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István Apáthy and his School

In 1886 István Apáthy, the scarcely 23-year-old eminent assistant professor beside Tivadar Margó, Professor of the Department of Zoology and Comparative Anatomy of the University of Budapest, was delegated to one of the research places of the Stazione Zoologica in the Bay of Naples. He spent three years there without interruption, but till 1914 he returned several times. Thus he spent altogether 7 years in Naples, which played a decisive role in his life. Tivadar Margó contributed greatly to starting Apáthy on his quickly soaring career by involving him in the research of the peripheral nervous system of insects. Apáthy's career was also promoted by Anton Dohrn, head of the research institute, who entrusted Apáthy with the morphological and taxonomic investigation of leeches of the Bay of Naples. These circumstances greatly contributed to the fact that the young researcher having "a basic medical training became professor" (1.). Apáthy's exceptional talent developed at amazing rapidity. He visited several European capitals and famous biological institutes and thus greatly enriched his knowledge. At the same time he established excellent relations in his field of work. Owing to this and his internationally recognized activity, he became worthy of becoming professor of the Institute of Zoology and Comparative Anatomy of the University of Kolozsvár at 27 years of age in 1890.

The Zoological Station of Naples was the Mecca of biology; with its excellent equipment, peaceful atmosphere and eminent staff, it was a true home of research for Apáthy. A large part of his world-famous results were born here; here were laid the foundations, on which the later outstanding school of thought could be built and which largely determined the place and role of Apáthy and later his school in the history of biological sciences. It was essentially here that Apáthy became a true histologist, systematist, it was here that the processes of the evolution of the individual being and the species opened up before him. It was not by chance that he considered Italy his second homeland (2.).

His years spent in Kolozsvár were not in the least favourable. In its initial period, the Institute and its equipment were very poor (3., 4.). The youth "is very selfish and wants quick success" (5.). "Everybody in the desks and rooms of the University is only after the diploma" (6.). Besides this, he was slighted. At that time Apáthy's institute represented the periphery. Apáthy remarked dejectedly: "America proved to be nearer to Kolozsvár than Budapest was" (7.). He made this remark when a bunch of eminent foreign researchers visited Apáthy's institute, but from the capital only one researcher came. Many people came to Apáthy to study histology, first of all neurohistology, and to see for themselves all those things that

Apáthy had created out of almost nothing. One of the first guests was the German Bethe, one of the greatest admirers of Apáthy (8.). In the summer of 1898, Platon Stewart, outside lecturer of the University of Baltimore, worked in the precursor of the institute of international standard to be developed later, the so-called Miko-Lodge. Then Siegfried Mollier, "Privatdozent", later professsor of anatomy at the University of Munich, carried out neurological research.

With him worked in 1901 Joris Hermann of Brussels, them B. Zarnik of Würzburg, E. Goldlewsky of Cracow, J. Boeke of Amsterdam, who later became one of the directors of the Zoological Station in Holland. It was here that A. Hasselwander learned the methods of neurological research. The preparations of the Munich researchers won a prize of the Belgian Academy (9.). Here came on pilgrimage also Rimotti from Pisa, Stieda from Königsberg, V. Widakovitch from Buenos Aires, and Waldeyer from Berlin; of the Russian researchers A. Krassuskaya, later professor of neurology and psychiatry and J. Semen London from Petrograd (3., 4., 8.). It appears from this that at the end of the 19th century and the beginning of the 20th, the Institute of Zoology and Comparative Anatomy of the University of Kolozsvár was an international research center and a school of researchers who, for a longer or shorter time, learned from Apáthy.

Fundamentally different from Apáthy's international school was the more closely knit Hungarian community of the school. Its members were joined together by common scientific interests and emotions, and this in spite of the fact that sameness of the theme that generally charachterizes schools did not exist. The head himself was first of all histologist, microtechnician, and besides cytologist, systematist, taxonomist and researcher of ontogenesis and evolution of species; in fact, a polymath. A polymath, but not in the common meaning of the word. In his case the biological sciences cultivated by him were in close connection with each other and formed an organic whole. This is indicated by the varied, independent themes that belong to a great whole and that can be found with the members of the Apáthy school. Only a synthetizing mind possessing great knowledge was capable of coordinating them.

We keep a record of many eminent scientists, university professors, among them academicians, who belonged to Apáthy's school. Thus: József Baló physician, university professor, Sándor Bálint, Apáthy's coworker, zoologist, Károly Berde, university professor, Péter Beretzk, physician, zoologist, titular university professor, Lajos Boga, zoologist, Sándor Ébner, Béla Farkas, zoologist, university professor, József Gelei, zoologist, university professor, academician, István Győrffy, botanist, university professor, Ferenc Kiss, physician, university professor, Gábor Kolozsváry, zoologist, university professor, academician, János Lendvay, Jenő Mátyás, zoologist, outside university lecturer, Tibor Péterfy, biologist, Mihály Rotarides, zoologist, university professor, Andor Szüts, physician, zoologist, Lajos Varga, zoologist, titular university professor. (Although they cannot be considered as belonging to the Apáthy school, yet it is worth mentioning that 24 such instructors and researchers – chiefly in leading positions – worked at the Medical School of the University of Szeged, to whom when they were medical students, Apáthy gave practical training in histology in Kolozsvár between 1900 and 1919 (10.).

On the basis of the above, the question can rightly be raised: what was the secret of István Apáthy's great attraction? Why was he an example to be followed for so many?

First of all, his leading personality, his well-planned, systematic school-creating

works, his science-centered turn of mind, his intuitive and at the same time purposeful activity. These things are suggested by the following:

> "It vill not be bad, but rather lucky for science, if in time one or another department with its populous scientific staff becomes a small scientific society, because such a department will establish a school, and the school will create continuity and produce results in the cultivation of science" (5.).
> Cytology and microtechnique "are twin children of the last century. Both were concieved on German soil ..." and "with already the third generation of our eminent pupils, they still hold the leading role in biology."
> "The international school of embryology of the Zoological Station of Naples together with the German school of cytology participates in the development of microtechnique in the first half of the eighties... I claim a part of the successes of cytology and microtechnique for the Hungarian nation." (11.).
> Apáthy saw clearly the "the dominant science of the next century, unless unusual factors set back human progress by centuries, will certainly be the science of life, biology, in its broadest sense ..." (11.).

Apáthy, as it appears from many of his publications, was highly science-oriented. The following few examples also illustrate this.

> "The professors of a university devoted only to science, and not concerned with tasks of a technical school, would become purely scientists with greater probability that till now; because the students of such a university could not look there for anything but science." (9.)
> According to Apáthy, an important task of his institute was "to advance science by independent research work." This highest task "goes beyond the framework of college training" ... and "in the true and noble sense of the word, is genuine university education" (5.).
> "As for the professors of the university, they should be devoted scientists whose energy and ambition to work should not for a minute be diverted from advancing science and the education of a new batch of scientists." (5.)

It is not difficult to conclude from Apáthy's working method and suggestions that he possessed an excellent sense for pedagogy. He used it, wherever he could. He used it when he created a community, and also when he tried to put into practice the principles of creating a school. All this appears cleary from his educational activity.

> "The natural scientist can begin independent creative work of some value", Apáthy writes, "where somebody has left it off." – "Before we have seen of heard, smelled, tasted, or touched the things with our own senses and by means of our instruments in our own preparations, our own experiments, we cannot say of anything that we really know it." ... "These few words explain the importance of teaching by demonstration and learning by research, that is, the importance of the laboratory work of the students in the sphere of the natural sciences." (6.)
> Apáthy strongly stressed the importance of demonstration. "Guidance in the literature, reading together with the instructor, and many other things; all the things I give to my students or would like to give in the course of their practical training." (5.)

It is interesting how Apáthy described what a candidate can expect of the university:

> "First of all he can expect what we teachers of subjects connected with experiments demonstrate to them visibly and palpably, ... hundreds of illustrative examples, answers to many questions..."
> This is what he thought of the good lecturer:

"The good lecturer hangs on his students with all his nerves; he sees every smile, hears every word spoken in low tones, even in the last desk, he notices any inattention, and with all his mental energy and all the warmth of his words tries to captivate ... their diverted attention." (5.)

Apáthy was looking for the form of instruction that could be the most effective through the teacher's informality and humaneness. It seems he found it when "he was willing to conduct also the training himself" (3.). The success of creating a school of thought was largely determined by the relation that existed between Apáthy and his coworkers. An example of this is the correspondence between Apáthy and his eminent pupil and coworker, József Gelei (12.). Gelei studied cytology in Munich with Hertwig and Goldschmidt, and then with Boveri in Würzburg. At the first place, Gelei was received in miserable conditions and a high cost of living. To his letter describing the situation Apáthy replied in an impressive manner worthy of a leader:

"There the lack of equipment and the scarcity of opportunities are compensated for by hard work and the public spirit that stimulates everybody to work and to spare no effort. Our people, with due respect to the very few and only slight exceptions, are carrying on an almost constant strike and spend their whole lives scamping work, working as little as possible and using their abilities as little as possible."
"...the little hardship you will have to suffer abroad will be a very good preparation for using well the favorable opportunities provided at home."

In the interest of more efficient work, Gelei asked, among others, for a microtome:

"...I have pondered," replied Apáthy, "whether I should send you the microtome. If others there can achieve success with the means at their disposal, why could not you, too? Why should you have an advantage over the others in this respect? Yet considering that you have to use the short time at your disposal as well as possible, I have had the microtome sent to you."

In Würzburg Gelei's interest turned to experimental biology. He began to investigate the effect of radioactive radiation on ovogenesis, the maturation of the ovum. The result was surprising, but the problem was irrelevant from the point of view of the work going on in Apáthy's institute. In spite of this, Apáthy replied elegantly without the least sign of resentment.

"I wish you much success in the new line of your activities."

In the largest part of his time, Apáthy was almost constantly burning with the fever of creation. He deeply felt the driving force that is the essence, the basis, of all creative work.

"All problems solved make us poorer, all new tasks that we set ourselves make us richer." (3.)

A fragment of his speech made at an end-of-year ceremony completes these lines:

"Being satisfied with everything, the absence of longing for something better, or resignation to the ills are the worst enemies of progress." (5.)

Indeed, resignation is the death of driving force, of creative activity.

Apáthy's active, ardent patriotism was a powerful community-forming factor. This appears from the majority of his articles and speeches. For him patriotism was even more important than science. In his rector's inaugural he said:

> "...there will be more in our country who are scientists not only by their profession, but also by their view of the world, for whom science is not only a source of income, but also a passion relegating everything to the background, except the homeland." (7.)

Apáthy developed his school with the most talented persons, who deeply respected science and its embodiment. We bear this is mind when we try to see Apáthy's school-creating role in his narrower field of scientific activity.

> "More or less we are all still blind in the face of the mysteries of life" says Apáthy humbly. (The difference between the ganglion cells and the nerve cells. Gyógyászat [Medical Science], 1981).

This is why he studied the phenomena of life, the cells, the tissues, the functions bound to the structures, first of all the nervous system, and looked for evolution in everything, especially the order, the system in the living being. He tried to open his own eyes and other's eyes within the limits of the possibilities. He sensed, embraced and developed the idea of the evolution of individuals and species because he knew well that in this way he could get nearer to everything that he investigated, everything that awaited solution. He saw clearly that evolution is a normal process in the living world, the knowledge of which is an indispensable requisite in scientific work. This process needed comparison. Only those can think, discover great relationships, and synthetize, who can use their knowledge. Apáthy expressed these thoughts when in Kolozsvár he spoke of comparative anatomy, comparative histology – given prominence in "Independent Research" – and change called evolution. This is why he investigated evolution itself and generalized on the basis of the laws of ontogenesis and phylogenesis. This is why he considered it very important that his pupils and coworkers should also see clearly the process of evolution of the indvidual and the species, and should know the work and teaching of its classics (9.). Apáthy went his way, bearing in mind, not without doubts and sometimes errors. I think here first of all of his criticism of Darwin's theory (13.). Is the error Apáthy's fault? – Hardly. It is much more a sign of his greatness, of his genius; the expression of the principle that to err is first of all the right of the genius.

Apáthy displayed serious activity in the field of zoology. For instance he investigated not only the embryology, but also the taxonomy of worms with exhaustive thoroughness. His systematization was modern at the time, but even today, even in its outdated form, it deserves attention, for in many respects it was already an embryological system (14–17.). Even in this activity of Apáthy it was evident that "he systematized things thoroughly" (18.). He did it also when he categorized the living beings, when he established the order of phylogenetic characteristics, and when he grouped the physiological events.

Cytology, especially its genetic aspects, had an important place in Apáthy's diversified research work. This fact evidently played an important part in the birth of Gelei's outstanding results in cytogenetics (12.). But Apáthy also concerned himself with experimental genetics. "...with his inverse dog-breeding experiments he proved that with the process of evolution disturbed by inversion it is possible to activate atavistic characteristics". "In his last lectures he dealt also with the systematization of the symmetry of animals ... and asymmetrical organisms (18.).

He influenced Gelei and even the latter's pupils in this direction. Thus he lived on in many respects in Gelei and the latter's coworkers.

Apáthy owed his fame first of all to his microtechnique and his work in the field of histology, more exactly neurohistology. In this field he looked very methodically and purposefully for the best solutions in making histological preparations, fixation, mounting, sectioning and staining under consideration of the known facts of physics and chemistry. Apáthy was able to realize this grand enterprise. In the sublimate-osmic acid fixation he found the procedure that deformed the tissues least of all and which preserved the structure most closely resembling the living state. By using celloidin and paraffin consecutively, he advanced the technique of mounting considerably. The advantageous properties of the two substances made a much more perfect sectioning possible. In order to cut the material obtained by the procedure of double-mounting as perfectly as possible, he modified the knife of the microtome, its angles of inclination, and the knife-holder. He developed a new technique for sharpening the knife (19–22.). Thus it became possible to make section of 1–1/4 μm thickness, which was a unique achievement at that time. Apáthy went further also in the technique of staining. He developed and successfully applied the excellently differentiating trichrome staining method and the method of gold-impregnation. The latter requires especially great attention, but "out of 100 preparations at least one is always successful, and then it is so nice that it is worth the trouble" (23.). "This method is much superior to the others" (23.) and the preparations are so good that "they go around the world" (24.). Eminent neurohistologists admired the preparation and paid honor to their creator. According to Boveri, Apáthy was the greatest microtechnician; "Der Grossmeister der Mikrotechniker ... grössten lebenden Mikrotechniker", writes Pal Mayer (8.). According to Lenhossék, he was "magister mundi".

Apáthy, as the histologists in general, often had to grapple with the difficulties of fixing and staining. He investigated the causes and significance of the difficulties. He called attention to these phenomena in his inaugural address at the Academy (1908).

> "...definite physiological conditions are connected with definite stainability and fixability."

From this he concludes that this

> "show new and useful ways for further investigation of the nervous system." (25.)

His study of the histology of naiads, which he wrote as a young man, marks the beginning of his career leading to his successes (26.). However, he achieved his truly classical success with his gold-impregnated section of the alimentary tract of the sea leech **Pontobdella muricata.** It was in these sections that the neurofibrils became clearly visible (27., 28.) they served as a basis for Apáthy to develop his important principles concerning the structure and function of the nervous system. He formulated his conclusion in what he wrote about his institute in Kolozsvár;

> "Among my recent results, which are now generally recognized and referred to in the professional literature worldwide, I might perhaps mention particularly the neurofibrils as the discovery of the elements of the generally characteristic nerve current-conducting elements in multicellular organisms. These are neurofibrils, which – as anatomically independent, nowhere broken lines inside and outside the cells, ramifying into a complex, but everywhere continuous network – infiltrate the whole body of fully developed animals."(9.)

At this time, there was already some proof of the existence of neurofibrils, but "not even in 1883 could Kupffer convince everybody of it, in spite of the fact that he was already able to stain the filaments of the axonal matter of the nerve fibers of the frog and could thus distinguish them by their color from the matter between the filaments" (6.). This method was imperfect like that of Kupffer's pupil, Boveri. They saw the fibrils in the preparations of nerve fibers fixed with osmium and stained with acidic fuchsine in the axon. Previously Schultze (1868–71) had spoken boldly of the fibrils and their stimulus-conducting role, although as Lenhossék writes, "he did not really see the fibrils and could not see them with the precision required in histology" (23.).

Apáthy's results in neurohistology obliged the best neurohistologists of the world to take a stand in the matter, for Apáthy was opposed to the neuronology formulated by Waldeyer (Deutsch. Med. Wochenschrift, 1891), to the supporters of which belonged no smaller personalities than the other giant: Ramón y Cajal, as well as Harrison, Hanström, Retzius, Schaffer and Herrick, and among the Hungarian Lenhossék and later Ábrahám (24., 29.) and his coworker Minker. Disagreeing with their theory called **"contiquity"**, Apáthy and his followers: Bethe, Held, Boeke, Bielschowsky, Stör, Schröder, Lavrentjew etc. professed the doctrine of **continuity**. The hard struggle between the two camps is clearly reflected in Apáthy's never published 267-page treatise in German against Cajal: the treatise is kept in the Anatomical Institute of SZOTE (Albert Szent-Györgyi Medical University of Szeged) (30.). In this work divided into 19 chapters "Apáthy once with bitter irony – once in tone of disappointment and emotion defends his view presenting arguments and counter-arguments." Apáthy points out that Cajal's impregnation method is not selective: neurofibrils can be clearly demonstrated by it only in ganglion cells.

> "... solely on the basis of this technique and unimportant variations thereof, Ramón y Cajal felt himself entitled to judge everything that we and others had described and what he could not see in fine preparations he declared to be non-existent, mere hypothesis, and everything what he saw to be conclusive evidence, not artificial, but quite natural and wherever it was convenient to him, he declared it to be of neurological nature." (The quotations are from M. Kozma.) (31.)

Apáthy's, discussion, its manner and style are impressive. He was convinced that he was basing his arguments on the most perfect preparations of his time.

Discussion of the conflict of the two trends would be lengthy and go beyond the framework of this commemoration. Presentation of a small detail, is however, in order, because – altough the dispute about the preparations went on – it was impossible to get rid of its subjective character.

The various facts turned the scale in favor of neuronology (23., 24., 29., 32., 33.). In spite of this, open questions have remained to this day concerning the role of the neurofibrils. In this respect Lenhossék's standpoint is very instructive. In contrast to those who attribute to the neurofibrils only a passive role as framework, he states:

> "According to a third theory, which I myself support, the nerve cell and its processes participate in their entirety, in their fibrillar and interfibrillar parts, in the nerve functions; they conduct the impulses alike." (23.)

At the same time, he emphasized the supporting function of the neurofibrils, and he is not alone with this view.

It seems instructive to raise the question: How did the followers of Apáthy's school see these things? Szüts (1914), who had an inclination toward neuronology, regarded the fibrils as the supporting structure of the neurons (23.). József Gelei (33., 34.) and Béla Farkas (2.) identified the elements of the subpellicular neuronema system of the ciliates with Apáthy's neurofibrils and attributed impulse-conducting function to them.

György Rényi, one-time Hungarian assistant, professor emeritus of the University of Philadelphia "could demonstrate the neurofibrils in the axons of native preparations with a micromanipulator" in 1929. (Lóránt Jendrassik's contribution at the Apáthy symposium in 1962.) This was an important success proving wrong all those who denied the existence of the neurofibrils discovered by Apáthy and considered them artifacts.

The neurofibrils demonstrated convincingly by Apáthy are in the center of interest even now, nearly a century later. There have been efforts to elucidate their function by exploration of their structure. Szentágothai demonstrated earlier on that "... they clearly show a kind of material order" (36.). Electron microscopic and X-ray diffraction examinations have proved it (1., 37., 38.).

It is true that the fibrillar system of the neurons is made up of neurotubules, neurofilaments and microfilaments. These are elements that, taking suitable analogies into consideration, may constitute the cytoskeleton of the neurosol. Such a function is made likely by the existence of crossbridges between the fibrils. The chemical components of the latter made possible the flow-producing, material-transporting function of the neurotubules (the endoluminary transport of the extra proteins synthetized in the body of the cell and adhering to the microtubules). There is no mention of the possibility that these elements could somehow conduct impulses. This function is still attributed to the membranes of the neurons, which show changes in potential. This process can well be measured and its results numerically evaluated; therefore, consideration of other way of impulse conduction had been little thought of. Besides this process not yet cleared in Apáthy's time, the idea of neurofibrillar conduction was modern, even though some denied it and emphasized the supporting, strengthening function. All these facts evidently played a role in that the followers of Apáthy's school of thought, took no or little part in the discussions about the existence and function of neurofibrils.

We have presented here a part of Apáthy's life work, first of all his very important school of thought and the activities of the great scientist, and the impacts that contributed significantly to the development of his school. This is part of Apáthy's regrettably still unwritten biography. Unfortunately, only part of it. In any case, his portrait remains incomplete, because a large part of his works is lost. What has remained is not little, for the number of almost 200, and this is enough for us to be able to present the great scientist very nearly as he really was in his life. This is an urgent and important task. Apáthy died at the age of 59, but he continued to exercise his influence through his pupils, through his school of thought, and perhaps exerts his influence even in our days. Quite a few followers of Apáthy and his school were examples, who in the course of time have become ideals. Ideals, for those who want to use their talents for the benefit of science, their country and mankind.

See references on page 20.