capensis* and human plasma proteins. Origin on the left (arrow). Percentage protein indicated under curve.

TABLE 2
Lebeo capensis
Paper electrophoresis

Fish	Length cm	Weight gm	Sex	Hemo- toctrit %	Plasma- Protein mg/ml	Locality Winter	% Protein fractions (slowest to fastest)										Protein mg/ml Fractions (slowest to fastest)														
							Fractions (slowest to fastest)										1	2	3	4	5	6	7	8	9	10					
							1	2	3	4	5	6	7	8	9	10															
1	36.1	128	m	25.5	35.6	Barrage	1.5	6.4	6.4	10.6	21.2	14.9	6.4	10.6	19.1	2.1	0.53	2.28	2.83	7.6	7.55	3.02	2.83	7.6	6.80	7.75					
2	35.3	560	m3-4	28.3	36.8	Barrage	1.3	4.5	13.5	6.5	27.2	11.4	6.5	11.4	15.9	2.3	0.36	1.64	4.96	2.39	10.1	1.19	2.39	1.19	5.84	1.84					
3	32.0	512	m	30.8	30.2	Barrage	1.8	1.8	5.4	5.4	25.0	19.6	10.7	12.5	16.0	1.8	0.54	0.54	1.63	1.63	7.55	5.92	3.23	3.76	4.83	0.54					
4	30.0	503	m	33.8	38.7	Barrage	1.7	1.7	7.0	7.0	24.6	19.3	10.5	10.5	14.0	3.5	0.65	0.65	2.71	2.71	8.51	7.45	4.06	4.06	5.42	1.35					
5	31.0	509	m	35.8	39.0	Barrage	1.6	1.6	6.4	6.4	27.3	17.7	8.1	11.3	17.7	1.5	0.62	0.62	2.49	2.49	10.20	5.90	3.16	3.16	6.90	0.62					
6	32.0	568	m	32.6	30.8	Barrage	2.1	2.6	7.9	7.9	15.8	26.3	7.9	13.2	21.2	2.6	0.60	0.60	2.43	2.43	8.68	10.2	4.34	4.34	4.06	0.60					
7	33.0	675	m	25.6	17.6	Barrage	4.8	4.8	9.5	14.3	19.1	9.5	19.1	9.5	9.5	4.8	0.84	0.84	1.67	2.51	3.35	1.67	3.35	1.67	1.67	0.84					
8	32.5	568	f	28.2	32.0	Barrage	1.9	1.9	7.0	5.8	23.1	19.2	5.8	19.2	5.8	8.9	0.99	0.99	2.24	2.94	7.40	6.31	1.95	6.31	1.86	2.85					
9	31.5	578	f	26.0	43.2	Barrage	2.3	2.3	9.1	9.1	25.0	11.9	6.8	13.6	11.3	6.5	1.11	1.11	1.11	3.64	3.64	12.00	7.64	3.27	5.53	5.43	2.16				
10	29.0	433	m	39.2	44.0	Barrage	2.3	2.3	9.1	9.1	25.0	11.9	6.8	13.6	11.3	6.5	0.94	0.94	2.53	3.33	7.55	9.61	3.33	7.55	4.96	1.68					
11	36.5	732	m	42.0	49.6	Barrage	1.7	5.1	16.7	15.2	20.0	17.1	5.1	11.5	20.0	5.7	0.85	0.85	1.73	2.58	5.09	5.20	4.34	3.47	2.58	1.73					
12	42.0	922	f	27.6	30.4	Barrage	2.8	2.8	5.7	8.5	20.0	17.1	14.3	11.4	18.5	4.4	0.54	0.54	1.69	1.69	8.00	8.45	2.76	4.27	7.21	1.69					
13	35.4	598	f	41.8	38.4	Barrage	1.4	1.4	4.4	4.4	23.2	24.6	7.2	11.5	18.8	3.3	0.79	0.79	3.11	3.11	12.32	15.16	1.83	1.16	9.95	6.18	1.53				
14	38.2	837	m	33.8	46.4	Barrage	1.7	1.7	6.7	5.0	33.0	13.3	6.7	15.0	13.3	3.3	0.32	0.32	2.15	2.15	16.40	30.46	9.64	1.16	1.41	12.15					
15	33.0	508	f	22.0	32.0	Barrage	1.0	2.2	6.7	6.7	13.3	31.1	15.5	13.3	4.4	6.7	0.57	0.57	2.33	2.33	9.40	8.21	2.91	1.59	5.62	1.16					
16	36.6	697	f	43.0	38.8	Barrage	1.5	1.5	6.0	7.5	24.2	21.2	7.5	12.1	15.0	3.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
17	37.5	706	f	20.8	38.4	Villiers	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
18	29.5	340	m	26.8	36.0	Barrage	1.5	3.1	7.7	7.7	23.1	16.9	16.9	10.8	9.2	1.5	0.38	0.38	1.95	1.95	5.83	4.26	4.26	2.72	2.32	0.38					
19	36.0	876	f	26.9	25.2	Barrage	2.5	2.5	10.0	8.7	21.2	25.0	10.0	8.7	8.7	2.5	0.76	0.76	3.40	2.65	6.45	7.60	3.40	2.65	2.65	0.76					
20	33.0	682	m	34.0	30.4	Barrage	3.3	1.9	9.6	9.6	26.6	9.6	13.5	7.7	15.4	1.9	1.28	0.63	3.23	3.23	9.03	9.23	4.54	2.59	5.17	0.63					
21	30.0	1003	f	29.7	33.6	Barrage	4.5	3.4	12.2	12.2	19.5	14.6	7.3	9.8	12.2	4.9	1.99	0.96	4.87	4.87	7.81	5.83	2.92	5.92	4.67	1.99					
22	31.5	561	f	18.4	40.0	Barrage	2.2	2.7	7.7	8.3	20.9	19.1	9.7	11.9	12.6	3.6	0.76	0.76	2.77	2.95	7.94	5.94	3.32	4.33	4.59	1.27					
Mean				30.6-6.9	35.9-7.4																										
Distance from point of application (mm)																															
							0.5	2.0	4.0	6.5	7.5	10.0	11.5	15.0	17.5	19.0															
Relative mobility %																															
							2.6	10.5	21.3	33.9	52.7	60.5	79.0	92.5	100																

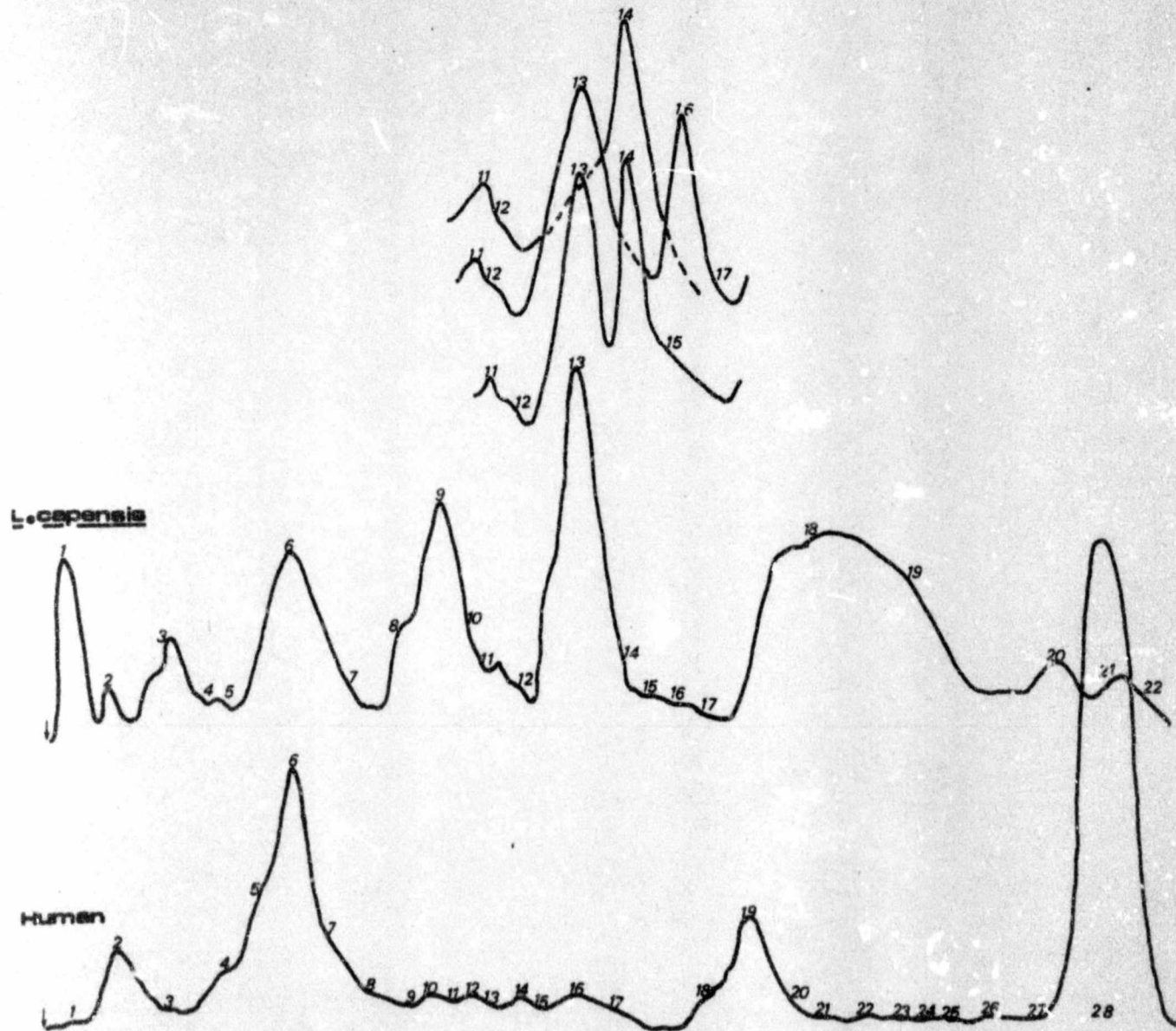


Fig. 2. Typical polyacrylamide gel electrophoresis of L. capensis plasma compared to that of the human. Origin on left. Variations in the pattern are observed in fractions 13 - 16. (Variations in percentage protein of existing bands).

TABLE 3

Labco capensis
Gel Electrophoresis

		Fractions (slowest to fastest)																					
		Protein %																					
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
1	6.7	0.9	1.9	1.9	1.4	1.9	5.7	2.9	1.9	3.2	1.4	1.4	1.4	8.6	7.6	7.6	1.9	2.9	27.9	5.3	7.2	3.3	3.3
2	2.0	1.0	6.9	1.4	1.4	1.4	4.6	3.0	4.6	4.6	1.4	1.4	1.4	7.6	7.6	7.6	2.9	1.8	27.9	4.4	3.3	1.6	2.3
3	3.0	2.2	2.4	1.5	5.2	4.6	3.0	1.9	1.9	1.9	2.2	1.5	1.5	2.2	2.2	2.2	6.7	2.2	2.2	3.4	3.0	3.0	2.2
4	6.0	1.3	3.8	1.9	1.9	3.8	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	4.4	3.2	2.2	28.4	3.8	5.0	2.5
5	3.6	1.4	3.6	2.9	1.9	1.9	2.9	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	4.3	3.6	2.2	23.1	4.3	5.8	2.9
6	4.0	1.6	3.2	1.6	2.4	2.9	4.5	4.5	2.4	2.4	1.6	1.6	1.6	3.2	3.2	3.2	4.0	8.1	4.0	21.0	4.6	6.5	2.4
7	6.7	2.2	3.4	1.4	4.5	5.6	2.4	2.4	2.4	2.4	2.4	2.4	2.4	5.6	5.6	5.6	11.2	4.5	3.4	4.5	4.5	4.5	4.5
8	4.0	1.6	2.6	2.1	4.1	5.6	2.4	2.4	2.4	2.4	2.4	2.4	2.4	5.6	5.6	5.6	11.2	4.5	3.4	4.5	4.5	4.5	4.5
9	2.2	0.5	2.2	1.6	2.7	3.8	3.8	3.8	2.2	2.2	2.2	2.2	2.2	3.8	3.8	3.8	7.6	3.7	2.2	23.6	4.9	7.6	2.7
10	1.7	1.1	4.0	2.3	2.9	2.9	4.5	4.5	2.2	2.2	2.2	2.2	2.2	4.5	4.5	4.5	9.0	2.5	2.5	25.0	4.5	4.5	2.7
11	3.0	2.0	5.0	3.0	1.5	4.0	4.0	4.0	3.0	3.0	3.0	3.0	3.0	4.0	4.0	4.0	3.8	3.7	3.7	23.6	4.9	7.6	2.7
12	4.5	1.9	1.9	2.6	1.9	4.5	4.5	4.5	2.6	2.6	2.6	2.6	2.6	4.5	4.5	4.5	9.0	2.5	2.5	25.0	4.5	4.5	2.7
13	4.0	1.5	6.0	1.5	2.0	5.0	5.0	5.0	2.0	2.0	2.0	2.0	2.0	5.0	5.0	5.0	2.6	8.3	2.6	21.2	5.1	4.5	2.6
14	2.6	1.5	2.3	2.3	3.0	4.5	4.5	4.5	2.3	2.3	2.3	2.3	2.3	4.5	4.5	4.5	2.6	8.3	2.6	21.2	5.1	4.5	2.6
15	2.6	1.5	2.3	2.3	3.0	4.5	4.5	4.5	2.3	2.3	2.3	2.3	2.3	4.5	4.5	4.5	2.6	8.3	2.6	21.2	5.1	4.5	2.6
16	3.3	1.6	3.5	2.5	2.5	2.5	2.5	2.5	3.5	3.5	3.5	3.5	3.5	2.5	2.5	2.5	2.6	8.3	2.6	21.2	5.1	4.5	2.6
17	2.6	0.8	2.6	2.6	2.1	3.4	3.4	3.4	2.6	2.6	2.6	2.6	2.6	3.4	3.4	3.4	2.6	8.3	2.6	21.2	5.1	4.5	2.6
18	2.3	1.4	4.2	0.9	3.1	4.6	4.6	4.6	2.3	2.3	2.3	2.3	2.3	4.6	4.6	4.6	2.6	8.3	2.6	21.2	5.1	4.5	2.6
19	2.8	1.2	2.0	0.8	1.6	3.2	3.2	3.2	2.8	2.8	2.8	2.8	2.8	3.2	3.2	3.2	2.6	8.3	2.6	21.2	5.1	4.5	2.6
20	1.5	1.6	5.0	0.5	1.6	3.9	3.9	3.9	1.5	1.5	1.5	1.5	1.5	3.9	3.9	3.9	2.6	8.3	2.6	21.2	5.1	4.5	2.6
21	1.5	1.6	5.0	0.5	1.6	3.9	3.9	3.9	1.5	1.5	1.5	1.5	1.5	3.9	3.9	3.9	2.6	8.3	2.6	21.2	5.1	4.5	2.6
22	3.9	1.6	3.9	1.5	3.1	3.1	3.1	3.1	3.9	3.9	3.9	3.9	3.9	3.1	3.1	3.1	2.6	8.3	2.6	21.2	5.1	4.5	2.6
Mean	3.8	1.4	3.5	1.7	2.6	4.6	2.5	3.2	2.2	1.9	1.9	1.9	1.9	2.2	8.0	5.9	3.7	3.8	2.7	21.7	4.4	4.9	2.7
		Distance from point of application (mm)																					
0.5	1.5	2.5	3.0	5.5	7.0	7.5	11.5	14.0	16.0	17.5	18.5	20.0	22.5	24.5	28.0	32.5	37.5	46.0	52.0	54.0	54.0	56.0	56.0
		Relative mobility %																					
1	3	4	5	10	12	13	20	25	29	31	33	36	40	44	50	58	67	82	93	96	100	100	100
		Protein mg/ml																					
		Fractions (slowest to fastest)																					
1	2.21	0.32	0.66	0.48	0.68	2.30	1.03	0.69	1.17	0.48	0.48	0.48	0.48	3.06	2.67	0.68	0.68	1.03	9.80	1.09	2.56	1.17	1.17
2	1.03	0.66	0.66	0.66	0.66	1.69	0.84	1.69	1.69	0.66	0.66	0.66	0.66	2.67	2.67	0.68	0.68	1.03	9.80	1.09	2.56	1.17	1.17
3	0.91	0.67	0.67	0.67	0.67	1.69	0.84	1.69	1.69	0.66	0.66	0.66	0.66	2.67	2.67	0.68	0.68	1.03	9.80	1.09	2.56	1.17	1.17
4	1.26	0.67	0.67	0.67	0.67	1.69	0.84	1.69	1.69	0.66	0.66	0.66	0.66	2.67	2.67	0.68	0.68	1.03	9.80	1.09	2.56	1.17	1.17
5	1.41	0.64	1.41	1.13	0.54	1.76	0.76	1.76	1.76	0.66	0.66	0.66	0.66	2.67	2.67	0.68	0.68	1.03	9.80	1.09	2.56	1.17	1.17
6	1.23	0.64	0.99	0.43	0.74	1.76	0.76	1.76	1.76	0.66	0.66	0.66	0.66	2.67	2.67	0.68	0.68	1.03	9.80	1.09	2.56	1.17	1.17
7	1.54	0.39	0.60	0.19	0.74	0.99	0.79	0.79	0.79	0.66	0.66	0.66	0.66	2.67	2.67	0.68	0.68	1.03	9.80	1.09	2.56	1.17	1.17
8	0.95	0.22	0.35	0.59	1.17	1.68	1.68	1.68	1.68	0.66	0.66	0.66	0.66	2.67	2.67	0.68	0.68	1.03	9.80	1.09	2.56	1.17	1.17
9	0.82	0.22	0.35	0.59	1.17	1.68	1.68	1.68	1.68	0.66	0.66	0.66	0.66	2.67	2.67	0.68	0.68	1.03	9.80	1.09	2.56	1.17	1.17
10	1.49	0.53	0.58	0.99	1.49	0.74	1.99	0.99	0.99	0.66	0.66	0.66	0.66	2.67	2.67	0.68	0.68	1.03	9.80	1.09	2.56	1.17	1.17
11	1.37	0.53	0.58	0.99	1.49	0.74	1.99	0.99	0.99	0.66	0.66	0.66	0.66	2.67	2.67	0.68	0.68	1.03	9.80	1.09	2.56	1.17	1.17
12	1.53	0.53	0.58	0.99	1.49	0.74	1.99	0.99	0.99	0.66	0.66	0.66	0.66	2.67	2.67	0.68	0.68	1.03	9.80	1.09	2.56	1.17	1.17
13	1.07	0.69	1.07	1.07	1.07	2.03	1.39	1.39	1.39	0.66	0.66	0.66	0.66	2.67	2.67	0.68	0.68	1.03	9.80	1.09	2.56	1.17	1.17
14	1.28	0.61	1.07	1.07	1.07	2.03	1.39	1.39	1.39	0.66	0.66	0.66	0.66	2.67	2.67	0.68	0.68	1.03	9.80	1.09	2.56	1.17	1.17
15	3.01	0.61	1.07	1.07	1.07	2.03	1.39	1.39	1.39	0.66	0.66	0.66	0.66	2.67	2.67	0.68	0.68	1.03	9.80	1.09	2.56	1.17	1.17
16	0.76	0.35	0.96	0.35	0.96	2.51	1.42	1.42	1.42	0.66	0.66	0.66	0.66	2.67	2.67	0.68	0.68	1.03	9.80	1.09	2.56	1.17	1.17
17	0.76	0.35	0.96	0.35	0.96	2.51	1.42	1.42	1.42	0.66	0.66	0.66	0.66	2.67	2.67	0.68	0.68	1.03	9.80	1.09	2.56	1.17	1.17
18	0.76	0.35	0.96	0.35	0.96	2.51	1.42	1.42	1.42	0.66	0.66	0.66	0.66	2.67	2.67	0.68	0.68	1.03	9.80	1.09	2.56	1.17	1.17
19	0.83	0.27	1.06	0.27	1.06	2.51	1.42	1.42	1.42	0.66	0.66	0.66	0.66	2.67	2.67	0.68	0.68	1.03	9.80	1.09	2.56	1.17	1.17
20	0.83	0.27	1.06	0.27	1.06	2.51	1.42	1.42	1.42	0.66	0.66	0.66	0.66	2.67	2.67	0.68	0.68	1.03	9.80	1.09	2.56	1.17	1.17
21	0.83	0.27	1.06	0.27	1.06	2.51	1.42	1.42	1.42	0.66	0.66	0.66	0.66	2.67	2.67	0.68	0.68	1.03	9.80	1.09	2.56	1.17	1.17
22	1.56	0.64	1.34	0.64	1.34	1.24	0.64	1.34	1.34	0.66	0.66	0.66	0.66	2.67	2.67	0.68	0.68	1.03	9.80	1.09	2.56	1.17	1.17
Mean	1.32	0.50	1.29	0.64	0.89	1.71	0.90	1.15	2.60	0.68	0.68	0.68	0.68	2.90	2.09	1.25	1.36	0.97	7.95	1.60	1.78	0.93	0.89

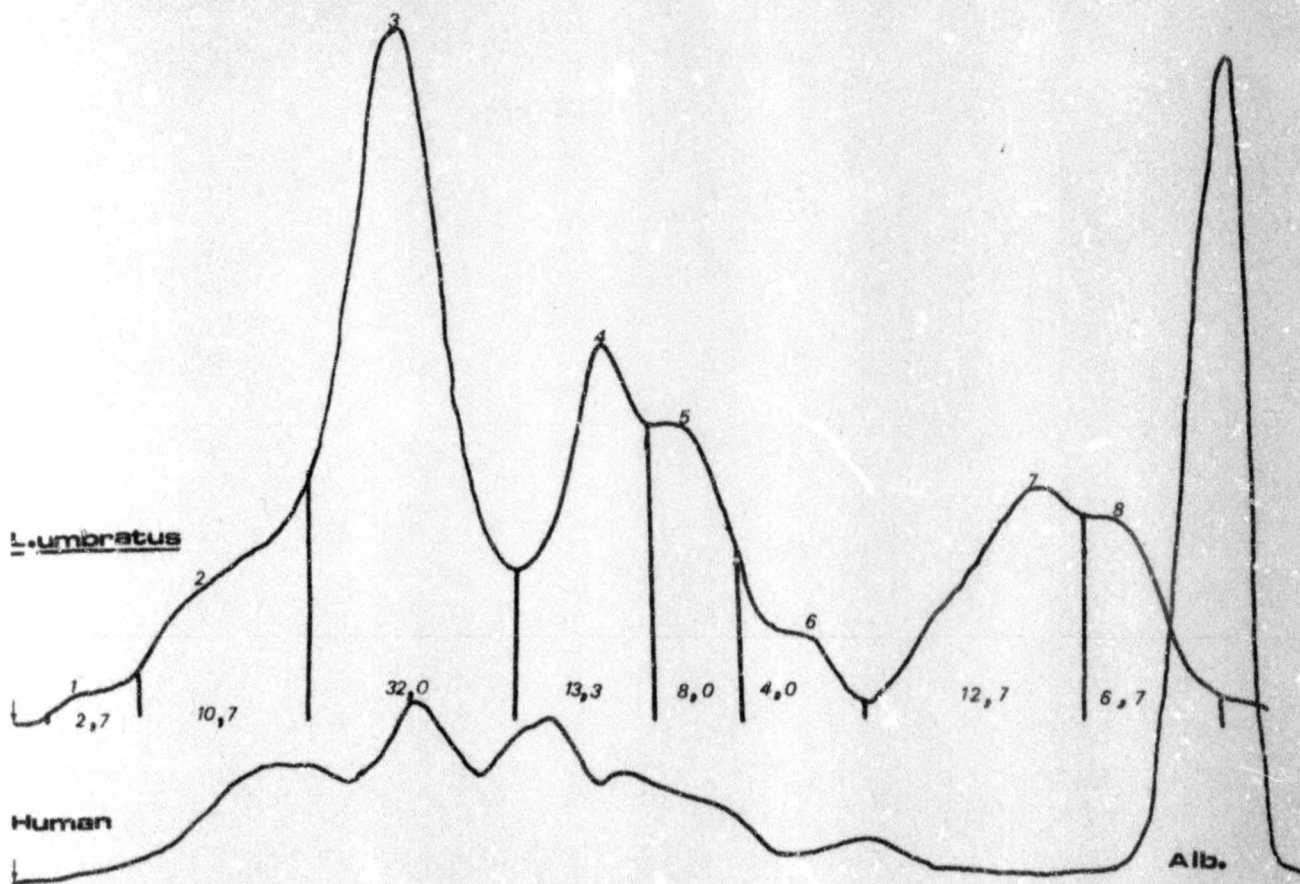


Fig. 3. Typical paper electrophoretogram of L. umbratus and human plasma proteins. Origin on the left (arrow). Percentage protein indicated under curve.

TABLE 4

Labes umoratus

Paper electrophoresis

Fish	Length cm	Weight gm	Sex	Hemo- tocrit %	Plasma Protein mg/ml	Locality Winter	Protein % Fractions (slowest to fastest)							Protein mg/ml Fractions (slowest to fastest)												
							1	2	2a	3	3a	4	5	6	7	8	1	2	2a	3	3a	4	5	6	7	8
1	37.0	813	f	26.2	28.8	Barrage	2.7	12.3	-	30.2	-	16.5	6.9	6.9	6.9	6.9	0.81	3.17	-	9.02	-	4.92	2.06	5.57	2.06	
2	36.0	834	f	30.0	32.0	Barrage	1.1	10.0	-	28.9	-	16.6	16.6	15.5	5.5	7.8	0.35	3.20	-	9.25	-	4.95	4.95	1.76	4.61	
3	43.0	1181	f	30.0	40.0	Barrage	4.2	12.5	-	31.3	-	14.6	14.6	8.3	8.3	8.3	1.67	5.00	-	12.51	-	3.32	3.32	5.00	3.32	
4	42.0	1106	f	32.3	39.0	Barrage	1.6	8.9	-	28.6	-	14.3	14.3	23.2	3.6	8.9	0.72	3.47	-	11.45	-	9.01	9.01	1.41	4.60	
5	44.5	1296	f	27.3	31.5	Barrage	2.7	10.7	-	32.0	-	13.3	13.3	8.0	4.0	6.7	0.85	3.37	-	10.01	-	4.45	2.52	1.26	3.28	
6	40.0	972	f	28.8	30.4	Barrage	2.9	5.8	7.3	16.5	10.7	14.6	14.6	14.6	5.8	9.7	0.88	1.77	2.37	5.01	3.25	4.44	1.77	3.53	2.45	
7	40.0	942	f	29.3	28.8	Barrage	3.6	8.3	14.3	22.0	-	12.5	12.5	8.9	5.3	10.7	1.04	2.57	4.12	7.20	-	3.60	2.57	1.53	3.09	
8	39.0	851	m	23.1	27.2	Barrage	2.9	7.4	-	36.8	-	13.2	13.2	10.3	7.5	8.8	0.79	2.01	-	10.00	-	3.80	2.80	2.04	3.59	
9	37.0	838	m	34.3	30.4	Barrage	3.1	10.9	-	42.2	-	12.5	13.5	6.3	4.7	9.4	0.94	3.31	-	12.80	-	3.72	1.92	1.43	3.31	
10	37.0	665	f	33.4	32.0	Barrage	1.3	5.3	9.2	15.6	12.6	11.8	11.8	11.8	9.2	7.9	0.42	1.69	2.95	5.05	4.29	3.78	2.55	4.63		
11	42.0	1145	m	32.3	29.3	Barrage	1.7	6.7	-	41.6	-	13.3	13.3	8.3	5.0	10.0	0.46	1.80	-	11.79	-	3.76	2.35	1.42	3.26	
12	43.0	1340	f	31.3	29.5	Barrage	1.9	5.6	9.6	17.3	13.5	11.5	11.5	9.6	7.7	7.7	0.54	1.66	2.74	4.84	3.85	3.26	2.74	2.19		
13	36.0	654	f	21.6	26.5	Barrage	4.6	11.6	-	36.4	-	13.5	13.5	7.7	7.7	7.7	0.54	2.19	-	5.53	-	3.65	2.19	2.19		
14	39.5	768	m	22.9	21.2	Barrage	4.6	11.6	-	27.6	-	15.3	16.3	4.6	13.9	11.6	0.93	2.43	-	5.88	-	3.45	0.98	2.94	1.57	
15	42.5	846	f	25.0	20.9	Barrage	3.3	3.3	13.3	16.7	13.3	10.0	10.0	8.4	11.7	6.6	1.02	1.02	4.10	5.15	4.10	3.09	2.59	3.61	4.00	
16	36.5	727	m	26.5	27.4	Barrage	2.0	10.2	-	30.5	-	18.4	18.4	8.2	4.1	8.2	0.55	2.80	-	8.36	-	5.04	2.25	1.53	5.04	
Mean				28.4 ± 3.6	30.3 ± 4.4		2.6	8.6	10.8	28.7	12.7	13.9	10.0	6.9	13.5	8.6	0.79	2.60	3.26	6.50	3.85	4.22	3.16	2.06	4.08	2.59

Distance from point of application
(mm)

0.5	2.0	4.0	6.0	9.0	10.0	12.5	15.0	18.5	20.5
Relative mobility									
2	10	20	25	44	49	61	73	90	100

Author Hattingh Johann

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