

STUDIES ON THE PLASMA COLLOID OSMOTIC PRESSURE OF THE RIVER LAMPREY, *LAMPETRA FLUVIATILIS*, L.

BY A. J. McVICAR* AND J. C. RANKIN

School of Animal Biology, University College of North Wales, Bangor, Gwynedd LL57 2UW

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Values for the total plasma protein concentration of different teleost species range from 3.5–7.0 g% (Field, Elvelhjem & Juday, 1943; Fine, Boffa & Drilhon, 1963; Larsson & Lewander, 1972; Hargens, Millard & Johansen, 1974) and this considerable interspecific variation is reflected in values for the plasma colloid osmotic pressure which ranged from 0.87–2.75 kPa (Keys & Hill, 1934; Hargens *et al.* 1974).

Because of the comparatively low molecular weight of albumins, an albumin solution will exert a greater osmotic pressure than a globulin solution of similar concentration. The albumin:globulin ratio of teleost plasma was generally greater than one (Field *et al.* 1943; Harris, 1974) and a large proportion of the plasma colloid osmotic pressure could be expected to be due to the albumin fraction. The total protein concentration of lamprey plasma was 5.4 g% (Logan & Morris, 1981), comparable with that of teleosts, but the dominant fraction of the proteins consisted of globulins greater than 100 000 Da.

Adult river lampreys, *Lampetra fluviatilis* L., were captured in the River Severn during their autumnal migration in November–December, and transported to Bangor as described elsewhere (Logan, Moriarty, Morris & Rankin, 1980). Blood samples (100–150 μ l) were obtained from the caudal vein using a lightly heparinized syringe, centrifuged (1500 *g* for 5 min) and the colloid osmotic pressure of the plasma supernatant measured using a membrane osmometer based on a design by Aukland & Johnsen (1974) incorporating a 30 000 Da cut-off membrane (Amicon PM30). The osmometer was calibrated using a water manometer. Some groups of fresh-run fish were adapted to a range of salinities up to 50 ‰ seawater (500 mosmol l⁻¹) for at least 14 days during December before blood sampling. Data were analysed using Student's *t*-test, or by linear regression.

The plasma colloid osmotic pressure (COP) of female lampreys was 1.42 ± 0.10 kPa ($N = 6$) which was significantly greater than that of male fish of similar body weight (COP = 1.13 ± 0.08 kPa, $N = 9$) and this may have been due to the presence of pre-ovalbumins which have been reported to be present in lamprey plasma (Logan & Morris, 1981). There was a positive correlation ($r = 0.51$, $P < 0.01$) between plasma COP and body weight, possibly because female lampreys tend to be larger than males (Abou-Seedo & Potter, 1979). Unfortunately, the sex of immature lampreys

* Present address: Department of Physiology, Medical School, University of Birmingham, Birmingham B15 2TT.

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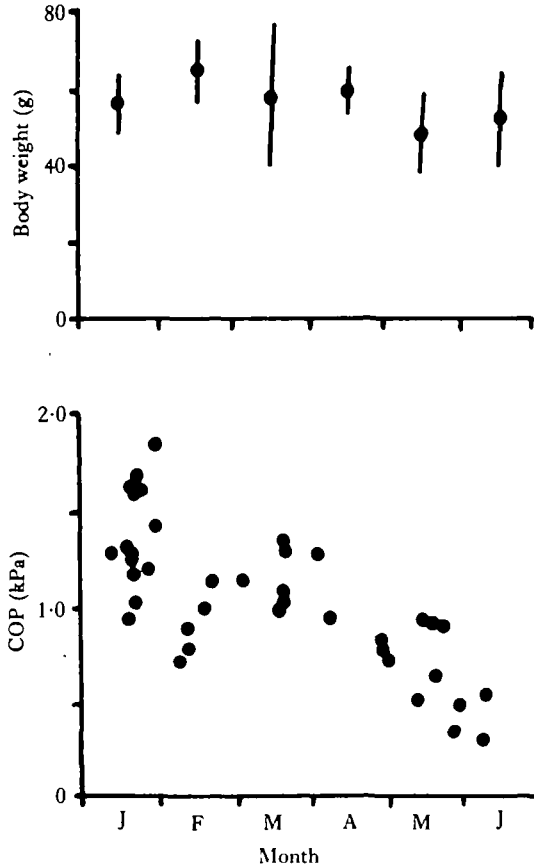


Fig. 1. The colloid osmotic pressure (COP) of systemic plasma samples taken from freshwater lampreys at different times during their spawning migration, and the body weights of the fish concerned. Colloid osmotic pressure values are of one sample from individual fish, and body weights are given as means \pm s.e.m. of the fish sampled during each month.

cannot be ascertained without dissection, and the mean plasma colloid osmotic pressure of immature fish during December–March, regardless of sex, was 1.20 ± 0.04 kPa ($N = 59$) (mean body weight = 53.3 ± 1.6 g). This value is within the range found in teleosts (see above) and is remarkably high considering most lamprey plasma proteins are globulins (Logan & Morris, 1981). A similar value was found for plasma of another cyclostome, the Pacific hagfish, *Eptatretus stoutii* (Riegel, 1978).

At maturity (during April–June) the plasma COP, regardless of sex, was 0.55 ± 0.05 kPa (mean body weight = 49.8 ± 2.0 g), a decrease of 54.1% ($P < 0.001$). Plasma samples taken from lampreys at different times between capture and maturity showed that a reasonably high colloid osmotic pressure was maintained until the latter stages of maturation were reached (Fig. 1). Because lampreys cease to feed after the onset of the spawning migration, mature fish had been starved for approximately 5–6 months. Fully mature sea lampreys, *Petromyzon marinus*, had significantly lower plasma (Webster & Pollara, 1969) and total body (Beamish, 1979) protein concentrations than fresh-run migrants. River lampreys did not exhibit a marked proteinuria shortly before spawning (Logan & Morris, 1981) and the decline in plasma collo-

Table 1. Plasma colloid osmotic pressure (kPa) of fresh-run lampreys adapted to fresh water (FW), 20, 30, 40 and 50 % sea water (%SW) for at least 2 weeks

FW	20%SW	30%SW	40%SW	50%SW
1.17 ± 0.09 (12)	1.18 ± 0.08 (11)	1.15 ± 0.13 (10)	1.04 ± 0.08 (11)	1.24 ± 0.18 (4)

Values are means ± s.e.m. and numbers of fish are given in parentheses. Differences between the means are not significant.

osmotic pressure in animals in the final stages of maturity suggests that extensive catabolism of proteins occurs in mature lampreys.

In an animal with low systemic blood pressure, changes in plasma colloid osmotic pressure may have important implications for renal function, since the osmotic pressure produced by retention of proteins in the glomerular capillaries opposes the hydrostatic pressure favouring filtration. The lamprey glomerulus retains PVP molecules of between 10 000 and 40 000 Da (Logan & Morris, 1981) so the use of a 30 000 Da cut-off membrane in the present study should give data relevant to glomerular filtration dynamics. The fact that plasma colloid osmotic pressure did not vary significantly in environments of different salinities (Table 1) suggests that changes in the plasma colloid osmotic pressure are not involved in the changes in single nephron glomerular filtration rate observed in lampreys when external salinity is altered (Rankin, Logan & Moriarty, 1980).

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