catches I got the idea that this copepod population deserved some special notice. Using my Sedgwick-Rafter counting cell I enumerated the micro-copepoda in one tenth of each catch and calculated the numbers per catch for the seven stations on the northern line of cruising, which extended 140 miles to sea from the general vicinity of San Luis Obispo. Separate records were kept of numbers in naupliar and copepodid (post-naupliar) stages.

A very few individual catches showed no specimens in the fraction counted, but no station showed less than 310, and two exceeded 1,000 per station. In numbers per cubic meter the range would be from about 10,000 to 30,000, a population far from negligible, especially when the constancy of representation is considered, both seasonal and geographical. The largest individual catch from any of the seven stations (134,000 per cubic meter) was made at a depth of thirty meters about seventy-five miles offshore. In most catches the numbers of nauplii were slightly larger than the aggregates of post-nauplii stages.

The tendency to show greatest abundance at or near a depth of thirty meters was very distinct in all cruises, possibly with some relationship to time of day and night, although the time correlation does not appear clear to me. That level was in the lead at four of the seven stations, and it was second at two. Twenty meters and forty meters were somewhat alike. The three levels were within the leading three in fourteen out of twenty-one instances. Contrariwise, the surface and sixty-meter levels were *not* within the leading three at any station.

No clearly marked seasonal differences were observed, although June seemed to be a little the best.

Locality differences were fairly notable, though not so prominent as the differences of levels. The station nearest shore (about nine miles) did not appear most prominent at any depth. On the other hand, the seventy-five-mile station was highly prominent at different depths, no other station showing so well. A few random counts at stations in other lines followed on the cruises indicated that micro-copepoda were regularly represented by considerable populations even at stations nearly two hundred miles from shore, *i.e.*, in waters clearly oceanic in character.

The largest single catch of micro-copepoda was taken with a large catch of diatoms at thirty meters at the seventy-five-mile station. One or two others of the larger catches also gave the impression of a tendency to larger numbers in catches containing notable numbers of diatoms. Superficially, one may be tempted to link such observations with the view commonly expressed by marine biologists that copepods feed heavily on diatoms. Unfortunately for this linkage, the micro-copepoda seem to be too small to feed successfully on the diatoms. For example, in this largest catch most of the diatoms (a large form of *Rhizosolenia styliformis* Btw.) were larger than the nauplii and as long as most of the copepodids.

Even more noticeable than the presence of the micro-copepoda was that of debris or detritus in all catches. In some catches two hundred miles from shore the volume of inert material appeared far greater than the combined volumes of diatoms, dinoflagellates and other micro-plankton. Variable proportions of these inert particles were organic in aspect at different times at different stations, but there was enough constancy of representation of organic material to suggest the idea that the micro-copepoda may depend upon it largely for sustenance; directly by ingestion, indirectly by feeding on bacteria or other organisms associated with the particles. Of course, this does not mean that association with the diatoms does not help the small copepods. It is entirely possible that they need the oxygen liberated by the latter and that the diatoms are benefited by the opportunity to use their wastes.

On account of my commitment to investigations of phytoplankton populations I shall not be able to give any more attention to these fascinating problems of the micro-copepoda. I am offering this memorandum because no quantitative study of marine micro-copepoda at seven specific levels, at all seasons of a single year, in a series of stations extending from littoral into oceanic waters has ever been made before. It is intended merely to give direct evidence of the existence of an important animal population which can be studied to advantage by methods similar to those used for phytoplankton at the Scripps Institution of Oceanography. It is possible that these populations of very small animals constitute an important feature in the supply of foods for young fishes and other prominent marine animals.

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MARSH GAS IN THE ECOLOGY OF SOME PEAT-BOGS

The peat-bogs or muskegs of the north have been of great interest to plant ecologists and botanists from the highly specialized character of the flora and the peculiarly severe conditions which the plants must endure to survive. There are few habitats which offer more unfavorable conditions in many respects or such a wide range of extremes as these areas, oftentimes very small, afford. Investigations have shown that the pH values of the sphagnum water itself may be as low as 4.5 and that of the carex bog 7 or near this figure, while the open water in places may show a pH of 9. Many other conditions may obtain here which the majority of our mesic plants are unable to tolerate, including stagnancy and lack of aeration or oxygenation, oftentimes low temperatures due to a permanent frozen substratum a few feet below the bog, lack of sufficient nitrification and low available nitrogen supplies, possibly the presence of organic toxins.

Whatever the synthesis of conditions may be, it is obvious that we have here a habitat and an environmental complex which is highly selective for certain types of flora, among which *Sphagnum, Ericaceae,* carices and other sedges and certain conifers are prominent at one place or another depending upon local conditions, successional stages, etc.

The writer in his youth spent much time observing a small natural bog and pond known as Grassy Pond, Oxford, Massachusetts, the origin of which of course was associated with the last retreat of the Pleistocene ice sheet. A deep basin had been created in the hills, in part here, by a superb esker which had dammed the drainage on the east perhaps 40,000 to 50,000 years ago, if the geological clock is correct. At any rate it was obvious enough that a much larger pond had existed here in the beginning, but it had at last reached the old age stage of its history, represented now mainly by a peat bog with *Sphagnum* in places, quaking bogs, sedges, heaths and with only a small area of free water remaining. There was black, oozy, organic mud everywhere.

It was evident that plant life had been mainly responsible for this profound reclamation. In every respect it is typical of thousands of bogs or muskegs scattered over New England and Canada, but around Grassy Pond there was no trace of living black spruce or of other conifers so characteristic of the more northern coniferous area.

In summer the writer found much interest in traveling barefoot through this bog, to observe the various plants and birds dwelling here, for such plants as *Pogonia ophioglossoides, Calopogon* and *Arethusa* made a colorful flower garden of the area. Traveling here became precarious in places, for the tenacious sedge carpet moved with undulations as one walked along over the soft black ooze, causing the sustaining mat of interlacing roots to sink 8 to 10 inches into the water. In July and August the mat sinking beneath one's footsteps caused a copious rush of big bubbles of gas to the surface. Many times the writer amused himself collecting two quart pailfuls of this gas by holding the pail inverted over the up-rushing bubbles as he walked along, after it had been so manipulated as to become filled with water. When the pail was full of the lighter gas, which was methane or marsh gas, CH_4, he fired it with a match to observe the explosive puff which followed. Great quantities of this marsh gas, it seems, reposed beneath these tough rootlayers of the sedge mat as a zone of bubbles which could not well escape until trampled upon so that they were forced through the organic ooze and interlacing roots. Peculiar conditions prevailed here, for the thin layer of water over the sedge mat was extremely warm due to the absorption of heat from the sun's rays, while to the bare foot the water and ooze below the root zone remained very cool.

It is now relevant to inquire as to what effect if any this marsh gas may have upon the growth of the plants in this peculiar habitat. Is it an additional unfavorable factor with direct more or less toxic effects to which these bog plants must adjust themselves, since it is soluble in water to the extent of 3.3 per cent. by volume at 68° F.? Whether or not it exerts toxic effects, indirectly this gas can not but prove to be an unfavorable factor to some plants, since its presence in abundance in the root zone must greatly dilute the air and the free oxygen supplies leading to conditions of oxygen starvation which many plants of the higher lands seemingly can not tolerate, as is well known.

A striking feature of these methane areas, however, is the abundance of the sedges and the other vegetation naturally colonized here and apparently thriving.

A very extensive literature has developed dealing with the effects of various types of illuminating gas on plants, but as yet no general agreement has been reached as to just what specific components are responsible for the injuries, death or other effects observed. It is well established that these gases in the soil and in the air, under certain conditions may prove very harmful to large trees, shrubs or herbaceous plants.

The coke-oven type of illuminating gas with which some of the work has been done contains a variety of constituents in considerable amounts, including hydrogen as high as 50 per cent., methane 25 per cent., carbon monoxide 8 per cent., nitrogen 10 per cent., naphthalene 3.5 per cent., besides small amounts of carbon dioxide, oxygen, illuminants, etc. A number of these components are unquestionably very harmful to plants in one way or another, and the deleterious effects produced represent a resultant of many factors, making it impossible to decide which unfavorable factors were responsible and to what degree.

Natural gas is extremely rich in methane, running as high as 75 per cent. to 100 per cent., with only very small amounts of some of those constituents which may be present and very injurious in the manufactured coke-oven types.

The gas of the Grassy Pond bog probably closely approaches this type, a nearly pure methane gas, since it was practically odorless, indicating that hydrogen sulfide was not present.

It is well known that the bog methane is due to bacterial decomposition mainly of cellulose vegetable matter under anaerobic conditions. The gas of the activated sludge process of sewage disposal may also contain 80 per cent. or more of methane.

Recent studies of chemists have aimed to find methods of converting farm wastes such as corn stalks, etc., into a fuel gas, and processes have been proposed which will produce a gas with about 50 per cent. of methane. These results are significant, since methane is exceedingly valuable as a beginning step in the production of hydrogen, ammonia, . . . (NH_3), etc.

Since methane gas, through the increasing use of natural gas and proposed conversion of farm waste, may in the future play a more important part in life, it is well to know all its ecological properties both in nature and in the laboratory.

Methane, it would appear, is a strikingly inactive gas chemically and physiologically, and it is said it can be breathed in concentrations up to 45 to 50 per cent. of the air volume, with no particularly noticeable ill effects aside from a lowering of the oxygen content. It is the active element of the dreaded "fire damp" of coal mines.

The plant life of the Grassy Pond bog would seem to substantiate this inactive physiological behavior, and to the heaths (*Ericaceae*), sedges and other vegetation of these habitats it is perhaps as inert in itself as the free nitrogen which is the necessary diluent component of our atmosphere.

To say the least, marsh gas may be an important environmental factor in some peat bog areas, and under certain conditions may help to create a low oxygen atmosphere in the water and air surrounding the roots of a group of normal associes of these areas, which are highly tolerant of such conditions.

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PATENTS FOR CHEMICAL COMPOUNDS

DR. CHARLES E. RUBY has recently criticized[1] the policy of the United States Patent Office and Courts for granting and sustaining patents for new and useful chemical compounds. He affirms that such chemical compounds are not human creations but are entirely acts of nature. In this he is entirely incorrect. Although many chemical compounds are found naturally occurring, the synthetic methods of chemistry enable many very useful pure substances to be produced that are not found in nature. The conception and eventual construction of new and useful chemical compounds are accomplished only and entirely through the application of human mental and physical activity. This most certainly constitutes invention, for invention can not consist of more or less than the adjustment of nature to human use and needs.

New and useful chemical compounds should be and are classified together with new plants and new machines. A new printing press could, in a certain sense, be called an act of nature; for is not its operation and construction down to the minutest detail governed by the laws of nature? What fundamental difference is there between the concept of a new chemical compound and the invention and construction of it by means of chemical reactions and the concept of a new machine and the invention and construction of it by means of mechanical operations? A new chemical compound is no more made available for human use by nature than is an automobile. If a new engine is invented, a patent may be issued on the engine and not upon the use of lathe and drill press in its construction. Similarly, if a new chemical compound is invented (and it is without question at least as much of an invention as the engine in that it requires as much human ingenuity to conceive and produce it) a patent is and should be issued on the compound and not on the reactions used in its production.

If our patent laws are changed so that new and useful chemical compounds are not given the benefit of patent protection, a considerable amount of chemical research will be immediately stopped and society will lose the benefits of both the research and the new compounds. Restricting the patent protection to the method of production of the compound will not give enough protection to warrant the expense of the research, because once the usefulness of a new compound is shown many methods of producing it can be found.

There is only one minor difference between the construction of a new compound and a machine. The one is accomplished through processes and the other operations; but basically they are the same, as the fundamental laws of mechanics and electricity govern both methods of procedure. From a patent point of view, the birth of the idea, the initial construction, the development and the testing of the results follow the same pattern in both cases.

Our great mechanical improvements of the past were greatly stimulated by patent protection. Let us not now retard our present age of chemical development by withdrawing patent protection.

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[1] SCIENCE, 89: 387, 1939.

THE CONFIGURATION OF GLUTAMIC ACID FROM SCARLET FEVER ANTITOXIN

AFTER reading the remarkable paper by Kögl and Erxleben[1] in which they showed that the glutamic acid, and to a lesser extent some other amino acids of tumor proteins, were partly of the wrong configuration, it

[1] F. Kögl and H. Erxleben, *Zeit. Physiol. Chemie*, 258: 57, 1939.