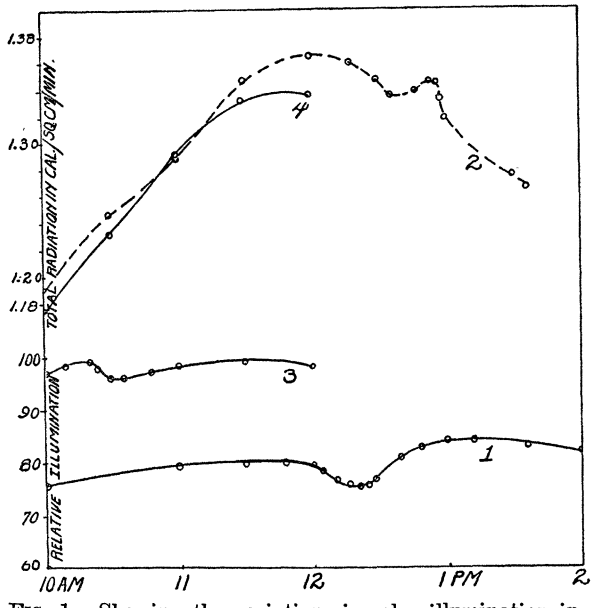

FIG. 1. Showing the variations in solar illumination intensity and total radiation.

vations. In making the observations the pyrheliometer and the cell were located near each other. Days were selected when there was no evidence of clouds or haze. The air in the region of the laboratories was entirely free from smoke. The days on which observations were made can well be called clear and cloudless.

Curves 1 and 2 were plotted from observations made on July 26, while curves 3 and 4 show the variations several days later. Curves 1 and 3 show the variations in the solar illumination intensity. Curves 2 and 4 show, respectively, the simultaneous variations in the total radiation. These data were selected from a series of observations to exhibit the magnitude and rapidity of the changes in illumination.

It is at once apparent from the illumination curves that on these days rather rapid changes are superimposed upon the changes due to zenith distance. Also, changes in illumination are not indicated by changes in the total radiation, although in curve 2 of July 26 a rather small but sudden change occurs in the total radiation at 11 A. M., and another more marked change between 12:40 and 1 P. M. Curve 4 shows only the gradual change in total energy, while simultaneous readings of illumination show a sudden change at about 10:20 A. M.

That a relation exists between radiation intensity and illumination has been shown by Kimball.[1] This relation is that radiation in calories per minute per cm² on a horizontal surface multiplied by 6,700 will give the illumination in foot-candles on a horizontal surface within ±5 per cent., the variation being characteristic of the position of the sun. This relation agrees, in general, with the present results, but does not account for the rapid changes found.

In a study of the penetration of light into water, Shelford and Gail[2] did not take into account any variations in the incident light, although they apparently suspected variations to exist. In a later study, Shelford[3] *assumes* that, under a cloudless sky and a very clear atmosphere, the intensity of the visible solar light incident on the surface of water is constant between the hours of 10 A. M. and 2:30 P. M. Variations due to solar zenith distance and the smaller variations illustrated in curves 1 and 3 show that such constancy does not exist.

Poole and Atkins,[4] during a series of determinations of the penetration of the *total* visible light into the sea near Plymouth, found variations in the incident light with a bright sun, although they do not state that the sky was cloudless and the atmosphere clear.

It is evident that in making measurements of the absorption of visible light by ocean waters a knowledge of the variations in the incident light is quite necessary. The results of a study of the penetration of some of the components of visible solar light into the waters of Puget Sound and of Southern Alaska will be published soon.

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BORRELIOTOSES: FOWL-POX, MOLLUSCUM CONTAGIOSUM, VARIOLA-VACCINIA

THE judgment first expressed by Borrel,[1] that the specific granules of fowl-pox may well be the actual virus of this disease, a view later held by Lipschütz and by Paschen with respect to the specific granules of molluscum contagiosum and vaccinia, has received from recent studies strong support. Evidence has likewise accumulated which effectively upholds the view that the specific cellular inclusions (Bollinger bodies, molluscum bodies, Guarnieri bodies) of these three infections are composed essentially of colonies of the respective viruses which appear to be microorganisms and seem to require an intracellular environment in their hosts for their reproduction.[2,3,4,5]

[1] H. H. Kimball, *Mo. Weather Rev.*, 52: 473, 1924.

[2] V. E. Shelford and F. W. Gail, *Pub. Puget Sound Biol. Sta.*, 3: 141, 1922.

[3] V. E. Shelford, *Pub. Puget Sound Biol. Sta.*, 7: 151, 1929.

[4] H. H. Poole and W. R. G. Atkins, *Jour. Marine Biol. Assoc.*, 14: 170, 1926; *ibid.*, 15: 455, 1928.

[1] A. Borrel, "Sur les inclusions de l'epithelioma contagieux des oiseaux," *Compt. Rend. Soc. Biol.* 57: 642, 1904.

[2] C. E. Woodruff and E. W. Goodpasture, "The Infectivity of Isolated Inclusion Bodies of Fowl-Pox," *Amer. Jour. Path.*, 5: 1, 1929.

[3] E. W. Goodpasture and C. E. Woodruff, "A Com-

This evidence in substance may be summarized as follows: It has been demonstrated that the specific cellular inclusions of fowl-pox, molluscum contagiosum and vaccinia, namely, the Bollinger bodies, molluscum bodies and the Guarnieri bodies, are composed in large part of compact aggregations of enormous numbers of specific granules, respectively the Borrel, the Lipschütz and the Paschen corpuscles. There is good evidence that the great mass of these corpuscles if not all are regenerated within the infected cell. In the case of fowl-pox it has been proven that individual inclusions are totally and fractionally infective.[6] The corpuscles of fowl-pox, molluscum and vaccinia are demonstrably filterable. These granules, unlike the banal proteid granulations of cells, are not dissolved by dilute acids and they are resistant to tryptic digestion. They are likewise insoluble in lipoid solvents. In the case of the granules of fowl-pox and vaccinia there is agglutination in the presence of specific immune serum,[7] and in suspensions of virus centrifuged at high speed there is a marked parallelism between the concentration of specific granules and the concentration of virus. The vaccinia corpuscles have been found to increase in tissue cultures containing the virus. There is morphologic evidence of division of the granules by fission. Finally these granules react characteristically to certain staining methods, notably the silver method of Morosow, so that demonstration of them in preparations which contain them in considerable amount is thoroughly reliable in the hands of competent observers.[8] They are not readily or at all exhibited by the staining methods used to demonstrate bacteria. While the final demonstration of reproduction of these granules in the absence of tissue cells has not yet been attained, there is sufficient reason for judging that one is dealing here with a group of viruses which are micro-organisms and, in natural infections, obligatory cytotropes.

In the entire field of cytotropic viruses these are the only ones which present conclusive evidence of an association of the active agent with minute coccoid granules which have a definite and uniform morphologic and physical structure, and stain characteristically by Morosow's method. The diseases which these viruses cause are also in many respects analogous. In each case the virus attacks ectodermal epithelium, and induces an eruptive lesion which presents the specific cytologic feature of intracytoplasmic inclusions composed essentially of the uniform corpuscles.

There has always been difficulty in unifying the virus group of diseases. The fact of filterability, the concept of cytotropism and a better understanding of viral lesions are nevertheless helping to resolve some of the confusion. Owing to the fact that the virus class is so difficult of definition, it has seemed to me of primary importance to correlate any small group of virus diseases as specifically as possible whenever the facts warrant such an association. The group I have been discussing, which contains such notable examples as variola-vaccinia, fowl-pox and molluscum contagiosum, is at the present time separable from the general class of virus diseases into a more homogeneous one because of the presence of visible granules which have definite and similar characteristics and constitute an essential part of their analogous specific lesions. I therefore think it justifiable at this time to designate this group by generic and specific names on the basis of their specific granules, and I would suggest that fowl-pox be taken as the generic type. It was Borrel who in 1904 first discovered the specific coccoid granules of this disease, and later investigators have shown that they constitute the essential component of the cellular inclusions, that they are fractionally infective, and that the so-called Borrel bodies are filterable and specifically agglutinable by immune serum. It would therefore seem appropriate that Borrel's name should be associated with this group.

There is no adequate proof, however, that the granules of these diseases are viable, nor for that matter, that any cytotropic virus is a living thing; consequently a name which would at present classify these corpuscles among the living agents of disease might be misleading. One should rather choose a specific name which is non-committal as to the biological status of the agent.

I would therefore propose the name *Borreliota* as a generic title. The suffix *iota,* the Latinized name of the smallest Greek letter, has I am told by reliable authorities, an ancient and honorable usage signifying smallest particle. Translated in this sense the title Borreliota would mean the small particles or corpuscles of Borrel. The form Borreliota is either singular or plural.

The difficulty of applying specific terminology to

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parison of the Inclusion Bodies of Fowl-Pox and Molluscum contagiosum," *Amer. Jour. Path.*, 7: 1, 1931.

[4] E. G. Nauck and E. Paschen, "Der Morphologische Nachweis des Pockenerregers in der Gewebekultur," *Zentralbl. f. Bact.*, 124, (Orig): 91, 1932.

[5] E. W. Goodpasture, A. M. Woodruff and G. J. Buddingh, "Vaccinal Infection of the Chorio-allantoic Membrane of the Chick Embryo," *Amer. Jour. Path.*, 8: 271, 1932.

[6] C. E. Woodruff and E. W. Goodpasture, "The Relation of the Virus of Fowl-Pox to the Specific Cellular Inclusions of the Disease," *Amer. Jour. Path.*, 4: 713, 1930.

[7] J. C. G. Ledingham, "The Aetiological Importance of the Elementary Bodies in Vaccinia and Fowl-Pox," *Lancet*, 525, Sept. 5, 1931.

[8] M. A. Morosow, "Die Färbung der Paschenschen Körperchen durch Versilberung," *Centralbl. f. Bakt.*, I. Orig., 100: 385, 1926.

certain members of this group is apparent when one considers the fact that the virus of smallpox and that of cow-pox, while differing in certain important ways, are in reality to be considered modifications of the same virus, because they cross-immunize against each other. In other words there is not a specific difference between them, and this probably applies to other modified strains such as those of horse-pox, swine-pox, goat- and sheep-pox. It would therefore seem advisable to use not only a specific, but a subspecific or variety name for the corpuscles of such related strains. I would therefore propose the following terminology:

Borreliota variolae hominis: specific corpuscles of smallpox (Paschen bodies, elementary corpuscles).
Borreliota variolae bovis: specific corpuscles of vaccinia (Paschen bodies, elementary corpuscles).
Borreliota variolae equi: specific corpuscles of horse-pox.
Borreliota variolae porci: specific corpuscles of swine-pox.
Borreliota variolae ovium: specific corpuscles of sheep and goat-pox.
Borreliota molluscl: specific corpuscles of molluscum contagiosum (Lipschütz corpuscles).
Borreliota avium: specific corpuscles of fowl-pox (Borrel corpuscles).

The acceptance of such a nomenclature based upon adequate experimental data would do much to attract attention to this related group as a whole, and would obviate the great confusion of terms now in use such as Borrel bodies, Lipschütz granules, Paschen corpuscles, elementary bodies and so on. At the same time the probability that the specific granules in question represent micro-organismal etiological agents would be duly recognized.

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A CONTRIBUTION TO VOWEL THEORY[1]

TWO main theories of vowel production have been advanced, namely, the harmonic or steady state theory and the inharmonic or transient theory. The harmonic theory, advocated mainly by Wheatstone, Helmholtz and D. C. Miller, holds that the vocal cords generate a complex wave having a fundamental and a large number of harmonics. A wave at its source will contain all the frequencies that it will ever contain. The so-called resonating cavities (pharynx, mouth, nasal cavities, paranasal sinuses) will act to magnify those frequencies of the wave near the resonating frequencies of the cavities, the amount of amplification depending upon the damping constant of the cavity. The reinforced frequency bands determine the vowel quality.

The inharmonic or cavity tone theory, advocated mainly by Dodart, Willis and Scripture, holds that the wave or series of puffs from the vocal cords acts only as an agent for exciting the transient frequencies that are characteristic of the resonating cavities. Certain frequencies in the wave need not be present in the source but may be added by the resonating chambers. According to this theory, the vocal cords emit puffs of air, each puff setting the air in the above cavities into vibration, resulting in the so-called "cavity tones." The frequency of a cavity tone is determined by the natural frequency of the cavity, and is not dependent on any frequency aspect of the exciting or cord tone. This vibration of the cavity tone soon diminishes until it is started anew by a second puff. Here, as with the harmonic theory, the vowel quality is dependent upon the natural frequencies and damping constants of the vocal cavities.[2] The findings reported in the present paper tend to add weight to the inharmonic or cavity tone theory.

In order to delimit sharply the problem the head and neck of a cadaver was used to furnish the so-called resonating cavities and a pure sine wave as the force to act on these cavities. Our specimens (two male) presented normally extensive sinuses and normal nasal, oral and pharyngeal cavities (determined by sectioning the head after completion of the experiment). The soft palate was so fixed as to present an opening into both the nasal and the oral cavity which were patent. Both specimens had teeth. The source of the sine wave was a General Radio low frequency oscillator Type 377–B, activating a high-grade head phone. The waves were conveyed to the larynx or directly to the microphone from the head phone by a rubber tube 90 cm long and with a lumen 5 mm in diameter. For studying and recording the waves a Jenkins and Adair C6 condenser microphone with one additional stage of high quality amplification and a Westinghouse oscillograph were used. For all frequencies scouted, 120, 200, 300, 400, 500, 600, 700, 800, 900, 1000 and 1200 ~, the waves were studied first by holding the end of the tube carrying the sound directly in front of the microphone. With the exception of one frequency, 120 ~, all frequencies presented sine waves. Secondly, the waves were studied by placing the nose and mouth of the cadaver directly in front of the microphone after the rubber tube had been inserted through the trachea, into the ventricle of the larynx, just above the level of the vocal cords. The head was suspended from the ceil-

[1] This paper reports a part of a larger research program suggested by the late Dr. Henry J. Prentiss, head of the department of anatomy, University of Iowa. The program is now being kindly supported by Dr. E. M. MacEwen, present head of the department of anatomy.

[2] For a fuller discussion of vowel theories see H. Fletcher, "Speech and Hearing," 1929, Macmillan; and G. O. Russell, "The Vowel," 1928, Ohio State University Press.