It has been stated by Sir William Ramsay:[2] "As sodium and potassium are much more widely distributed than lithium, it is more likely that they are the chief products from copper, and that some modifying circumstance has determined the formation of a trace of lithium. . . . Lithium was mentioned because it is an unlikely constituent of dust, glass, copper, etc., which were tested specially to prove its absence."

There are two statements here which, according to my experience, appear to require modification. That potassium and sodium are more abundantly distributed than lithium is true, but that these are more widely distributed is not strictly correct; nor can it be accepted as unquestionable that lithium is an unlikely constituent of dust, glass, copper, etc. Evidence to the contrary is based upon facts divided into three categories—firstly, those derived from the qualitative spectroscopic analysis of common ores and minerals usually associated with the alkali metals; secondly, analysis of the crude salts of the alkalies, such as the Stassfurth minerals and nitrates from Chili and Bengal, show that they contain lithium and rubidium, with not unfrequently cæsium. Facts belonging to the third category are derived from experimental evidence, which is both quantitative and spectrographic, the source of the spectra being the oxyhydrogen flame. When half a gram of material yields a photograph of the spectrum of lithium on which the four chief lines are visible—namely, $\lambda\lambda$ 6708, 4603.07, 4132.93 and 3232.82—there cannot be less than 0.0089 gram of lithium present. When only the lines 6708.0 and 4603.07 are visible, the quantity is not less or more than 0.0041 gram.

When only the red line is photographed the quantity is not more than 0.002 gram, and with half this quantity the line ceases to be photographed. It follows, therefore, that from the evidence afforded by the number of plates on which this line appears there could scarcely be less lithium in the 0.5 gram of material analyzed than 0.2 per cent.

Further results have been obtained with several other metallic compounds, but the sensitiveness of the flame reaction varies extraordinarily with the spectra of different elements.

Mr. Ramage and I found in 170 common ores and minerals potassium and sodium, and with these common elements rubidium and lithium were very generally associated. Thus, of sixty-two iron ores, rubidium was found in sixty-one. In sixteen red hæmatites, massive minerals of the purest type, rubidium was contained in four. Where potassium and rubidium occurred lithium was invariably found. It was found in limestones, in dust, in the Bessemer flame, in ordinary pipeclay, tobacco pipes, and a great variety of siliceous minerals, such as the Dublin granites; in Donegal kyanite, which contains 98 per cent. of aluminium silicate; and in asbestos. It was found in dust which fell from the clouds, in volcanic dust, in soot, in flue-dust from chemical works, and in that from copper smelting and refining works. This last material contained lithium, sodium, potassium, rubidium and cœsium, copper, silver, calcium, strontium, aluminium, gallium, indium, thallium, iron, nickel, cobalt, manganese, chromium, lead, zinc, cadmium and tin. Upon such evidence as this it is impossible to corroborate the statement that potassium is a more widely distributed element than lithium, or that lithium is an unlikely constituent of dust, glass, copper, etc.

[2] *Nature*, March 5, 1908, p. 412.

## *SPECIAL ARTICLES*

### ON THE ORBITOSPHENOID IN SOME FISHES

I WISH to call attention to the following paragraph recently published by Dr. L. S. Berg[1] in reference to an orbitosphenoid alleged by different authors from time to time to exist in various fishes.

> Das Orbitosphenoid fehlt bei allen untersuchten Formen. Prof. Starks, der diesen Knochen bei den Fam. Berycidae und Monocentridae fand, sagt in seiner interessanten Abhandlung folgendes:[2]

[1] "Die Cataphracti des Baikal-See," p. 26. Wissensch. Baikal-See Exped., Lief III., 1907.

[2] *Proc. U. S. Nat. Mus.*, XXVII., 1904, p. 601. "It is remarkable to find this archaic character

among the spiny rayed fishes, though it is well in keeping with the pneumatic duct to the œsophagus, which some of the Berycoid fishes are said to have. The presence of orbitosphenoids is common among the lower forms from the bony Ganoids up to and including the Salmoids. So far as the author can ascertain, they hitherto have not been found in forms more specialized than the last. They have been searched for in vain in the following: *Aulopus, Synodus, Esox, Fundulus, Aphredoderus* and nearly all of the families of the Hemibranchs, Synentognaths and the Percesoces." Den gegenüber kann man einwenden, (1) dass das Orbitosphenoid nicht allen niedrigeren Teleostei eigenthümlich ist. So fehlt es unter den Malacopterygii bei *Osteoglossum, Gonorhynchus, Chanos,*[3] *Cromeria,*[4] unter den *Cobitidini* bei *Cobitis, Misgurnus, Acanthophthalmus,*[5] und (2) dass ein Orbitosphenoid bei mehreren Formen, die im System höher als die Salmoniden stehen, bekannt ist. So besitzt nach Vrolik[6] *Aulopus filamentosus* (*Scopelidae*) ein "sehr ausgedehntes Orbitosph" (p. 270, Taf. XX., Fig. 30). Ferner ist dieser Knochen bei *Galaxias*[7] vorhanden, ebenso unter den Acanthopterygii: bei *Micropterus salmoides,*[8] bei *Pomacanthus paru,*[9] bei *Grammicolepis,*[10] bei *Regalecus.*[11] Wir finden folglich das Orbitosphenoid unter den Acanthopterygii bei den verschiedensten Familien, von so niedrig organisierten wie die *Berycidae* angefangen bis zu so hohen wie die *Trachypteridae.* Weitere Forschungen werden wahrscheinlich zeigen, dass dieser Knochen noch mehr verbrietet ist, als man früher angenommen hat.

Referring to part 1 of Dr. Berg's conclusions I wish to point out that in my above quotation I said that an orbitosphenoid was *common* in fishes below the Salmonidæ, not that it was always present as Dr. Berg appears to have inferred.

In reference to part 2 of his conclusions I have carefully examined a number of specimens of both *Micropterus* and *Pomacanthus* and several of their close relatives, and find no orbitosphenoid, nor is there any mention of this element in any other report on these forms. The common yellow perch is a close relative of *Micropterus,* and since the time Cuvier first took it as an anatomical type of spiny-rayed fishes its skeleton has been described a great many times, but without mention of an orbitosphenoid. Dr. Boulenger, in the first volume of the second edition of the "Catalogue of Fishes in the British Museum" has worked out the osteology of a great number of the basses, perches and sun-fishes, but without finding an orbitosphenoid.

Either the internal descending wing from the frontal, or the anterior part of the alisphenoid, has been mistaken for this element in *Micropterus* and *Pomacanthus.* There is often a slight mark across the alisphenoid which may have been interpreted as a suture dividing the bone into two parts. This appears to have been the case in *Grammicolepis,* to judge from the picture, though I have had no opportunity for examining the skeleton. As to *Aulopus,* my specimen (*A. japonicus*) certainly has no orbitosphenoid, though the picture of *A. filamentosus* published by Vrolik shows a well-developed one. It seems probable that somewhere there has been a misidentification of material. Dr. Berg has misinterpreted Dr. Swinnerton's statement in regard to *Galaxias.* Swinnerton referring to this genus, says, "owing to the absence of an orbitosphenoid [etc.]." On the preceding page, however, he gives a figure of the cranium of *Galaxias* in the anterior part of the orbital cavity of which is a portion marked "os." To "os" I find no reference in the text, though it may as well refer to a cartilaginous or membranous orbital septum as to an ossified orbitosphenoid.

[3] Ridewood, *Proc. Zool. Soc. Lond.*, 1904, p. 59; *op. cit.*, 1905, p. 485, fig. 140–1, p. 489.

[4] Swinnerton, *Zool. Jahr. Abt. Anat.*, XVIII., 1903, p. 63, fig. F.

[5] Sagemehl, *Morph. Jahr.*, XVII., 1891, p. 579.

[6] *Neid. Arch. für Zool.*, I., 1873.

[7] *Haplomi:* Swinnerton, *Zool. Jahr. Abt. Anat.*, XVIII., 1903, p. 63, fig. G.

[8] Centrarchidæ, Shufeldt, U. S. Fish Comm. Rept. 1883, XI., 1885, p. 804.

[9] Chætodontidæ, Shufeldt, *Jour. Morph.*, II., 1889, p. 290, fig. 10.

[10] Zeidæ, Shufeldt, *Jour. Morph.*, II., 1889, p. 280.

[11] Trachypteridæ, T. Parker, *Trans. Zool. Soc. Lond.*, XII., 1886, p. 12, T. IV., fig. 7, 11.

*Regalecus* has a large orbitosphenoid, and Mr. Tate Regan has recently shown[12] that *Lampris* and *Velifer* also have one. I believe these and the Berycoid fishes to be the only spiny-rayed fishes in which the orbitosphenoid has been proved to exist.

Dr. Berg has apparently not appreciated the true significance of the presence of an orbitosphenoid in *Regalecus* when he remarks towards the end of his paragraph that this element has been found from so low a group as the Berycoids to so high a one as the Trachypteridæ. Instead of indicating that an orbitosphenoid may be looked for anywhere among the Acanthopterygii it rather indicates the primitive character of *Regalecus*. Mr. Regan (*op. cit.*) has, in fact, recently placed it in close relationship with the Berycoid fishes, but whether or not *Regalecus* (with its relatives forming the group Tæniosomi) originated from the Berycoid fishes, it is at least as primitive as they are, and belongs in the system not far from them. If it is true that *Grammicolepis* has an orbitosphenoid it would indicate its position also to be not far from the beginning of the series of spiny-rayed fishes.

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### AN EXPLANATION OF THE CAUSE OF THE EASTWARD CIRCULATION OF OUR ATMOSPHERE

IN SCIENCE for December 20, 1907, I have shown that the principle of the conservation of energy demands that *temperature must be taken as a measure of the intensity of ether vibration;* this mandatory condition at once gives us the information that only the Newtonian law of radiation can be true, and this claim is upheld by my interpretation of existing observations (as explained in the closing paragraph of that paper). I then demonstrate that the absolute temperature of space at the earth's distance from the sun is probably less than two degrees centigrade.

As known gases become either liquid or solid when the temperature is reduced to within a few degrees of the absolute zero, a planet can have no atmosphere unless its surface-temperature is above the critical temperature of the gas which forms the atmosphere.

From the differences between the polar and equatorial temperatures near the earth's surface, and from the decrease in temperature with increasing height above the surface, it is known that the atmospheric layers near the surface of the earth act as a trap to retain the heat until the temperature reaches a limit which varies with varying atmospheric conditions; beyond this limit the loss of heat through radiation into space is just equal to the heat received, so that no farther increase in temperature takes place.

As the direct rays of the sun can strike only one half of the earth's surface at a given instant, while the equivalent heat is later on radiated from the whole surface of the earth, it is plain that the mean *solar* component of earth-radiation can not at its maximum exceed one half of the sun's radiant effect at the earth's distance from the sun, or 0°.75, if 1°.5 is adopted as the temperature of space; practically, therefore, the whole terrestrial radiation into space is due to inherent earth-heat.

Let us, provisionally, take it for granted that on the average the atmospheric layers near and in contact with the earth's surface have, by reason of the trapped heat, a temperature 100° higher than would be the case if no heat were stored in these lower layers, we then readily arrive at the results given in the following table:

| Distance above Earth's Surface (in Miles) | Terrestrial Radiation | | Temperature of Direct Solar Rays | Gravity |
|---|---|---|---|---|
| | Earth's Component | Sun's Component | | |
| 0 | 200.° | 0.°7 | 0.°7 | 1.00 |
| 10 | 199. | 0.7 | 1.+ | 0.99 |
| 100 | 190. | 0.7 | 1.+ | 0.95 |
| 1,000 | 128. | 0.6 | 1.+ | 0.64 |
| 10,000 | 16. | 0.1 | 1.5 | 0.08 |
| 100,000 | 0.1 | 0.0 | 1.5 | 0.04 |

From an inspection of the above table we learn that during the first few hundred miles the decrease in temperature, due to radiation, is only one degree for each additional ten

[12] *Proc. Zool. Soc. Lond.*, 1907, pp. 634–643.