resemble the data reported by these investigators and suggest that in this respect the underlying genetic phenomenon may be similar. The exact nature of the defect in acatalasemia is at present not clear.

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Presence of Myoglobin in "Cartilage" of the Marine Snail Busycon

Abstract. The odontophore of the snail *Busycon* has been found to contain myoglobin. The red pigment is readily extracted with water, and spectrophotometric analysis shows the characteristic peaks of myoglobin at 575 and 539 mμ. Although the odontophore is considered to be cartilaginous, it contains, not a chondroitin sulfate, but a polyhexose sulfate. This unusual chemical composition may be responsible for the absorption of myoglobin by the odontophore.

The occurrence of myoglobin in the marine snail *Busycon caniculatum* was first noted by Ball and Meyerhof (*1*), who studied the myoglobin and respiratory enzymes of the muscles associated with the radula of this snail. Since the blood pigment of *Busycon* is hemocyanin, it is of interest to note the occurrence of an additional oxygen-carrying pigment. In recent studies on the cartilage-like tissues of some marine invertebrates it was noted that the odontophore (the supporting rod for the radula in the proboscis) of *Busycon* contained a bright red pigment. This pigment was readily extracted with water, and subsequent analysis of the aqueous solution of pigment in a Beckman model DU spectrophotometer proved it to be myoglobin. This solution of pigment gave an α peak at 574 mμ and a β peak at 538 to 539 mμ. These peaks are in agreement with the data of Ball and Meyerhof (*1*) for the muscle myoglobin of *Busycon*.

Myoglobins have a higher oxygen-carrying capacity and are more soluble than hemocyanin. Therefore, myoglobin would probably be a more efficient respiratory pigment in the comparatively active movements of the radular apparatus. The radular musculature is rich in myoglobin, and so is the odontophore, to which the muscles are attached. The fact that the odontophores of young snails do not contain myoglobin and that those of older snails do accumulate the pigment suggests that myoglobin is stored there and is not essential to the metabolism of the tissue.

The odontophores of snails are frequently thought of as being cartilage tissue. With the advent of biochemical analysis, cartilage is currently defined as tissue which contains one or more of the chondroitin sulfates and which, upon hydrolysis, yields a hexosamine (D-galactosamine), a uronic acid, and sulfuric acid. Alkaline extracts of the odontophore extracted with potassium chloride and potassium carbonate (*2*) yielded a material which, upon ionophoresis (borate buffer, *p*H 10.0; potential gradient, 18 v/cm), produced a spot which stained metachromatically with alcoholic thionin (0.15 percent in 65-percent ethanol). This metachromatic material had an ionophoretic mobility (−12.2) slightly greater than that of chondroitin sulfate (−11.8). Pronounced streaking of the material during ionophoresis indicated that the extracted material was badly degraded. On improving the methods of extraction by use of trypsin digestion (*3*), an extract was obtained which gave no indication of being degraded. This extract was strongly metachromatic and had an ionophoretic mobility similar to that of the alkaline extract.

Upon acid hydrolysis (4.0*N* HCl for 18 hours or 1.0*N* H_2SO_4 for 4 hours in sealed glass tubes) and subsequent chromatography (butanol:acetic acid:water, 3:2:1), neither hexosamine nor uronic acid was detected. The only hydrolyzate product detected was glucose. Sulfate analysis (*4*) indicated that the extract contained ester sulfate. The polysaccharide of the odontophore is therefore a polyglucose sulfate and not one of the mucopolysaccharides normally found in cartilage (*5*). Since the odontophore does not contain the polysaccharides characteristic of cartilage, it cannot be considered normal cartilage. A further analysis of the apparently unique chemical composition of the odontophore may help to explain why the myoglobin is absorbed by the chondroid matrix (*6*).

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Notes on the Champlain Sea Episode in the St. Lawrence Lowlands, Quebec

Abstract. Palynological studies, coupled with geological investigations and radiocarbon dating, have shown that the Champlain Sea episode in the St. Lawrence lowlands is in part contemporaneous with the Two Creeks interstadial of the Wisconsin glaciation.

Recent studies made on Pleistocene deposits of the St. Lawrence lowlands, Quebec, involving stratigraphic studies by Gadd (*1*), Karrow (*2*), and McClintock (*3*), and palynological studies by Potzger (*4*), Potzger and Courtemanche (*5*), and me (*6*) have clarified the chronology of the late Pleistocene events in that area enough to warrant a reassessment of the previously accepted sequence of these events.

The palynological studies (Fig. 1) have indicated conclusively the regional presence of the postglacial pine period (Fig. 1, pollen zones III and IV), the hypsithermal interval (*7*), and the earlier spruce maximum (Fig. 1, pollen zone V) in post-Champlain Sea deposits of the St. Lawrence lowlands.

In sediments older than those showing the spruce maximum (zone V) the higher percentages of pine pollen (*Pinus banksiana*), accompanied by an increase of non-tree pollen, have been interpreted as evidence for a late-glacial episode (zone VI). The high percentages of pine pollen should, perhaps, be explained by over-representation due to the high pol-

len production of pine. This effect becomes more apparent when the total amount of tree pollen from local sources is low.

The late-glacial episode was followed by a change toward a colder and moister climate, or both (*8*), as indicated by the marked increase of spruce (zone V). This increase of spruce, often accompanied by an increase of balsam fir, cannot be explained as a local development in the forest succession because in all diagrams this spruce maximum has a definite age and position, preceded and followed by other regionally consistent maxima and minima in other pollen graphs. Hence this spruce maximum must be caused by a regional climatic change and can be used as a chronological marker in the pollen stratigraphy.

The pine zone (Fig. 1, zones III and IV) consists of an early part (zone IV), characterized by pollen of jack pine (*Pinus banksiana*), and a main part (zone III) when pollen of white pine (*Pinus strobus*) and red pine (*Pinus resinosa*) were predominant. The main part of the pine pollen zone (zone III) is believed to be contemporaneous with the postglacial hypsithermal interval (*7*). An age of 5000 to 7000 years for this interval seems generally acceptable.

The spruce maximum (zone V) is necessarily older and may correlate with the upper part of the spruce zone in Connecticut, dated at 8155 ± 410 years (radiocarbon sample Y-282). Since the pollen record in the St. Lawrence lowlands extends somewhat further back in time, an age of 8500 to 9000 years, based on palynological and paleobotanical reasoning, seems conceivable for the earliest postglacial pollen-bearing sediments. It was most encouraging when a radiocarbon age of 9430 ± 250 years (sample L 441-C) was obtained for the basal sediments of the St. Germain bog near Drummondville (*6*, p. 5).

Since the pollen diagrams showing pollen zones V and VI at the base are from the center of the St. Lawrence lowlands, only about 300 feet above present sea level, it follows that the main part of the Champlain Sea episode must be an older event; the maximum limit of the marine inundation of the area reached the present elevation of 600 feet.

Furthermore, the studies by Gadd (*1*) and Karrow (*2*) have conclusively proved that, contrary to the interpretation by Osborn (*9, 10*), the St. Narcisse moraine a few miles north of the St. Lawrence River at Three-Rivers, Quebec, was formed by ice from the north and the readvance was contemporaneous with a part of the Champlain Sea episode.

In this connection it should perhaps be mentioned that recent mapping and

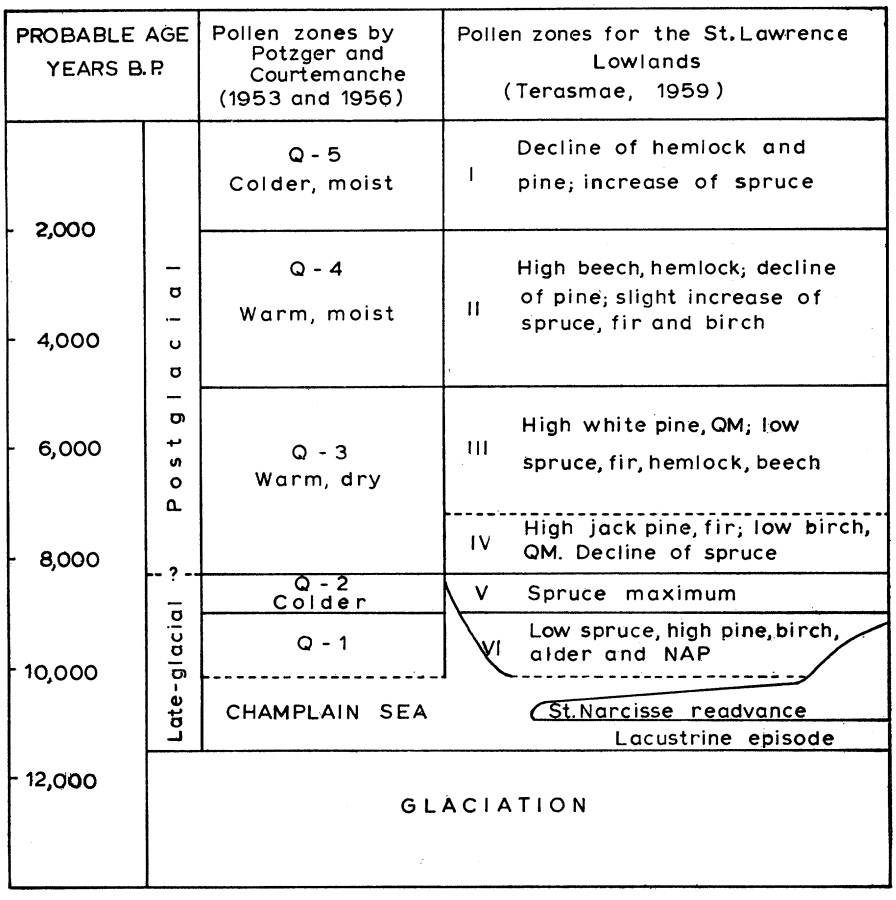

Fig. 1. Pollen zones and late Wisconsin events in the St. Lawrence lowlands (QM, *quercetum mixtum*; NAP, nonarboreal pollen).

study of Pleistocene deposits in the lowlands have failed to support Osborn's speculation about a local ice lobe in the lowlands (*9, 11*) and, as also shown by Gadd (*1*), I have been able to prove to my satisfaction that the "marine crevasse fillings" in the Lotbiniere area (*9*) are longitudinal and parabolic dunes formed on the crest of the Drummondville moraine (*1*) in early post-Champlain Sea time. The sand is clearly windtransported and contains no fossils.

Some years ago samples of marine shells, embedded in deposits of the Champlain Sea, were collected from sites near the highest marine limit in the Ottawa and Montreal area, by Elson, Prest and Wagner of the Geological Survey of Canada and these samples were dated by the radiocarbon method at the Yale Geochronometric Laboratory (*12*). The following dates (*13*) were obtained: 10,630 ± 330 years (Y-215), 10,850 ± 330 years (Y-216) and 11,370 ± 360 years (Y-233). On grounds of possible contamination by old carbonates and the fact that "they were incompatible with the dated Great Lakes sequence," these dates were discarded by Flint (*12*, p. 278) as "probably spurious." Since these dates are consistent among themselves, it is my opinion that they may be of the right order of magnitude and thus approximately date an early phase of the Champlain Sea episode. This view is shared by H. de Vries of the Groningen radiocarbon laboratory, Holland, who accompanied me on field trips to the St. Lawrence lowlands last summer. These dates would be, indeed, difficult to explain if the time limits generally suggested for the Champlain Sea episode (from about 5000 to 7000 years ago) were correct (*12*, p. 272).

The present evidence indicates that the Champlain Sea episode in the St. Lawrence lowlands may be in part contemporaneous with the Two Creeks interval and hence the St. Narcisse readvance can perhaps be correlated with the Valders (?) substage. The palynological studies, supported by radiocarbon dates, suggest that pollen zone V, showing the spruce maximum, may indicate a later readvance of ice in northern Quebec and probably at Cochrane, Ontario. If so, this readvance should have occurred about 7500 to 8000 years ago. It is interesting to note that the sequence of events as outlined above is in accord with the results of studies made by Fairbridge (*14*) on the Late-Pleistocene eustatic sea-level fluctuations.

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Growth Responses of Phycomyces to Polarized Light Stimuli

Abstract. The effectiveness of stimuli in air depends upon the direction of polarization. For sporangiophores immersed in a medium of refractive index similar to that of the protoplasm this dependence disappears. These facts indicate that one is dealing with simple Fresnel reflection losses and not with dichroism of oriented photoreceptors.

For the tropic response of *Phycomyces* sporangiophores, Castle (*1*) observed that light polarized horizontally (electric vector perpendicular to the long axis of the sporangiophore) was 10 to 15 percent more effective than equal incident flux polarized vertically. Castle concluded that the differential response to polarized light was due to Fresnel reflection losses at the front surface of the cylindrical sporangiophore. Reflection losses are larger for vertically polarized light. Recently, however, Jaffe (*2*) stated, without explanation, that differential reflection cannot explain the observation.

Table 1. Average values of intensity (arbitrary units) necessary for growth response null. "Polarized vertically" denotes that the electric vector was parallel to the long axis of the sporangiophore; 15 to 18 determinations were averaged for each 450 mμ value and only 7 and 4 for 380 mμ value. Standard errors of the mean are given.

Direction	In air ($\lambda = 450$ mμ)	In air ($\lambda = 380$ mμ)	In FC-43 ($\lambda = 450$ mμ)
Polarized vertically	1.24 ± 0.02	1.21 ± 0.01	1.06 ± 0.04
Polarized horizontally	1.00 ± 0.03	1.00 ± 0.06	1.00 ± 0.05

He suggested that since the photoreceptors of *Phycomyces* are likely to be dichroic, the differential response might be due to an alignment of photoreceptors within the sporangiophores.

To test this hypothesis the relative effectiveness of horizontally and vertically polarized light in producing growth responses was measured by a null method. The apparatus, intensity units, and growth response measurements have been described previously (*3*). Sporangiophores were rotated continuously (2 rev/min). A standard blue stimulus of fixed intensity impinging bilaterally 60° from the vertical long axis of the sporangiophore was alternated every 5 minutes with a test stimulus impinging unilaterally 90° from the vertical. The monochromatic test stimulus (wavelength 450 or 380 mμ) was plane polarized by a glass laminated linear polarizer (Polaroid Corp., HN22). The dispersing elements of a Beckman DU spectrophotometer were used as a monochromator, and the intensity of the test beam was controlled by varying the slit width. Intensity as a function of slit width was calibrated against a thermopile standard with an RCA 935 phototube-amplifier system.

The increase in sporangiophore length was measured to the nearest micron for each 5-minute period. The difference in growth during two consecutive 5-minute stimuli (blue followed by test) was ideally zero if the test stimulus matched the blue stimulus. If the test signal was too large, a growth response maximum occurred during the blue stimulus (response occurs 5 minutes after stimulus) and a positive difference, blue minus test, was observed. If it was too small, a minimum occurred during the blue, and a negative difference was observed. For a given intensity and polarization of the test stimulus the sum of the differences for three cycles was plotted against log slit width. The intensity necessary for a growth response null was determined graphically.

In air (Table 1), the horizontally polarized beam is about 20 percent more effective than the vertically polarized beam, as would be expected from Castle's observation for the tropic response. The growth response has the advantage of requiring no assumptions about the spatial distribution of the light within the sporangiophore in producing a response, except that the light must enter to be effective.

If the observed effect were due to dichroism of oriented receptors, the magnitude of the effect might be expected to be different for a second strong absorption band. However, the response differences for the two directions of polarization at two action spectrum maxima, 380 and 450 mμ (*4*), were identical.

To eliminate reflection losses, sporangiophores were stimulated while immersed in totally fluorinated tributylamine (FC-43, Minnesota Mining and Manufacturing Co.). The FC-43 has an index of refraction at 25°C of 1.29, which is close to the average value for intact sporangiophores (1.38) (*5*), and is optically inactive. Thus, the reflection losses are negligible, since they are a function of the square of the difference in index of refraction at the interface. In FC-43, growth rates are normal and a usual time course of response to a large pulse-up is observed. Since there is little focusing effect, continuous rotation of the sporangiophores was unnecessary. In FC-43 (Table 1) there is no significant difference in growth response for the two directions of polarization.

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On the Instrumental Conditioned Reaction Evoked by Electrical Stimulation of the Hypothalamus

Abstract. Weak electrical stimulation of the hypothalamic lateral area of satiated goats elicited the previously established conditioned reflex of putting the left foreleg on the food tray and then eating the food given as reinforcement. When, during stimulation, food was not given, an extinction of the conditioned reaction took place.

Experiments on alimentary conditioned reflexes performed several years ago by one of us (*1*) led to the conclusion that an already established instrumental reaction is due to the excitation of a hypothetical "alimentary center" caused by the conditioned stimulus. The discovery of the feeding center in the lateral hypothalamic area (*2*) has suggested that it may correspond to our hypothetical center. Therefore, to test our conclusion, we performed experiments with electrical stimulation of the hypothalamic feeding center of satiated animals.

An instrumental conditioned reflex of putting the left foreleg on the food tray was established in four goats; every movement was reinforced by a small amount of oats. After a period of training, the hungry animal, on entering the