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COMMEMORATION OF JÓZSEF GELEI, ON THE OCCASION OF THE TWENTY—FITFH ANNIVERSARY OF HIS DEATH*

I have received the honourable task of erecting a monument, for the second time, to the memory of an illustrious predecessor and friend, the academician Dr. JÓZSEF GELEI, professor of the University in Szeged. I say: "for the second time" because I paid homage and expressed my devotion to him when we surrounded his coffin and — remembering a breath-taking folk-song, the "Blue forget-menot" sung by him and his students in the train, on the occasion of his last study-tour, as if bidding a last farewell to us — among the dun-coloured clods of earth I saw a bunch of wood forget-me-not flying towards the coffin which separated him from us, definitely and for ever. Who JÓZSEF GELEI was, was and is known by anybody who has ever made approaches to him, having the privilege of listening to the explanations of

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his profound ideas arranged in exact sentences on the thesaurus of nature whose doors, openable only with much work and love, he did frequently open before those longing for knowledge and thirsting to obtain it. He was a man, a man of great sensitivity, a natural scientist saturated with a deep and unselfish love of science, who made his mark on the history of biology and is thought of with revence by anybody who enjoyed — even if only once — the humanism bursting out of him and that splendid spirit given only to exceptional individuals.

He was born at Árkos, in County Háromszék, on August 20, 1885. His father was a smallholder whose hands were often chapped by the stilt of plough, the snath, and the axe-helve. His will was seasoned by the time. He was brought up by the summits towering to the sky, the talkative springlets, the whispering pine-woods, by the oak-trees facing the storm and the multiform flowers opening their petals one after the other on the plot of grass of the woodland-clearing, to be a sensitive, trustful, and considerate man. He was taught among forked lightning, and by the dark clouds of hailstorms that man is an obedient tool of the great nature, struggling with an unsurpassable might. And he also learned that to the mountains which cannot be approached without toilsome work one must return, because at a great hught the wind is cool and the evening comes early. At this school the child JÓZSEF GELEI, was also educated. Here he learned to know, admire and love the great nature, and to trust in intellect which protects us from dangers if we have enough of it. Anybody knowing JÓZSEF GELEI well had to find sooner or later, that this was the background determining his deeds, governing the course of his life, and providing encouragement and help to his everyday conduct. In this school he also learned that all others are human beings, too, and that nobody is either entitled to contemn, nor obliged to look up to, others.

He finished his primary schooling at Árkos, his grammar-school studies in Kolozsvár, taking his final examination in 1903. Then he was matriculated to the Faculty of Mathematics and Natural Sciences of the University in Kolozsvár, for Studying of natural history and chemistry. Of his teachers, the one who made the greates effect on him was the professor of zoology, ISTVÁN APÁTHY who, recognizing the particular interest of the ambitious boy in zoology and particularly in histology and cytology, had him appointed to demonstrator in the Institute of Zoology and Comparative Anatomy in the University in 1905. In this way, an opportunity was provided for him to work under excellent conditions practically unrivalled in the world at that time. Before long, he became professor's assistant and worked in this capacity until 1912. His doctoral thesis was made on an animal belonging to the freeliving flatworms (Turbellaria): the *Olisthanella hungarica*, discovered by him in the waters in the neighbourhood of Kolozsvár. With this paper he became "engaged" to the Turbellaria and in the course of investigating these he enriched the systematic and anatomical literature concerning this animal group with a number of productions of imperishable value. In the course of this activity the spiritual complexion of a meditating inquiring biologist took shape in him with the ever determined endeavour to look for the place and explanation of every biological phenomenon in the function of the cell, and to resort exclusively to the cell in order to understand the biological phenomena. Here, beside his master, he became while still young a histologist, a microtechnicist and one of the early cytologists producing preparations with his simplest tools, that are looked on with admiration even in the age of the electron microscope.

In order to enable him to obtain a deeper insight into the problems concerning the life and structure of the species belonging to Turbellaria, in 1906 ISTVÁN APÁTHY sent him to Graz, to the professor, of Hungarian origin, LAJOS GRAFF, where he spent a year. During this time not only did his vision broaden considerably but also his knowledge concerning the animal groups increased and gained strength. As his principal, as well as he himself, were primarily interested in histology, and later cytology, of animals and in the genetic relations of these, he chose for the object of his research work the easily accessible large flatworm, the milk-white turbellarian *(Dendrocoelum lacteum)*.

In 1911, he spent a year in Munich, in the Institute of RICHARD HERTWIG who was not only a researcher of repute and of a wide field of interest but also an excellent teacher and Head of Department, from whom he could learn much in many areas and in whose great and well-equipped Institute he could work comfortably.

In 1912, also for a year, he stayed in Würzburg in Boveri's Institute and from him he learned much, particularly concerning experimental approaches. He also made a great impression on BOVERI with his microtechnical knowledge and his particular practical sense. Here he continued the histological and cytological investigations into Dendrocoelum which later resulted in the recognition of the longitudinal pairing of chromosomes.

From 1912, he was working in Apáthy's Institute as a middle school teacher, holding there a subordinate post where he could deal, free from any administrative work, with exclusively scientific research work.

In 1914, he obtained the qualification of privat-docent of the University in "comparative cytology" and in this quality, too, he continued functioning as a subordinate teacher in Apáthy's Institute until 1919 when he was appointed teacher of the Unitarian grammar-school in Kolozsvár.

Somewhat interrupting the course of what I have to say, let me mention that only now as I am writing my commemoration do I understand why JÓZSEF GELEI loved ISTVÁN APÁTHY so much and looked up to him, why he always spoke of him with an unsurpassable admiration, his face assuming an expression of transfiguration when, during our conversations, there was any talk of him in any context. So far, I have only known of ISTVÁN APÁTHY that he was an excellent neurohistologist, an unequalled microtechnicist and an unshakeable protagonist of the continuous connection between neurons, the continuity. I had no idea of that he was such a careful educator, such a long-sighted leading personality, so high on the top of his vocation. At any rate, had I known this about him, then I should have mentioned this, in my written commemorations about him, as his highest merit.

The year 1924 brought a large change in József Gelei's life when he was appointed to the chair of the Department of General Zoology and Comparative Anatomy, in Szeged. He had to leave Kolozsvár where he had spent his young years, had become a slave to science, a highly competent researcher and a devoted of nature. He had to leave the river great Szamos in which, as told by himself, he had learned swimming after being pushed by somebody from the riverside into the water, suddenly and unobserved. He had to leave the glorious Institute where there was peace, work had its honour, and man was considered as man by the others. In Szeged he was received by a great vacuum and great poverty. The Institute of Zoology and Comparative Anatomy of the University, the Director of which he became, found

provisional place in a middle school, scantily and without any equipment. The terrible conditions not only impeded any considerable research work but also induced great deficiencies in instruction. Luckily, the situation changed before long. He obtained a spacious, clear, large Institute consisting of several fine premises. As Rockefellers material subsidy duly arrived, he was able to organize such a superb, well-designed Institute, suitable both to the requirements of instruction and to those of scientific research work, that in the range of experimental zoological institutes it stood all the demands of the first place, even if judged by foreign standards. Everything contained in it, as it was arranged, demonstrated that the organizer was well beyond the capacities of this country and what he had learned there, as he produced at home something far better than it had been. If there was any failure in this Institute — it was that there were very few students. Not only did the places established for foreign research workers remained unclaimed, but there were hardly any researchers for the positions belonging to the Institute.

After the return of Transylvania, the University, which had escaped from Kolozsvár to Szeged, returned to Kolozsvár. But, as is known well enough, in 1944 it had to leave Kolozsvár again in such a way that even the books, equipments and instruments remained there, without exception. JÓZSEF GELEI left for Szeged. As, however, the Chair in the Szeged University was occupied, he drew back for a time to his farmstead in the neighbourhood of Szeged, running there an intensive farming on the „blessed" sand, as he called is. After a few years, however, a Biological Department was organized in the Medical Faculty of the University in Szeged and JÓZSEF GELEI was invited and appointed to the Chair. At first, he was given a room in the Institute of Anatomy where, without co-workers and equipment, he had to be content with lecturing to his students. Later on, upon the request of the Medical Faculty, we placed at his disposal a few rooms which he developed a well-functioning institute, supplied well both from the points of view of personnel and instruments. When this Institute began setting to work, although he was still far short of the usual age limit, he was reminded by some serious pathological changes to be sparing with „oil" and „work". Work however is not only a feeling of want but an everyday need, medicine and consolation for anybody who was born to work and enjoys doing it. GELEI went on with working and the oak facing the storm was felled by the implacable disease. The floating wick, when its flames gave light to others, burned itself, as well.

If — after the foregoing — I have to give an account of everything done by JÓZSEF GELEI in the field of science — and I feel it my duty to do so — then I have to differentiate — as it was also the case in the commemoration of our common friend, LAJOS VARGA, in the rich scientific production, between three periods.

The first period began when in 1905 he was appointed demonstrator of the Institute of General Zoology and Comparative Anatomy in the University of Kolozsvár, and it lasted up to 1924 when he received the Chair of the University of Szeged. This period started with two prize papers in which he described the animal species found in the vicinity of Kolozsvár. It was continued by describing the already mentioned turbellarian, named *Olisthanella hungarica,* this being Gelei's doctoral thesis. When he was the professor's assistant, he began his histological investigations into *Dendrocoelum lacteum,* the results of which were published in a monograph entitled „Tanulmányok a *Dendrocoelum lacteum* OERST. szövettanáról" (Studies in the histology of *Dendrocoelum lacteum* OERST.), for which the „Vitéz"-prize

of the Hungarian Academy of Sciences was awarded to him. The only defect of this work was that it was not published in any international language. He who knows that life — with its unextricable complexity, I could also say, mysterious character — becomes only cognizable in its phenomena and causes in the tissues and cells, presented to him as if by magic with an adequate technique: finds a revelation in almost any chapter of this valuable work. The beautiful illustrations, praising the artistic execution of the author's hand, the sober but clear interpretation of the relations seen under the lens of the microscope, the rich literary knowledge; all support the conclusion that the author of the work dealt with an inimitable ability and technique, and material which was more suitable for dissecting cytological problems than any other which could be found.

There falls to this time Gelei's other work, entitled „A kromoszómák hosszanti párosodása s a folyamat örökléstani jelentősége" (Longitudinal mating of chromosomes and the genetic importance of this process), being similarly of major significance and published by the Hungarian Academy of Sciences in 1920.

The promptings to this work were given to him by BOVERI in Würzburg who, as an experimentator, was respected by him as a second master. In the work, which is a pearl among the morphological cytological investigations, there was proved the genetically important fact that the chromosomes of the leptotene-stage thread mate longitudinally. By this process, as the authour himself writes, "the sticking together of two homologous chromosomes of paternal and maternal origins are meant, starting from their ends, while always qualitatively equal parts of these face each other". It is at the same time, made possible by this "mating" — the author continues — that, „in the way of the division of ripening, the number of chromosomes comes down to half, and previously that, while mating, the identical parts are exchanged and chromosomes of a new reconstruction created". In these theses — as GELEI himself says — there was established nothing new. It had already been pronounced by MONTGOMERI that the mating partners descended from two parents. SUTTAN declared the equivalence of their homology and SCHREINER *et al.* that of the parts facing one another in the pairs. All these were however, according to GELEI, but declarations which generally long preceded the evidence. His investigations, he says, "do mean a progress in as much as they prove the statements of the authors mentioned" and his own "identical opinion, every-where with direct observations".

For the investigations he used the ovary of the milk-white flatworm *(Dendrocoelum lacteum)*. He studied the oocytes and chromosomes in pulped and stained preparations. The examination with shredding suggested by FLEMMING in 1887 for cytological investigations, is — as GELEI says — comfortable but the results are only to be accepted "with due criticims and after the assessment of results on sections". To be sure, the process is very useful because in the preparations obtained in this way the cells are placed in a single layer and thus, touching the fixing solutions or their vapours immediately, are excellently fixed. The procedure is also good because the pulped preparations are investigated without being embedded and so the stains applied to the chromosomes exert a stronger effect on them than on sections made from an embedded substance. It is a particular advantage of these preparations that in them the nucleus can be seen in full while in sections, even if these are made in series, the connections are only to be found with great difficulty. GELEI made pulped preparations from his material, *Dendrocoelum lacteum* in the following way. Small pieces cut from the ovary were put on the slide and moved about with a dissec-

ting needle. The result was that the oocytes fell out of the ovary-piece and adhered to the slide. As in the oocytes of *Dendrocoelum* the nucleus is surrounded by the cytoplasm only in the form of a pale border, the resulting oocytes proved to be particularly suitable for investigation into the nuclear content. It was also easy recognize and study the constituents of nucleus and the chromosomes themselves in the preparations because the achromatin framing between the chromosomes remained colourless after staining. Because of this, the preparations were very good for investigating the chromosomes appearing in the oocytes. Some difficulty was, caused by the fact that only those chromosomes became sharply visible which were situated in the upper part of the preparation, looking towards the lens of the microscope. These obscure the chromosomes lying below them, making it very difficult to recognize, and still more to examine the latter. GELEI however, quickly and easly got round this problem. Instead of the usual slide he used a large gloss cover-ship and covered the preparation with similar cover-ship. In this way, he could examine both sides of the same oocytes. Another trouble that strongly impeded the investigations, was that the cell-saps evaporated in the dry air leaving an artefact unfit for use. Then came forward JÓZSEF GELEI, the microtechnicist, constructing a so-called dressing case for solving the task. In this he could produce preparations in a quantity according his choice in the presence of water-saturated air. The device was a square metal case the airspace of which could be cut off from the external dry air during pulping. The air filling the interior of the case could be preserved in a durably wet state with slips of wet paper. He could thus carry out fixing, as well.

He found Altman's fluid to be the most suitable for fixing the nuclear substance and the thread-chromosomes. A disadvantage of this was that he couldn't subsequently carry out any elective staining Flemming's fluid led in his hands to a good result, as modified according to BENDA, and with Apáthy's sublimated osmic acid mixture and his own formalin-osmium mixture. For staining, the procedure of ROMANOVSKY-GIEMSA was exclusively used, stainig the chromatinic substance in any form of it reddish violet. The colour did not become diffuse even when greatly magnified and in the preparation even the deepest lying details could be seen well. For making sections, the substance was fixed in one of the above mentioned fluids, and embedded in Apáthy's celloidin paraffin. From this, 1 to 5μ section series were made.

After using the procedures and methods enumerated, carefully, as new results for the science, the following were ascertained. When the oocytes achieved the size of motheroogonia, in the nucleus a separate glomus is formed of chromatic threads. The threads very likely correspond to the diploid 14 chromosome number. From the thread-glomus, as directed by the chromosomes, a form of bunch develops in the formation of which the leading part belongs to the centrosome. The chromosome number is still 14 in the bunch.

The thread-chromosomes, which show a regular granularity because of chromidia, are approximately as long as the chromosomes of oogonia. In the bunch, the double chromosome stock and the equal length of pairs can be established. The equally long, i. e. homologous chromosomes do not lie adjacently. The longitudinal mating occurs in the following way. The mating chromosome-ends come into close proximity to each other in a confined field. In this location, the "legs" of the chromosomes obtain a more or less parallel situation. In this situation between the chromosomes pointing into the same direction, some free ways suitable for moving come

into being. Then mating begins in the following way. The separate pairs contact each other as is to be explained by the appearance of the pairing instinct. Mating starts from the ends and continues towards the middle. In the meantime, the chromidia of the pairs set themselves face to face with one another in pairs. The adjacent pairs adhere to one another, are pressed together and grow shorter. The mating pairs, after mutually, exchanging their parts, are rearranged.

In the course of analysing the single phases of mating exactly, it became ascertained that chromosomes must have some facility of movement and displacement and, some thing consistent with this purpose is needed in their substance. As the free "legs" of the hardly adhered pairs are always of the same length, and in addition, the pairs are supplied with the equal number of chromidia and are equally thick, it can be considered as demonstrated that only the thread-chromosomes of equal length can be paired. With this, there was demonstrated, for *Dendrocoelum*, Montgomery's supposition that in every chromosome-pair a paternal and a maternal chromosome stick together. In respect of *Dendrocoelum*, the correctness of Suttan's supposition was also proved; that the two by two equally long chromosomes are homologous, and qualitatively equal but the chromosomes of different length are qualitatively different. On the basis of profound observations and the logical reasonings connected to them, Gelei's a final conclusion is that "like any mating cells or protozoa, chromosomes also get a new individuality during their rearrangement connected with their mating, as a consequence of which they do not transmit by heredity the same faculties which passed to them from their forbears".

I dont know what is said to all, this by the electron microscope, nucleic acids, gene-surgery, gene-transplantation, molecular biology and generally by the science of our age distributing many and great novelties, by the genetics, but I do know that József Gelei's analytical results concerning the longitudinal mating of chromosomes belong to the most beautiful achievements of experimental cytology. The questions that were answered by these brought us nearer to recognizing the laws of nature which are everywhere and always the same, unchanged and unchangeable.

The demonstration of the longitudinal mating of chromosomes was the outstanding result that assured GELEI a lasting name in experimental cytology. His durable demonstrations and fine drawings soon found their way into world literature and won high appreciation and honour not only for GELEI but to the Hungarian biological sciences, in general.

The second period of József Gelei's scientific reserach work began in 1925 and lasted until 1945. In this period he continued his histological and cytological research work concerning Turbellaria and described new flatworm species from the fauna of this country. He often visited the Biological Research Institute at Tihany and became intensively connected with the research work concerning the living world of Lake Balaton. In this period he began his investigations into Protozoa which led to world-wide success and raised him the ranks of the greatest protistologists of the world. Here were manifested his extraordinary many-sidedness and his comprehensive mind embracing the whole domain of general biology, comprising all of the provinces of systematics, ecology, ethology, physiology, and phylogenetics.

He was led by his general biological contemplation to the world of Protozoa where he, in this second period of his scientific activity, achieved so many successes and made so many valuable contributions.

The event starting these investigations of GELEI, as I learned from GELEI him-

self, was the following. As the newly appointed professor of zoology in Szeged, he visited a zoological morphological practical class led by BÉLA FARKAS, a later professor systematic zoology (zoological taxonomy) at the University of Szeged. In this practical training, the undergraduates examined *Paramaecia* collected in the borrowing pits at Szatymaz. GELEI sat down at the microscope of one of the undergraduates, and began to look at the *Paramaecia*. He was long staring at them because he had perceived already, at the first glance, that the animal was not the *Paramaecium caudatum* but another protozoan belonging to the Ciliates (Ciliata). This recognition turned Gelei's attention to the Ciliates living in the neighbourhood of Szeged and later to those living around the whole country. The high degree of organization by which these animals are characterized incited this biologist who was well versed in research into fine structures, to progress from looking for habitats and describing the species found, more and more towards investigating the internal organization. From among the results achieved in this respect, the demonstration of the neuronema systems and the description of the excretory organ systems is most considerable.

Neuronemata are called by GELEI the fine silvery lines demonstrated in the body of *Paramaecium caudatum* with his own silverizing procedure. He distinguished two parts of the neuronema systems being in contiguity with each other, attributing a function to these systems which is similar to that of the multicellular nervous system. One of these parts is called by him a central and the other a peripheral neuronema system. It is interesting that while concerning the neuron-linkages of Metazoa he professed — relying on the instructions of his master, APÁTHY — the tenet of continuity, in the neuronema system of Protozoa he demonstrated contiguity in the connection between central and peripheral systems. Gelei's establishments in regard to the neuronema systems have attracted great attention and found high appreciation in many places, together with similar results of KLEIN in Vienna. There were, of course, abundant difficulties, although those who had dealt with the physiology of Protozoa, and primarily of Ciliates, were fully aware of the fact of intracytoplasmic impulse conduction and supposed the presence of the element, of this conduction. This was not the case with the neurohistologists and among these MIHÁLY LENHOSSÉK who, as I heard from GELEI himself, was not inclined to consider the silvery lines made visible by impregnation, as neuro-elemets even after the conclusive activity of GELEI and his school for as many as ten years.

We have also confirmed that the silvery-line system is demonstrable with silver impregnation in the body of Holotricha infusoria, mainly of *Paramaecium caudatum*, but not the suggestion that the movement of Ciliates is governed by this. To be sure, when stained and impregnated the immense quantity of nerve fibres in the palatal mucosa of frogs, without having found the connections, I was almost convinced — and said so to GELEI — that the movement of cilia was directed by the nervous system. I had to entrust the solution of this problem to the electron microscope. I am unaware of the result in case of Ciliates, whether or not there was achieved anything new by means of the electron microscope. But I have become satisfied that in the case of Vertebrates it has not demonstrated any connection between cilia and the nervous system. I have carefully investigated the situation, in convincing photographs, in kidney and tongue of the frog where there are extremely imposing ciliary fields without finding, however, any connection between the nervous system and cilia.

Gelei's investigations, published concerning structure and function of the excretory organs of Protozoa, are neat and valuable. According to these, the excretory

organ of the higher Protozoa is the pulsating vacuole or, as named by GELEI, the throbbing small cavity, and the ducts leading there. All of these are preformed formations, having a definite place in the organism of the animal. There are two efferent ducts to discharge the products of decomposition. These are short tubes lined with ectoplasm, and surrounded by a thick cuticular ring. The efferent ducts are bordered towards the vesicle by a protoplasmatic valve. The efferent ducts are also standing formations, not disappearing on contraction (systole), only some parts of the wall come closer to one another, of the ducts leading there the content only became known after impregnation by silver and staining with osmic acid. The afferent ducts grow wider immediately before the vesicle to form ampoules connected to the vesicle by the spray duct. This clear and valuable work, giving a detailed description of the problem-complex, was published in Budapest, and entitled "A véglények kiválasztó szerve alkati, fejlődéstani és élettani szempontból" (The excretory organ of Protozoa from constitutional, evolutionary and physiological points of view), in 1935.

The third — and shortest — period of the scientific activity of JÓZSEF GELEI began in 1945 and lasted up to his death. In this time he continued collecting diligently, examined the material collected very thoroughly and published particularly his results which were valuable from the general biological point of view, in this country and abroad. He discovered mass productions and biocoenoses in the pools left behind after rainfalls and with the series of observations made there, he also came over to the meteorological biology. He was very much interested in this, as in everything he considered as new in biology. He diligently visited the springs and brooks in Bükk and Börzsöny, and looked for the interconnections between the living world, the situation, the seasons, and the weather. In 1950 his paper entitled "Az egysejtűek morphogenezise, tekintettel SEVERCOV morphogenetikus alapelveire" (Morphogenesis of Protozoa with regard to Severcov's morphogenetic basic principles). In this he found the thirteen basic principles applied by SEVERCOV, the prominent comparative anatomist, to demonstrating the origin of Metazoa, to be conclusive also in investigating the phylogeny of Protozoa. In this connection, he himself laid down four more basic principles considered as serviceable for demonstration in the phylogeny of both Protozoa and Metazoa. By this time he already felt and knew that, as he said to me, "his heart is limping".

The slowly but surely killing disease progressed from day to day. He nonetheless worked and, although he was histologist he hoped in secret. His last way, leading him to the mountain of Dobogókő, finished in a cilinic of the University Medical School in Budapest. Here stopped the motor because the brooklet "which is driving the heart", ceased flowing.

I have drawn the life of a man as I have seen as y have heard and as y have read it in a maze of writings. It is already 25 years since József GELEI left us. His mortal remains merged into the sweet mother earth but the chromosomes he took along as an inheritance from the river Olt to the riverside of the Tisza, are surviving, moving, looking for place, mating longitudially, and the thread of life is more elongated by the MOIRAI. His memory is still alive in his numerous family, each member of which was loved by him very much. It is preserved by the forests, the fields, the talkative springs, and by Mother Nature whose heart-beat he so frequently listened to with such an unextinguishable love. It is preserved by us, Hungarian biologists, by the immense host of biologists all over the world, by his works of imperishable value

in which he bequeathed to us the products of his winged spirit and artistic hand, furnishing evidence that he loved science passionately, could be enthusiastic about it, could work, struggle and, if necessary, suffer for it.

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