LETTERS TO THE EDITORS

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Oxygen Affinities of Respiratory Blood Pigments in *Serpula*

Serpula, a marine annelid worm, is the only animal known to possess two respiratory pigments in its blood, namely, chlorocruorin and hæmoglobin[1].

The hæmoglobins of mammals and of a variety of invertebrates have a considerably higher affinity for oxygen than the chlorocruorins of Serpulimorpha[1,2], a high affinity meaning that the pigment is oxygenated at a low pressure of oxygen. If, therefore, a mixture is made of an oxychlorocruorin and human oxyhæmoglobin, and then oxygen is progressively removed from the solution, a spectroscope shows that the α-band of oxychlorocruorin vanishes before the α-band of oxyhæmoglobin. But when the naturally mixed pigments in the blood of *Serpula* are gradually deoxygenated, the two α-bands disappear simultaneously. This means either that the hæmoglobin of *Serpula* has an unusually low affinity for oxygen, like that of the chlorocruorins hitherto examined, or that the chlorocruorin of *Serpula* has an abnormally high oxygen affinity.

This interesting point has remained unsettled since the time that the duplicity of the *Serpula* blood pigment was discovered, owing to the difficulty of finding big specimens of *Serpula*, which in most places is not an abundant serpulid. I have, however, now been fortunate in getting several moderately large live individuals of *S. vermicularis* L. from Plymouth. The worms were cut up in water and the liquid centrifuged, giving a solution with the brown colour characteristic of the blood of this genus. It is known that the relative quantities of the two blood pigments in *Serpula* vary with the age of the animal; in the solution which was prepared this time the two α-bands were equal in intensity. To a small optical glass tube containing about 0·5 ml. of the diluted *Serpula* blood, enough human blood was added to double (approximately) the intensity of the α-band of oxyhæmoglobin. Then a very small crystal of sodium dithionite was dropped in to remove most of the dissolved oxygen from the solution. The result was that, viewed with the microspectroscope, the α-band of oxychlorocruorin was seen to vanish, while the intensity of the α-band of oxyhæmoglobin was about halved. It is clear that only the human respiratory pigment remained in the oxygenated state; the hæmoglobin of *Serpula* was deoxygenated, together with the chlorocruorin. On aeration the bands reverted to their initial strengths. The experiment, which was repeated four times, showed that the chlorocruorin of *Serpula*, like other chlorocruorins, has a low oxygen affinity, and that likewise the hæmoglobin of *Serpula* has a low oxygen affinity. In this property the latter pigment differs from the hæmoglobins of other invertebrates[2] but resembles those of some fishes[3].

The hæmoglobin of *Serpula*, like all other hæmoglobins, contains protohæm. The chlorocruorins have their own peculiar hæm, chlorocruorohæm[4], and their proteins differ from globin of hæmoglobin[5]. It may well be that in the hæmoglobin of *Serpula*, protohæm is united to the protein of chlorocruorin and that this endows it with its low oxygen affinity.

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Density of Bottom Animals on the Ocean Floor

Our knowledge of the density (number and weight per sq. m.) of bottom animals in deeper waters is very scanty, since very few quantitative samples have hitherto been taken, and none at depths exceeding 1,000–1,400 m. It may therefore be of interest that the Danish Deep Sea Expedition in the *Galathea* has succeeded in taking thirteen quantitative samples with a 0·2 Petersen grab off the West African coast at depths between 820 m. and 3,782 m. The weight and number of species and specimens per sample are given in the accompanying table.

Locality	Depth (m.)	Weight of living animal per sample (gm.)	No. of species	No. of specimens
Off Takoradi	1,480	0·3	3	9
Off the Congo	2,680	0·1	1	1
,, ,,	1,480	0·3	3	3
,, ,,	820	0·9	4	6
,, ,,	985	0·2	2	2
,, ,,	1,150	0·2	1	1
,, ,,	1,460	0·4	4	4
Off Angola (Lobito)	3,782	0·62	4	6
,, ,,	2,430	0·42	2	2
,, ,,	1,508	0·3	4	7
,, ,,	1,200	0·6	6	17
,, ,,	1,006	0·8	4	4
,, ,,	985	0·5	4	8

Summarizing these results, it will be seen that the average weight of living animals in the six samples off the Congo from between 820 m. and 2,680 m. is 0·37 gm. per sample, that is, 1·85 gm. per sq. m. The number of species is on an average 2·5 per sample, that is, 12·5 per sq. m., and the number of specimens 3 per sample, that is, 15 per sq. m. These figures seem surprisingly high compared with those hitherto found at depths of about 1,000 m. in the Mediterranean, off Scotland and off Greenland. If the figures for the Angola coast are considered, the average weight per sample represents 0·5 gm., that is, 2·5 gm. per sq. m., with 3 species and 7 specimens per sample, that is, 15 and 35 respectively per sq. m., which seems to be a very high figure considering the fact that the depths are between 1,000 m. and 4,000 m.

There seems to be a difference between the deep sea off the Congo and off Angola, since the density of specimens appears to be distinctly higher off Angola. This is in good agreement with the fact that the productivity of the sea increases towards the south due to the influence of the Benguela Current and the upwelling water.

If we consider the results of the investigations with the Petersen grab in more shallow waters and

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