COMMONWEALTH OF AUSTRALIA.

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DEPARTMENT OF NATIONAL DEVELOPMENT.

BUREAU OF MINERAL RESOURCES
GEOLOGY AND GEOPHYSICS.

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RECORDS NO. 1954/50

COLLENIA REEFS

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Collenia is a name for calcareous structures in rocks of Upper Proterozoic (Algonkian) time and of world-wide distribution. It is described as the calcareous secretion of primitive microscopical algae, which themselves are never preserved. A number of similar forms are described under various names, and for brevity, they are all commonly referred to as "Cryptozoon" or "Stromatoliths", or even as "calcareous algae".

The authority on the taxonomy of the "Stromatoliths" is Ch. D. Walcott, whose papers are generally known and need not be mentioned for this reason. Several profound studies have been made by C. L. and M. A. Fenton, who discuss the taxonomy as well as the environment of the algae, and their paper "Algal Reefs or Bioherms in the Belt Series of Montana", Bull.Geol.Soc.Amer., Vol. 44, p.1135, 1933, may serve as an introduction to their studies.

Walcott and the Fentons are regarded as the authorities on the subject in the circle of English and the western languages. However, a great work on primordial algae has been done by the Russian authors Maslov and Volegdin which describes the occurrences in Siberia, which, I think, are the most extensive ancient algal formations as yet discovered. I am unable to give any references to their work, though before the war I studied the papers and had some personal contact with the authors. It would also be profitable for a student of the subject to look into Hirmer's "Handbook of Palaeobotany" (in German) and Julius Pia's book "Die rezenten Kalksteine" (1953).

There are some recurrent opinions and interpretations of the subject, often presented as new, or old, but never covering all faces of the problem:

1) The algae are declared to be inorganic (e.g. P. E. Raymond, Bull.Geol.Soc.Amer., Vol. 46, p.375, 1935), a one-sided decision to which I shall return later.

2) A taxonomy of the algae is not justified, (i) because taxonomically different algae build similar, or comparable "reefs"; (ii) because several sorts of algae may simultaneously be the builders of a single structure; and (iii) because the form (reefs, concretions, incrustations) of the secretion of a similar assemblage of algae depends on the environment. This is correct to a certain degree, of course. It reflects the imperfection of the present knowledge only. Collenia itself is characteristic and has been stratigraphically tested, and can be verified from its morphology.

3) The algae are not confined to the Algonkian or Cambrian rocks, but confusingly similar stromatoliths occur also in younger deposits, up into the Tertiary, and even similar Recent limestones exist. This is only partly correct: I think that in Australia, for example, as in America, correct discrimination between Collenia (Algonkian) and Cryptozoon (Cambrian) is possible without knowledge of the superposition or other evidence.

I think that not all structures regarded by authors as algae are organic. Many of them, especially from younger systems, being described as Stromatoliths, and even designated as "Collenia" or "Cryptozoon", are exceptionally regular slump bodies (compaction flowage, gravitational slumping released by an earth tremor, etc.) and are the main source of confusion. Both the antagonistic parties, the absolute defenders and the absolute opponents of the organic and the inorganic interpretations make the same mistake of a too-liberal extrapolation. Each case has to be tested on its own merits.

Most important is the reconstruction of the original environment of the Algonkian Algae. I think that Wallcott's interpretation, as long as it is not substituted by a better one, is still valid. The Beltian (=Algonkian in a global sense) rocks are deposited in intracontinental basins, closed to a normal marine life. There were, however, no obstacles for the algae to be spread over the world, their spores being carried by winds.

Conditions for an extensive development and thickness of the "reefs" and "biostromes" may be also outlines:

1) Ample sunlight, which means shallow water.
2) Slow inorganic sedimentation, because an excessive supply of mud or sand may prevail in the competition and cut off the algae from the contact with water, with the light and the supply of food. Interuption (temporal or even final) of algal growth in the Proterozoic sediments in Arnhem Land by arenitic sediments (sandstone, oolites) has been observed by the author.

3) Supply of food, especially of nitrogen (in the form of nitrates and nitrites) was essential. This may indicate reasonably cool water eliminating fatal denitrification by bacteria. The question of denitrification for Proterozoic limestones has been profoundly discussed by a Russian author, Pravoslavlev (reference not accessible). It is furhter discussed in a paper of A. A. Opik, on the origin of the Estonian Ordovician marine oil shale (in a book: H. von Winkler "Der Estlandische Brandschiefer", not accessible to me). It contains references to the problem of denitification in marine conditions. Ample and more modern material can be found in journals dealing with marine biology and hydrology.

Of course Algonkian is a remote time, and narrow uniformdtarianism may fail here. Perhaps the algae were able to exploit the atmospheric nitrogen directly.

Further exploration of the environment of the Collenia may be possible by the study of similar algal occurrences in younger rocks. It is, perhaps, the only correct way, because fossils may help considerably. The following reasoning may indicate the line of study:

1) The only fossils in the Algonkian limestones are the algae, and if they are present, they dominate the rock (explanation: Walcott's theory of intercontinental basins).

2) In post-Algonkian sequences formations dominated by stromatolithic algae are known also (e.g. Howell, Roberts and Willard, Bull.Geol.Soc.Amer., Vol. 61, p.1355, 1950), in which other fossils occur only in interbeds, and the faunas are meagre. Why the algae eliminate other life, or why the eutrophic environment favoured by the algae was prohibitive for other life, is yet to be discovered.

3) In marine sediments, algae (Girvanella, Sphaerocodium) may occur dispersed and commingled with other fossils. When the algae form beds, these beds are remarkably poor in other organisms. On the other hand some algae (Verticillata, e.g.) never behave in this way.

4) Why in the Algonkian sequences do extensive calcareous formations also occur practically without algae? Was the water in such cases too warm or too poisonous? - A supply of algal spores was certainly present!

I think it is a complex geological, biological, and bio-geochemical problem, and deserves a purposefull search for more facts in the Algonkian terrain and collaboration of naturalists.

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N.B. Ch.Deiss's "Cambrian - Algonkian Unconformity in Western Montana", Bull.Geol.Soc.Amer., Vol. 46, p. 95, 1935, is certainly a very fine study of the Algonkian problem of the Rockies. It is a notable counterpart to the illustrious papers of the Canadian authors dealing with their sector of the Rocky Mountains.

12/10/54.