

whose upper limit in the north, at any rate, may be put at above 100 metres.¹ Now, if we calculate the depth to which the rays of the sun penetrate, after passing through the same distance in the water, assuming always that the rays are direct and that the rate of absorption is the same, we find that the rays will have passed through the same distance to reach a depth of 500 metres in lat. 50° N., that they will pass through to reach 650 metres in lat. 33° N., or 300 metres in lat. 67° N.

The transparency of the water, however, varies greatly in different regions. If we take the results of previous observations during different expeditions, we may set down the visible depth in the open sea as being roughly 50 metres in lat. 33° N., 40 metres in lat. 50° N., and 25 metres in the Norwegian Sea in lat. 67° N. Taking this into consideration, we find that there will be the same *intensity* from the rectilinear rays—

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|----------------|----------|-------------|
| In lat. 33° N. | at about | 800 metres. |
| „ 50° | „ | 500 „ |
| „ 67° | „ | 200 „ |

The red and black animal forms, therefore, as has been found in the investigations I have just described, have an upper limit in the different waters which corresponds everywhere with the same intensity of light.

Increase of
pigmentation
with increase
of depth.

Very interesting also is the fact that certain dark bathypelagic forms appear as varieties differing in the intensity of their colours. Broch from his study of the “Michael Sars” collections thus recognises four varieties of the deep-sea medusa *Atolla bairdi*: (1) stomach alone containing pigment; (2) peripheral muscular belt also pigmented; (3) the brown pigment distributed also on the lower side of the bell, while gonads are

¹ Sir John Murray reports that in Upper Loch Fyne, in Loch Etive, and in some other sea-lochs of the west coast of Scotland, which are cut off from the ocean by submerged barriers, red prawns and other red crustaceans are very numerous in depths of 50 to 70 fathoms (about 270 to 310 metres); for example *Nyctiphanes* (*Meganyctiphanes norvegica*), both adult and young, can always be captured in these lochs by dragging nets one or two fathoms above the bottom. This species possesses ten phosphorescent organs: one pair in the eye peduncle, two pairs on the under side of the thorax, and the remaining four in the median line of the abdominal segments. Sir John believes that these organs are used as a kind of “bull’s eye lantern,” and enable the *Nyctiphanes* to see and pick up the minute particles of organic matter which are settling on the bottom-deposits. Many specimens of this species were kept in aquaria for a considerable period, and were observed to light up and shut off their phosphorescent organs at will. The surface layers of water in these Scottish lochs are much less saline than the deeper layers, and contain much suspended matter, so that the penetration of light is much obstructed. Besides *Nyctiphanes* other red or red and transparent crustaceans are always to be captured in the deeper water-layers of the Scottish sea-lochs, such as *Calanus finmarchicus*, *Eucheta norvegica*, *Conchocia elegans*, *Boreophausia raschii*, *Pandalus annulicornis*, *Pasiphaea sivado*, *Crangon allmani*, *Hyppolyte securifrons*, etc. (see Murray, *Scot. Geogr. Mag.*, vol. iv. pp. 353-6, 1888; *Comptes rendus des Séances du 3me Congrès international de Zoologie*, Leyde, 1895, p. 107).