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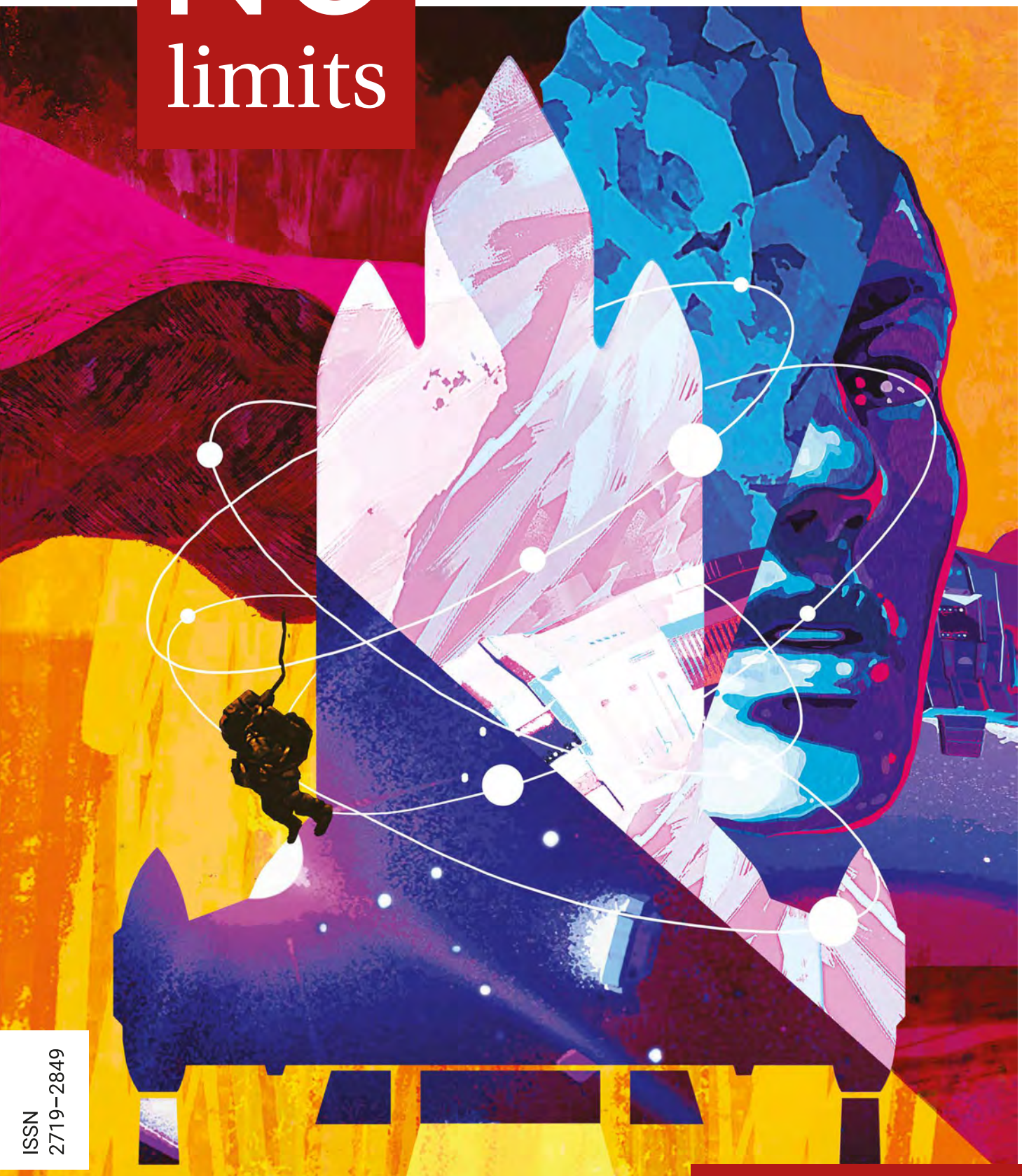

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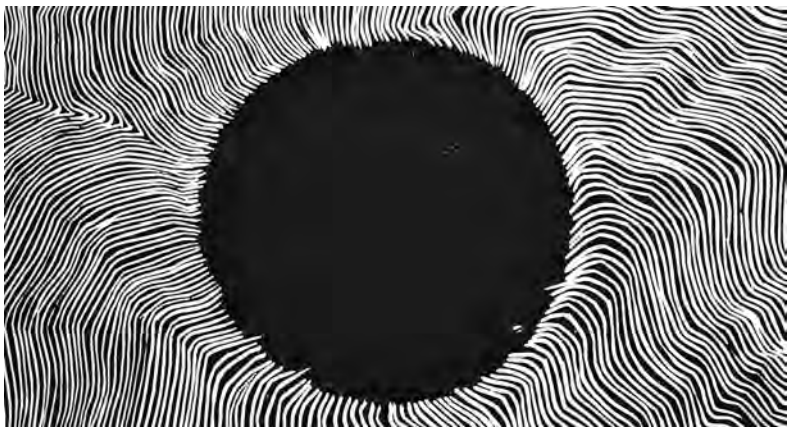

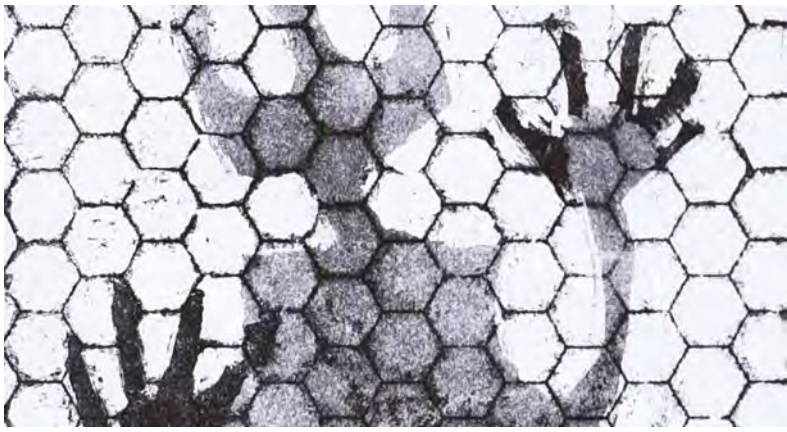

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A SKIN CANCER IMAGING CLIP

When examining moles on the skin for cancer risk, dermatologists most often evaluate them using a dermatoscope, a device with built-in illumination that magnifies the affected area. In particular, they pay attention to the asymmetry of the infiltration, differences in color, or uneven edges. Moreover, dermatologists also try to observe the deeper structures of the infiltration. These measures are important due to the fact that the probability of curing skin cancer depends on the thickness of the tumor. If the size of the infiltration does not exceed 1 mm, a surgical removal of the lesion provides the chance of completely curing the patient. However, the use of a dermatoscope does not allow to precisely measure this thickness and the internal structure of the infiltration. An interesting solution to this problem was proposed by researchers from the University of Silesia in Katowice and the Silesian Medical University. They designed a special clip which provides support in the diagnosis of skin cancer, including malignant melanoma. The method of examination proposed by them is non-invasive and safe even for places affected by lesions. The clip can also be used to monitor the progress of treatment both in hospital and at home.

The project's authors are Assoc. Prof. Eng. Robert Koprowski and Prof. Eng. Zygmunt Wróbel from the University of Silesia and DPharm. Sławomir Wilczyński and Professor of Medicine Barbara Błońska-Fajfrowska from the Silesian Medical University in Katowice.

COMPOUNDS FOR ANTI-CANCER THERAPIES

Unsuccessful therapies and undesirable side effects which reduce the effectiveness of drugs and lower the quality of patients' lives are still the biggest challenges faced by the pharmaceutical industry in the search of new active substances used in the pharmacological fight against cancer. Cytostatic drugs are an interesting example of such compounds. However, they are characterized by low selectivity, which means that they are able to damage not only cancer cells, but also healthy ones, which results, among others, in the occurrence of the above-mentioned adverse effects. In addition, some types of cancer are resistant to these substances, and this in turn reduces their applicability.

Therefore, researchers developed new derivatives with an integrated naphthalene ring for the production of anticancer agents which would show high selectivity towards normal cells. The patented compounds could be used as active substances especially in drugs effective in the treatment of colorectal cancer, particularly tumors with mutations of the TP53 gene.

The authors of the solution are researchers associated with the University of Silesia in Katowice: Assoc. Prof. Anna Mrozek-Wilczkiewicz, Dr. Katarzyna Malarz, Prof. Robert Musioł, MSc. Ewelina Spaczyńska, MSc. Klaudia Krzykała, and Prof. Josef Jampilek from the Comenius University in Bratislava (Slovakia).

FASTER DIAGNOSIS OF ALZHEIMER'S DISEASE

Quinoline derivatives belong to the group of chemical compounds with a particularly broad spectrum of application. Due to their unique properties, they can be used in antimicrobial drugs for the treatment of bacterial and parasitic infections or malaria. They also have anticancer properties. Moreover, they are able to capture metal ions, and can therefore be used in analytical techniques for marking these ions in various materials. Thanks to their fluorescent properties, some of them help to diagnose Alzheimer's disease. In dentistry, quinoline derivatives facilitate the imaging of carious lesions by dyeing them.

Chemists from the Faculty of Science and Technology at the University of Silesia developed a new derivative of para-iminostyrylquinoline and indicated its application. The compound is to be primarily used for the detection of metal ions, especially zinc ions, in human or animal cells. This will allow for a quicker diagnosis of various diseases associated with disturbed cellular levels of this element. Examples of such applications include the diagnosis of Alzheimer's disease or disorders of the immune system as well as studies related to fertility enhancement.

The authors of this invention are: Assoc. Prof. Anna Mrozek-Wilczkiewicz, Dr. Katarzyna Malarz, Prof. Robert Musioł, and Dr. Barbara Czaplińska.

SCIENCE NEWS

MEMBRANES FOR REMOVING TRACE AMOUNTS OF HEAVY METALS

Researchers from the University of Silesia developed a method to produce special membranes designed primarily to remove trace amounts of heavy metals from aqueous solutions. Moreover, these membranes can be used to mark ions of toxic metals, such as lead, chromium, or arsenic, by spectroscopic methods.

The patented and environmentally friendly membranes are the result of combining the excellent properties of cellulose, a fibrous material, with the advantages of silica. Thus obtained membranes are mechanically and chemically stable and can be used in acidic, neutral, and basic environments depending on the adsorbed ion's type. Appropriate chemical modification of the silica's surface improves its adsorption properties and allows for a selective adsorption of certain ions. The method of obtaining these membranes is quick, simple, and does not require significant funds.

The authors of the invention are chemists associated with the Faculty of Science and Technology at the University of Silesia: Prof. Rafał Sitko and MSc. Ewa Łukojko.

FUNGICIDES AS SAVIORS OF THE WORLD'S CULTURAL HERITAGE

Scientists from the University of Silesia in Katowice developed active substances that can be used to save the most valuable book collections (incunables, manuscripts, old prints) and archives as well as various surfaces e.g. of paintings or posters. Fungal colonies, which have taken a liking to cellulose and the microclimate of library nooks and crannies, pose a particular threat to these invaluable works of art and literature. Although conservators protect valuable objects by e.g. disinfection, many pathogens become resistant to known antimicrobial compounds over time, and subsequent studies have repeatedly demonstrated the harmful effects of various preparations on books and human beings as well. Some of the chemical compounds used hitherto have carcinogenic and narcotic properties. Moreover, they may also cause allergies. The solution developed by the scientists has the potential of contributing to the health protection of persons who disinfect book collections and archives.

The authors of the new solution are Dr. Agnieszka Bangrowska from the Faculty of Humanities at the University of Silesia and Prof. Robert Musioł from the Faculty of Science and Technology of the University of Silesia.

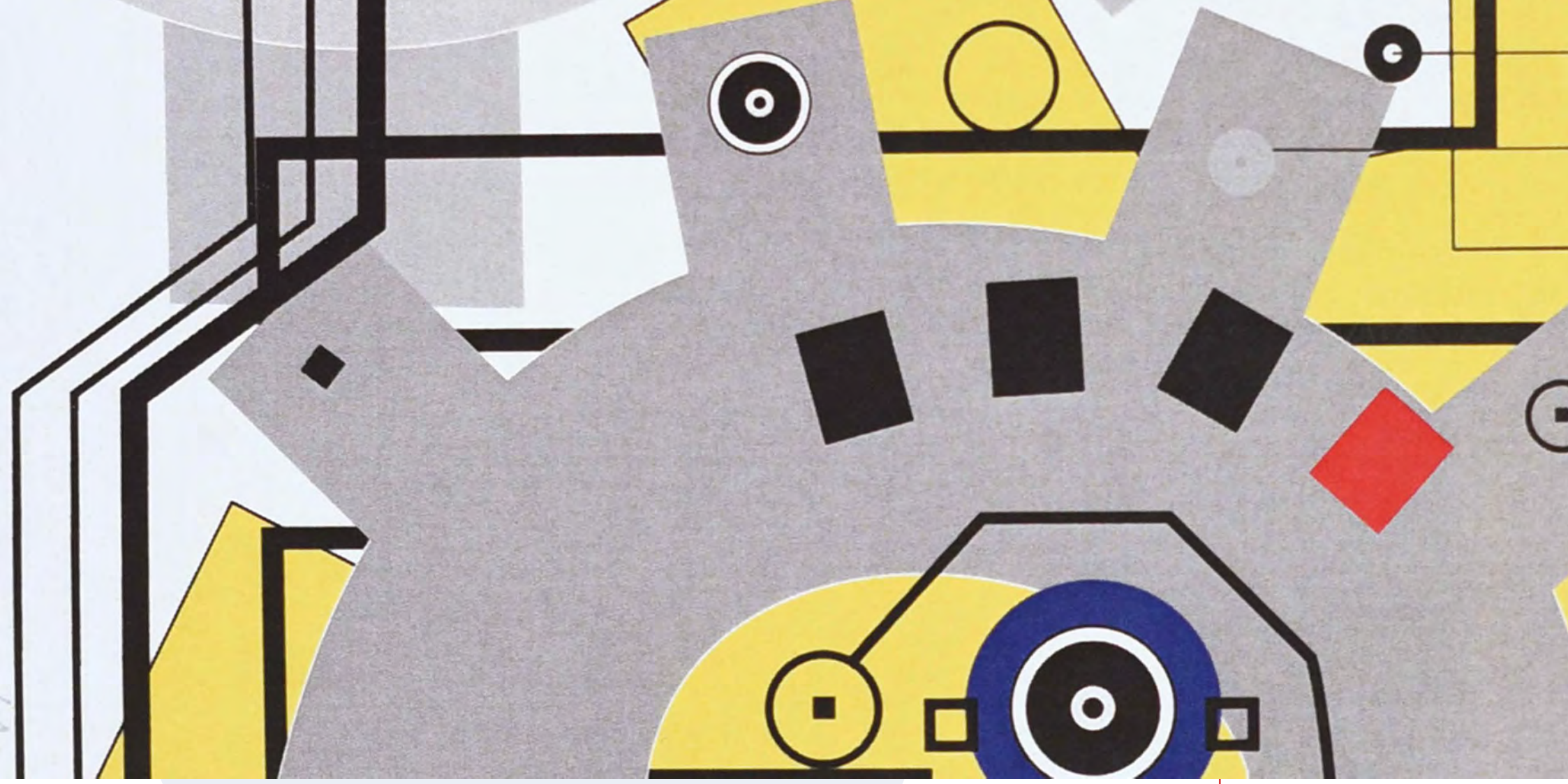
Author: Katarzyna Stołpiec

text: Maria Sztuka

STANISŁAW LEM

A FANTASIST WHO GAVE NAMES TO HIS DREAMS

The amount of literature exploring the phenomenon of Stanisław Lem's work surpasses the literary legacy of the author of *Solaris*, which includes not only novels, short stories, and essays, but also articles, reviews of non-existent books, interviews, columns... The creations of the author's unlimited imagination have fascinated researchers in many scientific disciplines: literary scholars, philosophers, sociologists, astronomers, and futurologists. Linguists had to be included in this group, since Lem, a great dreamer and fantasist, poured his brilliant ideas onto paper and described his invented worlds using not only the existing resources of Polish dictionaries, but also borrowings from foreign languages as well as his own neologisms.



Katia Lazar, *Mood I*, Poland

Dalia Żmuda-Trzebiatowska, *Power Plant*, Poland

The new worlds had to have a new terminology; nothing could be the same as in *real* (by the way, the word "real" is also an abbreviation coined by Stanisław Lem, and this synonym for the real world appears already in *Return from the Stars* written in 1961). Lexicons seemed too poor, so he supplemented them with his own vocabulary, masterfully juggling with cores, prefixes, and suffixes – a linguist's paradise.

The Internet, a global system enabling users to digitally exchange information and e-books, audiobooks replacing paper books, portable computers and cell phones as one device – all these achievements of modern technology had functioned in Stanisław Lem's books much earlier than they appeared in reality. The great futurist, however, had not foreseen that language professionals would use his extraordinary linguistic intuition and his ability to give new names to the creations of his phenomenal mind to... teach and learn foreign languages.

Prof. Jolanta Tambor, a linguist from the Institute of Linguistics at the Faculty of Humanities at the University of Silesia, Director of the School of Polish Language and Culture at the University of Silesia, uses Lem's neosemantization and neologization in language teaching. Prof. Tambor wrote about the language of the author of *The Cyberiad* in her doctoral dissertation (*Język polskiej prozy fantastyczno-naukowej* i.e. *The Language of Polish Science-Fiction Prose*) and many scientific publications. On the basis of the short stories: "How the World Was Saved"; "Trurl's Machine"; "The First Sally (A), or Trurl's Clectronic Bard", she developed aids for teaching Polish as a foreign language.

The principle of creating names, presented almost in a nutshell (a description how solaristic terminology is created), woven into the intriguing plot of the novel *Solaris*, turned out to be an excellent teaching method for exercises on the principles of Polish word formation.

"When creating future worlds, Stanisław Lem first built them in his own imagination, inventing societies of the future," Prof. Jolanta Tambor explains. "He had to create appropriate social and political institutions as well as future technical means. He gave them names, following the principle that the unnamed does not exist. By doing so, he gave more credence to the illusion of the created world. He used virtually all known methods of enriching vocabulary: creating word-forming neologisms, building phrasemes, and borrowing from other languages. Lem was an author and a fantasist who dreamed and gave his dreams names."

What were the sources of his knowledge? After all, he did not study Polish philology, linguistics, grammar, or word formation. For Lem, careful observation was sufficient. He listened to the discussions of linguists and read various types of linguistic advice. Moreover, at the end of the 20th century, language culture was present in every medium. He simply listened and remembered, and a phenomenal linguistic intuition was the tiny but crucial building block.

According to Prof. Jolanta Tambor, Stanisław Lem's scientific mind could not fail to notice the rapidly growing number of compounds in which one segment is a repetitive element, usually of foreign origin, especially with regard to technology. Since there are astrologists, it seems natural that symmetriads orbiting Solaris had to be studied by symmetriadologists; since there are cosmodromes in reality, transgalactodromes were created in Lem's world. Using repetitive segments, he let his imagination run wild and equipped new worlds with aeromobiles, televisits, a teletrans, or a teleport. Though these names sound familiar, they were created at the beginning of the 1960s and can be found in the novels *Solaris* (1961) and *Invincible* (1964), and it is worth remembering that the appearance of *Solaris* on bookstore shelves coincided with the flight of the first human into space (April 12th, 1961).

Several hundred examples of terms created by Lem allow Prof. Tambor to teach a number of enriching lessons in word formation. Lem was also aware of word formation series and, by flawlessly following the rules, made plausible the existence of lectons, nolars, nightzebs, nallyrakers, neotremes, and thus the fictitious world

became as real as the computer on our desk. In science fiction, everything is possible; it merely suffices to observe the changing reality, to confront it with your own imagination, and to be willing to share your thoughts.

In Stanisław Lem's prose, Prof. Jolanta Tambor found another excellent teaching aid. Many lecturers teaching foreigners the Polish language are at a loss at how to explain, especially to English speakers, the grammatical construction of the so-called double negation. They do not understand why negations need to be repeated in Polish. These intricacies are superbly explained by Lem in the short story “How the World Was Saved.” The machine built by Trurl performs actions that begin with the letter “N”. Klapaucius comes to check it and gives orders: "Machine, do Nothing!" When the machine does not perform any actions, an argument arises between the creator and the controller. Klapaucius insists that, in Polish, "doing nothing" and "doing Nothing" (i.e. something) do not mean the same. Lem clearly explains the difference through the mouths of his characters. They fiercely argue about the meaning of the double negation and the single negation, and they almost stop the machine, which understood the command literally and wanted to turn everything into nothing i.e. to eradicate. “After this exercise,” the linguist assures, “I no longer have any problems, and the students do not argue about double negations.”

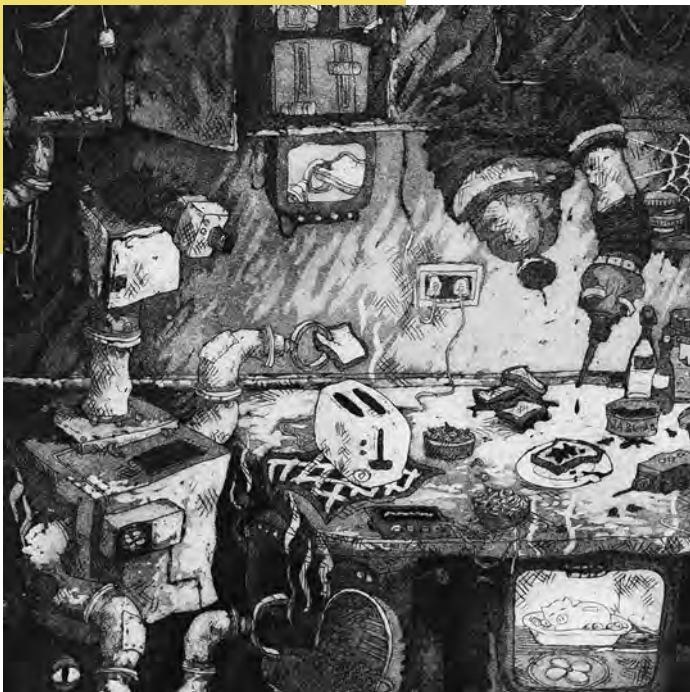
The linguistic talent of the author of *Mortal Engines* is not limited only to creating new vocabulary, since it covers also higher i.e. syntactic-semantical and textual levels of language. "Lem had an excellent understanding of the potential of language, the possibility to play verbal games thanks to the use of ambiguity, polysemy, but also syntactic and textual transformations," the researcher explains.

Lem uses numerous synonyms and his language is extremely rich; he draws from literature, scientific journals (due to his deep interest in politics, literary theory, philosophy, biology, cybernetics, astronomy, the progress of technology, medicine, biotechnology), from the media, and resorts to long forgotten texts. The author looked for the forms and genres that suited him most, and in so doing, gave additional authenticity to the lofty style in *Tales of Pirx the Pilot*, and build a fairy-tale future, consciously playing with archaic structures in *Mortal Engines*.

Polish readers were seduced by Lem's linguistic imagination, and therefore, it is not surprising that his original neologisms, complex grammatical compositions, and archaisms are not an obstacle in the reception of the writer's works. It could thus seem that his language is hermetic and understandable only to Polish readers, but nothing could be further from the truth. Stanisław Lem is probably the most frequently translated Polish author in the world, both in terms of the number of translations and with regard to the number of languages, of which the writer himself mentioned over forty. How is this possible? Prof. Jolanta Tambor is in contact with many translators from all over the world. Slavs obviously have the least problems, since after all, Slavic languages overwhelmingly feature motivated lexical units with more obvious semantics, which brings them closer to Polish. Authors of English and German translations also find it more convenient to deal with this (neo)terminology, since although new words in these languages are created differently than in Polish and have different suffixes and construction rules, they are still legible and retain Lem's specificity. Chinese translators face a much more difficult task, as their language has no word formation in our sense, but since they are able to assimilate all technological novelties at the speed of light, they also found a way to deal with Lem’s works. This was proven by Professor Zhao Gang of Beijing Foreign Languages University, who translated *Solaris* to Chinese.

"A translator must not only convey the plot, but also the mindset which is characteristic for the given language area. This is the reason why Lem requires very good translators, and the popularity of his prose around the world proves that such language specialists exist," concludes the linguist.

In one interview, Stanisław Lem, talking about his interest in the Polish language, lamented that most people do not really know it in depth. Lem not only knew Polish perfectly but also enriched this language and left his permanent mark in it.



Dalia Żmuda-Trzebiatowska, *Robots' Machine*, Poland

i

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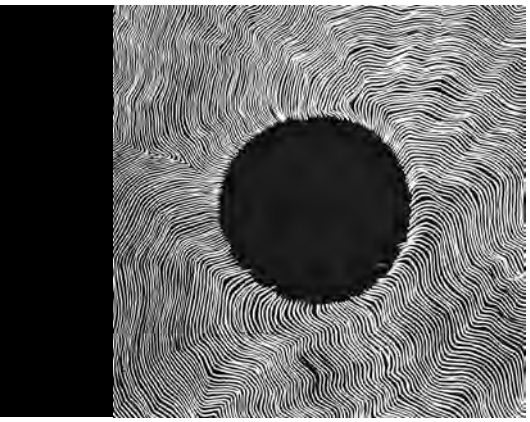
Worlds known from literature or science fiction films have accustomed us to terrifying contacts with the Other; be it through the invasions of extraterrestrial civilizations or the concept of soulless artificial intelligence. When in 1938, the US radio station CBS broadcast the radio play *The War of the Worlds*, based on the eponymous novel by H.G. Wells, panic is said to have broken out among the audience. It turned out, however, that the sounds of the inhabitants fleeing from "aliens" were only a simulation and originated from an archived recording of a plane crash. Thus, the fear of an alien invasion shifted to a fear caused by the power of a new, disembodied form of communication. Could this be how an actual confrontation with an alien life form of life would look in reality? Stanisław Lem goes even further and asks what the story of the Other would sound like and whether we would be able to hear it at all.

If we were to think about the depictions of non-human voices and ways of communication in Lem's work, probably the first work coming to our minds would be *Solaris*. It is a novel about the psyche and love, and above all about the limits of human reason, the apparatus of concepts and senses in an encounter with an alien life form. Arguably, it has become the most recognizable text of the Polish futurologist. The protagonist Solaris featured already in its title, an intelligent entity covering the entire planet with its size (or being an ocean-planet), sends numerous signals to various explorers. These signals, however, despite numerous years of scientific work, remain only incomprehensible aberrations that cause extreme emotions in people. Solaristics, an autonomous field of research in the novel, becomes a record of the failure of science in the encounter with the Other and at the same time exposes the limits of humans and their convictions of being unique.

In comparison, the bloodthirsty aliens from Wells' novels, who emulate the violent patterns of behavior known from human history, become easier to digest, since they are more human. Such an anthropomorphic scenario, albeit tempting due to its predictability, is, according to Lem, unlikely. "We can be prepared for surprises, troubles, and dangers we cannot imagine today – but not for the return of demons and monsters from the Middle Ages disguised as technical larvae," he explains in *Summa Technologiae*.

However, Lem does not close the discussion, as *Solaris* leaves the readers with more questions than answers and provokes them to ask even more. For example, would the *logos* of the rational ocean become clear to humans if Solaris spoke to the characters in Polish or English, and not by means of phantoms and monolithic constructions growing out of its surface? Based on this problem, Lem wrote a lesser-known story in which he actually gave the voice to the Other, creating a space in which the Other can autonomously tell its own story.

Golem XIV is constructed as a transcript of the lectures of the eponymous supercomputer, including a foreword and afterword by fictional human scientists. Already at the beginning of the book, Lem justifies the concept of the machine's narrativity, which turns out to be one of its most primal features. It was precisely the ability to create scenarios of potential events, i.e. to predict or rather make stories unfold,



Aleksandra Duma, *How The World Was Saved*, Poland

text: Piotr F. Piekutowski

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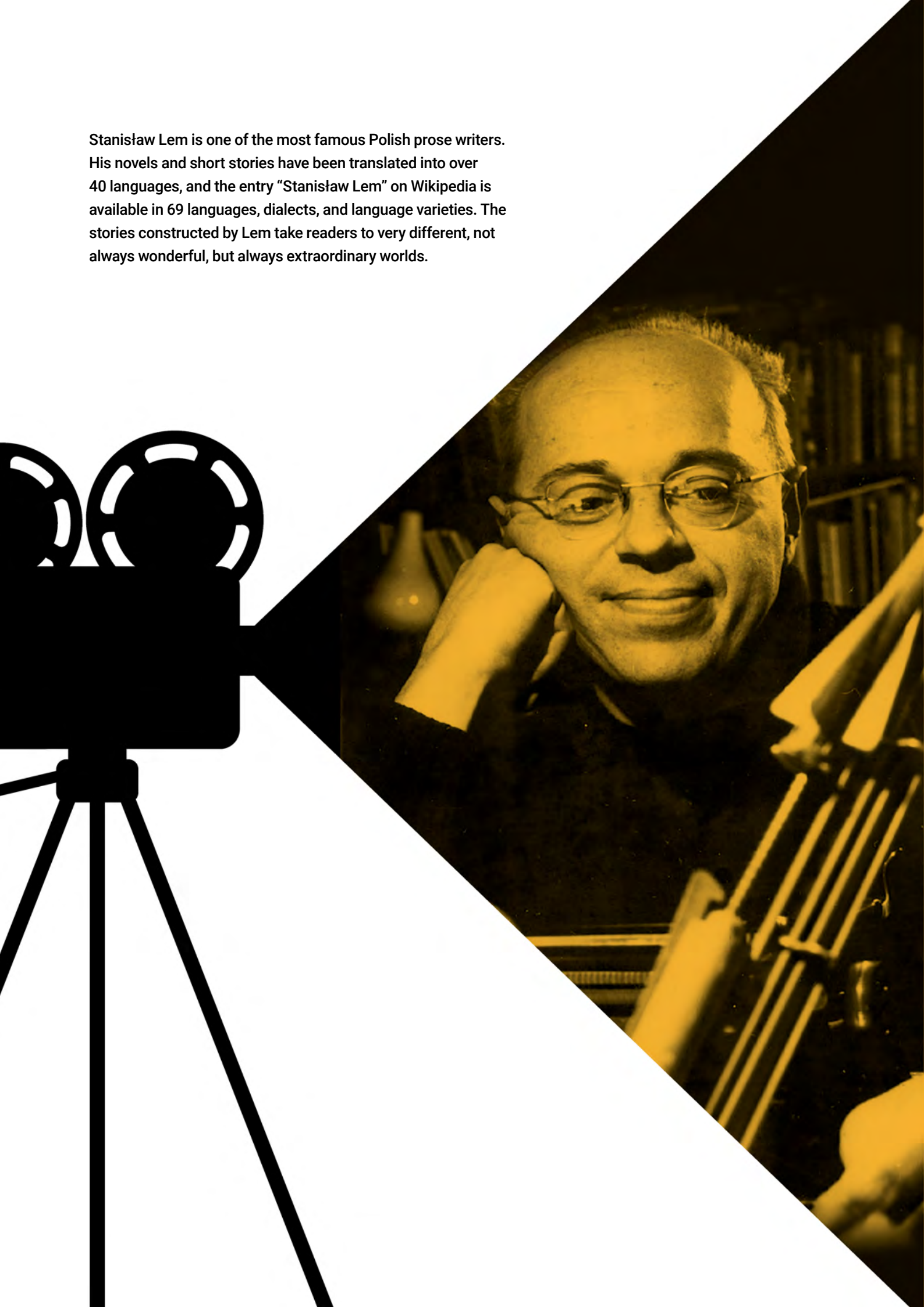
which characterized Golem's military ancestors. The situation in which a computer holds lectures, both about itself and about the human being, is one manifestation of its need to participate in language, to be entangled in communicating and narrativizing reality.

In *Golem XIV*, the Other has the answer to probably every question that haunts humanity. It does not seem that there is a communication barrier. Obviously, Golem has no biological body or senses; it is a perfect machine, pure Reason, however, the being's way of expression is consciously adjusted to the human audience. Has the problem of hearing and understanding the Other thus been solved? Quite the opposite. The lecture halls are gradually becoming empty, at the same time, however, attempts to communicate with *Golem* are made more rarely, and the super-intelligent computer itself is realizing its powerlessness to make inhuman words comprehensible to humans.

The lack of understanding of the Other in Lem's text can be explained by the multitude of differences between the being and humans. Golem is not a person; the style of storytelling, emotions, the individual character as well as the "self" are fluid, resorted to only as a set of useful but interchangeable tools. However, the problem of the dramatically increasing number of differences becomes pale in comparison with language itself, since, paradoxically, it is the root of misunderstanding, as Golem says: "these are my very troubles, when I make attempts and try to use your language. The difficulty is not only, as you see, that you are not be able to ascend my mountain, but also the fact that I cannot descend all the way to you, for when descending I lose on the way what I was to report."

The meeting of a human being and the Other made possible by the adoption of human language in *Golem XIV* ends in a failure. The compromise of complying with linguistic rules paralyzes both sides, and the medium of communication itself becomes a barrier. Eventually the artificial Reason retires to a higher level of being and becomes silent, leaving behind merely a monumental, mechanical body. In his works, Lem repeatedly provokes us to take up the challenge of hearing the Other, but at the same time warns us about the main problem of humans – "I must tell you that we really have no desire to conquer any cosmos. We want to extend the Earth up to its borders."

Stanisław Lem is one of the most famous Polish prose writers. His novels and short stories have been translated into over 40 languages, and the entry “Stanisław Lem” on Wikipedia is available in 69 languages, dialects, and language varieties. The stories constructed by Lem take readers to very different, not always wonderful, but always extraordinary worlds.



AN AUTHOR WHO HATED MOVIE ADAPTATIONS OF HIS BOOKS

text: Dr. Agnieszka Tambor

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Today, we also know that Lem was an exceptionally far-sighted writer: "Spent the afternoon in a bookstore. There were no books in it. None had been printed for nearly half a century. [...] The bookstore resembled, instead, an electronic laboratory. The books were crystals with recorded contents. [...] They could be read with the aid of an opton. It was similar to a book but had only one page between the covers. At a touch, successive pages of the text appeared on it. But optons were little used, the sales-robot told me. The public preferred lectons – lectons read out loud, they could be set to any voice, tempo, and modulation (S. Lem, *Return from the Stars*).

In this short excerpt of Lem's novel which, what should be emphasized, was written in 1961 (sic!), not only can we see today's fully-fledged e-books, but the author also accurately predicts the domination of audio content over writing, and the quoted excerpt is just one of the numerous examples showing that Lem was not only an excellent writer but also possessed an extraordinary gift of observation, thanks to which he was able to create alternative, quite attractive worlds.

How is it then possible that we still have not seen a Marvel blockbuster in the form of a movie adaptation of the novels by this extremely popular science fiction author? The answer to this question is very simple: Stanisław Lem chronically hated films based on his texts and treated every adaptation as a sacrilege. The only adaptations he recalls with a positive feeling are those that were never made. "I made the best deal with the Americans in the late 1960s. At that time, Michael Rudesone bought the rights from me to produce *The Invincible*. I believe *The Invincible* is a work that could look very well on the screen. It is spectacular, has an amazing scenery: flying clouds of insects. However, the production of such a film would have to cost a fortune, and it would be a commercially risky project. Therefore, Rudesone spent four years unsuccessfully looking for producers, while paying me considerable royalties due for option extensions. After all, the film wasn't made, and it would probably be terrible, but I earned a lot. Nice memories." (source: www.lem.pl)

"Terrible" is one of the milder words Lem used with regard to "his" movies. So let us take the risk and make a brief overview of the most famous screen adaptations of Stanisław Lem's prose in the eyes of its author (the screen adaptations were discussed in a famous interview conducted with the writer in 2000 by film critic Łukasz Maciejewski): *The Silent Star* (a Soviet version of *Solaris*): trash and socialist realist ugliness: "On the set of this film, I was so angry that I stomped my feet and yelled to Tarkovsky: You, durak (fool)!; *Inquest of Pilot Pirx*: cheap and boring; *Hospital of the Transfiguration*: "all I saw on the screen was a variety of elementary nonsense"; *Professor Tarantoga's Expedition*: "You should thank God you didn't have to watch this." Lem also completely distanced himself from the most successful film adaptation of his prose, the American version of *Solaris*. Actually, the "parting" with the work took place with the consent and even encouragement of the producers. "The more the American side becomes involved in a project, the thicker is the contract restricting the author's rights to interfere, and the thought that forty screenwriters decompose my text doesn't give me much satisfaction. At this point, I'm not even allowed to have a look at the text of this script. I'm not allowed, but I also don't want to, because I'm afraid that after reading this, I'd probably go crazy on the spot." Actually, the only film that the writer accepted is the short movie *Przekładaniec* (translated to English as *Layer Cake*, *Hodge Podge*, or *Roly Poly*) directed by Andrzej Wajda. However, the approval comes from the fact that it was Lem who wrote the script for the adaptation.

Was it the writer's character that did not permit any changes in the texts he had written, or was Lem unaware of film language rules and did not want to come to terms with the framework of the audiovisual translation process, including the sometimes necessary interference with the content? Probably not. Perhaps it was rather the directors and screenwriters who did not want to accept that Lem's faithfully screened texts would actually bring the best results and profits. "The biggest problem of contemporary science fiction is [...] infantilism. For years, all those poor scriptwriters have not been able to tell anything new except space wars and sinister visitors from an alien planet, and this seems increasingly boring, monotonous and stupid to me," Lem said, and it is impossible not to agree with him. 20 years after this interview was conducted, not much has changed... What would an ideal movie production based on Stanisław Lem's novel look like? Let us hope that someday we will finally find out, although the writer himself would certainly consider this currently non-existent film as garbage unworthy of his work.

Stanisław Lem in 1966 / Photo shared by Wojciech Zemek, the writer's secretary

Dr. Agnieszka Podruczna conducts research on science fiction in English-language post-colonial literature, however, she deals with specific sci-fi literature – not only with works related to North America, but also written by non-white women; authors who come from minorities and diasporic or indigenous communities.

SCIENCE FIC

TELLS US NOTHING ABOUT THE FUTURE

The texts analyzed by Dr. Podruczna show that the traditions of postcolonial science fiction writing can be at odds with the mainstream of this genre.

"It seems to me that there is a belief that humans are destined to conquer the cosmos and subdue all that it contains. The texts that I deal with slightly question this view. The mainstream belief that humanity has to leave Earth and conquer other planets is in a sense an extension of the colonial tradition of Western countries," the philologist remarks.

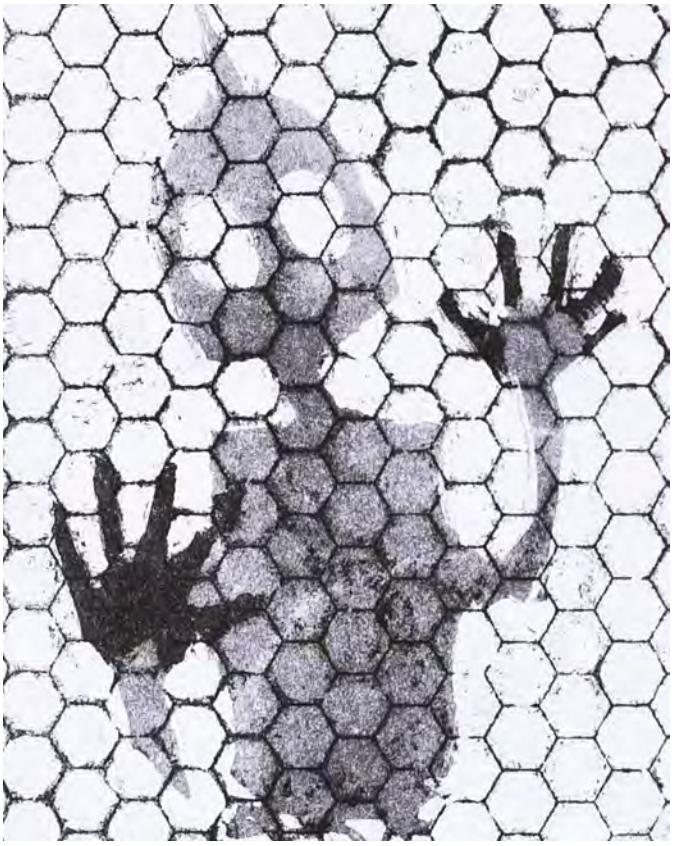
In her doctoral thesis, *Reading the Body of the Other in Feminist Postcolonial Science Fiction*, Dr. Agnieszka Podruczna focuses on the ways in which the female body is represented in postcolonial science fiction written by women. The researcher discusses works by Canadian authors of various origins, such as Larissa Lai, Nalo Hopkinson, Celu Amberstone, and Suzette Mayr, as well as writers with an African background – Nisi Shawl and Carole McDonnell. In the analyzed works, the female body becomes a transgressive subject i.e. one that crosses or blurs boundaries and a subject opposing and resisting colonial practices. It is worth emphasizing that science fiction itself is very interested in issues of the body and embodiment, an aspect present in works by genre classics dealing with androids, such as Philip K. Dick.

Many of works by these authors deal with the issues of reckoning with the colonial past and slavery, resettlement, looking for a home, and being between two worlds. It is expedient to note that writers of indigenous, Canadian, or American descent write about their lack of belonging in slightly different ways than authors whose families come from other parts of the world or who immigrated at a later point in life. The defining feature of this literature is the way it looks at the Alien, namely from the Alien's point of view. The Alien can also speak in its own voice. As one of them, Nalo Hopkinson (one of the more famous authors of postcolonial science fiction) writes in her introduction to a volume of stories: for people like her, whose communities have suffered the trauma of colonialism, a spaceship appearing somewhere on the horizon is not something fictitious. These communities have lived through it and are the Aliens in this context.

One of Nalo Hopkinson's novels entitled *Midnight Robber* is particularly noteworthy. Its action takes place in a distant future in which interplanetary travel is possible. The main character lives on one of the planets colonized by people from the Caribbeans. On the one hand, the novel meets all genre requirements, and on the other hand, it is literature dealing with reckoning, maturing, and traumatizing events.

"I share the view held by many science fiction scholars that the genre does not really tell us anything about the future. However, it tells a lot about the present and the past," Dr. Podruczna remarks.

TION



Amanda Chamoń, *Trap*, Poland

The development of our species has significantly been influenced by various cultural trends, civilization breakthroughs, and historical events. Mary Shelley wrote in 19th century Britain, and therefore her narrative is a reflection of this era: scientific discoveries, progress in medicine, the industrial revolution. Her protagonists are people of that time trying to find their role in a new situation, asking themselves what a human being really is. Herbert George Wells, who lived at the turn of the 20th century, created stories dealing with alien invasions. These texts reflect the prevailing moods in the society of that time and the growing fear of war. In the 1950s and 1960s, an international race to the moon was underway. As a result, countless narratives about the conquest of space, such as Ray Bradbury's *The Martian Chronicles* or numerous books by Isaac Asimov, appeared in science fiction novels. The 1980s followed suit; the beginning of the computer era. Consequently, cyberpunk found its way into the genre, for example in works by William Gibson, the American creator of this sub-genre of sci-fi, or by Philip K. Dick. Due to advances in technology and research on artificial intelligence in the 1990s, people have become increasingly interested in robots, androids, and AI. Nowadays, these topics are also very popular in science fiction as well as in movies and computer games.

"We try to imagine what the future will look like, but the framework of our society, the political, social, or cultural climate limit us in a quite significant way. Therefore, European sci-fi literature is different from the American, although common points could be found," the researcher remarks.

Another interesting theme in science fiction is how authors portray their – and therefore our – images of Aliens. In the great majority of cases, they are anthropomorphic characters. Aliens usually have two arms, two legs, a head, and are basically humans repainted in gray. They also exhibit human characteristics: they are peaceful or aggressive, kind or angry, greedy or selfless, and even, *nomen omen*, humanitarian.

The genre studied by Dr. Agnieszka Podruczna, postcolonial science fiction, is young, but draws heavily from the tradition of the genre. Most of the books were published at the very end of the 20th century or already in the 21st century, so we are talking about very contemporary fiction.

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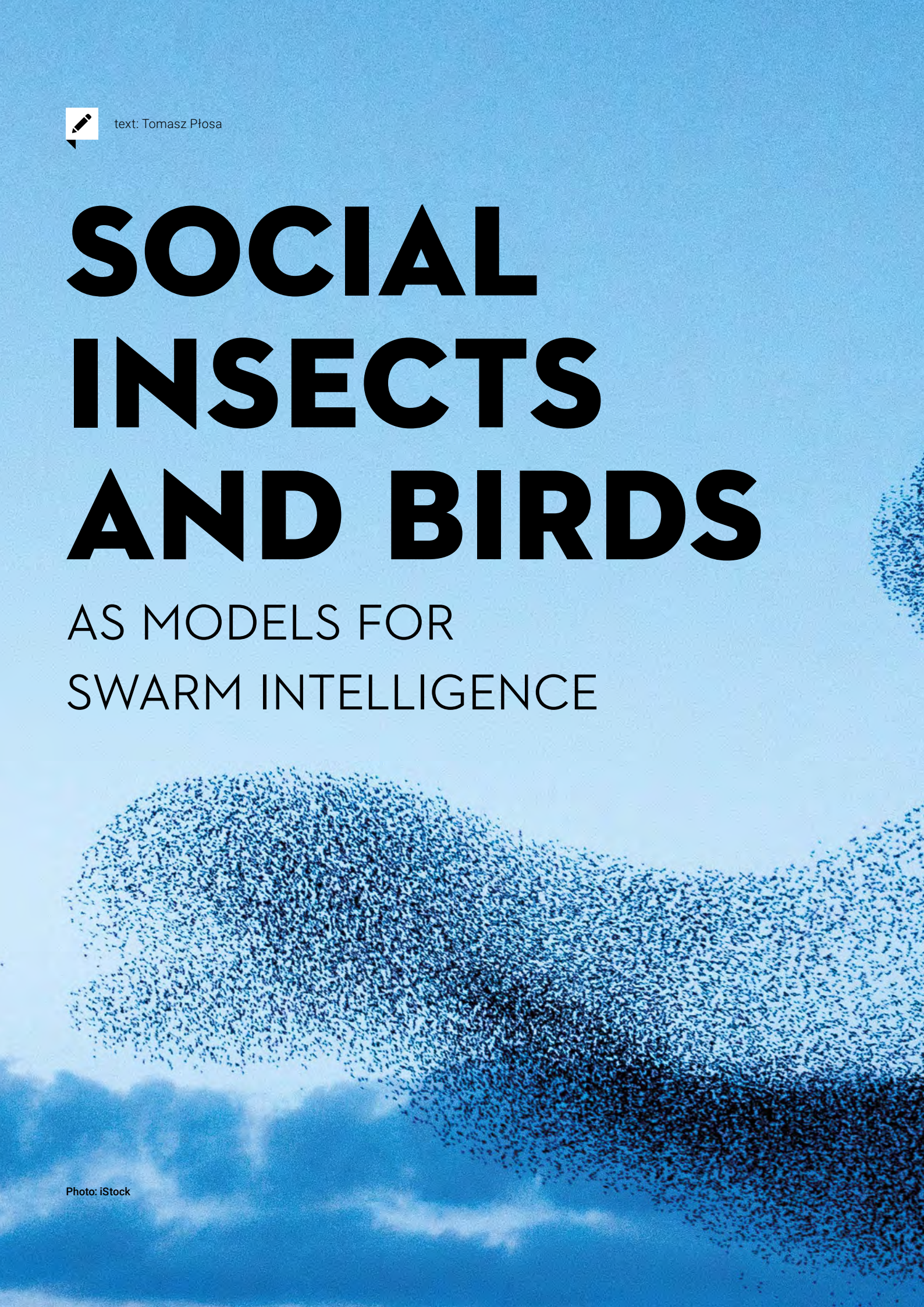
text: Tomasz Płosa

SOCIAL INSECTS AND BIRDS

AS MODELS FOR SWARM INTELLIGENCE



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It is very possible that, at least once in our lives, everyone of us was impressed by the fluidity of movement of wild birds flying in a flock or by a bank of colorful fish presented in a nature documentary. Both birds and fish move in a harmonious and coordinated way, steering in a given direction in a symmetrical pattern or even suddenly changing their direction – but without bumping into each other or breaking their formation. This is a true phenomenon of nature, and precisely these are the phenomena that researchers not necessarily associated with natural science began to look at. Subsequently, they created artificial intelligence algorithms based on mathematical models observed in the natural world which are useful for solving specific optimization problems.

The collective pattern of individual behavior in self-organizing systems such as flocks of birds, banks of fish, or colonies, was used to create an artificial intelligence technique called swarm intelligence (SI).

In the Polish language, the more direct translation of the word "swarm" (or "herd") is reluctantly resorted to, partially due to the fact that it features negative associations, such as "to act in a herd," which implies unintentional or unconscious action, and therefore we rather speak of "dispersed intelligence," says Prof. Urszula Boryczka of the University of Silesia at the Faculty of Science and Technology, who in her research work deals with e.g. metaheuristic algorithms, including algorithms based on natural phenomena. – We speak of metaheuristics or higher-level heuristics because such algorithms do not enable us to solve a given problem but only suggest how to find an algorithm capable of doing it.

Can the search for metaheuristic algorithms be treated as part of bionics? No, since bionics is the industrial application of specific technologies based on solutions found in nature, such as ultrasonic sonars (modeled on echolocation used by bats and dolphins) or the famous swimming suits produced by Speedo for the Olympic Games in Sydney in 2000. Their texture resembled shark skin, and 83 percent of gold medals were won by swimmers wearing this particular suit. In the case of swarm intelligence, we rather speak of biological mimesis or biomimicry.

"Regardless of whether we are talking about bionics or biological mimesis, it is worth to carefully look at what nature is telling us. Stanisław Lem used to say that technology is an extension of nature, and that is why we place such emphasis on searching for a phenomenon in nature," says Prof. Urszula Boryczka. "As a result, we also have algorithms based on the phenomenon of bioluminescence in glow-worms or on the waggle dance of bees."

So, as a reminder: first, we observe what happens in nature, then – by analyzing the behavior of a given population, which consists in finding a mechanism of communication and interaction between its individuals (agents) aimed at learning to improve their behavior – an appropriate mathematical model is created. It later serves as the basis for an algorithm applied to solve a particular optimization problem, i.e. the one related to the efficiency of action. Thus, for example, the Particle Swarm Optimization (PSO), an algorithm proposed by social sociologist James Kennedy and his fellow engineer Russell C. Eberhart as a simulation of collective behavior, is used to solve global optimization problems. Moreover, inspired by the way birds and fish move, in the 1980s Craig Reynolds created the algorithm of a swarm whose agents are so-called boids. This technique of artificial intelligence was used for the first time in the movie *The Lion King*, in the scene when a herd of antelopes scared by hyenas runs down a ravine, and Mufasa is killed as a result. This algorithm was used a few years later in the famous *Lord of the Rings* adaptation to move the Orc forces, but at first the Sauron's Orcs scattered in different directions due to the fact that incorrect parameters had been entered. This is because the need to tune and adjust parameters is the biggest obstacle to the correct application of a given metaheuristic.

Another very well-known algorithm based on distributed intelligence is the Ant Colony Optimization (ACO) algorithm proposed by Marco Dorigo, Vittorio Maniezzo, and Alberto Colorni, derived from the behavior of ants during foraging i.e. looking for food outside the anthill. Ants leave their colony and, moving in a completely random manner, extensively search a certain space and leave a so-called pheromone trace. When their mission of finding food is successful, they return to the "base," thus reinforcing that mark on their path. When other ants encounter it, they start to follow the same path, marking it even more with pheromones, which subsequently "attract" more of their kin (positive feedback, autocatalysis occurs). However, the pheromone trail evaporates after a while, so

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the most popular paths will be the shortest ones i.e. those which make it possible to most quickly transport food to the anthill and to leave the strongest pheromone trace. It is thanks to them that indirect communication takes place between two agents on the basis of stigmergy – one agent modifies the environment, and the other responds to this modification in the new environment, and later reinforcement learning occurs.

The ant algorithm can help to solve optimization problems with graph representation, such as the traveling salesman problem. The gist of the problem is this: a salesman, when setting off from point A, must visit several other points and return to point A at the least possible cost. This is a rather abstract example, but ACO has also been applied in the creation of transport networks (in order to avoid the most congested places or those where accidents occurred) or with the purpose of automatically creating computer programs (by formulating the goals that a given program should pursue, on the basis of the so-called anthropoid programming).

It is worth noting that in the recent years there has been a major breakthrough in the field of algorithmics. Until recently, it was believed that an algorithm must guide us from the input data to a specific result by applying procedures or constraints. Thus, the tendency was towards determinism, completely ignoring randomness, the positive aspect of which was also pointed out by Stanisław Lem in his writings.

"It can be presented using the metaphor of a drawer with socks," says Prof. Urszula Boryczka. "Imagine you have one black sock and want to find a matching second black sock in a drawer, among many socks of different colors. In the past, algorithmics would postulate an integer search that would give us a specific result: we would either find the second black sock of the pair, or we would come to the conclusion that there is no such match at all. Contemporary metaheuristic algorithms allow us to perform a rough search of the possible solutions, thanks to which we obtain a satisfactory one i.e. we conclude that we can choose a sock in color which is similar to black – after all, wearing two different socks is becoming increasingly fashionable."

What are the challenges algorithmics has to face? Prof. Boryczka has no doubt that the greatest of them is to create a mathematical model of human consciousness for the purpose of building artificial intelligence. There has already been some success in this field (IBM's Deep Blue computer winning over chess world champion Garry Kasparov in 1997 or DeepMind's AlphaGo program winning against professional players in the ancient Chinese game *go* in 2015 and 2016), but the way to mimicking the functioning of our brain, a phenomenon which has been looked at by algorithmics since at least the 1960s, is still very long. In order to attain this goal, a description of such elusive elements as intuition, self-awareness, or feelings influencing decision-making would be necessary. Systems that mimic honeybee behavior and are able find a consensus (Bee Colony Optimization, BCO) could be used for this purpose.

According to Prof. Urszula Boryczka, however, if we could create a full mathematical description of the decision-making process that takes place in our brains, we would be one step away from understanding the workings of the human mind. Deep Learning, which uses neural networks as well as machine learning algorithms, will give us a hint of the direction we should take in the future.

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Photo: Oleksiy Mark / Fotolia

ALL OUR ACTIVITIES LEAVE A DIGITAL FOOTPRINT

text: Agnieszka Niewdana

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Computers are omnipresent in our lives. They perform the necessary actions for us, capturing large amounts of information, which is now easy to obtain, process, and store. Information is recorded both by our computing devices by means of which it is saved on local data carriers (disks, flash drives) as well as in so-called computing clouds. Using computer systems and logging into the appropriate account and service allows us to perform personalized activities. We increasingly often use the option of saving our data "somewhere on the Internet."

However, due to personalized resources and cloud-based services, information about us, our resources, and our activities is meticulously recorded by software managing the access to cloud computing and all other online services. Each of our activities leaves a digital footprint e.g. when we use social networks, online stores, or financial services. It is worth remembering that we also leave such a trace when making purchases in physical stores and using payment or loyalty cards. Actually, we do not leave it only when we pay cash.

Notwithstanding the fact whether the digital footprint makes it possible to identify us or we remain anonymous, it contains information about our activity e.g. what, when, and for what amount we purchased, what financial transaction we carried out, what we searched for on the Internet, where and how we traveled, what photos we took (when and where as well). Traces of our activity recorded in computer systems are associated with a number of significant problems related to, among others, confidentiality of information about us. Unauthorized use of this information for e.g. criminal purposes is both possible and dangerous. Information recorded by IT systems can, however, be used in many ways that are beneficial to us.

Information recorded by the banking system over a certain period is not only a record of individual events, but also, in an implicit way, a reflection of the processes taking place in terms of the funds in our account. A detailed analysis of a larger number of events from a certain period may allow for the deduction of many, often surprising facts about real events in our lives. For example, the end of a steady monthly income flow from a certain account may indicate a potential job loss, but the simultaneous start of a flow of income at a higher level may simply indicate that we have a better paid job.

The analysis of anonymous purchases in a self-service store can reveal an abundance of information important to the store's owner. The contents of the shopping baskets can enable them, for example, to select groups of goods which are most often bought together. Their identification can be used for such an arrangement and display of goods that the most frequently purchased ones are located in the immediate proximity.

These examples show simple applications of the currently very important field of artificial intelligence, namely intelligent data analysis, also known as data science. The concept of extracting knowledge from data is not new; it is derived from the concept of machine learning. The first known and successfully applied methods in this field were developed in the second half of the last century. The best known algorithms are ID3, C4.5, C5.0 by Quinlan, AQ by Ryszard Michalski, a Pole living and researching in the USA. Machine learning algorithms are based on examples from which they are supposed to automatically learn something new. To *learn* means to create a description containing previously non-existing knowledge about regularities, relationships, and trends found when learning data. The concept of machine learning was intended to *teach* the machine how to solve a problem in a way other than using the algorithmic method. The results of the algorithm can be different; they usually take the form of decision trees or decision rules. In both cases, the results of the machine learning algorithm allow to make an attempt to classify new cases.

Machine learning actually allows us to discover knowledge about the problem being solved. By broadening and generalizing this concept, we come to the concept of data mining. The goal of data mining is to discover previously unknown, useful, and non-trivial knowledge implicitly stored in data. Due to the fact that obtaining data for exploration may require additional activities, e.g. purification and preparation, and the result of the exploration – assessment and verification, a wider process, including exploration as one of its elements – is referred to as knowledge discovery in data. Nowadays, the ability to acquire data sets which may contain hidden but relevant knowledge is relatively easy and widespread, and these data sets can be large in terms of volume.

The first and second decades of the 21st century were a time of great progress in the field of information technology. Computers have become faster, and their ability to store and process a wide variety of information is enormous. Every day we take pictures, have conversations via various communicators, send documents, or pay for purchases with a money card. We do not give any consideration to the question where this data is collected and how it can be used.

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INTELLIGENT SYSTEMS FOR ENHANCED DECISION-MAKING

They are interactive computer programs designed to collect, process, and analyze huge amounts of data necessary to point the way to the best solution. Based on the knowledge gained from experts in different fields, an intelligent expert system based on built-in inference algorithms which simulate human thinking processes its knowledge (accumulated in the system and obtained from a user who consults such a system) in order to obtain new knowledge, i.e. make a decision.

The expert system, as the name already suggests, is a type of tool or software that simulates an expert in a particular field. It is designed to support humans in decision-making and can even replace an expert in certain circumstances, if necessary. This is usually the case when the expertise is needed in many places at the same time or when access to an expert or specialist in a given field could be too expensive. There are many applications of such systems, they can be found in practically every area of life; in the form of simple assistance applications, operating on travel agency websites, in banks, or in medicine.

Expert systems are also used in so-called intelligent buildings. Systems implemented there are designed to ensure savings, safety, and a sense of comfort based on certain external, internal, and functional information of the building. They check the closing of gates, doors, or windows, manage lighting, power, heating equipment, air conditioning, and respond in case of fire. A human could perform all these tasks on a daily basis, but their automation definitely increases the comfort of life and allows to supply

Photo: Romolo Tavani / Fotolia

a greater number of persons with the same type of functionality.

The intelligence of expert systems is made possible by translating the knowledge of domain experts into the knowledge base of the system and implementing inference algorithms which simulate the human reasoning process. In such a process, on the basis of certain sentences called premises (conditions), the truthfulness of other sentences called conclusions (decisions) is recognized. In other words, the inference process, both in our case and in the case of machines, translates into if-then chains such as: "If CONDITION, then DECISION." Depending on the task assigned to the expert system, we can distinguish two types of inference algorithms: forward inference (data/facts driven) and backward inference (goal driven). The first one allows, on the basis of input data (observations/facts), to derive new knowledge from the system by activating rules with premises we consider true. The second types allows to confirm the truth of a certain hypothesis by confirming the truth of the premises defining that hypothesis.

A much more obvious application of artificial intelligence systems is recommendation systems. Recommendations are commands which result from the collection of vast amounts of data and from the repetition of certain outlines or purchasing patterns. A recommendation system allows, therefore, to match the proposed content to the user's taste.

It is also important not to forget about medical systems where expert systems are very important. They are used, for example, for medical imaging. A doctor, even if he or she is a specialist in a given field and has extensive experience, is not able to quickly analyze thousands of medical imaging photos and detect certain symptoms, e.g. cancer symptoms, in a short time – as quickly as a machine.

The sources of recommendation are machine learning algorithms which improve automatically through experience. The more representative data are gathered, the better the quality of knowledge provided to the system. Machine learning algorithms build a mathematical model from sample data to make predictions or decisions without direct human programming.

We are living in the time of big data. The term means a variety of data generated from different sources, at high speed, and in large quantity. Therefore, the word "big" refers not only to the quantity, but also to the variety and structure of data as well as to the relationship between them. Nowadays, big data is of key importance in all areas of the economy – from transport and logistics, through banks, medicine, telecommunications, to profiling the behavior of Internet users.

However, technological development must be followed by hardware progress that will allow to collect huge amounts of data. The cost of their maintenance is equally important, and another important factor is the issue of data management. Data warehouses or huge data repositories use special software, so-called data mining algorithms. They are used to explore and manage data as well as to extract useful knowledge from huge amounts of data.

The range of data mining algorithms to choose from is very wide. The best known of them are association rule algorithms (e.g., in online stores), which allow to create shopping patterns by finding associations between the products purchased by clients. Another important algorithm is the clustering (or cluster analysis) algorithm. It looks for similarities between the analyzed objects and divides them into groups in which the objects are as similar to each other as possible, and as different as possible from objects belonging to other groups. This algorithm makes it possible to perform a task in segments and works well, for example, when segmenting customers characterized by e.g. a similar shopping profile. Another noteworthy method of machine learning are artificial neural networks. These networks are analytical techniques based on the learning process in the cognitive system and the neurological functions of the brain. They are capable of predicting new observations on the basis of other observations following a learning process performed on existing data.

Assoc. Prof. Agnieszka Nowak-Brzezińska, Professor of the Faculty of Science and Technology at the University of Silesia, researches decision support systems, mainly knowledge mining algorithms. One of the tools she uses are cluster analysis algorithms. They are applied e.g. in the financial industry: in banking transactions or credit decision support as well as in the detection of fraud and suspicious operations. In medical systems, they are useful in searching for unusual disease symptoms.

text: Katarzyna Stołpiec

A SMART RESIDENCE

OR A SMART RESIDENT?

Remote lighting, a heating system, or a refrigerator providing information that we have run out of butter are just a few examples of smart technologies that are increasingly present in modern homes. Is the smart home, i.e. an apartment equipped with devices connected to the network and directed by smartphones, able to meet the expectations of users? And what is the next surprise being prepared for us by its creators?

Photo: Fotolia

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Smart technology, also known as intelligent technology, is increasingly used in various aspects of our lives. Instead of a traditional timetable at bus stops we come across boards informing us what time the next bus arrives. Parking barriers lifting automatically without the need for the driver to collect a ticket. Real-time information about traffic jams or monitoring systems recording images from almost all city streets and squares. All of this contributes to an increase of safety and comfort in our everyday lives.

The creators of new tablet and smartphone models as well as application developers introduce many innovations so that their solutions never go out of fashion and constantly remain attractive products for their owners. The never-ending flow of novelty leads to a constant hunger for new technology. We constantly want more, easier, faster, and more attractive solutions. Companies producing such devices are competing at high speeds to create increasingly interesting and fancy devices or technological innovations. "Smart" household appliances, washing machines enabling us to weigh the laundry and choose the optimal amount of water and, on top of that, run by Wi-Fi as well as heating or lighting controlled electronically. Some of them are very practical, others not so much...

One of the interesting gadgets we can equip our homes with is a closet which irons and folds clothes. Gal Rozov, an Israeli software engineer and founder of the company FoldiMate, spent two years working on a robot that would take over the chores of ironing and folding. In 2018, FoldiMate, together with the German company BSH Hausgeräte, presented a prototype of a device slightly larger in size than a washing machine which can fold t-shirts, blouses, sweatshirts without hoods, pants, dresses as well as blankets and towels. The owner is only responsible for washing and drying the laundry. The rest is done by the machine.

Another device that has enjoyed considerable and long-term popularity is the coffee maker. The latest coffee machines feature the option "create a drink playlist" thanks to which you can enjoy and serve your guests their favorite types of coffee. The intelligent coffee maker is able to heat cups, brew the beverages one by one (cups must be changed manually), send notifications about a possible lack of water, coffee beans, or milk, and reminds its owners to put the milk container in the fridge if it has been inside the machine for too long.

Warming drawers are becoming an increasingly popular kitchen appliance. Siemens offers its customers drawers which warm tableware before serving a meal. In these drawers plates with dishes or glasses containing drinks are kept at a temperature of 30°C to 80°C.

Around 2011, the company LG produced TVs with a so-called *magic remote* and a speech recognition module enabling the user to change channels using human speech. The device was very popular around the world, although in Poland it did not cause such enthusiasm – probably because the commands and orders initially had to be uttered in a foreign language. To meet the expectations of its customers, LG decided to implement artificial intelligence executing Polish commands. In addition to this ability, the AI adapts to the user's habits and not only responds to their style of uttering commands, but also analyzes their cinema tastes to accordingly select the repertoire. Natural Language Processing (NLP) is a novel technology which reacts to a person's individual way of speaking, including their pronunciation, talking pace, and tone of voice. As a result, clear pronunciation is not necessary, since the TV, thanks to the constant updates made possible by a permanent Internet connection, has adapted to its owner's speaking style. In order to send voice commands, the user has to press the button with the microphone icon on the remote and utter a command. Thanks to the DeepThinQ platform, the TV instantly adapts to the user. The microphone option on the remote limits the hardware's capabilities. Without microphone activation, the TV does not respond to spoken words, and residents' conversations are not recorded anywhere.

The company LG announced that in the near future, TVs with built-in AI will become the center for supervising home electronics. With the use of Wi-Fi or Bluetooth, it will be possible to even more conveniently control home theater speakers or a music device, automatic vacuum cleaners, or air conditioners.

However, the possibilities offered by Smart Home are not limited to individual appliances. Entire rooms, such as the bathroom, can be technologically integrated. Using a tablet PC, smartphone, or other Android or iOS device, the user can remotely fill the bathtub with water at the desired temperature. It also features a schedule that programs the bath for specific days and times. To make a relaxing bath even more enjoyable, the multiroom system allows the owner to play their favorite music in the room. At the same time, the light becomes dim, and the bath water is illuminated in the color of the user's choice. After pre-setting, the underfloor heating is activated so that the surface before the bathtub becomes warm. In addition, the underfloor heating dries the splashed floor, which significantly reduces the risk of slipping and falling. Such a bathroom, apparently subjected to technological innovations to the smallest details, is equipped with the necessary ecological equipment. The taps are equipped with water consumption meters, water-saving faucet aerators (fine mesh nets mounted on the ends of the tap, thanks to which the flowing water is aerated, and its consumption can be reduced by up to 60%), and flooding sensors.

Smart technology offers us a luxurious future, although modern construction, especially of single-family homes, is already equipped with many of these amenities. The pace of technological development is so dizzying that it is hard to imagine what else the future will surprise us with.

STUDYING MEMORY PROCESSES IN THE BRAIN

Let us imagine that we meet a person on the street who looks familiar. We feel as if we met before, but we cannot recall the details of this relationship. What is happening in the brain in such a moment? What are the differences in the cognitive process when we merely think we know someone and which differences are there when we actually meet our colleague, friend, or neighbor?

Although scientists have been trying to uncover all the secrets of our brain for years, we still know little about this part of our body. How we learn, how the process of remembering and forgetting occurs, how all life activities are controlled – these are examples of just a few fundamental issues.
Knowledge of the processes taking place in the body of a healthy person can provide inspiration to look for ways of treating people with various neurological disorders and inhibiting disease processes. Knowledge from the field of neuroscience is also sometimes applied in sciences related to artificial intelligence, primarily in so-called machine learning. Sales specialists are also eagerly interested in the results of this research. Various analysis methods are already in use, such as electrooculography and eye-tracking. Thanks to this method, we learn, for example, where most people focus their attention when browsing e.g. websites. This is where advertising materials are placed.

Every day we are attacked by billions of pieces of information per second. Only a small part of them is registered by our consciousness. Therefore, certain processes must take place in the brain that allow us to select data and process it in a very short time. Each of these processes is studied by various groups of scientists with different specializations.
Memory processes and studies making use of specialist methods of analyzing the brain's electrical activity are of particular interest. Dr. Karina Maciejewska, a physicist from the University of Silesia, completed a research internship at the UC Davis Center for Neuroscience in California (USA), during which she began collaborating in the Dynamic Memory Lab research group led by Prof. Charan Ranganath. The stay abroad was an opportunity, among others, to learn about specialized methods of analyzing cognitive signals of event-related potentials (ERPs) and conducting scientific experiments in the field of memory research in humans.

In her scientific work, Dr. Maciejewska primarily analyzes the basic electrical activities of the brain (EEG and ERPs) as well as other biological signals in healthy humans. The researcher's aim is to deepen knowledge about the electrical activity of the human brain in various cognitive states, such as language comprehension, sensory perception, decision-making, and remembering. Such studies provide a better understanding of how the brain works in states of normal function. As a result of this research. the knowledge of the psychophysiological activity of the central nervous system (CNS) and its response to external stimuli is deepened.
At the time of her internship, Dr. Karina Maciejewska started a cooperation with a group of researchers who used three main measurement techniques to study long-term memory processes. They analyze the brain's electrical activity, use magnetic resonance imaging to monitor which areas of the brain become activated during a given process, and finally conduct behavioral

Photo: Fotolia

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research, that is, invite a group of volunteers and, following a study scenario, measure certain parameters, such as reaction speed, number of correct and incorrect answers etc.

"I learned about the research projects at the University of California and the techniques used to analyze some selected processes. Directly after my return, I continued to study the brain's electrical function using electroencephalography (EEG) and event-related potential (ERP) analysis," the physicist says. "I invite volunteers to the study who put on a special cap with 32 electrodes on their head. They then perform various tasks, and the device monitors the electrical activity of the brain. This examination is obviously painless and does not affect human functioning."

Subsequently, the data thus obtained is interpreted. Depending on the command being executed, areas of the brain are identified where significant activity can be observed. This is not easy.

"Every human reaction will be noted, a blink of an eye, a momentary lack of concentration, thinking about something other than the task... What do we do when someone asks us not to think about anything for a moment? This is usually when the most distracting thoughts patterns appear. Bearing all this in mind, we must properly interpret the obtained results in order to find those impulses that are actually responsible for the brain's work related to our memory," the researcher explains.

Prof. Charan Ranganath's group studies primarily processes related to long-term memory which allows humans to retain memories, to remember events that happened both yesterday and several years ago. However, American scientists focus on two recognition processes. The first is the assessment of familiarity that activates long-term memory, the second is recollection which "browses" information available in memory and compares the data with what is perceived. Both processes occur simultaneously and are known to independently contribute to assessing familiarity of an object or information, however, they are supported by different areas of the brain. Because of this, scientists are looking for an answer to the question of how these processes support recognition, which consists in matching information with data already stored in our memory.

Let us return to the question posed at the very beginning, i.e. how it happens that sometimes the person we meet merely seems familiar to us, whereas we recognize other ones without any problems, give their names and characterize the given relationship. Researching memory processes is a complicated process. There are many as yet unproven hypotheses explaining this phenomenon, since studies are still being conducted.

It is worth knowing, however, that the mere fact that we pay attention to two processes of recognition is extremely important, as it allows – through the use of various research techniques – to check how brain activity changes in different situations, and this brings us one step closer to unveiling another mechanism of how this complex organ functions.

TARDIGRADES

SUPERHEROES AND SLEEPING BEAUTIES

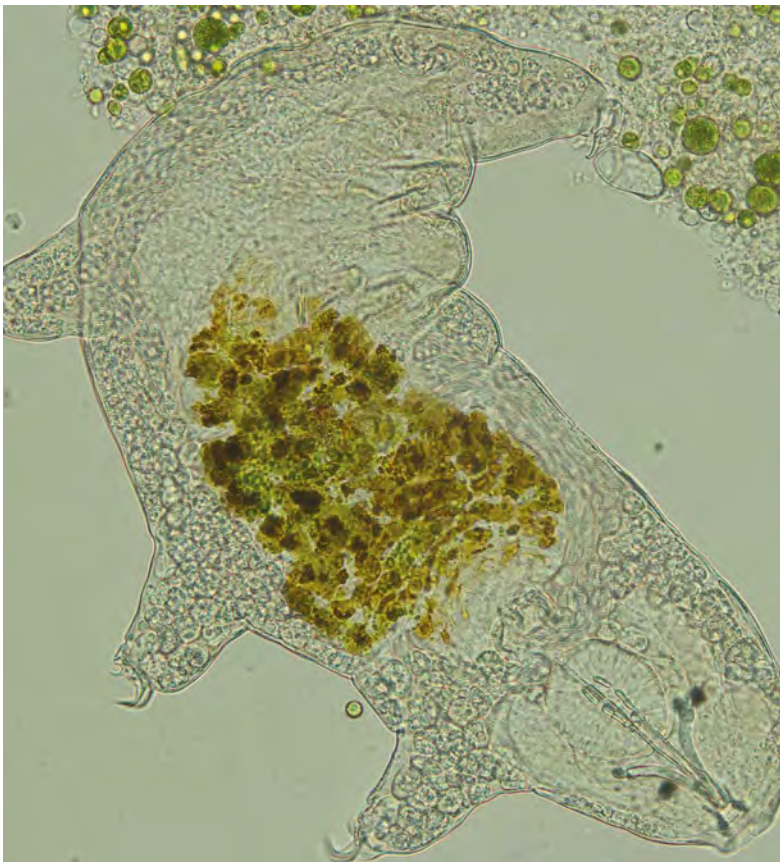
Tardigrades (popularly known as water bears or moss piglets) are often referred to as indestructible animals that can withstand very high and extremely low temperatures, prolonged droughts, and even exposure to cosmic radiation. What is behind this remarkable resistance, and is there really nothing that could harm them?

Photo: iStock

***Paramacrobiotus experimentalis* female immediately before laying eggs**
Photo: Assoc. Prof. Izabela Poprawa

"The fact that tardigrades are frequently referred to as water bears is probably due to their body shape and their way of movement. When they move around, they are quite clumsy and evoke some feeling of sympathy," says Dr. Izabela Poprawa from the Faculty of Natural Sciences at the University of Silesia, who has been studying these unusual invertebrates for years.

Tardigrades are the subject of intense scientific inquiries. Their body structure and extraordinary ability to survive in the most difficult, extreme conditions arouse great interest.



Herbivore tardigrade *Dactylobiotus dispar* on the prowl
Photo: Assoc. Prof. Izabela Poprawa

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EVERY SUPERHERO HAS WEAKNESSES

It is true that tardigrades survive excellently in extreme environmental conditions. They can overcome temperatures close to absolute zero, i.e. on the order of -270°C, as well as those as high as 150°C. They managed to survive a journey into space. Although they prefer humid environments, such as moss-covered habitats, we can find them in subpolar areas as well as in a nearby sandbox or home garden. Can we perceive them with naked eyes? The largest specimens are about 1.2 mm long, but there are not many of them. The vast majority of tardigrade species are only about 0.5 mm long.

Active animals are exposed to the same dangers as other organisms on Earth, and there are no exceptions. However, when something disturbing is happening, the body of tardigrades goes into a state of cryptobiosis, i.e. latent life. Depending on the conditions, it can be e.g. a state of anhydrobiosis caused by too little water, cryobiosis – due to too low a temperature in the environment, osmobiosis – due to a change in salinity, or anoxybiosis occurring as a result of insufficient oxygen levels.

In the state of anhydrobiosis, metabolic processes are so low that they are practically difficult to detect. In addition, as a result of dehydration, tardigrades form a so-called tun. Because their body constricts, the evaporation surface is reduced, and excess water is removed from the body etc. All this is done in order to survive.

We do not know how many years they can survive in this state, so far documented experimental research has shown that at least... thirty. And here we come to another paradox. Tardigrades are like sleeping beauties. Studies have shown that their bodies do not age during their state of cryptobiosis. In practical terms, this means that if a forty-year-old person fell into such a state and woke up, say, a hundred years later, their body would still be forty years old. Therefore, it is not surprising that scientists want to know the secrets of tardigrades.

Although they are able to manage extreme conditions, recent studies show that tardigrades can be harmed by the effects of... global warming.

"In a state of cryptobiosis, they can survive in a really challenging environment, but may not in time acclimatize to the slightly higher temperatures which have increasingly become the norm today. It is worth mentioning that this study was conducted on only one species of tardigrades, which should of course be taken into consideration, but the results should – and do – give us food for thought," the biologist says.

AND WHAT IF A HUMAN BEING GAINED THE POWER OF A TARDIGRADE?

Tardigrades were first sent into space in 2007 – in a state of anhydrobiosis. Most of them woke up after their return, but among the four traveling species, *Milnesium tardigradum* turned out to be the greatest superhero. After being rehydrated, they recommenced all basic life functions, including reproduction.

The remarkable abilities of these small organisms fire the imagination of people. What if we traveled to Mars, for example, in a state of cryptobiosis, without experiencing the negative effects of a long journey, without aging? As of today, such considerations are obviously mere fantasy, but since there are organisms on Earth that have certain capabilities, it means that some potentially interesting solutions are not alien to nature.

Of course, there is still a long way to go to discover all the secrets of tardigrades. Scientists discovered several proteins and other substances responsible e.g. for protecting the DNA of these invertebrates from damage caused by various extreme conditions or for influencing the process of water crystallization in the body, which is of particular importance in the state of cryobiosis, since due to the change in its state of aggregation, water could tear the cells of their tiny bodies apart.

Research shows that the range of solutions is huge and specific to a given species. A better or worse adaptation to difficult conditions is also influenced by the stage of development of the given individual. This topic is one of the main scientific interests of Prof. Izabela Poprawa. The analyses are conducted in cooperation with a team of scientists from the Adam Mickiewicz University in Poznań. Researchers study e.g. at which stage of development the survival rate in the state of anhydrobiosis in certain species of tardigrades is the highest. This is experimental research. First, selected specimens are dried, then watered and observed, and all relevant parameters are recorded. In the next stage, genetic tests are planned.

"My main interests also concern the reproductive system of tardigrades, which is of great importance in taxonomy and phylogenesis," says Prof. Izabela Poprawa.

Tardigrades are positioned between arthropods and *Onychophora*. Therefore, our researcher looks for features to better understand their classification. Modern tools support scientists on this quest. Thanks to advanced technologies, it is possible to reconstruct a three-dimensional image of various elements of the reproductive system and then compare it with reconstructed parts of the organisms of the two sister types we are interested in. These results have made a great impression in the scientific world and bring us closer to a better understanding of invertebrates.

The amount of literature exploring the phenomenon of Stanisław Lem's work surpasses the literary legacy of the author of *Solaris*, which includes not only novels, short stories, and essays, but also articles, reviews of non-existent books, interviews, columns...

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