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Wilhelm Reich's Claim of the Heterogenesis of Eukaryotic Amoebae

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Abstract

To this day there is still no definitive model for the evolutionary emergence of eukaryotic cells. Before WWII, there existed two non-Darwinian models that have now been forgotten - the symbiotic and the orgonomic theories, which are contrasted in the present review. Both had in common the notion that the eukaryotic cell was simply a spontaneous assemblage of prokaryote-like vesicles. The orgonomic model further claimed *de novo* generation (heterogenesis) of eukaryotic cells (protozoa) from the spontaneous assemblage of such prokaryote-like vesicles out of dying and decaying tissue cells, or from sterilized soil infusions. However, both claims are found to be wanting in their experimental foundation.

COMMUNICATION

> "One cell is transformed into another fundamentally different form. (...) The formation of biologically independent entities from biological organisms of a different kind goes on continuously within the body."
> W. Reich, "The Cancer Biopathy", 1947, p. 79

1. Symbiotic theories of the emergence of eukaryotic cells

It was in Oslo, in 1936, that Reich initiated most of his electrochemical research into the so-called question of "spontaneous generation", today the subject matter of "biopoiesis" - the origins of life, or, more specifically, the genesis of living cells. A fundamental irreverence has always been attached to the expression "spontaneous generation", as if the notion that life sprang anew threatened all successive dominant conceptions of life - whether religious conceptions that ascribed life to the creative power of a god, vitalist conceptions that ascribed it to a vital force providing the organism with a unity, or evolutionary and mechanistic conceptions that restricted life to the power of a "germplasm", the genes or the DNA.

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In the nascent biology of late XIXth century nothing was yet firmly established, but a polarity of views had already formed, with one set becoming dominant. We may call "cell theory" to that then dominant view, but the facts are that it resulted from the convergence of a series of distinct theories - in the fields of bacteriology, cell biology and evolutionary biology. There was the model of the "cell continuity theory" (R. Virchow, R. Remak, M. Schleiden) proper, which held that all cells can only arise from other cells (*Omnis cellula ex cellula*, in Virchow's dictum). At that time, the concept of a cell did not yet apply to the world of the prokaryotes. By cell one typically meant a nucleated cell, what we now call a eukaryote, whether it be a free-living protozoon (or protista) or a complex metazoon - a plant or an animal. Indeed, the then emerging dominant view had married the fundamental tenet of cell theory with the convictions of Darwin, Weismann and E.B. Wilson - ie, that the nucleus alone specified hereditary determinations, and thus only a nucleated cell was a cell. When, in his 1890 book "*The Elementary Organisms*", Richard Altmann proposed that a eukaryote was assembled by the growth of a colony of what he termed "bioblasts", and the subsequent formation of an enclosing membrane, he was met with derision [1]. Yet, 8 years later, Carl Benda demonstrated the existence of crystal violet staining granules in eukaryotic cells, and he termed them "mitochondria", from the Greek *mitos* (thread) and *khondrion* (small granule). But almost another 2 decades would pass until Altmann's "bioblasts" were shown by Cowdry [1-2] to be the same as Benda's "mitochondria".

With Pasteur's tremendous advances in microbiology, it became apparent that prokaryotes were nonnucleated cells with independent powers to assimilate and grow (capacity for metabolism) and multiply by division (capacity for reproduction). But it also became firmly established that bacterial contamination occurs not by "spontaneous generation" of bacteria, but by infection, whether with one or more living bacteria or with their 'germs' or spores. In particular, as it concerned resistance to sterilization with heat, it became accepted dogma that only bacterial spores could resist such procedure. As Pasteur put it in his 1864 address to the French Academy of Sciences at the Sorbonne, the cell continuity theory and the theory of air germs were indissociable: "There is now no circumstance known in which it can be affirmed that microscopic beings came into the world without germs, without parents similar to themselves". [3]

The acceptance that bacteria were cells with a life of their own inevitably provoked a return of interest in Altmann's proposal. At a lecture at the University of Chicago in 1893, the Japanese zoologist S. Watasé suggested that the eukaryotic cell resulted from the union of many diverse organisms, which composed both the cytoplasm and the chromosomes, including the centrosomes (we rely on Prof. Sapp's account of Watasé's lecture [1]). Watasé referred to the work of others who in his view had demonstrated that the chloroplasts of plants must have arisen as symbiotic algae (the green-blue algae that today are identified as cyanobacteria). The eukaryotic cell had to have formed as a symbiotic mul-

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tiplicity between complementary and distinct microorganisms, vindicating A. de Bary's doctrine of symbiosis and the work of A. Schimper (Bary's former student) in the early 1880's that had demonstrated how plant chloroplasts only multiply by binary fission inside the host cell. As Sapp puts it, with Watasé's lecture and the emerging theory of symbiosis, what were considered to be the organs of a cell now became viewed as independent organisms in their own right.

Then, in 1918, in his book "*The Symbionts*", P. Portier claimed to have cultured bacteria from healthy animal tissue that he had identified as being mitochondria. The confrontation with the microbiologists at the Pasteur Institute was inevitable [1] - since Pasteur's germ theory held that bacteria were causes of disease, it was unacceptable to view bacteria as able to live symbiotically in healthy animal tissue. Accordingly, the claim that mitochondria were free-living bacteria could only be the result of unwitting contamination of the lysates of eukaryotic cells. The issue, however, was far from over. The biggest assault on Pasteur's germ theory would come in 1927 from Ivan Wallin, in his book "*Symbioticism and the Origin of the Species*". Against Darwinism, Wallin held that symbiosis was the major evolutionary force in the development of new species, and the basis for a constant, ongoing phylogenetic creation. He maintained that differentiated eukaryotic cell structures were the product of bacteria-like mitochondria which had somehow entered some primitive bacteria and established a mutually advantageous relationship of symbiosis. Wallin also claimed to have succeeded in growing mitochondria from cell-free lysates in peptone-enriched agar media containing beef broth, a liver infusion or serum extracted from human blood, after mechanically tearing liver tissue from fetal and newborn rabbits [4]. His method of staining mitochondria with Janus Green was also a direct, live histochemical identification of the vesicles in his cultures.

Again, established bacteriologists reacted with disbelief and derision. Despite Wallin's careful sterilization procedures, his mitochondria were 'merely cocci' or 'their germs' that had contaminated his preparations. There could be no beneficial role for bacteria, let alone a symbiosis-driven evolution of the eukaryotic cell. The reaction of "cell biologists" and "evolutionary biologists" was identical - claiming that the notion of speciation by symbiosis ran counter the nucleocentric conception of the cell, which entirely ignored the role of the cytoplasm in the life of a cell.

It is in this context that Reich's investigation of the role of the microscopic vesicles that he called "bions" and the histochemical and cellular processes that led to their formation ("bionic vesiculation", "bionic disintegration", etc) took place. Like Altmann, Watasé, Portier, Wallin and others before him, Reich was also convinced by his own observations that the nucleated cell arose from the cooperative interaction and association of vesicles or bions. The "bions" in fact play the same role as Altmann's "bioblasts". Reich termed the first type of bion that he claimed to have identified PA-bion precisely for its ability to form packets that surrounded themselves with an envelope or membrane to

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become a structure analogous to an amoeba or an amoeboid cyst; thus PA stood for Packet Amoeba, as Reich claimed that he could observe PA-bions grow and form such amoeboid structures *in vitro* (see **Fig. 1**).

The main difference between Reich's theory of the PA-bions and Altmann's "bioblasts", or the mitochondria of Benda, Cowdry and Wallin, or the chloroplasts of Schimper and de Bary, was that Reich claimed (1) *heuristically*, that these PA-bions formed *heterogenically from the decomposition* of healthy or diseased tissue, and (2) *experimentally*, that they were produced by the very techniques employed for sterilization, and thus (3) constituted proof for the spontaneous generation of universal prebiotic or protobiotic vesicles [5], ie a primitive form of prokaryotes. If all his predecessors in "vesicle theory" were already at odds with cell theory, Pasteur's germ theory and Darwinism, Reich's conflict with the same schools of scientific doctrine is only further aggravated by his claim that the bions formed spontaneously and anew from the decay of eukaryotic cells. In other words, the chasm

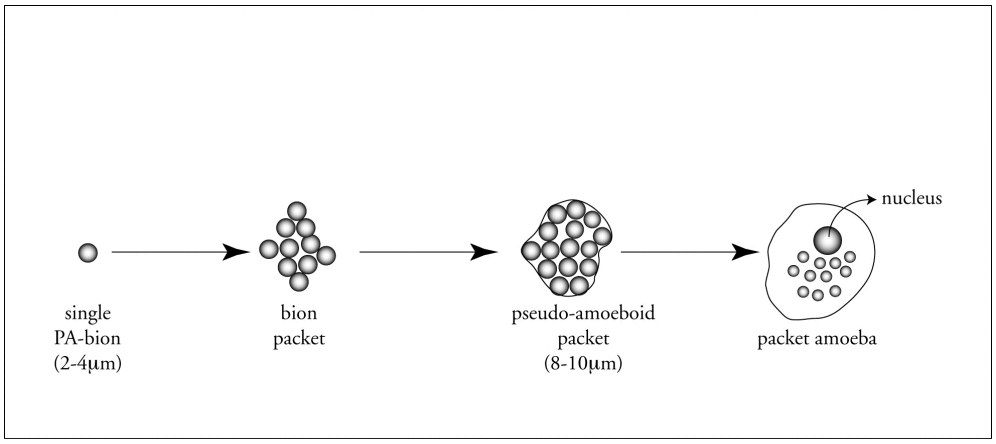

Fig. 1 - Schematic of Wilhelm Reich's theory of spontaneous heterogenesis of eukaryotic (amoeboid) cells.

was further deepened by Reich's claim of evidence - using the sternest sterilization procedures - for the spontaneous generation of these bions from animal and plant tissue. Yet, at the same time, Reich also claimed that the vesicular structure of normal or healthy eukaryotic cells was the cooperative result of PA-bions or vesicles that lived and worked inside the eukaryotic cell [6]. It was therefore ambiguous whether these bions were necessarily created anew (heterogenesis) from the decomposition of tissue, or whether the lysis procedure simply released them - much as Wallin's mechanical lysis

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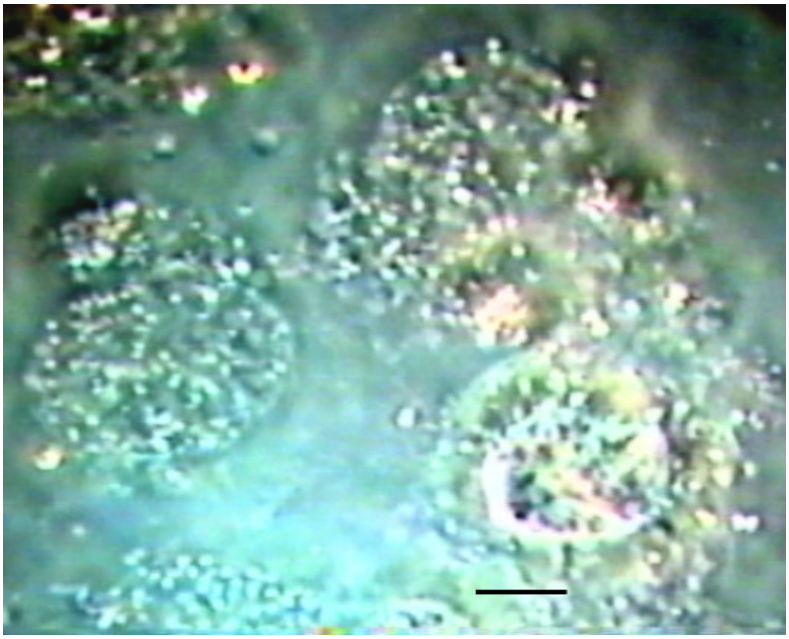

Fig.2 - Lysis of *Strombidia* with release of highly motile mitochondria and dinoflagellates (both would have been indistinctly referred to as 'bions' by Reich). The contours of two of the nuclei and the plasmalemma are still recognizable. Original mag. 630x, phase contrast, Sony TRV68 camera. Bar is 15µm.

was deemed to do for the mitochondria that Wallin claimed to have cultured. Moreover, assuming that 'PA-bions' were a term that could be operationally but unequivocally identified with, say, mitochondria, would necessarily exclude it from encompassing a myriad of other organellar symbionts that result, for example, from the lysis of protozoa (and disregarding, in this argument, the plethora of parasitic bacteria that may be found inside protozoa). Indeed, the more relict protozoa, such as *Pelomyxa palustris*, have no mitochondria, and yet contain plenty of endosymbionts (thin methanogenic bacteria of two types [7-8], and thick, hydrogenosome-like bacteria [9] that they release upon lysis. More frequently, along with mitochondria, protozoa contain blue-green algae (referred to as cyanellae in the endosymbiotic stage), dinoflagellates (zooxanthellae) and green algae (zoochlorellae) that provide energy and organic carbon, organic nitrogen and oxygen to the host. Lysis of these protozoa inevitably releases a variety of endosymbionts that are capable of autonomous and independent growth and reproduction. Lysis of Strombidium, an oligotrichean ciliate, releases both dinoflagellates and mitochondria, all presenting intense activity and practically undistinguishable in size and appearance, as shown in **Fig. 2** and **Mov 1**.

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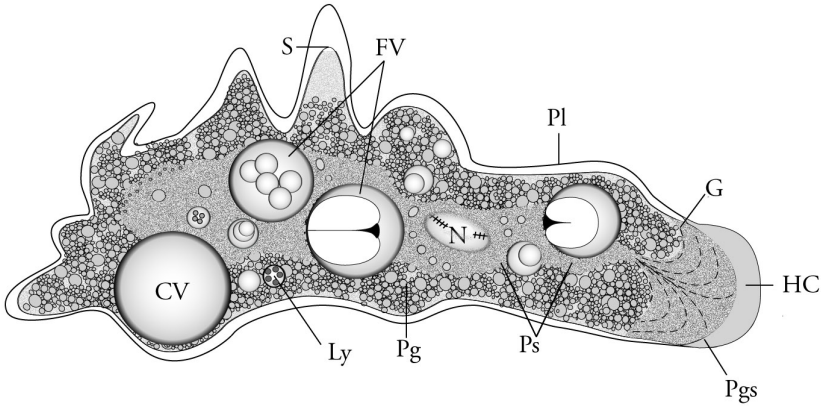

Legend

CV, contractile vacuole
FV, food vacuole;
G, region of gelation;
HC, hyaline cap;
Ly, lysosome;
Pg, plasmagel;
Pgs, plasmagel sheet;
Pl, plasmalemma (including plasma membrane);
Ps, plasmasol;
S, region of solation or pseudopod formation;
N, nucleus.

Fig. 3 - Illustration of horizontal optical section of *Amoeba proteus* (aka *Chaos diffluens*).

Obviously this introduction cannot touch on the complexity of all the processes involved in, and raised by, Reich's theory of the "bions", or *a fortiori*, on the complexity of the problems raised by Portier's and Wallin's claims to have grown mitochondria in cell-free lysates. The accompanying papers will try to do so - and hopefully will succeed in providing the reader with the requisite details concerning the biological and physical processes implicated in these problems. For purposes of the present review, we simply wanted to place Reich's theory of the bions in its proper context - something seldom done, if ever - and in doing so, to examine the evidence he claimed to have obtained regarding the *in vitro* generation of eukaryotic cells by the activity of PA-bions produced from tissue lysates in a variety of manners.

2. Reich's theory of the bionous emergence of eukaryotic cells

Reich's investigation of the biopoietic emergence of eukaryotic cells dates back to 1936. His first microscopic observations of living cells were made on protozoal organization, motion and behavior. He made a point of concentrating primarily on the observation of live specimens over long periods of time, an activity that cost him repeated bouts of conjunctivitis. By the application of various

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millivolt potentials and currents in the milliampere range, he related the observed cytoplasmic streamings, their cessation and initiation in different amoebae (*Amoeba proteus*, *A. limax*, etc) to wave-cycles of polarization at the cell surface, with which the applied electrical fields could interfere [10] (for the structure of a typical amoeba, see **Fig. 3**, a drawing of a typical *Amoeba proteus*). The electrophoretic experiments convinced him that the motion of the protozoa was directed by their sensing of the electrostatic lines of force in a medium, which, in turn, determined the distribution of existing chemical gradients. Similarly, there was a role which the same lines of force played within protozoa but, differently from what happened in the external medium, inside the cell they seemed to exhibit a field organization which was not dispersive but centripetal, centered at the core of the cell, where the nucleus generally resides in uninucleated cells [11].

In his mind, the picture of the cellular system which emerged was that of a system of centripetal electrical gradients seated on the nucleus and capable of accumulating electric charge. Discharge of the accumulated electricity displaced charge centrifugally towards the cell periphery, thereby originating radial endoplasmic streamings. Reich realized that the outer parts of the cytoplasm (ectoplasm) were more and more gelated and less vesicular than the central endoplasm, and suggested that the endoplasmic streamings would transduce the centrally accumulated charge to the membrane by dystension (swelling) of the more gelated ectoplasm. This was triggered by the electrical repulsion of the cytoplasmic vesicles. The swelling or expansion of the cell reflected a temporary situation of hypertonicity of the cytoplasm with respect to the external medium, the inner pressure driving an increase surface tension [12]. When the surface tension equalled the inner pressure, a discharge of electricity to the external medium led to the release of molecules and fluid (detumescence) and a contraction of the cytoplasm back to isotonicity with respect to the surrounding medium. The discharge thus reversed the direction of the cell's internal electro-chemical gradient from centrifugal back to centripetal (see **Fig. 4**). In accordance with this explanation, Reich's formula for the function of the orgasm applied entirely to the biological pulsation of unicellular systems - as it did to multicellular organs or entire living systems. The cell pulsated as a function of inter-related electrical and fluid-mechanical processes, and the order of these processes was one and the same.

Reich now became certain that the pulsation of protozoa was caused by the alternative electrical charging and discharging of the internal vesicles of a cell: when charged, the vesicles maximized their electrical repulsion and drove the expansion or swelling of the cell, as well as the transduction of charge from the cell's core to the cell surface; in turn, electrical discharge from the cell surface decreased the charge of each vesicle, and permitted the cell to contract. The mechanical and chemio-osmotic process was thus driven electrically. This was consistent with his observations of the agonist-like biochemical involvement of certain ionic species (Ca^{2+} vs. $2K^{+}$, H^{+} vs. OH^{-}), certain lipoproteins

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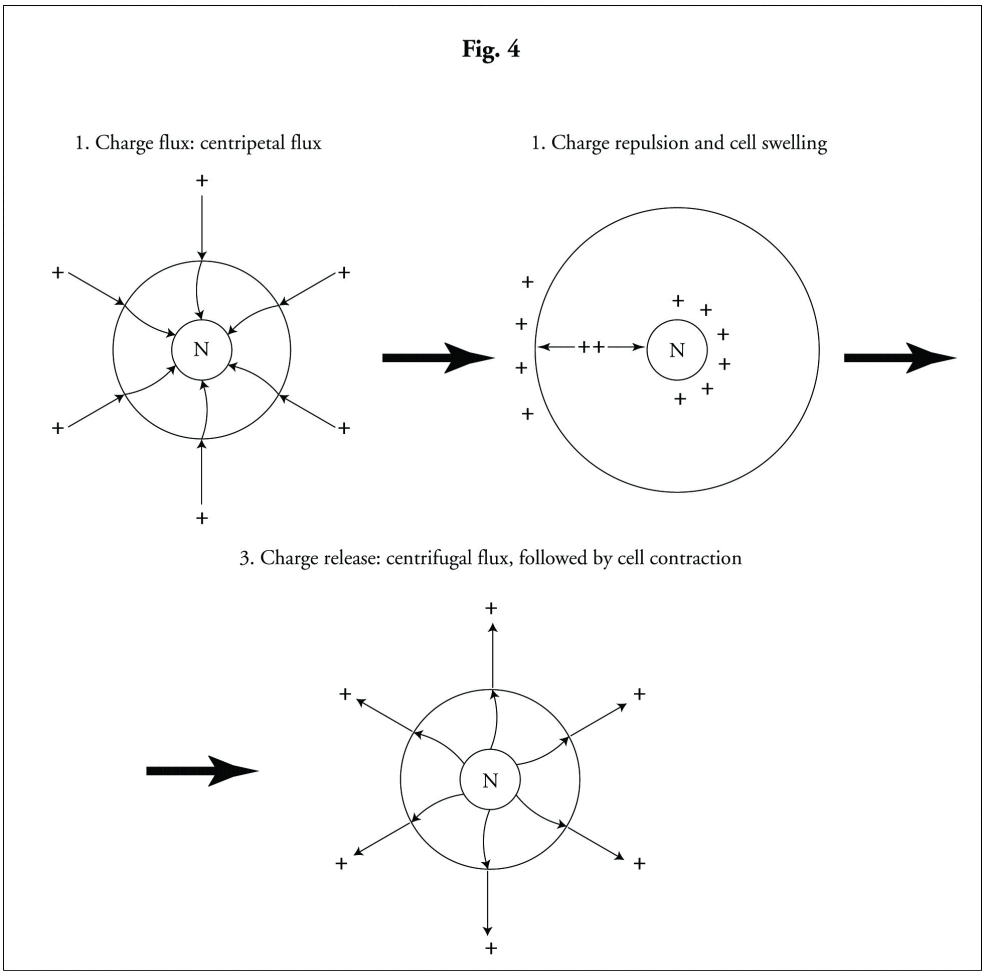

Fig. 4 - Electric flux during pulsation, according to Reich.

and neurochemical mediators with the alternating pulsatory functions of the autonomic nervous system, tissue cells and protozoa.

Reich's interest in biopoiesis began in earnest with the observation that chemically-induced swelling of the cellulose wall of plant cells provoked a slow vesiculation of the dying tissue. An identical process of bionic vesiculation could be observed and accelerated when the same tissue was boiled, and even more so when autoclaved. In both instances, Reich observed the formation *in situ* (in the dead or dying tissue) of large coccoid inclusions that displayed quivering activity, rotation, bio-luminescence and rolling motion. Reich indicated that "the microbes are of unequal size, about 2-6 µm long and less than that wide" [13]. From these dimensions one can conclude that these forms were oval

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or elongated, yet Reich frequently interchanges the terms 'cocci', 'vesicles' and 'bions'. To make matters more difficult - and by the same token less precise - Reich also employed the term "PA-bions" to designate the various refractile packet or heap formations formed by the association of these vesicles, and as a consequence later gave their dimensions - in his book "*The Cancer Biopathy*" - as ranging from 2 to 10 µm [14].

As we already remarked, these bions were not at first seen by Reich as constituting full-fledged living forms, ie as being *bacterial cocci* or prokaryotic *cells* proper, but intermediary stages in the formation of cells, or pre-biotic 'energy quanta' - the precursors of 'real cells'. He referred to them as "nucleus-like" (*Kernartige*) vesicles (*Blätschen*), alluding to the similarity of each vesicle to the typically rounded nucleus of an eukaryotic cell [15]. Subsequently, he observed - and recorded on film - how these coccoidal forms seemingly aggregated into growing regular (sarcinoid) or irregular (staphylococci-like) packets, a process which he took as evidence that these vesicles were *de novo* forming a proto-protozoon - a nucleated cell. The nucleus would be derived from conversion of one of the vesicles of the aggregate - and in multinucleate formations, by conversion of several of the vesicles. At this stage of the process, Reich would refer to these aggregates as "packets of vesicles with nuclei" (*Gebilde mit kernen*) [15-16]. These "nucleated packets", at some point, appeared to become immobile and produce a thickening at their periphery, which Reich interpreted as the spontaneous formation of a cellular surface membrane in the final stages of the process of creation of a proto-amoeba - referring to these forms as "packet amoeba" (*Blätschen Gebilde*). He suggested that this resolved the puzzle posed by the presence of amoebae and regular and irregular packets of vesicles in boiled infusions of plant tissue and soil - largely disregarding the very real likelihood that he was rather unduly clumping into one general notion very different "microbes" - chloroplasts released from plant tissue; mitochondria released from plant cells, animal cells or soil protista; micrococci and staphylococci present in the samples and capable of withstanding boiling; and amoebae present in plants and soil that are notoriously capable of encystment. The concept of a PA-bion had therefore lost most of its challenging specificity and gained no real, constitutive or symbiotic multiplicity. Indeed, the variety of elements composing the latter would depend on uncontrolled variables. Yet Reich was convinced that the 'PA-bion multiplicity' was a well defined one, composed of round vesicles, nucleated protocells, crawling fully-formed amoeba and, if this was not sufficiently unlikely, also "long motile rods" [17].

It was, therefore, without a sufficiently solid basis - and only on the barest of phenomenological evidence - that Reich concluded from these initial observations that one cell form (nucleated cells from a given tissue) could give rise ("be transformed") to an altogether different cell form (a nucleated proto-amoeba). This, he claimed, was evidence for heterogenesis, ie the *de novo* "spontaneous generation" of one type of eukaryotic cell from a totally different type of eukaryotic cell.

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Accordingly, the coccoidal vesicles or bions that Reich thought heterogenically formed from dead tissue, received their full name as "Packet Amoeba" vesicles or PA bions.

Today, it is easy to recognize the naive errors of Reich's view of the evolution of eukaryotic cells. The process that he, along with Altmann, Portier and Wallin, was alluding to - the existence of colonial tendencies amongst bacteria which may have led to their agglutination into a single eukaryotic cell - is not recognized as having any phylogenetic status. Current serial endosymbiotic theory (SET) only contemplates evolutionary introduction of mitochondria, chloroplasts or hydrogenosomes by some form of ingestion on the part of *an already existing* eukaryote [18-20]. Moreover, the process of association - or even growth - into packets may well have been at work in Reich's preparations irrespective whether his PA-bions were a mix of released mitochondria, chloroplasts or hydrogenosomes, or 'true" staphylococci or micrococci preparations, without this process of association in any way implying that the end-product was an amoeboid, eukaryotic cell. Moreover, Reich's infusion procedures did not rule out the ability of protozoal cysts to survive extreme conditions - and he could thus not rule out simple resistance to heat sterilization as an explanation for any observed protozoa.

In all of this, Reich largely missed the essence of what he had experimentally discovered - not that eukaryotic cells arose *de novo* from prokaryote-like microbes, but that prokaryote-like microbes released from existing eukaryotic cells resisted autoclavation and could be cultivated as autonomous cellular systems. Had he succeeded in biologically identifying these microbes, he could have made an epochal discovery. Our following communications will focus precisely on the real discovery made by Reich in the course of his "Bion Experiments" - and its neglected import. In this context, it is noteworthy that Reich never related the concept of his PA-bion vesicles to the bioplasts of Altmann, the chloroplasts of Schimper, or the mitochondria of Portier or Wallin - nor, by the same token, realized that, if his hypothesis of heterogenesis was wrong, the evidence he had obtained for the thermal resistance properties and ability to grow in "cell-free media" on the part of these PA-type vesicles clearly implied a fundamental role for symbiosis with prokaryote-like microbes in the development of eukaryotic cells.

From the preceding, it is apparent that Reich believed that he was observing *in vitro* the "spontaneous generation" of eukaryotic protozoa or proto-amoeba. Seemingly, he did not fully realize that, if he could independently grow the vesicles he called PA-bions, the vesicles themselves were already cells, albeit enucleate - as if the term "cell" only applied to nucleated cells, ie to eukaryotes, and not to prokaryotes, as in fact it should and it does. Moreover, he refused at first to assimilate his PA vesicles to prokaryotes or bacteria, for reasons that we shall discuss in the follow-up communication [21].

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Reich was convinced that the natural organization of protozoa could be observed in both nature and the laboratory, as the process of composition of a eukaryotic protocell from the self-assemblage of bions or vesicles. The reverse also held true for him - that eukaryotic cells (tissue cells or protozoa, rather indistinctly) also broke down by vesiculation of the cytoplasm, what he termed "bionous disintegration of tissue". The heterogenesis of one cell type into another was a phenomenological consequence of the bionous breakdown of a cell and the subsequent spontaneous re-organization of these bions into new cell types. It was from this viewpoint that, whether the vesicular breakdown was normal, in the physiological sense - as one would have to argue is the case with the breakdown of the cytoplasm of the megakaryocyte into platelets, or of the cytoplasm of the secretory cells of the mammary glands into cytoplasts - or was instead the result of putrefaction, the process always resulted - in Reich's view - in the production of PA bions.

There is no way that modern microbiology can today confuse replication-mediated aggregates of prokaryotes with actual protozoa or protista. No such transformation is known or has been identified, while, on the other hand, 'colonial' packet-type cocci - in either irregular or regular formations - are now known to envelop themselves with a pellicle, whose structure is entirely different from that of the plasma membrane of all eukaryotic cells, protista included [21]. Reich's interpretation of his *in vivo* observations as the emergence of protista from the spontaneous assemblage of PA cocci is an artifact of the technique employed, since light microscopy is not sufficient to distinguish between grossly similar but totally different biological objects - such as DNA-containing cocci, DNA-containing cytoplasmic organelles of the endosymbiont variety (whether mitochondrial, plastid-algal or hydrogenosome types of endosymbionts), platelets, cytoplasms and even fat globules - that may be involved in very different biological processes that only bear a gross resemblance to one another. Moreover, he did not produce any indisputable evidence for his contention regarding the emergence of eukaryotic cells - such as time-lapse photography showing a coccus-like packet forming and transforming into a nucleated or crawling amoeba.

3. Reich's claim of the emergence of eukaryotes from "orgone-charged water"

The conviction that his "Bion Experiments" had proven that eukaryotes emerge from the spontaneous formation, association and replication of bion vesicles emboldened Reich to aggravate the error of that conviction. Though having been billed as one of his most "extraordinary discoveries" by several of his self-styled followers, Reich's Experiment XX [22], where he claimed to have observed the biogenesis of protozoa (eukaryotic cells) from filtered "bion water", is in fact one of his worst conceived and performed experiments. Essentially, in Experiment XX, water was added to sieved garden soil which was either boiled for one hour or autoclaved for 20-30 minutes at 121°C and

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15lbs pressure, after which the water was filtered off from the soil. Reich does not specify this critical step, so that the filter porosity that he employed is unknown and one is left to assume that it must have been a gross filtration. Immediate observation revealed the presence of motile and vibrating cocci. Again we underline that here resided the real discovery of Experiment XX, one that has nothing to do with the emergence of eukaryotic cells: once more, that, *filtered or unfiltered*, there were microbes in the soil that resisted the standard autoclavation procedure - and that these microbes appeared to be identical to those he obtained in 'cell-free lysates' from the autoclavation of healthy plant or animal tissue.

But Reich's claims regarding Experiment XX were altogether different. He viewed the experiment as proving that from the filtered supernatant of boiled or autoclaved soil he could obtain PA-type vesicles and ultimately amoebae. From the fluorescence of the filtrate, he inferred that the energy content of the 'soil bion water' was high. Yet, since boiling or autoclaving dissolved and suspended many of the soil constituents in the filtered solution, it is not surprising - though surprise was Reich's reaction - that the filtrate exhibited the same fluorescence as bouillon or milk register at the fluorophotometer. Reich also observed that the same preparations eventually developed rot bacteria when boiled but not when autoclaved [23]. To complete Experiment XX, Reich placed the filtrate in sealed ampoules or sterile flasks and refrigerated these for periods of varying duration. At various times he opened the ampoules or flasks and, upon thawing, observed the presence of single vesicles, regular and irregular packets, as well as fully formed amoebae. These results he regarded as a demonstration that, from matter highly-charged with energy, both bions and spontaneously formed eukaryotes would emerge. Accordingly, Reich's main claim from Experiment XX was not the formation of PA bions or cocci - or their resistance to sterilization techniques - but the development of "protozoon-like forms" of considerable size (160µm by our own estimates, see **Fig. 5** and plates 45 & 46 of Reich's "*The Cancer Biopathy*") that he designated as "plasmatic flakes". Reich describes their growth by elongation, how they sink to the bottom of the vessel (permitting him to replenish their cultures) and how "they develop into contractile protozoa which move in a rapid, jerky manner" [24].

The obvious methodological limitations to Reich's conclusions from his observations in Experiment XX relate to the deficient filtration step. For Reich to extract the type of conclusion he did, he would have to have filtered his autoclaved soil infusion with a molecular filter (porosity of 50 nm or less). He could have used a Berkfelt 0.25µm filter - as he did in the separation of his "T-bacilli" [25] - but this still would not have kept viable mycoplasma from entering his filtrate. As is today known, not even filters with a 0.1µm porosity could have retained viable mycoplasma. He would have had to employ filters with 50 or 20nm porosities before he could produce a molecular filtrate, but these were not available in his time. The gross filtration that he employed could never have prevent-

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Fig. 5 - Artist's rendition of Reich's figure 45 in "*The Cancer Biopathy*".

ed the transfer of bacterial spores and protozoal cysts, or unknown thermally hyper-resistant submicroscopic 'micro-organisms', into his filtrate. It is true, Reich was not interested in the details of sterilizing methodology, since he regarded the boiling or autoclavation, and the subsequent filtration, as being sufficient sterilization for him to make the assertions he made - which, in what concerns Experiment XX, he summarily stated as follows:

"We had discovered a process by which orgone energy existing freely in water, ie not bound up in bionous matter, can organize itself into plasmatic, living substance exhibiting all the criteria of life. (...) We may therefore differentiate between the production of bions from matter already organized (...) and the organization of orgone vesicles from unorganized energy (...)" [26].

This is one of the least brilliant texts of Reich. Should Reich, in all scientific honesty, have allowed himself to make such a claim? The answer, we are afraid, is that he could not. The autoclavation step was impressive, but the filtration methods he employed could not have removed a variety of *prokaryotic and protozoal* contaminants from the filtrate - they just were not fine enough! In the absence of a true molecular filtrate, the notion that eukaryotic cells could have arisen in vitro *de novo* from high-energy water was an incautious fancy.

We surmise from Reich's description of the plasmatic flakes and their "jerky" motion that what he observed was most likely the development of cultures of *Trichamoeba osseosaccus* (first identified by Eugene Bovee, as an amoeba which measures up to 150 µm, see **Fig. 6**) that typically presents slow or no movement, or instead may employ "bag-like locomotion" (Bovee's words) moving by means of a "single, indeterminate pseudopodium". They have bright submembrane chromatin granules and refractile edges, and are commonly found in fresh water swamps, pools of water on ground

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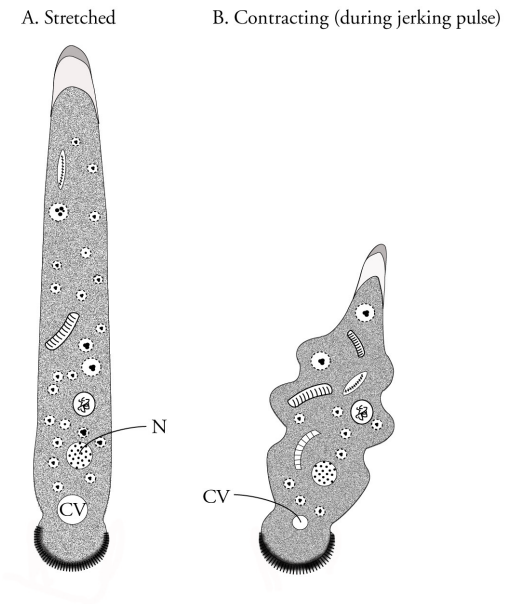

Fig. 6 - *Trichamoeba osseosaccus*, 80-150 µm (after Bovee)

with vegetation or moist soil. If our surmise is correct, then the value of Reich's Experiment XX in this respect might be limited to having identified a protozoon whose cysts can resist autoclavation in the conditions he employed. This should not surprise one terribly - especially since non-moist soil like that which Reich suspended in Experiment XX is rich in precisely the cysts of a variety of forms of amoebae. Encystement is most frequent in species of protozoa that live in ephemeral water puddles [27]. And, indeed, in Reich's Plate 45, other protozoal forms can be readily seen that suggest Coccidial amoebae, so it is rather likely that his preparation XX had a mixture of protozoal species. Moreover, evidently the rare *Trichamoeba osseosaccus* is not the only candidate for the 'plasmatic flakes' of Reich's Experiment XX. Other elongated, spear-shaped amoebae (or amebas) exist that present locomotion by aperiodic pulsed contractions, and have the requisite large size, such as *Subulamoeba saphirina* (see **Fig.** 7). The still poorly known order of the *Hartmannellidae*, is filled with 'limax'-type amoebae that are slug shaped and have contractile sac-like locomotion.

These considerations force one to conclude that, unlike what Reich claimed, he neither proved that protista can emerge *in vitro* from the self-assembly of bions or prokaryotes into "packet-amoeba", nor did he prove that protista can be formed - abiogenically - from "orgone-charged filtered bion water". The former was an optical artifact - or better, an inference from an optical verisimilitude

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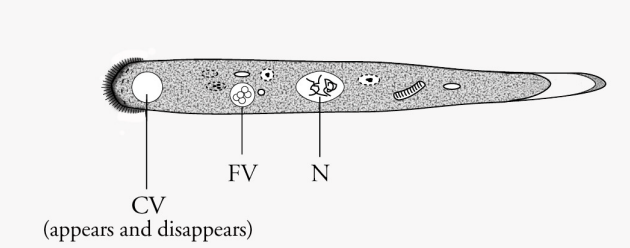

Fig. 7 - *Subulamoeba saphirina*, 100-130 µm (after Bovee)

(including, for instance, the optical confusion of a refractile micrococcal envelope with the plasma membrane of an eukaryotic cell) - and a biological and taxonomical error [21], and the latter a gross methodological mistake prompted by an insufficient filtration step. In between these two errors, Reich sank the real discovery he had experimentally made with his Bion Experiments and even Experiment XX - that healthy tissue, whether from animal or plant, and including soil protozoa, breaks down into autoclavation-resistant "microbes" that *normally live symbiotically within* the eukaryotic host cell, but which, given the right conditions, survive the demise of the host to autonomously grow and replicate. His task should have been, in this respect, one of formally demonstrating either that his PA-bions corresponded to then known algae-like chloroplasts or bacteria-like mitochondria (or still other undiscovered symbiont), or that they resulted from the growth of spore-forming hyperthermally resistant cocci present either inside of the disintegrating eukaryotic cells or as contaminants in the preparations employed. The absence in Reich's investigation of any formal or alluded-to linkage of PA-bions with either chloroplasts or mitochondria - suggests it is either the result of a deliberate rejection of the symbiosis theory of evolution, from Altmann to Wallin, or, once again and more likely, a mere prolongation of the conviction that PA-bions were formed *de novo* from the molecular materials released from dying or dead eukaryotic cells. Yet, convictions aside, Wallin claimed to have demonstrated that the mitochondria he could grow *in vitro were released* from the lysis of eukaryotic cells - and this should have caught Reich's eye and attention, since Wallin had published his work in the late 1920's, a decade before Reich's investigations. There was, accordingly, no invocation of spontaneous generation or any heterogenesis in Wallin's work, and this should have given Reich pause. At any rate, and irrespective of Wallin having been also considered a heretic, the overt absence of this connection, or of its exploration, in Reich's 'bion work' could only have hurt Reich's case for the concept that the lysis of eukaryotic cells results in PA-bions capable of autonomous growth and metabolism. We will explore this connection in subsequent communications.

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3. Vallery-Radot R (1937) "The life of Pasteur", The Sun Dial Press, Inc, NY, NY, p. 109.

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5. We use the two very different terms interchangeably ('prebiotic' and 'protobiotic') because Reich somewhat inconsistently claimed both that (1) the bions were preliminary stages of life (ie prebiotic) that arose spontaneously not just from decomposing tissue (heterogenesis) but also from inert, or lifeless matter (abiogenesis); and that (2) they were primordial bacteria-like microorganisms (protobionts) that were cultivable and reproduced by fission, which are cell properties.

6. Reich wrote: "(...) the vesicular ('honeycomb') plasma of an amoeba must be very closely related to the vesicular structure of the desintegrating plants. Could it be possible that an amoeba or other protozoan with a similar vesicular structure is nothing more than a cluster of vesicles enclosed and shaped by a membrane?" (**Reich W (1938) "The Bion Experiments", Farrar Straus Giroux, NY, NY, p. 38.**]

7. van Bruggen JJ, Stumm CK & Vogels GD (1983) "Symbiosis of methanogenic bacteria and sapropelic protozoa", *Arch Microbiol*, 136:89.

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10. Reich (1938) op. cit., pp. 132-133.

11. For a more detailed examination of Reich's theory of amoeboid motion, and a comparison with other theories, contemporary and posterior to his, the reader is directed to a much older essay of ours, "*XXth century theories of amoeboid movement*", soon to be published.

12. Reich W (1927) "The function of the orgasm", republished by Simon & Schuster, NY, 1973 edition, p. 284 ff.

13. Reich W (1939) "Bion experiments on the cancer problem", Oslo, Norway, p. 11.

14. Reich W (1948) "The cancer biopathy", republished by Farrar Straus Giroux, NY, NY,

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1973 edition, p. 32. Unfortunately it is apparent that Reich applied the term "PA-vesicles" indistinctly to single vesicles, regular and irregular packets of the vesicles and even to amoeboid cysts or amoebae that he found in his preparations; see next paragraph and consult **Fig. 1** to understand Reich's rationale.

15. Reich (1938) op. cit., p. 62.

16. Idem, p. 52.

17. Idem, p. 68.

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21. Correa PN & Correa AN (2010) "The PA & SAPA bion experiments and protoprokaryotic biopoiesis", *J Biophys Hematol Oncol* 1(2):1.

22. Reich, W (1951) " 'Cancer cells' in Experiment XX", *Org Energy Bull*, 3:1.

23. Reich (1948) op. cit., p. 65. Note that this is evidence that these rod bacteria were resistant to boiling but not autoclavation.

24. Reich (1948) op. cit., p. 70.

25. Idem, p. 36.

26. Idem, p. 62.

27. Grell, KG (1973) "Protozoology", Springer-Verlag, Berlin, DE, p. 44.

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