ON FORAMINIFERA FROM THE GULF AND RIVER ST. LAWRENCE.

By G. M. Dawson.

By way of introduction to these notes, I may state that the reader will find some account of the curious and interesting animals to which the paper relates, with figures of characteristic examples, in Vol. IV, new series, of this Journal, page 413; and that several species found in the Gulf of St. Lawrence have been catalogued by Principal Dawson, in the same Journal, Vol. V, page 188 *et seq*. The following table is, however, the only approach to a complete view of the species and their distribution hitherto attempted.

Many of the deeper samples were small quantities of mud brought up in sounding, by Capt. Orlebar, R.N., of the Coast Survey, and by him kindly presented to Dr. Dawson.

The specimens from Labrador were obtained from material dredged by the officers of the Geological Survey; those from Prince Edward Island, were from a specimen secured by C. Robb, Esq.; and those from the Bank of Newfoundland, were obtained from the late Sheriff Dickson, of Kingston.

The somewhat extensive series from Gaspé Bay was obtained during a dredging expedition in the summer of 1869. The mud was sampled when brought up by the dredge, and reserved for examination, the depth being ascertained as carefully as possible. Several very rich and interesting samples are also from the dredgings of Mr. J. F. Whiteaves, F.G.S., in Gaspé and its vicinity. Mr. Whiteaves has also gone over this material with care, and has detected some additional species.

The means were unfortunately not at hand for ascertaining the temperature at the bottom. But, though there is reason to believe that the water at Gaspé Bay is somewhat warmer than the Gulf of St. Lawrence in general, the mud as it came over the boat's side felt icy cold to the hand, showing even here what a great effect the iceberg-laden Arctic current has on the bottom temperature. The number of species tabulated must not in every instance be taken as a criterion of the relative richness of the localities, as much often depends on the amount of material at disposal. This is especially the case when comparing dredgings with soundings.

The general aspect of the Gulf of St. Lawrence Foraminifera is northern, and in many places closely resembles the fauna of the Greenland coast and the Hunde Islands, as given in Parker & Jones' Memoir.* The Gulf, at least so far as its Foraminifera are concerned, evidently belongs to the Arctic province, the limits of which skirt the Banks of Newfoundland and pass from thence southward to Cape Breton.

The refrigeration of its waters depends on the Arctic current, which, entering the Straits of Belle Isle, floods the whole bottom of the Gulf with water almost at the temperature of the Arctic seas. To these conditions the series of collections from Gaspé offers somewhat an exception, and is of a slightly more southern character, both as regards the species represented and the developement which they attain. This difference depends on purely local causes, which, while slightly changing the character, give opportunities for a very abundant developement of Foraminifera, more especially of the arenaceous forms. Gaspé Bay in no part exceeds 50 fathoms in depth; is about 20 miles in extreme length, well land-locked, and disturbed by no other current than that caused by the ebb and flow of the tide. The depth is not so great as to allow of the incursion of the cold and deep layer to any great extent, and the proximity of land and the shelter thus afforded tend still further to modify its temperature.

The bottom, in most of the deeper parts, is composed of fine sand and mud, and this it is which favors the very large developpment of arenaceous forms.

Past the mouth of Gaspé Bay sweeps the very strong tidal current of the St. Lawrence, and immediately we pass the shelter of Ship Head and come within its influence, the changes in the Foraminifera become strikingly apparent. The bottom consisting for the most part of clean gravel or coarse sand, most of the arenaceous forms disappear at once, and instead of the abundance of Nonioninas and Miliolas previously found, a very large proportion consist of Planorbulina lobatula, which can hold its own, attached to seaweeds and polyzoons. Polystomella Arctica also becomes somewhat prominent, while the Lagenidæ and Entosolenidæ appear in abundance.

What few sandy forms do occur are depauperated and composed of very coarse particles. The Foraminifera as a whole however are very abundant, and in some samples dredged by Mr.

* Philosophical Transactions, 1865.

Whiteaves almost equal in quantity those in the deeper Atlantic soundings.

In the estuary of the St. Lawrence itself, Bulimina pyrula becomes a somewhat common form. Among forms which in the Gulf of St. Lawrence may be mentioned as specially characteristic of deep water, are Nodosaria (Glandulina) lævigata, Globigerina bulloides, very small; Bulimina, principally B. squamosa, also small; Uvigerina pygmœa, Cassidulina.

From depths greater than 100 fathoms all the Foraminifera are very small and delicate; and Lagenidæ, Buliminidæ, Globigerina bulloides, together with a few depauperated Nonioninæ, constitute the greater part of the fauna. From these depths also come many Diatoms, mostly Coscinodiscus, and Sponge spicules. Polystomella striatopunctata is almost everywhere prevalent, though it nowhere attains to any very great size, and below about 30 fathoms, becomes small and generally rare, and continues increasing in rarity till it almost disappears at 300 fathoms. In some localities, at about 30 fathoms, P. Arctica is abundant, and greatly surpasses in size the ordinary Polystomellæ occurring along with it. The remaining P. striatopunctatæ also at this depth often show a remarkable proneness to run into modifications resembling one or other of the numerous species and varieties into which the genus is subdivided, but as the transition series are complete, it is very difficult to place the bulk of the specimens satisfactorily under them. It has been thought better in the table to include as many as are easily seen to be modified striatopunctatæ under that name. Nonionina Labradorica, though not so universally distributed as the above, is a very characteristic species in the Gulf. It seems to be best developed and in largest numbers at about 30 fathoms. It thins off both in numbers and size as we go into shallower water, and decreases much in size, though not so perceptibly in numbers as the water deepens to 100 fathoms and below. There is a remarkable absence of Miliolas in the estuarine parts of the Gulf, which strongly contrasts with their abundance in Gaspé Bay, and also on the Atlantic coast of Nova Scotia, and south.

One specimen of a curious sandy form of Cornuspira foliacea was obtained at a depth of 18 fathoms at Gaspé.

Biloculina ringens scarcely occurs above 30 fathoms.

At Murray Bay, which is only about 60 miles below the point where, at least, the surface of the St. Lawrence becomes perma-

nently fresh, the Foraminifera become very scarce and poor. Polystomella striatopunctata is the most common, but it has become very small. Nonionina Labradorica, Lituola Canariensis, and Trochammina inflata also occur, but all much reduced in size, and scarce relatively to the amount of material examined. On passing from the Gulf to the east of Newfoundland, or to the south of Cape Breton, a change from the Gulf Fauna is immediately detected. Polystomella striatopunctata, there so common, becomes rare. Nonionina Labradorica to a great extent ceases to appear, and Uvigerina pygmœa and Cassidulinidæ become more frequent.

The arenaceous Hippocrepina, (Fig. 2,) and Lituolæ (Figs. 1 and 3) are most plentiful at depths less than 20 fathoms. Lituola scorpiurus (Fig. 4) goes down to the greatest depths in Gaspé Bay, and is yet abundant at 10 fathoms, while the immense Rhabdopleura abyssorum (Fig. 6) only appears at about 20 fathoms, and continues from that point increasing in numbers and size to the depth of 50 fathoms, which is the greatest depth in Gaspé Bay, where alone it has been found.

The distribution of these Foraminifera would tend, with other facts, to show that these organisms, together with most other marine animals of low organization, do not depend, to any great extent, on the depth or intensity of daylight, but almost entirely on the *temperature* of the water, as Dr. Carpenter maintains in his account of his recent deep-sea dredging, so that they would not give very satisfactory evidence of the conditions of deposit of Post pliocene or other beds, unless other facts were at disposal to show the depth, when the Foraminifera would give valuable assistance with regard to the climatic conditions at that depth. The quality of bottom has however, much to do with the general *facies* of the Foraminifera, as with other animals. For, as shown above, calm water, with a bottom composed of fine sand and sediment, is particularly favorable to the arenaceous forms, though, even under these conditions, they do not thrive in the very cold, deep water (such as that below 100 fathoms) in the open Gulf. A strong current at once causes all sandy forms to disappear, mostly, no doubt, from want of the fine materials necessary for their shells, and brings in a large preponderance of Truncatulinas, Lagenidæ, &c.

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* The figures refer to the numbers of the wood-cuts.

The arenaceous forms, with the exception of those which are tubular, constitute a series parallel to the calcareous forms, and the members of which graduate into one another. It seems not improbable that the individuals of the same species may assume either appearance. It does not appear, however, that the same individual can present both forms at successive periods. On the other hand, the sandy forms may really constitute a distinct group parallel to the others. Sketches of some interesting forms are given which do not appear to be precisely similar to described species. These have been kindly examined by Dr. Parker, of London, who regards the Lituolæ represented in figs. 1 and 3 as new species, to which he assigns the names *L. findens* aud *L. cassis*. The form represented in fig. 2 he regards as the type of a new genus, to which, from the horse-shoe shaped form of the aperture, he gives the name *Hippocrepina*, naming the species *H. indivisa*.

Fig, 1. Lituola findens, P. Fig. 2. Hippocrepina indivisa, P. Fig. 3. Lituola cassis, P. Fig. 4. Lituola scorpiurus. Fig. 5. Nonionina scapha, var. Labradorica (313 ftms.) Fig. 6. Bulimina Presli., var. squamosa (313 ftms.) Fig. 7. Rhabdopleura? Fig. 8. Polystomella Arctica. Fig. 9. Biloculina ringens. Fig. 10. Lagena sulcata, var. Fig. 11. Entosolenia striato-punctata. Fig. 12. Entosolenia marginata. Figs. 1, 2, 3, 4 and 7 are drawn to a scale half that of the other figures.

TABLE I. — *Showing the Distribution of Twenty-three Gatherings of Foraminifera, from the Gulf and River St. Lawrence, and neighbouring parts of the Atlantic.*

(C) common. (R) rare. (S) small specimens. (L) large specimens.

FORAMINIFERA.	313 Fathoms, Gulf St. Law. Lat. 48° 25′; Long. 60° 20′	250 Fathoms between St. Pierre and Scatari.	200 Fathoms, Cape Camille.	144 Fathoms, North-east of Anticosti.	140 Fathoms, Gulf St. Lawrence.	40 Fathoms, Cape St. Nicholas.	Labrador.	Banks of Newfoundland.	Off West Cape, Prince Edward Island.	Off South Coast, Cape Breton, 90 Fathoms.	Gaspé, North-west Arm, 7 Fathoms.	Gaspé Bay, 10 Fathoms (sand.)	Gaspé Bay, 10 to 15 Fathoms.	Gaspé Bay, 16 Fathoms.	Gaspé Bay, 16 to 17 Fathoms.	Gaspé Bay, 18 to 20 Fathoms.	Gaspé, bet. Ship Head and Cape Bon Ami, 30 Fathoms.	Gaspé Bay, off Grande Grève, 35 Fathoms.	Gaspé, off Ship Head, 30 to 40 Fathoms.	Gaspé Bay, off Grande Grève, 40 to 50 Fathoms.	Gaspé Bay; Grande Grève, St. George's Cove.	Gaspé, River St. Lawrence, off Cape Rosier Village.	Riv. St. Lawrence, Murray Bay, 15 to 20 Fathoms.
Nodosaria (Glandulina) lævigata	*R			*R	*R												*	*S		*		*R	
Dentalina pauperata	*R																						
— communis																	*R L			*		*L	
Lagena sulcata																	*	*	*R	*L	*R		
— — var. distoma	*	*R		*								*R						*					
— — var. semistriata							*										*	*	*R	*L		*R	
— — var. lævis		*R																					
— — var. substriata									*														
Entosolenia globosa	*						*R								*R			*	*		*R		
— costata							*R		*R			*R		*				*R S	*R		*		
— melo, D'Orb.							*R	*R				*L							*R	*R			
— caudata, D'Orb.								*											*R				
— marginata, var. ornata							*R																
— marginata																							
— squamosa																			*				
— striato-punctata																							
Polymorphina lactea	*R					*								*	*S							*R	
— — var. compressa							*		*R L			*R L	*C L	*L									
Uvigerina pygmæa								*R		*C S											*R S		
Globigerina bulloides	*C S	*C S		*			*R	*R											*R S		*R		

	Sounding.	Sounding.	Sounding.	Sounding.	Sounding.	Sounding.	Dredging.	Dead Balanus, bro't up on cod hooks.	Sand from an Anchor.	Sounding.	Sounding.	Dredging.	Dredging.	Dredging.	Dredging.	Dredging.	Dredging.	Dredging.	Dredging.	Dredging.	Dredging.	Dredging.	Dredging.
Textularia agglutinans								*R							*R S								
— — var. biformis							*R																
— — var. Verneuilina polystropha							*					*		*		*R							
Bulimina Presli, type	*																						
— — var. pyrula		*	*C	*C	*						*R									*R L			
— — var. squamosa	C	*C		*			*R																
— — var. Bolivina costata		*																					
— — var. marginata		*		*																			
— elegantissima																*C							
Cassidulina lævigata							*R	*					*			*R	*	*	*	*	*	*	
— crassa																	*	*	*	*R	*	*	
Truncatulina lobatula							*C L	*C			*S	*R					*C		*C		*L		
Rotalia Beccarii	*	*R																					
Pulvinulina repanda, sub. var. Karsteni		*R					*			*C S							*	*	*R	*R	*R S		
Patellina corrugata																			*R S				
Polystomella crispa, var. striato-punctata	*R S	*R		*R S	*		*		*C		*C S	*S	*C	*C S	*	*S	*C	*R S	*C S	*R S	*S		*C S
— — var.									*R														
— Arctica																	*L		*L		*L		
Nonionina scapha								*C										*			*		
— — var. Labradorica	*	*	*	*C	*C		*	*R			*C		*		*	*	*L	*C	*	*C L	*R	*	*S
Lituola nautiloidea, var. Canariense			*				*				*R S		*	*	*C		*R S	*C L		*C	*C L	*C	*S
Trochammina inflata												*C S		*		*C S			*R S				*S
Cornuspira foliacea?		*R S												*R S		*L					*R S		
Quinqueloculina seminulum	* R		*R	*			*		*			*C L	*C L	*C S		*R S	*R S	*L		*L	*L	*C L	
— — var. subrotunda							*R																
— — var. agglutinans							*						*S	*		*S		*	*R S	*R	*R S	*	
— — var. Ferussacii							*R											*L		*L		*L	
— bicornis, var. elegans									*R														
Triloculina tricarinata																*R	*R S	*R S				*R	
Biloculina ringens	*						*R													* R	*R	*R	

TABLE II.—*Supplementary List of Peculiar Arenaceous Forms.*

(See Figs. 1 to 4, and Fig. 7.)

FORAMINIFERA.	Labrador.	Gaspé Bay, 10 Fathoms, (sand.)	Gaspé Bay, 10 to 15 Fathoms.	Gaspé Bay, 16 Fathoms.	Gaspé Bay, 18 to 20 Fathoms.	Gaspé Bay, 16 to 17 Fathoms.	Gaspé Bay, off Grande Grève, 35 Fathoms.	Gaspé Bay, off Grande Grève, 40 to 50 Fathoms.	Gaspé Bay, St. George's Cove.	River St. Lawrence, off Cape Rosier—Whiteaves.
Lituola findens, Parker—Fig. 1	....	....	....	*C L	*	*	....	....	*R	....
Hippocrepina indivisa, P.—Fig. 2	....	....	....	*C L	*C	....	....	....	....	....
Lituola cassis, P.—Fig. 3.	....	*	*C	*C L	....	*	....	....	....	....
Lituola scorpiurus—Fig. 4	*	....	*C	*C L	*	*C	*C L	*C	*C	*C L
Var.—Fig. 4	....	....	....	*C L	....	....	*C L	....	....	....
Rhabdopleura—Fig. 7	....	....	....	....	....	*	*C L	*	*C L	*C L

NOTES ON THE STRUCTURE OF THE CRINOIDEA, AND BLASTOIDEA.

By E. BILLINGS, F.G.S., Paleontologist of Geological Survey of Canada.

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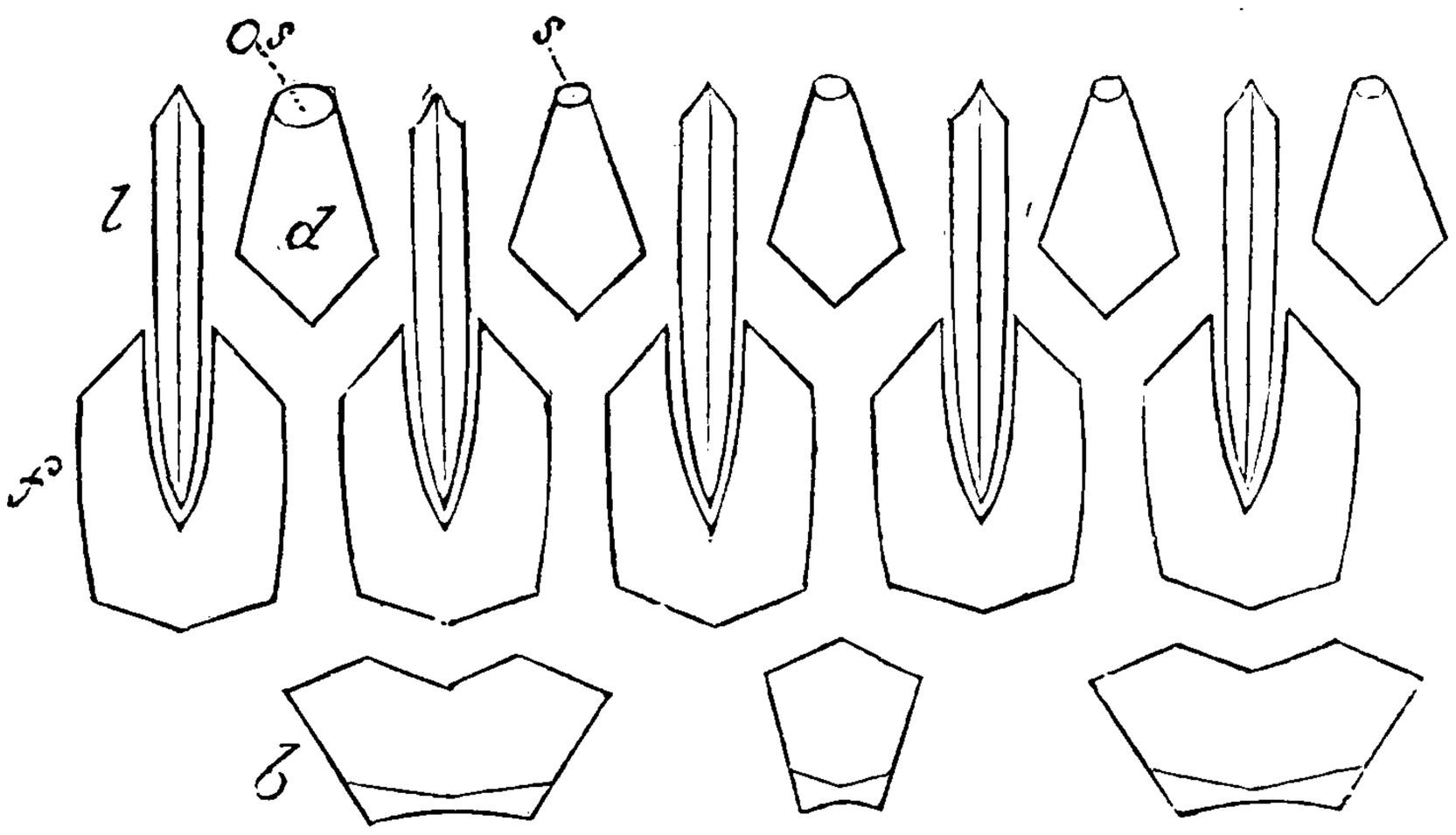
6. ON SOME POINTS RELATING TO THE STRUCTURE OF PENTREMITES.

1.



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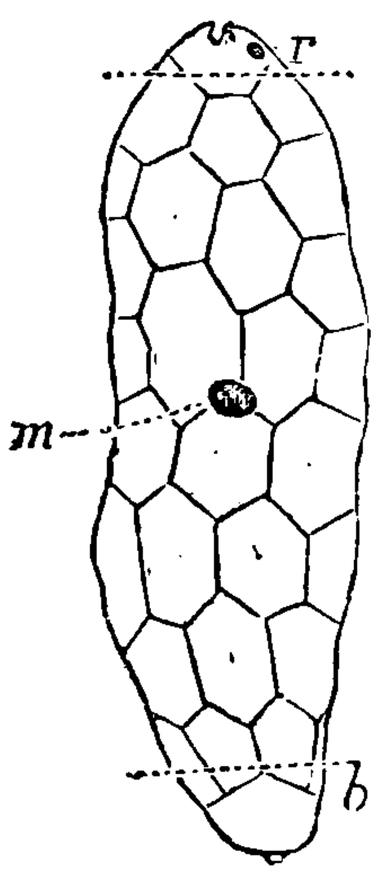

Fig 1.—Calycine plates of *Pentremites*, —*b*, the basals ; *f*, one of five forked plates; *d*. deltoid plate ; *l*, lancet plate ; *os*, oral spiracle ; *s*, spiracle.

Fig. 2.—*Caryocystites testudinarius*, Hisinger,—*b*, basal plates ; *r*, radials ; *m*, mouth.

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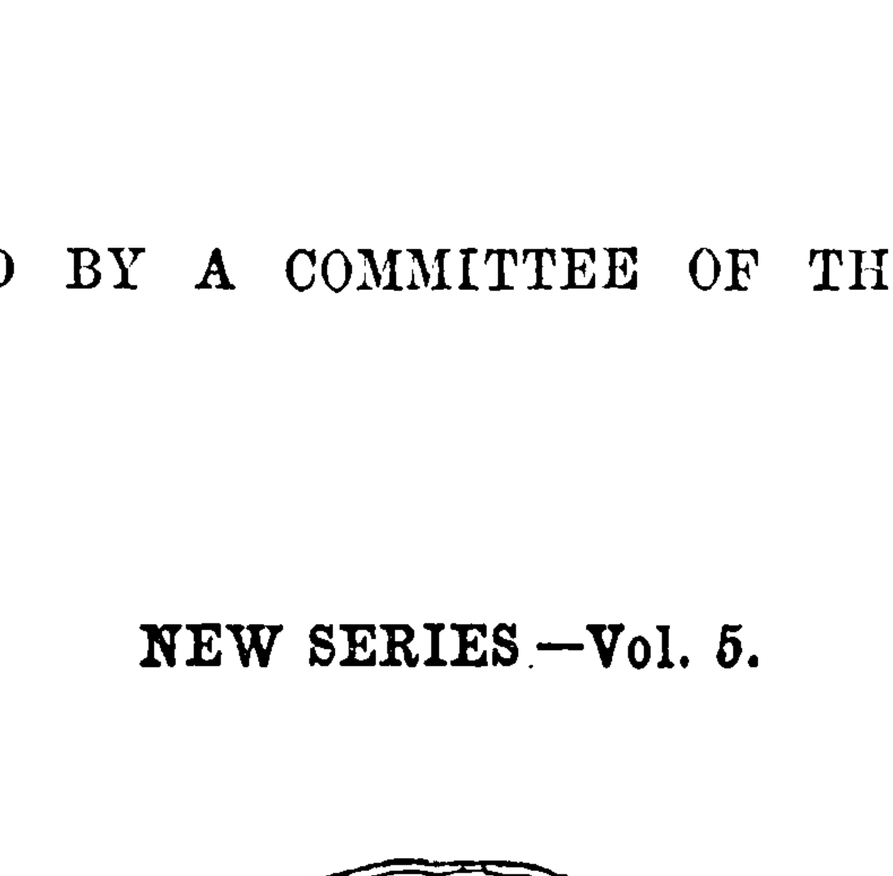

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