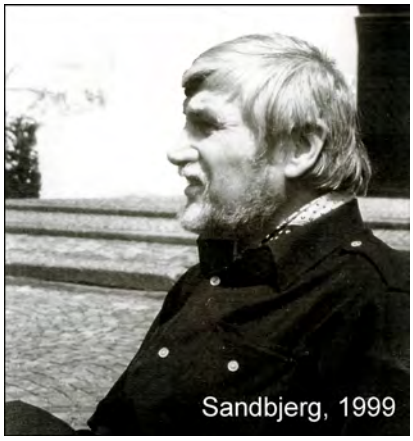
HISTORICAL METALLURGY

The Journal of the Historical Metallurgy Society
Volume 49 Part 1 for 2015

Radomír Pleiner

1929 – 2015

A celebration of his life and work



Radomír Pleiner's death in January 2015 marked the end of an era. For sixty years he was one of the key figures in the study of early iron working, as demonstrated by his remarkable publication record of 12 books and over 250 papers (Cleere 2011). He initially trained as an archaeologist and it was his teacher Professor Jan Filip, the renowned Celtic scholar and editor of *Archeologické rozhledy*, who suggested that he should carry out research into early ironworking. By his early thirties Radomír had been awarded his first doctorate, had published his first three Czech monographs, in 1955, 1958 and 1962, had written over 30 papers and had established the metallography laboratory at the Institute of Archaeology in Prague. For many people this would have been a satisfactory career, but for Radomír it was only the beginning.

At the suggestion of Jan Filip, in 1966, the *Comité Pour la Sidérurgie Ancienne* (CPSA) was founded, under the auspices of the International Union of Prehistoric and Protohistoric Sciences (UISPP), with Professor Walter U Guyan as President and Pleiner as Secretary. Radomír remained the secretary for nearly forty years, creating an international and inter-disciplinary network of scholars and institutions engaged in the study of the archaeology and the archaeometallurgy of iron, who became corresponding members of the CPSA.

During this period he played a vital role in the rapid development of the discipline by collating new research, abstracts of publications, information on work in progress and summaries of conferences. This was all published as the CPSA *Communications*, printed twice-yearly in *Archeologické rozhledy* and circulated as offprints to members. The total of 67 issues of the *Communications* comprised several thousand items, forming a crucial source of information in the pre-internet age. Key factors in this were Radomír's linguistic skills, enabling him to act as a bridge between the (old) east and the west, combined with his enormous energy. The contacts which he made and encouraged through this work, and through his presence at many conferences all over Europe, resulted in him establishing close relations and friendships with a great many of the people involved in the study of early ironworking and he became a guiding light for several generations of scholars.

An obituary was printed in the Spring 2015 issue of *The Crucible*, outlining his career and achievements, but it was decided that a longer, and less formal, celebration of his life and work should also be prepared. Sadly, some of his contemporaries, who could have given more personal accounts of his early years, are no longer with us. Even in the past few years several other of the founder and senior members of the CPSA have died, including Olfert Voss, Kazimierz Bielenin and Ingo Keesmann. The tributes which follow include a number of personal reminiscences from the golden years of Radomír's career, which are in roughly chronological order, as well as a few thematic items. They are all a clear demonstration of the affection in which Radomír was held, of how widely his inspiration and influence were felt by his friends and colleagues and how they are still felt by succeeding generations.

His lasting legacy will undoubtedly be his two magisterial books, *Iron in Archaeology: The European Bloomery Smelters* (2000) and *Iron in Archaeology: Early European Blacksmiths* (2006) which formed a fitting conclusion to his long and uniquely successful career. However, for those who had the privilege of knowing and working with Radomír it will be for his human qualities that he will be long remembered. As one of the contributors to this Celebration pointed out, his parting gift to us all was to enable the renewal of contact between old friends and for us to join together in paying homage to a great man.

Peter Crew and Jiří Hošek

A story of a friendship – Pleiner and Bielenin

Recently, whilst preparing an article for the memorial book to celebrate the 90th birthday anniversary of the late Professor Kazimierz Bielenin (Karbowniczek *et al* 2014), I had the opportunity to browse through his collection of notes and documents kept in the archives of the Archaeological Museum in Kraków. Among the foreign correspondence I came across numerous letters from Professor Radomír Pleiner. Having read just a few, I realized that the two men had been true friends who felt profound respect and appreciation for each other, as well as their scientific achievements.

The beginning of their acquaintance dated back to the end of the 1950s. They both were already regarded as renowned specialists in the field of ancient metallurgy, though Radomír had started his adventure with archaeometallurgy a few years earlier. After publishing his book in 1958 *Základy slovanského železářského hutnictví v českých zemích*, he was considered an expert on the subject in professional circles. Kazimierz had also been carrying out field research for some years, and he had just started to publish the results. Information coming from Poland concerning the unprecedented discovery of an enormous iron-smelting centre in the Świętokrzyskie (Holy Cross) Mountains was of much interest to a young scientist from Prague, so it was no great wonder that the two passionate professionals soon met.

Already in 1959, Radomír had participated in the excavations of one of the bloomery ironworks at Podchełmie, site 1. The cooperation which then started appeared so attractive and productive for both sides, that an agreement about mutual Polish-Czechoslovak experimental research on smelting processes in bloomery furnaces was signed in Kraków in the same year. The project was realised in the years 1960–64, first in Poland at the Academy of Mining and Engineering in Kraków, then at Nowa Słupia, and later at Březno in Czechoslovakia (Radwan and Pleiner 1963; Pleiner 1969).

One of the first successful bloomery experiments at Kraków in 1960. Kazimierz Bielenin and Radomír Pleiner.

General view of the Czech-Polish experiments at Březno in 1964. In the centre of the group are Radomír Pleiner, Elżbieta Nosek, Mieczysław Radwan and Kazimierz Bielenin. Furnaces of several different types were tested: the Želechovice type are built into the bank, with the free-standing Scharmbeck type at the rear.

Březno 1964. Radomír with the Scharmbeck furnace.

The partnership exchange of experience and sharing the same passion drew the two researchers close together, thus creating a solid base for their long-lasting friendship. They frequently proved it by supporting and helping each other. It is worth remembering, that both of them came from behind the so called 'Iron Curtain', which brought them even closer together. They possessed the same sensitivity and systems of values,

while their professional activities encountered similar difficulties and problems resulting from the restrictions of the regime. Scientific work in the conditions of real socialism was quite a challenge; nevertheless both men passed that test with flying colours.

Radomír had a specific attitude towards Poland and Poles, resulting not only from the friendships he had established, but partly also from his family past. After Czechoslovakia had been annexed by Germany, in March 1939, his father Vladimír made his way to Poland and, with other refugees, joined the famous Czech-Slovakian legion fighting on the Polish side during World War II.

2005 was the 50th anniversary of the research into the ancient iron working in the Holy Cross Mountains. This was celebrated both by a conference at Kielce and by exhibitions at Kielce and at the Archaeological Museum in Kraków. On this occasion both Bielenin and Pleiner were presented with the Knight's Cross of Merit, for their co-operation with the Polish Republic and their contribution to European science. In addition, a bronze commemorative medal, designed by Bielenin, was cast and presented to people who had contributed to the project, including Radomír of course (Bielenin and Suliga 2007).

Polish archaeologists will always remember a great scientist, a devoted friend and mentor, whose considerable scientific authority greatly benefitted our professional environment.

Szymon Orzechowski

Radomír Pleiner in Poland

I first met Radomír in 1961 during an experimental iron smelting in the Holy Cross Mountains, which took place in Nowa Słupia, next to the original smelting place discovered by Kazimierz Bielenin. Apart from Pleiner and myself (a beginner disciple of ancient metallurgy), Professor Mieczysław Radwan and Kazimierz Bielenin also participated in this smelting. At that time, Radomír was already a widely known archaeologist whose books and publications on ancient smelting and blacksmithing techniques had inspired many archaeologists, metallurgists and chemists to research on iron objects and slag.

Already at the beginning of our acquaintance, Radomír proved to be an extremely nice and friendly colleague, in spite of his fame. This is illustrated by an event after the completion of the smelting. We set out into the region of Łysa Góra in order to search for heaps of slag

The 2005 Kraków exhibition. Radomír and Kazimierz looking at the photographs from their 1960s experiments.

and possible smelting sites. Suddenly, while descending from the slope of the mountain I sprained my ankle, which rendered further search impossible. We were far away from the road and the situation grew complicated. Without much hesitation, Radomír took me in his arms and carried me until we met a local inhabitant. We completed our journey on a cart pulled by two chestnut horses.

Before my departure to Nowa Słupia I did not expect that this first experimental smelting would become the beginning of my many years of friendship with Radomír Pleiner and Kazimierz Bielenin.

In 1964, Rado invited us to Březno, where excavations had been carried out with his wife Ivana, as part of the Czech-Polish experiments. The programme of experiments also included an everyday morning bath in an ice-cold river – of course, to improve our health.

After the foundation of the CPSA, Kazimierz and I were meeting more often during the symposia and conferenc-

The experiments at Nova Slupia, 1961. From the right: Radwan, Bielenin, Nosek, Pleiner.

es held under the patronage of the Comité. Radomír had a special talent for organisation, and these meetings, held in various countries, were an excellent opportunity to exchange experiences and learn new research methods. Both Kazimierz and I regarded the participants in these meetings as members of a large family of enthusiasts of ancient metallurgy. Sessions, excursions and informal meetings also offered an opportunity to consolidate our friendship. It also sometimes happened that we had an opportunity to listen to Radomír's beautiful singing and guitar playing, as well as to watch Kazimierz's magical trick of eating fire.

Radomír was always very benevolent and helpful to younger colleagues. A significant detail comes to mind. In Poland, a Congress on History of Science and Technology was held in 1962 and part of proceedings took place in Kraków. In my home Radomír organised an informal meeting with Professors C S Smith, R Tylecote and T Wertime. I felt extremely moved at that time as these guests were excellent scholars of international reputation and it was only a few years since I had begun to study ancient metallurgy. Until this day I keep in the Museum a gift from Professor Smith – a Japanese picture scroll, showing the history of origin of the samurai sword.

I will always remember Radomír as an excellent and extremely talented scholar. He was a direct and nice man, benevolent and friendly, and gifted with a great sense of humour.

Elżbieta Nosek

Radomír in Russia, with Boris Kolchin

Radomír Pleiner paid great attention to the experimental modelling of the bloomery process. He emphasized that our knowledge of early metallurgy should be based not only on the results of archaeological excavations, chemical, mineralogical and metallographic analyses of slag and iron objects, but also on the data obtained in the course of experiments (Pleiner 2000, 132). He participated actively in programmes of experimental smelting realized in the Czech Republic, Poland, Great Britain, Austria, France, Sweden and Norway. In 1962 Pleiner visited Russia and observed the important iron smelting experiments carried out by Professor Boris A Kolchin in Novgorod (Radwan and Pleiner 1963).

In the spring of 2004 I first visited Prague. It seemed impossible for me to be there and not to take the opportunity to meet Radomír Pleiner, whose publications I had read during my student years. By that time I had heard a lot about Radomír from my teacher Boris Kolchin. At that time, Radomír was just completing his fundamental research work *Iron in Archaeology: Early European Blacksmiths*. We talked about the problems of archaeometallurgy and recalled Kolchin, who would by then have been 90 years old.

Radomír Pleiner with Boris Kolchin during the experiments at Novgorod in 1962. Photo: Archive of the Institute of Archaeology RAS Moscow.

Radomír introduced me to his disciple and colleague dr Jiří Hošek and since then we have been continuing our scientific co-operation. This has resulted in the accomplishment of several joint research projects. To some extent these projects developed certain problems relating to the history of iron metallurgy first raised by Radomír.

In late 1970s Radomír published a review of research works devoted to the history and geographical spread of pattern-welded knives (Pleiner 1979). In the joint work with Jiří Hošek we have summed up the results of investigation of pattern-welded knives discovered in the territory of Medieval Rus' and what is now the Czech Republic, during the last four decades. The analysis has brought us to the conclusion that pattern-welded knives discovered in the territory of the Czech Republic are probably the result of local production, while isolated items of this kind from the medieval Russian sites confirm their foreign origin (Hošek and Zavyalov 2014).

Guided by the ideas of Pleiner and Kolchin on the experimental modelling the bloomery process, I have undertaken a continuation of research in this field. I considered it most important to choose the raw materials available to medieval iron workers and to investigate the sites with well-preserved remains of iron production (Zavyalov and Ratkin, 2009). As a result, three ore fields exploited by medieval iron workers have been identified in the territory of the Ryazan Region.

With special satisfaction I recall the attention paid by Radomír to the scientific works by Kolchin and his disciples. Of help in this respect was his good knowledge of Russian, which allowed Radomír to get acquainted with works published in Russia, Ukraine and Belarus, and to inform the international scientific community about them.

I express my confidence that all professionals involved with Radomír Pleiner will retain a good memory about him and for a long time will refer to his scientific heritage.

Vladimir Zavyalov

Magister ferrariarum

Radomír Pleiner was a *rara avis* in the early 1960s when we first met. In those days I was working as an editor at the Iron and Steel Institute in London, but I had already become deeply interested in archaeology and had begun studying the subject in my spare time at the London University Institute of Archaeology (now part of University College London). At the suggestion of the then Director of the Institute, Professor W F (Peter) Grimes, I decided to look in depth at the iron industry of protohistoric and Roman Britain. However, I found the literature on early ironmaking was very sparse and much of it of somewhat dubious quality, so I consulted the late Ronnie Tylecote at Newcastle University. He told me that I should read the work of an archaeologist named Pleiner at the Archaeological Institute in Prague, one of the very few archaeologists working in this neglected field.

When I represented the Iron and Steel Institute at a conference organized by the UN Industrial Development Organization in Prague in 1963 I took the opportunity to seek out Radomír, who invited me to his remarkable office/laboratory in the Letenská basement. Our first expedition together was to look at slag that had been discovered during roadworks in a small Bohemian town, and from there we went on to visit his wife's important excavations at Březno. This marked the beginning of a fruitful collaboration and a friendship that lasted up until his death.

We next met in Prague at the 7th Congress of the International Union of Prehistoric and Protohistoric Sciences (UISPP) in 1966, which saw the birth of the *Comité Pour la Sidérurgie Ancienne* (CPSA). The impetus stemmed from Rado, whose energetic and inspiring secretaryship of this remarkable international group ever since its creation made an immense contribution to our understanding of this hitherto neglected field of research and fieldwork, once relegated to a secondary role and largely the province of professional metallurgists and local archaeological amateurs. Its birth was celebrated in great style by a party at the apartment of Radomír and Ivana, which brought together veterans such as Kazimierz Bielenin, Elżbieta Nosek, and Ronnie and Liz Tylecote. At this delightful occasion the new Committee launched what became a tradition – that of singing songs from many countries (often to the accompaniment of Rado's guitar), as well as appreciating the cuisine and drinks of the host country. One of my most vivid memories of these of these meetings concerns that which took place in Northern Ireland, ably organized by Brian Scott, despite the fact that this region is noteworthy for its lack of evidence of early ironmaking. An excursion to visit a famous whiskey distillery resulted in a prolonged impromptu concert for the benefit of our hosts.

But I have many other, more serious memories of Rado. It would be no exaggeration to assert that the study of ancient ironmaking owes the high level of esteem that it commands in the academic world of archaeology at the present time to Radomír Pleiner and to the profound influence that he exerted by example and by his generous encouragement of all those working in this field, the growth of which owes so much to his example. His research and the dissemination of the results of that research was exemplary, and he inspired many young archaeologists to enlarge and refine our knowledge of the making and working of iron in antiquity and to demonstrate its immense significance in the development of human societies. At the same time he was the most generous of scholars, willing to share his ideas and his results with colleagues and students alike. And, most of all, he was the warmest, most welcoming, steadfast, and entertaining friend and teacher. It was a conceit of his for many years to complain lugubriously and sonorously that 'I am an old man' – often described by his family and friends as proof of his Russian genes. This was, of course, nonsense: even in his eighties he remained as young in heart and mind as ever.

Henry Cleere

Pleiner in the Middle East

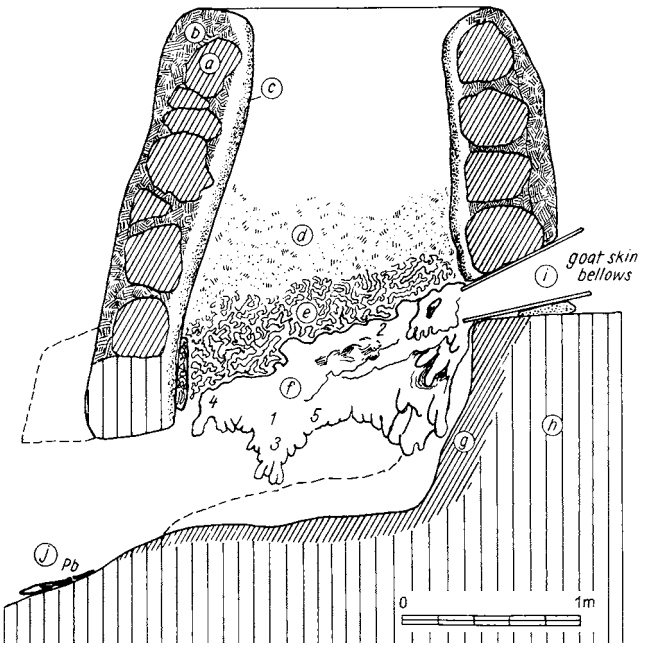
Radomír Pleiner is normally associated with iron and steel, with blacksmithing and bloomery furnaces, mostly across Europe. Reading the contributions in this Celebration reinforces this impression, but also paints a picture of a man of many talents, including a liking for travel and being good company. Already internationally recognised by his mid-30s, it is no surprise that he was invited by Joseph Caldwell to join his 1966 expedition to Iran, organised by the Illinois State Museum and funded by the National Science Foundation, which had the primary aim of carrying out excavations at Tal-i-Iblis.

The archaeometallurgical team, Cyril Stanley Smith, Theodore Wertime, Radomír Pleiner and Gholam-Hossein Vossouqzadeh, carried out a wide but rapid survey covering 'The Great Persian Desert', with a focus on ancient mining and smelting sites in Iran (Smith *et al* 1967). They then joined the main team at the excavations at Tal-i-Iblis, where some experimental work was carried out. This included two lead smelts, partly to test the interesting hypothesis that the smelting of lead ore, with a flux of iron ore, might have resulted in the discovery of iron in that region (Wertime 1968). Pleiner produced a detailed and well-illustrated report on the survey and the experiments, with some analytical work, but it was unfortunately never fully published (Pleiner 1967).

Pleiner was invited back for a second and much longer expedition in 1968, organised by Theodore Wertime, a US diplomat-turned-archaeotechnologist. This survey, in search of the beginnings of metallurgy, was funded by the Smithsonian Institution and the National Geographic Society in the USA and covered Afghanistan, Iran and Turkey. Wertime had invited a host of experts from a range of different disciplines to accompany him. The final team included several well-known scholars, such as Robert Brill from Corning, NY, interested in ancient glass, glazes and metals; Fred Matson, a ceramicist from Philadelphia, PA; Ezat Neghahban, an eminent Iranian archaeologist; and three archaeometallurgists, Radomír Pleiner from Prague; Beno Rothenberg from Tel Aviv, and Ronald Tylecote from Newcastle-upon-Tyne (Arab and Rehren 2004).

It is interesting to reflect on how very small the field of archaeometallurgy was at the time. During the early 1960s very few scholars specialised in early metallurgy and Pleiner was one of the leading figures. Since then the field has expanded beyond recognition. Where previously there had been only a handful of individuals, trained in a variety of disciplines from which they found their way to archaeometallurgy, there are now a large number of universities teaching the subject at post-graduate level, with many doctoral students working on a wide range of topics before taking up long-term positions in universities, museums and even private practice.

Tal-i-Iblis, southern Iran, 1966. Pleiner (standing) and Cyril Smith measuring the temperatures in an experimental lead-smelting furnace. From Wertime 1968, fig 10.



Pleiner's drawing of the sectioned lead smelting furnace at Tal-i-Iblis. a) dry bricks b) clay, sand and straw c) sand and clay lining d) charge of lead and iron ores e) slag f) lead slag, iron oxide and lead conglomerate g) burnt loess h) loess i) zinc sheet tuyere j) lead. Pleiner 1967, fig 12; reproduced in Wertime 1968.

What we are seeing here is the birth of a discipline. There were early short-lived starts in the inter-war period of the 20th century, but there were too few scholars to even get in touch and exchange ideas and experience.

Much of this early work was idiosyncratic and led to little if any accumulation of experience. Only with the emergence in the 1960s of a sufficiently large number of people active in this field did it reach a critical mass, further helped by improvements in communication and international travel. Clusters of activity formed: the central and eastern European teams who feature so strongly in these pages; the small but influential double star of Professors Ko (Beijing) and Maddin (Philadelphia), founders of the BUMA conference series designed as a circum-Pacific gathering; Cyril Smith at MIT in Boston MA, Beno Rothenberg in Tel Aviv and London, and Ronald Tylecote in Newcastle, all singular individuals in their own right; the German 'slag men', Bachmann, Keesmann, and Hauptmann to mention just a few.

Of these clusters the east-central European group was probably the one which best managed to integrate experimental and analytical metallurgy into their archaeological research agendas. It owes much of its cohesion and impact to Radomír Pleiner's tireless efforts and human qualities, as a visionary and prolific scholar and as a generous mentor and friend. Among the towering figures of the time, he is one of the few to have regularly bridged the gaps between these clusters, as for instance through his participation in the Middle Eastern expeditions, but also through his extensive travels elsewhere.

Not constrained even by the Iron Curtain, which bisected much of Europe's academic development during most of his active career, and boosted by his language skills, Pleiner also provided a true community service with his CPSA network and the *Communications*. It is unfortunate that the academic structure of the time did not allow him to become the centre of a school, thus building up a following of students who would spread the word. But it is testament to his personality that he managed to pass on his enthusiasm and knowledge in the way he did. There is now a generation of scholars which has been raised reading his early papers and magisterial text books, a generation which has been inspired to continue the work for which Radomír Pleiner laid such a solid foundation.

Thilo Rehren

With Thomsen at Varde, Denmark

In the spring of 1968 Radomír Pleiner managed to make a trip to Denmark and northern Germany to take part in the conference at Schleswig on the 18th and 19th of April. The conference was organized by Dr Kurt Schietzel, the director of the excavations at Haithabu, and was also attended by Robert Thomsen, an engineer from Varde in Denmark. During the 1960s Thomsen had already made several experiments in iron production, many of them in collaboration with the Danish archaeologist Olfert Voss. From 1968 Pleiner became a much appreciated part of the discussions within Danish iron research.

Varde experiments 1968. From the left: Schietzel, Pleiner, Thomsen and Tylecote. Photo from a local newspaper, from the Robert Thomsen archive at Varde Museum.

The first conference of the CPSA at Schaffhausen in 1970. 2 Guyan, 3 Bielenin, 4 Thomsen, 5 Voss, 6 Tylecote, 9 Bauhoff, 10 Pleiner, 11 Osann, 12 Inga Serning. Photo from the Robert Thomsen archive at Varde Museum.

It was Thomsen's first academic conference and he was impressed. He described Pleiner, Tylecote and Schietzel like this: 'Here they sat, a bunch of Iron Age geeks, who talked about ancient Persians, while I, who rarely read literature of higher scientific degree of difficulty than the Engineer's weekly paper, only with great difficulty was able to maintain a fairly gifted facial expression' (Lyngstrøm 2014; 2015).

Two days later the scene was set at the steel works in Thomsen's home town where workers had built four furnaces in which iron was to be extracted from local bog iron ore. The local newspaper was able to report that 'archaeologists from Czechoslovakia, Germany, England and Denmark had been able to make iron using an old Iron Age recipe'. At the same time Bernhard Osann

wrote to Thomsen as he was very concerned about his experimental work and wanted to help him. However, Thomsen could reassure him that the latest experiments had been supervised by 'die Prominenz der Eisengeschichtsforschung': Pleiner, Tylecote and Schietzel.

In 1970 Pleiner and Thomsen met again, this time at the Stadt Schaffhausen Museum zu Allerheiligen in Switzerland. The director of the museum, Professor W U Guyan, had invited Thomsen to attend a meeting of the CPSA. Thomsen wrote: 'I do not know if the *Comité pour la Sidérurgie Ancienne* UISPP was already established at this time, or whether it was precisely the foundation that took place in Schaffhausen, but I was warmly greeted by 12 to 15 people from 11 different countries. I knew some of them already; others were quite unknown to me. All the participants gave lectures and we spent three lovely days in Schaffhausen'.

It was on that occasion Thomsen gave a lecture with the title 'Remelting of iron in a forge' (Thomsen 1973). He proposed an alternative technique for refining iron, drawing attention to Ole Evenstad's (1782) description of re-melting iron and to the quotation from Aristotle, mentioned in Pleiner's *Iron working in ancient Greece* (1969). At that time, this was a revolutionary idea, but being both a blacksmith and an engineer Thomsen was able to transform the theory into practice. He managed to refine 2.5kg of iron into 1.5kg 'fine iron', comparable to that from the Iron Age, and produced refining slags similar to those from Haithabu and from Denmark. However, it was to be many years before other ironworking scholars began to fully appreciate the importance of Thomsen's work (Wagner 1990).

Pleiner and Thomsen met again at the conference in 1987 at Liblice near Prague. Here, to Thomsen's great surprise, Pleiner greeted him with kisses on both cheeks. Thomsen, as he wrote in his diary, would have preferred kisses from Pleiner's wife, whom he found extremely attractive, comparing her beauty to the Greek actress and singer Melina Mercouri. It was not until 1999 that Pleiner, without his wife, visited Denmark again for the Sandbjerg conference, but by that time Thomsen was dead.

Henriette Lyngstrøm

Rado behind the iron curtain

In 1970, as a new post-graduate student embarking on a PhD, I went to Prague to meet Radomír Pleiner, one of the top scholars in my chosen research field of early ironworking in Ireland. In those days, not long after the Soviet invasion, Czechoslovakia was a somewhat strange and forbidding place and following the less-than-friendly reception at the German border, I did wonder if the journey was a mistake. But the warmth of the greeting at the Archaeological Institute in Letenská dispelled that notion, and over the first of several meals at which Radomír introduced me to the excellence of Czech cooking and Czech beer, he also in a very short space of time helped me to see a clear and coherent research path.

Over the next few years, while I was working for my PhD, he was a most important mentor and friend. Along with others in Ireland, he encouraged me to explore the Irish literary and linguistic evidence which eventually formed a significant part of *Early Irish Ironworking* (1991). I became a member of the CPSA and found myself in the company not only of its Secretary, but also scholars including Kazimierz Bielenin, Henry Cleere, Elżbieta Nosek, Jerzy Piaskowski and Ronnie Tylecote. It was the induction into this group, and the encouragement and assistance freely offered, that shaped the course of my research over 20 years.

I have happy memories of the CPSA conferences, especially those in 1987 at Liblice and in 1989 at Ameliówka, near Kielce in the Holy Cross mountains, at the very end of the communist era. After the conference, in late October, I returned to Prague with Rado when the first 'escapees' from the former DDR were taking sanctuary in the BRD embassy there. The city was tense with a feeling that change was in the air and I remember standing with Rado in front of the National Museum, looking down over a grey and misty Wenceslas Square. The opinion then was that there might be some political relaxation, maybe in five years, maybe in ten. I left Prague on the 2nd November and by the 20th November communist Czechoslovakia effectively was no more.

Experiment with an Irish bowl furnace, Dundrum Co Down, 1990. Susan Crew, Radomír, Scott, Barry Hartwell.

The following year I had the pleasure of inviting Rado, along with the Crews, to take part in a field course in Dundrum, Co Down, which I taught with Barry Hartwell for the Queen's University Department of Archaeology. Rado as a teacher with the students was splendid, and there were a couple of very convivial evenings. Rado as a raconteur and singer of many songs in different languages – of which he was more than proficient in many – was an utterly delightful companion. As with anything in which Rado was involved, these were lively events in which one had great fun learning!

Also in 1990, I took early retirement from the Ulster Museum and spent much of the next eight years in Prague. This gave me the opportunity to work closely with Rado and I had the privilege of assisting him first with his book *The Celtic Sword* (1993) and then with his magisterial *Iron in Archaeology* (2000).

Unfortunately, after I moved to work in the US in 1999, I lost touch with Rado – much to my regret. But I treasure memories of many happy hours in his company. He was one of those characters whom one meets very rarely in a lifetime – scholarly, entirely generous with his knowledge and assistance and great fun to be around. His many contributions to the study of iron technology will be a source of inestimable value for a very long time to come.

Brian G Scott

The story of a medieval furnace

I met Radomír for the first time in 1974 on the committee for the excavation of a medieval bloomery at Olomučany, in the central part of the Moravian Karst. Since then he became my mentor and friend, lent me unavailable books, watched over my archaeological research and shared his experience. He was never annoyed and always supported me. It is about one of the furnaces from Olomučany which I should like to write and its connections with Radomír (Souchopová 1978).

I would like to remember one sunny autumn day in 1977. Radomír arrived at Olomučany, near Blansko, to see the completion of the excavation of one of the early medieval bloomeries. At lunch in the local pub we discussed the next experimental smelt and we decided to determine the most suitable furnace for it. Then we went to the excavation and we decided almost immediately – the best was the well preserved embanked shaft furnace, which you can see on the photo. We measured in detail its internal space and used it as the model for the experimental furnace.

Olomučany 1977. Pleiner bottom left, at the furnace; Souchopová top right. The others are the museum staff from Blansko, who were at the excavation on that day.

Then we sat down at the campfire, eating and drinking wine and imagining what this bloomery looked like at the end of the 9th century and what the medieval iron workers at such times would have talked about. As it gradually became dark the distant events became real…

This furnace was subsequently lifted from the ground and installed in the museum at Blansko. It became the model used for experimental smelts over the next few years. The best of the experiments was carried out in November 1986 at the iron foundary ČKD Blansko. After this experiment Rado suggested organizing a small conference within the foundry. We gave short lectures together with the metallurgist Professor Karel Stránský and dr Jiří Merta, with whom we cooperated for many years. At this factory meeting Radomír was equally helpful and attentive to his listeners as at any conference at a higher level. Even long after this special occasion I met people from the foundry who remembered this event well.

At the museum in Blansko 1987. Radomír Pleiner with some of the Liblice symposium participants.

In October 1987 the CPSA symposium *Archaeology of Iron* was held at Liblice. There was an excursion to the museum in Blansko where the furnace from Olomučany was on display and was the main focus for the discussions. The final part of this story was in the year 2000, when I was very honored that Radomír wished to put a photograph of the Olomučany furnace on the cover of his book *Iron in Archaeology: The European Bloomery Smelters*.

This memory of Radomír covers only a very small part of his extensive scientific work, but I know that this work will be a source and a stimulation for future generations of researchers. But I wanted also to remind myself of the clear sky high above the Moravian Karst and the beginning of our cooperation. Thank you Radomír, thank you for everything.

Věra Souchopová

Radomír Pleiner in Hungary

Even in the 1960s Radomír Pleiner had very good professional connections with the pioneers of research on the history and archaeology of iron in Hungary, including the historian Gusztáv Heckenast (1922–1999), the archaeologist Gyula Nováki (1926–), and the chemist Gábor Vastagh (1899–1987). Radomír took part in two international conferences in Hungary, the first of which was the 1973 meeting at the National Museum in Budapest – La formation et le dévelopement des métiers au Moyen Age (Ve–XIVe siècles), when five papers on early ironworking were given (CPSA *Communication* 13, 1974).

My connection with Radomír Pleiner originated from the second CPSA symposium at Eisenstadt in 1975. The

The Sopron-Somogyfajsz conference 1997, at the iron ore mining site in the forest of Kópháza, near Sopron. Susan Crew, Friedrich Toussaint, Radomír Pleiner, Gömöri.

The Bloomery Museum at Somogyfajsz, built by the Dunaferr ironworks, opened in 1997.

year after, as director of the Museum of Kőszeg, I was part of the commission from the Hungarian Ministry of Culture for a one month study tour of medieval Czech towns. In Prague I met Radomír at the Archaeological Institute, where he put a lot of the CPSA publications at my disposal to study. Radomír also recommended me to visit the Blansko Museum where he organized a meeting with Věra Souchopová who, as director of the archaeological excavations in the Moravian Karst, had excavated embanked bloomery furnaces very similar to those found in Hungary.

The second conference which Radomír attended in Hungary, in the spring of 1997, was a workshop organized by the Dunaferr-Somogy Foundation, the Working Committee on Industrial Archaeology (MTA VEAB, Veszprém) and the Sopron Museum. At this meeting Radomír delivered the opening speech on 'Comité pour la Sidérurgie Ancienne de l'UISPP. Thirty years of Work on the Earliest History of Iron'.

Part of the workshop was held in Sopron and part in Somogyfajsz, which was linked to the opening of the new bloomery museum (Őskohó Múzeum) in the forest near Somogyfajsz. The focus of the museum is the late 10th-century iron smelting workshop, with six of the bloomery furnaces *in situ*, and with displays of iron objects and other archaeological finds from the region. Outside the museum is an area devoted to experimental iron working which is still used today.

'Szépen hangzott a kalapácsok és az üllő zenéje Radomír ősi kovácsműhelyéből' – Nicely sounded the music of hammers and anvil from Radomír's ancient smithy. But sadly no longer does the charcoal glow in the hearth.

János Gömöri

Radomír Pleiner, a view from Norway

I first met Radomír Pleiner in Prague in 1977. We were a group of students from the University of Bergen and were on an excursion to Austria and Czechoslovakia. Our professor, Anders Hagen, had met Radomír on several occasions and he wanted us to meet this extraordinary person. At that time it was not an easy task since Radomír had limited possibilities to meet persons from outside the Iron Curtain. We understood that he could not welcome us in his Institute, so we met 'under the radar' at the Castle in Prague where he told us about his research and the situation for an academician who did not support the political regime. That was an unusual experience for a young Norwegian who believed in the freedom of thought and that knowledge was a benefit for all people.

Since then I have met Radomír at several international congresses. I have been impressed by his overview of the history of metallurgy. He had studied iron production in all parts of Europe as well as other parts of the world. He could communicate in English, German, French, Italian, Spanish and Russian and could write scientific papers in most of them. I think he even could understand some Scandinavian languages. It is difficult to underestimate Radomír's significance for the study of ancient iron production. He was the founder of the CPSA network that bound researchers from all over Europe together. His publications of the *Communications* were the main source of information before the internet became a useful tool.

Radomír Pleiner's book *Iron in Archaeology: The European Bloomery Smelters*, published in 2000, has been the 'Bible' for all of us who want to get an overview of ancient iron production. This book has since been on the curriculum for students that study archaeological technology in Trondheim. This impressive work is a manifest of Radomír's working capacity due to his network and his linguistic skills.

Radomír in 1977, talking to the Norwegian students at the Castle in Prague.

Budal 1991, at the re-excavated Storbekkan I furnace. Pleiner and Espelund in discussion, Stenvik rear centre.

At Røros copper mine. Espelund discussing the finer points of a ternary diagram with Alain Ploquin, watched by Michel Mangin. To the right: Paul Benoit, Pleiner and Elżbieta Nosek.

I will always remember him as an authority at conferences, leading discussions and meetings. Together with Arne Espelund we arranged a meeting in 1991 for the CPSA organization in Budalen in mid-Norway, far away from urban conditions, and Radomír was among the guests from 19 nations. It had not been easy for him to continue his work after the reduction of the Institute's activity and the possibilities to join international conferences were limited. I think he was embarrassed when he had to be supported by organizers with tickets and money to take part in a conference.

That meeting in Budalen was an opportunity to inform Radomír about our studies on iron production in the outskirts of Europe. Combined with extraordinarily good weather conditions it became a memory for life both for him and for us.

Lars F Stenvik

Radomír Pleiner – Maitre et ami

During the 1980 CPSA conference at Sankelmark, Schleswig, to which I had been invited by Professor Müller-Wille of Mainz, Radomír suggested a long walk. He wanted to know about the situation in France concerning early ironworking. I could offer him little information, except about my own work on the extensive evidence for smithing at Alésia, a small Gallic and Gallo-Roman town with an evocative name. He wanted to know if the research on the ancient and medieval mines in the Vosges and the Massif Central was still active, but that was the case only for the most recent periods.

In 1983, after the conference at Compiègne, Radomír and his wife invited a group of us (P Andrieux, P Benoit, J-P Jacob, Mangin) to visit Czechoslovakia. We had to cross the border and the customs separating our two worlds, where our luggage full of smithing cakes and other slags, presented by the two bearded members of the team, left the customs rather sceptical. We were able to see Ivana's excavations and the reconstructions of the Slavonic houses at Březno (Pleinerová 1986), one of which served as a relaxed place for a smoky and drunken evening, with frequent shouts of *Pivo* (beer). At Radomír's laboratory we were able to discuss the questions which were difficult for us, about the identification of different structures and the different types of slag waste from early ironworking.

Although the study of early ironworking had started in Poland and Czechoslovakia in the 1950s, it was only in the years after 1980 that modern research began in France. The CPSA conferences were crucial in this respect, with Radomír playing a central role. During the 1989 conference at Ameliówka, in the Holy Cross Mountains, he played an important part as a referee in a dispute between the groups of French researchers who were present. The year after, six of us created an association, SAFFEM, of those working in the fields of early mining and metallurgy. At first this covered only eastern France but it gradually spread to other regions with dozens of teams, both in the field and the laboratory, who are still active today; from 1988 onwards we held annual French-Swiss meetings at Villersexel to develop our research agendas.

In 1993 the conference at Besançon, organised with my students, was an occasion to present the recent research in eastern France in a European context. This was also an opportunity for Radomír to be a member of the jury, along with Paul-Louis Pelet, Ingo Keesmann

Besançon conference 1993. Fluzin, Mangin, Pleiner.

and Kazimierz Bielenin, for the PhD theses of both Philippe Andrieux and Hervé Laurent, who was then the leader of the Franche-Comté team working mainly on Middle Ages ironworking sites.

The CPSA *Communications* were an important source of information, not only by broadening our European perspective but by giving French researchers a way of sharing their work. A group of us used the *Communications* to prepare a bibliography of iron (Paquier and Mangin 1992) and also to prepare a new map and index of early ironworking sites in France and its bordering countries (Serneels and Mangin 1996). This was later extended by Marc Leroy (in Mangin 2004, 12–13), thus finally addressing the questions raised by Radomír some 20 years before.

The work on the materials from the smithing workshops at Alésia and its region had continued for those 20 years (Mangin *et al* 2000) and the scientific programme benefitted from significant contributions by Radomír, Philippe Fluzin and Alain Ploquin, though they did not always agree! These studies were finally published in a multi-authored paper with a major contribution from Radomír on the knives (Pleiner *et al* 2004). Fortunately his analyses had been completed before the 2002 flood of the Vltava engulfed his laboratory along with our knives.

Radomír was a teacher and a friend of French iron scholars for over 30 years and was a major influence on the development of French ironworking studies. Thank you Radomír both for your help and friendship.

Michel Mangin

Pleiner the metallographer

Having contributed to the chance discovery in 1976 and then to the excavation of the Celtic sanctuary at Gournay sur Aronde (Oise), the metallurgical study of the objects

from this site led me to discover both the publications of Radomír Pleiner and the discipline of archaeometallurgy, of which I had no previous knowledge. This changed the direction of my career! Radomír's global vision of archaeological objects was a strong influence, which led eventually to the creation in France of the CNRS laboratories devoted to archaeometallurgy (1984 URA 34, 1991 UPR 423, 1999 UMR 5060 etc).

In 1982 Radomír invited me to join the CPSA, of which he was the long time and indefatigable secretary. Our first meeting was at the Compiègne conference in 1983, *Journées de Paléométallurgie*. We met a real character who was equally adept at handling a trowel, the metallurgical microscope and the vodka bottle – always the best quality, of course, brought in his luggage. Radomír loved to party and the seminars often lasted until very late in the evening, in a very lively and convivial fashion.

From then onwards we were in regular contact and I gradually became aware of the very difficult conditions in which he worked, with old microscopes which he knew very well and was able to push to the limit to get them to talk about the archaeological material. At the Liblice conference in 1987 we presented our first metallographic images in colour, which Radomír could not believe were natural – he thought that we had coloured them artificially. Our equipment was, of course, better than what was available to him, which further re-enforces the great quality of the work which he was able to achieve. We did not always agree on everything. At the Norberg conference in 1995 he had difficulty accepting the antiquity of African ironworking and the interest of ethno-archaeology. He gave me a little sceptical smile, whilst gently nodding his head …

He had numerous opportunities to return to France: the Sévenans conference in 1990, the Besançon conference in 1993 and our experiments at the Beaune Archéodrome in 1996, when he still insisted that the blooms had to be quenched in water to prevent them from re-oxidation. We also had the opportunity to write a paper together on the iron ingots and knives from Alésia, with Michel Mangin and others, which was published in 2004. The montage of his excellent photographs is still in my memory.

Besancon 1993

Beaune experiments 1996

Each Christmas he was kind enough to send greetings to his friends and colleagues, with his small drawings of blacksmiths, each one different every year, which reflected great affection for his scientific community.

2005 and 2006 Christmas greetings drawn by Pleiner. [PF = Pleiner fecit?].

The last time we met, in 2007 at his home in Prague, he showed me his two books on ships (1994; 1998a), an interest of his since childhood when it was said that he used to draw just knights and ships. He had a great and eclectic curiosity and his interests were very wide. Thank you, Radomír, for your scientific work, for your warmth and for your dedication to your family of the CPSA.

Philippe Fluzin

Radomír and his Swedish connections

Radomír Pleiner was a great friend of the 'Grand Old Lady' of Swedish archaeometallurgy, Professor Inga Serning. Among other things, he took part in her excavation of a furnace on Gotland in 1963. It was through Inga Serning, as her students, that we got to know about Radomír Pleiner, and his publications were a great source of knowledge for us all.

In particular, in the library of the Swedish Institute at Athens in 1982 we discovered his slim volume on *Iron working in ancient Greece*, published in 1969, which was to have an impact on the future of our research. Not that we knew it at the time – we were only too happy to find something to help finish the written exercise set by our teachers. The great merit of the book was that it collected and interpreted the published archaeological material from ancient Greece and it was a major influ-

Norberg conference 1985, at Englesbergs bruk. 1 Pleiner (centre left), 2 Inga Serning, 3 Gert Magnusson, 4 Eva Hjärthner-Holdar, 5 Ronnie Tylecote, 6 Elżbieta Nosek, 7 Effie Photos, 8 Martha Goodway, 9 Donald Wagner, 10 Olfert Voss, 11 Sven Fornander, 12 Arne Espelund, 13 Gerhard Sperl (behind Pleiner), 14 Brian Scott, 15 János Gömöri, 16 Peter Crew, 17 Lars-Erik Englund, 18 Ing-Marie Pettersson Jensen, 19 Viking Wedberg. Photo courtesy of Jernkontoret.

ence in promoting the study of the archaeometallurgy of early iron. This book still remains a cited work after more than 50 years and was an inspiration for our later research on the beginnings of iron production in Scandinavia and Greece.

In 1985 Radomír attended the conference in Norberg, organised by Gert Magnusson and Jernkontoret. This introduced the new evidence for early medieval blast furnaces in Sweden, based on the evidence from the excavations at Lapphyttan, which was not without some controversy. Sadly this was the last occasion on which he met Inga Serning who died two years later.

At the 1995 Norberg conference he gave a most interesting paper based on the Březno excavations by his wife, Ivana, where a large area excavation of the multi-period settlement had revealed only a single slag-pit furnace (Motyková and Pleiner 1987). This was convincingly interpreted as the work of an itinerant smelter, whose iron from a single smelt would have had been of great importance to the community. The paper concluded with a plea for the further study of such small-scale bloomeries.

Uppsala conference 2001. From the left: Svante Forenius, Radomír Pleiner, Jonas Navasaitis, Lars-Erik Englund, Eva Hjärthner-Holdar, Susan Crew.

At the 2001 Uppsala conference Radomír played a central role as the veteran archaeometallurgist with his great knowledge and experience. He was full of energy and inquisitiveness and he calmed our nerves as first-time organisers. The conference was the last to be arranged under the auspices of the CPSA and was a fitting conclusion to our research project *Iron – A successful Innovation from Bronze to Iron in Scandinavia and Greece*. We were greatly thankful for Radomír's paper 'Iron in the Eurasian Bronze Age', eventually published in 2008 in the conference volume.

Through the years after the conference we kept in touch through letters about scientific matters and with Christmas cards. He always remained open to discussion and was always willing to help.

Eva Hjärthner-Holdar and Christina Risberg

Radomír in Ireland and Wales

I shall be forever grateful to Brian Scott for his invitation to the 1984 Belfast CPSA conference. The first evening was daunting, to say the least, with the arrival of the other delegates, few of whom I knew except through their publications. From their greetings and banter it was obvious that they were a well-established group, very familiar and friendly with each other.

However, it was clear very quickly that this was not an exclusive group. Tylecote, on the first evening, metaphorically sat me on his knee and enquired who I was,

Radomír at the 1990 Dundrum experiments with Susan Crew and Brian Scott.

where I came from and what I had done. It transpired that we had a common bond from our youthful interests in rock climbing. Ronnie had a bad accident on Idwal Slabs, in Snowdonia, resulting in the loss of a leg of which few people were aware.

After nervously giving my paper, on the early results from the excavations at Bryn y Castell, both Radomír and Kazimierz Bielenin made a particular point of acknowledging that another archaeologist, like themselves, had been badly bitten by the iron bug and they welcomed me to their community with open arms. At the time this was all rather overwhelming and it was not then apparent that both Rado and Kazi were to become close friends and colleagues in the quest for knowledge and insights into the problems of iron production.

Some years later, in 1990, Brian Scott invited us, along with Radomír, to take part in one of his series of practical courses held at the Belfast University field centre near Dundrum, Co Down. This was a rather surreal experience, carrying out the experiments with Brian's students against a background of noise from helicopters and gunfire from the nearby army firing range, at a particularly troubled time. However, it gave plenty of opportunity to quietly discuss the problems of smelting in Irish 'bowl-furnaces' among many other topics, in a quite different atmosphere to the often hectic and hurried discussions at conferences. Radomír was very gentle with the students, both encouraging and inspiring them to think for themselves, commanding immediate respect for his experience and deep knowledge of iron working and, in the evenings, for his intimate knowledge of Irish folk songs.

In 1997 we had the great pleasure of organising our own iron conference at Plas Tan y Bwlch; seven days of intense activity, with several field trips and a full

The 1997 conference delegates at Dolgun blast furnace. Radomír with his hand on the furnace, Kazimierz in the centre with a white jacket and cap, Elżbieta two to his left.

day of experiments, in unusually glorious weather for Snowdonia. This was all the more enjoyable because of the company of Radomír, Kazimierz, Elżbieta Nosek, Vagn Buchwald, János Gömöri, Albrecht Jockenhövel, Gerhard Sperl, Olfert Voss, Lars Stenvik and many of the other younger members of the CPSA. Kazimierz Bielenin hosted a late evening party, with several bottles of the finest Polish vodka, which resulted in a number of sore heads the following day.

The atmosphere of this conference was neatly summed up in Radomír's vote of thanks 'that he was glad once more to have been in the company of his international family' – of which, of course, Radomír, Kazimierz and Elżbieta had been founder members and by then were its grandparents.

Peter and Susan Crew

Experimenting with Radomír

One of my main interests has been in the field of experimental iron working, which Radomír and other European scholars had started to develop in the early 1960s, including of course Kazimierz Bielenin, unfortunately now also dead. I had the pleasure of working with Radomír and Kazimierz on several occasions, at Beaune in 1988, on Elba in 1989 and at Nova Słupia also in 1989. I was very impressed by Radomír's work and his furnace reconstructions, especially his desire not to be limited by a single approach, as evidenced in the extensive list of references in his *Iron in Archaeology* (2000).

The 1998 experiments at Beaune were part of a series carried out in tall Polish slag-pit furnaces, based of course on the excavations of Bielenin. These were fully instrumented and gave a large amount of data on the temperature profiles in the furnaces, under different conditions, and the effect of using different clays for the

Nova Słupia 1989, experimenting with a Burgenland-style furnace. Radomír and Brian Scott on the bellows, with Bielenin and Andrieux in the furnace pit. Right: Scott and Pleiner watching Andrieux quenching the bloom.

furnace walls (Andrieux 1991). These data were used for my PhD thesis, supervised by Michel Mangin, and I am also grateful to Radomír for agreeing to be part of the jury.

In May 1989, we tried to smelt the black sand ores collected from the beaches on Elba, concentrating on a reconstruction based on the Catalan furnace. The discussions were a great lesson for me, especially regarding the technical and scientific aspects and the questions which these raised. This meeting with Radomír left a great impression on me as a young archaeologist, being able to share ideas with a generous and experienced researcher who could express the questions clearly and not holding back his doubts, all in a dialogue which Radomír shared freely.

Later that year at the Kielce-Ameliówka conference, I was asked by Bielenin to carry out an experiment in his reconstruction of a large diameter domed furnace based on the Burgenland-type. This was blown for six hours by three bellows and with a great deal of help from Radomír, Brian Scott and the young students of Kazimierz. This was a remarkable occasion and an opportunity for me to benefit from the advice of two of the founders of modern archaeometallurgy.

These lessons remained for me a teaching model which I later used with my students. It was after these experiences that I began to ask questions about the indications which could help the metallurgist during the course of an experiment. I did not realise it then that it would take a total of more than 20 years and more than 100 experiments to develop my ideas about the psycho-sensory relationship between the furnace and the user, to allow the latter to become successful as I tried to show during the 1990 symposium in Belfort (Andrieux 1995).

Thank you Radomír, and Kazimierz, both for your inspiration and for your support.

Philippe Andrieux

Radomír Pleiner and his later professional life

Radomír Pleiner spent most of his professional life in Czechoslovakia under the socialist regime. After the Velvet Revolution, which took place in 1989, he believed, like so many others, that there would be a better life and a better future. Unfortunately, the forthcoming times turned out to be rather different and very difficult for Radomír.

In 1990 Radomír was one of the candidates for the post of director of the Institute of Archaeology in Prague, but it was finally his opponent dr Neústupný who became the new director. He considered that the Archaeological Institute of the Academy of Science in Prague was a non-effective institution and he basically sought to close it, or at least to drastically reduce it (Kuna 2012). Shortly after taking his post dr Neústupný closed the metallographic laboratory, which Radomír had established in 1963, and Radomír's assistant Mrs B Novotná was transferred to the editorial office of *Archeologické rozhledy*. Thus Radomír lost the possibility of conducting systematic metallographic research, although Mrs Novotná agreed to help him during her free time.

In 1992 Radomír was appointed as Professor by Charles University but as early as 1993, when the famous *The Celtic Sword* was published, he was retired and his position of archaeometallurgist was cancelled due to budget cuts. Nevertheless, as Emeritus Senior Scientist he could keep his office and he still attended the Institute and continued his work. His modest possibilities of metallographic research were reduced even more in the second half of the 1990s when Radomír's office was looted and his metallographic microscope stolen. After that, Radomír was dependent in terms of metallography on the help of his friends from the Brno University of Technology, Docent V Ustohal and Ing M Ptáčková, and new investigations became limited to individual objects, such as swords, though still of the highest quality (see for example Pleiner 1998b).

After this tough period, 2000 was a somewhat more encouraging year. The first volume of his synthesis *Iron in Archaeology* was published (Pleiner 2000) and through his initiative I was accepted into the Institute in the re-created position of archaeometallurgist. I

Radomír Pleiner pushing his armchair from his flooded office in 2002. Photo courtesy of the Institute of Archaeology of the CAS, Prague, v.v.i.

started with the renewal of the laboratory facilities and assisted Radomír in various tasks. Since we shared his office we could enjoy, along with morning coffee, long debates about archaeometallurgy and about human life in general. Radomír was at that time very active and working hard; he used to say 'even during my active career, I was not as busy as I am now'.

Everything seemed to be improving for both of us, but then the fateful year 2002 came. In August, the Institute was hit by an enormous flood that completely destroyed Radomír's office, including his archaeo-metallurgical library, which included the unique archive of the CPSA, comprising hundreds and hundreds of items. After the flood, part of the Institute was for a long time reduced in function. I received a few months of asylum at the Technical University in Liberec, and after my return to Prague I began with my colleagues to build a new restoration–conservation laboratory, located far from the city centre. Since then I saw Radomír less often and rather irregularly, because every meeting had to be arranged individually and in advance.

Despite all these complications, Radomír still provided me with a great deal of advice and he wrote many articles. In 2006 he managed to complete the second volume of his great synthesis *Iron in Archaeology,* dedicated to the blacksmiths craft (Pleiner 2006). After that he published less frequently, but he never stopped writing; Radomír had been preparing a somewhat modified version of the book *Iron in Archaeology: Early European Blacksmiths* in the Czech language.

Radomír was a very systematic and hardworking man, as is generally known. But we should remember him also as an extremely tough man, able to face and withstand any difficulty. All of this is worthy of admiration, and thanks to all this he left us with an unparalleled scientific legacy. But he was also a great man and I am sure that his human legacy is for most of us equally important.

Jiří Hošek

The Pleiner furnace 1958–2000

All over Europe, the study of the archaeology of iron reached a peak at the end of the 19th century but then it collapsed during the First World War. The revival of interest in the topic arose again only many years later, during the 1950s, in the northern and eastern parts of Europe. Radomír Pleiner was one of the prominent individuals in this small group of innovating researchers exploring this new field.

In the French speaking countries, with the remarkable exceptions of Salin and France-Lanord (1956), the resumption of research activities did not commence for another twenty years, from the late 1970s onwards, led by Paul-Louis Pelet in Switzerland, Michel Mangin and Philippe Fluzin in eastern France and by Claude Domergue in the south. From the very beginning contact was established by all these groups with Radomír Pleiner, who had already created the *Comité Pour la Sidérurgie Ancienne* (CPSA). During this early period, no French textbook was available and only a handful of archaeological monographs. Most of the literature was written in English or in German and access to publications remained quite difficult for many scientists.

In one respect a specific talent of Radomír played a particular role – he was a great designer who produced illustrations of high quality. They were line drawings in black and white, so they were easy to copy and reproduce, and they were accurate and easy to understand. Several of the illustrations have been of high importance for the popularization of iron archaeology and have been used by many researchers involved in the study of early ironworking.

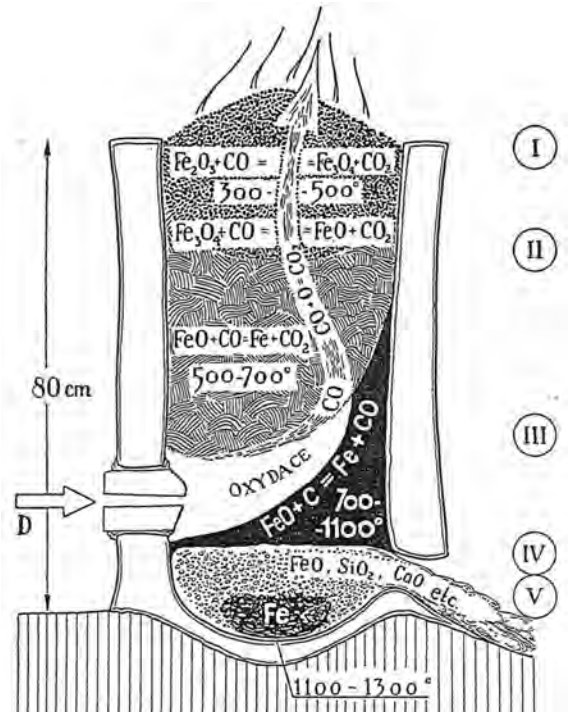
One of those figures of particular interest is the 'Pleiner furnace', first published in his 1958 monograph. On one single drawing all the basic concepts of the bloomery furnace were presented. This was a major achievement – but, on this figure, the flat-topped bloom is shown firmly sitting at the base of the furnace, below the liquid slag. This is clearly an indication of the then current state of knowledge of the bloomery process, still influenced by ideas from blast-furnace technology.

Further research by Pleiner lead him to change his mind rapidly, as reflected in his 1969 paper on the Březno experiments. However, the original drawing was already making its way through the major publications of the late 20th century. This figure has been reproduced and reinterpreted many times, all over the world by many of the leading researchers, and it is still common to meet one of its avatars on the internet of today.

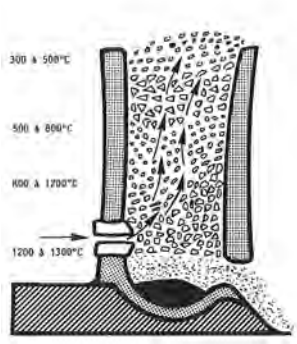
It caused some amusement in the 1990s when we began to find and collect reproductions of the drawing from a wide variety of publications. The original has been used by Cleere (1971; 1981), Serning (1979) and Magnusson (1986), without significant modification, and then by Iaroslavschi (1997), but with the bloom raised slightly from the base of the furnace into the slag pool. The latest direct copy was used by Lars-Erik Englund in his 2002 thesis, but with a long and carefully written caption in which he despaired of Swedish archaeologists who had continued to use the drawing until the 1990s without apparently realising that it was not correct.

Several re-drawn versions have appeared, notably those by Philippe Fluzin (in 1983, 1998 and 1999) which have enhanced temperature zones but still with the bloom firmly at the base of the furnace. The 1990 version by Rostoker and Bronson is heavily re-drawn and without attribution, but still has the basal bloom and is clearly based on the Pleiner furnace. In 1995 Hamady Bocoum re-drew the Fluzin version, adapting it for a large African shaft furnace, with a massive solid bloom sitting firmly at the base. A later variant is by Ineke Joosten, re-drawn for her 2004 thesis. For the first time the small bloom is shown in its correct position, just below the blowing hole, reflecting the results of her own experimental work.

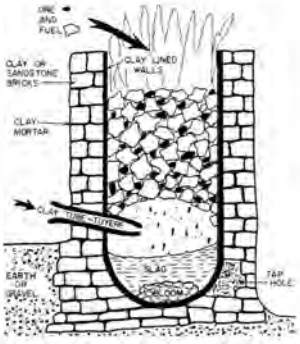
A notable exception to this generally slavish series of reproductions was the fine 1965 illustration by Kolchin. This has the iron above the slag and is again based his own experiments of the early 1960s, some of which Pleiner took part in. It is drawn in a very similar style to the Pleiner furnace and was almost certainly influenced by the original drawing.



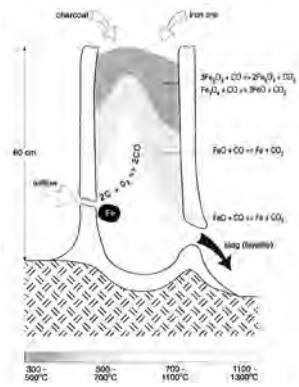
The original drawing of the Pleiner furnace, 1958.



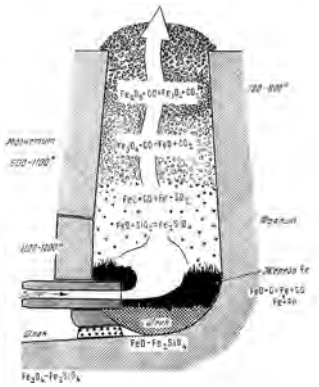
Fluzin 1993



Rostoker and Bronson 1990



Joosten 2004



Kolchin 1965

Despite the fact that since the 1970s many other more correct images have been published, of a wide variety of furnace types, with many by Pleiner himself, the persistent influence of the original drawing is a reflection of the slow (sometimes too slow) growth of the

appreciation of the mechanism of the bloomery process. It also emphasises the power of a good image, correct or otherwise, which in this case has now been widely used for nearly fifty years. It is rather ironic that, under particular experimental conditions, it has been shown that a bloom can indeed form at the base of the furnace, but that is another story.

Radomír Pleiner presented a new figure in his 2000 book. This was based on Tholander's experimental work, published in 1987. It is certainly more accurate, with more realistic temperature profiles, but it is a more complex drawing and more difficult to understand. It will be interesting to see how often and for how many years this version is reproduced in the future. The use of a good drawing is much better than a long text and it was one of the many appreciated talents of our late friend Radomír.

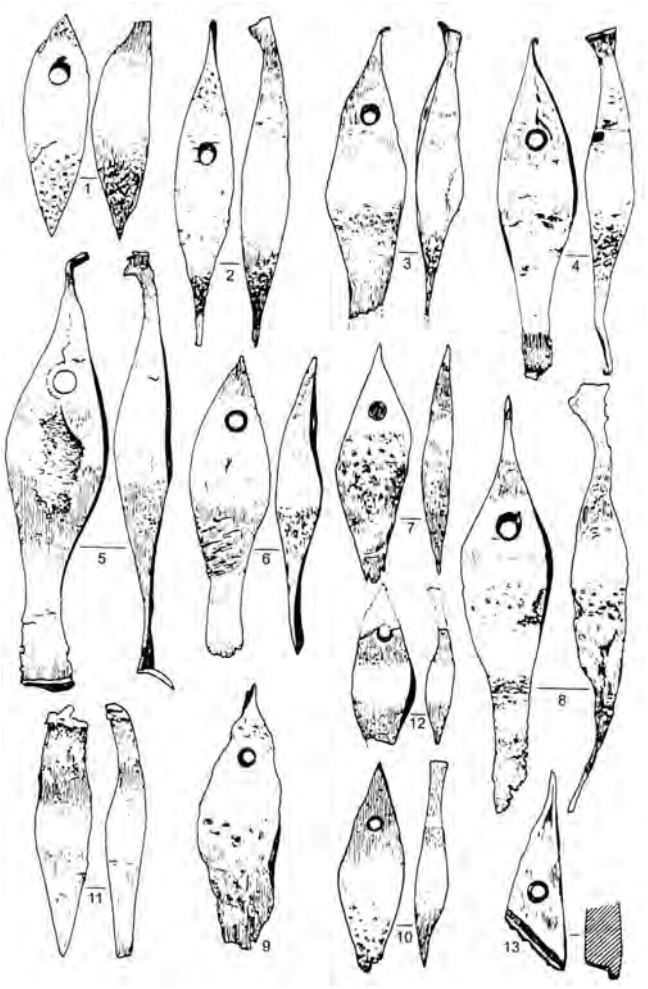
Vincent Serneels and Peter Crew

Two millennia of trade iron: bi-pyramidal bars

Iron is arguably the most important but the least fashionable of all the early metals of antiquity to be studied technologically – or in any other way for that matter – and perhaps for this reason we know and understand less about it and the development of early ferrous technology despite the obvious importance of iron and steel in the modern world. Radomír Pleiner devoted much of his life to correcting this imbalance in archaeological and metallographic studies and it is in large part because of his lifelong efforts that we know as much as we do.

Radomír Pleiner was perhaps the most dedicated and successful of an all too small band of scholars who have dedicated themselves to finding out about archaeological iron, understanding how it developed, and improving our perception of early iron in the wider archaeological world and beyond. This can best be seen be seen in his two splendid books devoted to the theme of *Iron in Archaeology*, as well as his numerous papers tackling other aspects of iron exploitation. These were often written with other scholars and one in particular is an excellent example of an all too rare cross-disciplinary approach, 'Iron in the Assyrian Iron Age' (Pleiner and Bjorkman 1974). Pleiner saw that the great value of studies like this was in the gathering together of evidence from other disciplines, combined with typological and analytical evidence so as to stimulate further ideas.

In this paper he drew attention to a very interesting and characteristic form of trade iron from the hoard



Fish-shaped bars of trade iron from later Assyrian sites. Nos 1–10 from Khorsabad, No 11 Susa, Nos 12–13 Nimrud (Pleiner and Bjorkman 1974)

found at Khorsabad in northern Iraq in the 1860s, in the late 8th-century BC strong-room of the palace of the neo-Assyrian king Sargon II, with more finds from the re-investigation by Loud in the 1930s. This huge hoard, of about 160 tonnes, is the biggest archaeological metalwork hoard ever found and included 50-60 examples of this very distinctive form of bi-pyramidal fish-shaped bar. These were correctly interpreted as examples of partly consolidated trade iron, where the characteristic fish shape was intended to show how the iron could be worked in different ways. In this case this was demonstrated by one end being drawn to a pointed head and the other end forged into a flat sheet tail. The holes were interpreted as being for suspension and transport, but they are more likely an indication of the general quality and malleability of the iron, with the holes being punched through a thicker part of the bars.

I was particularly grateful for the attention drawn to this type of bar by Pleiner, which made it possible for me to interpret a reference to fish-shaped iron bars in a new

study of the famous early 9th-century AD sword treatise (really a work on steel use) of Ya'cub al-Kindi which not only described these bars as still being made and traded at this time, but also gave their dimensions, which closely corresponded to those illustrated by Pleiner and Bjorkman (Hoyland and Gilmour 2006, 74 and fig 17). The description of this form of trade iron is quite clear, referring to bars which were square in section and one cubit (0.5m) in length. These bars were also called *shababit*, a characteristic form of fish, said to be wide in the middle but with a small head and a slender tail. The size and description more-or-less exactly matches that of the trade iron bars stored at Khorsabad and this suggests that the tradition of making this kind of bar continued largely unchanged in this region for some two millennia.

The survival of iron in the archaeological record is at best very uneven and trade iron is often largely invisible although we can predict its existence and development from what little is known. A large number of bi-pyramidal bars, known as *spitzbarren* (or *lingots* in France), have been found in central and south-eastern Europe. A recent discussion of this material is by Pleiner himself, as being part of 'The blacksmith's starting stock' (Pleiner 2006, 23–32). Iron of this form is known from a wide range of contexts spanning the last half of the first millennium BC, in particular from Hungary, Poland, Greece, central and south-eastern Germany and east central France. This suggests that it was widely used or traded across much of the southern half of Europe by the late first millennium, alongside many other forms of trade iron. The bi-pyramidal shape stays much the same although the hole of the characteristic fish-shaped form is seen in only a few of the European examples.

Rare examples of essentially the same form trade iron of medieval date have been found in ship wrecks. From the 12th century there are both short and longer pointed bars from the eastern Mediterranean (Galili *et al* 2105) and some 80 long pointed bars formed part of a consignment of trade iron in the cargo of a trading vessel which sank in the Ria Orio, in the Basque country, probably sometime during the 14th century (Crew *et al* 1997). These bars, although a broadly similar weight to some of the earlier types, are more elongated, measuring about 1m in length, due to the introduction of water-powered hammers by the 15th century.

Quite apart from Radomír Pleiner's pioneering work in drawing attention to so many aspects of iron technology, he was unusual amongst scholars of iron and steel technology in being well known and respected by many archaeologists and museum professionals from various countries, people with no direct involvement with the archaeometallurgy of iron. This dawned on me in 1980 when I was starting to put together ideas and material for my own PhD on iron and steel use in Europe and it was to the work of Pleiner, which I barely knew at the time, that I was guided by Leslie Webster, one of the main curators of the then early medieval Department of the British Museum. We owe Pleiner a great debt of gratitude for what he achieved in the understanding of the world of early iron and we should endeavour to follow his good example in every way we can.

Brian Gilmour

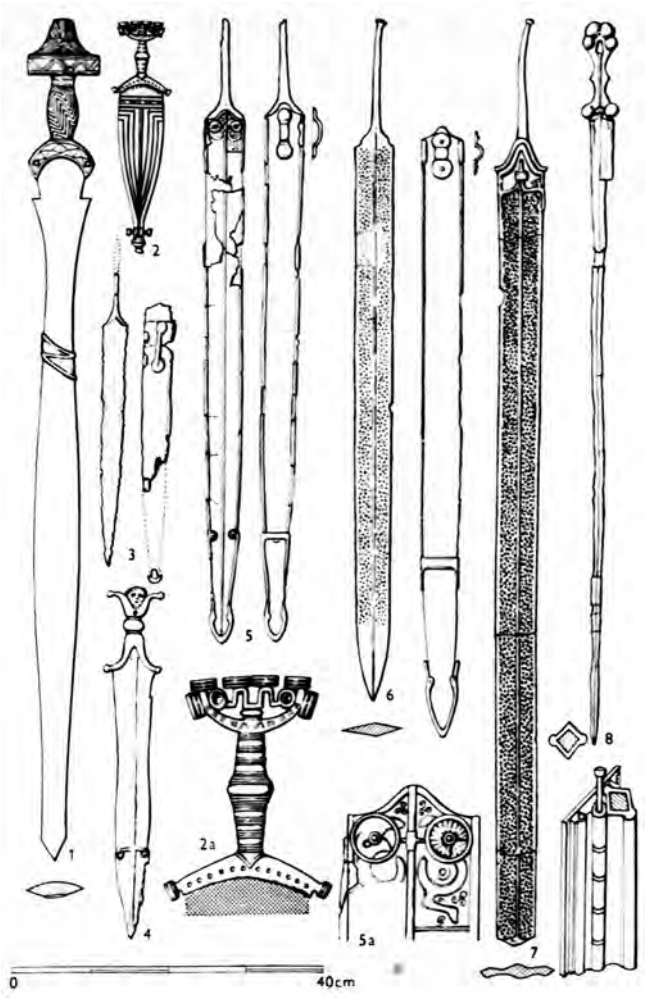
Radomír Pleiner and *The Celtic Sword*

The Celtic Sword was published by the Clarendon Press, Oxford, in 1993. It provided a unique contribution to the trans-European study of Celtic swords because it examined every aspect of the weapons. As a polymath with wide linguistic skills, Radomír Pleiner was able to draw on his knowledge of history and prehistory, and his studies of ancient iron working and production which had brought him into contact with others working in this field.

Pleiner used both archaeological and classical literary sources to outline the development of swords from the Bronze Age to the Iron Age Hallstatt and La Tène periods. He discussed the combat styles and the effectiveness of the blades as weapons, evaluating both the written Classical and Irish sources in relation to the type and construction of the swords, and also the archaeological remains, including burials.

This book contains a comprehensive summary of the recorded scientific examinations of existing swords, which is of great value as it includes information from many sources, some of which are not readily available. The sword cross-sections are categorised by their method of construction and composition.

As part of his innovative thinking, Pleiner enlisted an experienced practising blacksmith to replicate two types of blade, which permitted him to make an estimate of the time and metal resources required to make a simple sword. Although much work has now been done in this field by modern smiths, specialising both in the smithing of swords and on specific techniques such as pattern-welding, Pleiner must be one of the few to have included such a detailed quantification as part of a comprehensive study.



This elegant illustration, fig 2 from The Celtic Sword, shows the development of swords and daggers from the Hallstatt to the La Tène periods. 1 Holzwiesen, Germany, hilt adorned with gold; 2 Ludwigsburg-Römerhügel, Germany, dagger in a scabbard; 2a detail of the bronze hilt; 3 Pernant, France, short sword; 4 River Zihl, Switzerland, anthropoid bronze sword in scabbard; 5 Villeperrot, France, long sword in scabbard; 5a detail of the scabbard mouth; 6 La Tène, Switzerland, sword and its scabbard; 7 Port, Switzerland; 8 Chiemsee, Bavaria, and (below) suspension-lock of the scabbard (after Driehaus's radiograph).

The book is the first work of reference for anyone studying Iron Age swords. Ideas change as new information becomes available and archaeological emphasis alters, but this book remains both as a crucial source of infor-mation and also as a stimulation to anyone working in the same field to look not only at the metallographic structures of the blades but also to try to understand how and why they were arrived at. In my case, this prompted some experiments which were carried out on the mechanical properties of different arrangements of iron-steel composites (Lang 2011). I am sure that I am not alone in being inspired by and grateful for Pleiner's pioneering work.

Janet Lang

The CPSA – past, present and future

One of Radomír Pleiner's most significant initiatives was the creation of the *Comité Pour la Sidérurgie Ancienne* (CPSA) in 1966. The initial suggestion for this actually came from Jan Filip, Radomír's former teacher and then director of the Archaeological Institute in Prague, who gave vital support during the formative years of the CPSA (Pleiner 1991). Radomír held the post of secretary until 2004 and during this time he was also the editor of the twice-yearly *Communications*, totalling 67 issues. These were published in the journal *Archeologické rozhledy*, with offprints being sent to all the corresponding members of the CPSA, thus providing a crucial source of information in the pre-internet age.

An equally important activity was the series of conferences organised under the auspices of the CPSA. The first meeting was held at Schaffhausen in 1970, hosted by Walter Guyan, with just 12 delegates but from 10 countries. The second conference was at Eisenstadt in 1975, hosted by Dr Alois Ohrenberger, the director of the Burgenländischen Landesmuseum, with 20 delegates from 9 countries. These marked a new style of meeting, not only with papers and formal discussion but with field excursions, in the case of Eisenstadt to visit the excavations of the now well-known large diameter furnaces at Oberpullendorf and Klostermarienberg, recently excavated by Bielenin.

Thereafter the CPSA meetings were more frequent, being held almost every year and with an increasing number of participants, reflecting the rapid growth of early ironworking studies in most European countries. There were another 19 CPSA conferences from 1979 to 2001 held at Schaffhausen 1979, Sankelmark

Eisenstadt meeting 1975, at Klostermarienberg. From the left: Vastagh, Ohrenberger, Pleiner, Meyer, Bielenin, Sperl. Photo courtesy of János Gömöri and Hannes Herdits.

At Liblice 1987, the 20th anniversary CPSA conference. Olfert Voss with Radomír. Photo from the Thomsen archive at Varde Museum.

1980, Vordernberg 1981, Populonia 1983, Belfast 1984, Norberg 1985, Mainz 1986, Liblice 1987 (the 20th anniversary), Valle Camonica 1988, Kielce-Ameliówka 1989, Sévenans-Belfort 1990, Budal 1991, Ripoll 1993, Besançon 1993, Plas Tan y Bwlch 1997 (the 30th anniversary), Bienno 1998, Sopron-Somogyfajsz 1999, Sandbjerg 1999 and Uppsala 2001.

There were, of course, many other conferences and meetings which were concerned wholly or partly with iron, at least 50 in number, which were attended by members of the CPSA. Radomír was able to take part in almost all of these conferences, a remarkable achievement in itself, considering the travel and currency difficulties. There is no doubt that the CPSA conferences, which generally had between 50 and 60 delegates, were the most enjoyable and friendly of occasions, as indicated in some of the contributions to this Celebration, which helped to weld together a remarkable family of European ironworking scholars.

Only those members of the CPSA who actually attended these conferences can fully appreciate their unique atmosphere. However, an impression of the meetings can be gained from Pleiner's conference reports in the *Communications*, as well as an overview of the development both of the CPSA and of early ironworking studies. His introductory chapter to *Iron in Archaeology* gives an excellent summary of all this activity and of the generations of scholars involved.

In the first issue of the *Communications* in 1967 there were already listed 85 corresponding members and 19 institutions, from 22 countries. The growth of the CPSA was rapid and after the first five years of activity there were 144 members and nearly 450 bibliographic entries had been published. Reports were also prepared after 10 years, 25 years and 30 years of activity, with the bibliographic entries rising at a rate of up to 80 per year, to over 2050 by 1998.

These raw statistics hardly do justice to the enormous amount of work involved. Although Radomír had the full support of the Institute in Prague and some of his colleagues, at least until 1990, effectively he provided single-handed a comprehensive abstracting service which was of inestimable value to iron researchers all over Europe and beyond. A key element in this was the information sent to Radomír by the corresponding members. The first nine of the *Communications* were translated into French, but thereafter 'for technical reasons' they were in English. From 1982 to 1990 Henry Cleere helped by reading and correcting the manuscripts and thereafter this was done by Peter Crew. It was an enjoyable task, but rather a difficult one, trying to make the entries as clear as possible whilst keeping a flavour of Radomír's distinctive style. The method of production is of some interest. Every six months or so, Radomír would send a large batch of individually typed entries, usually falling out of a thin envelope which had been battered in the post, and then after correction he would re-type the whole of the manuscript ready for printing – and he preferred to use this laborious method even after he had use of a computer. The text was sometimes very faint and difficult to read – he must have held the world record for making a typewriter ribbon last as long as possible!

In 1990 there was a change, caused by the difficult situation at the Institute, in that Radomír no longer had its support for posting the offprints to members. This was also exacerbated by a doubling of the postage costs and Radomír, reluctantly, had to ask members for their voluntary help with the expense of the postage. The response to this was very positive and the *Communications* continued to appear both regularly and on time.

In April 2002 there was yet another change, in that no offprints of the *Communications* were to be provided by *Archeologické rozhledy* and instead, from No 67 onwards, they would be posted on the excellent website of the Institute. Events, however, intervened in the form of the disastrous flood in August. As well as the loss of the CPSA archive, Radomír reported that 'Because I have lost my last notes on the new literature I don't know whether I can complete issue 68 of the CPSA Communications. Sometimes I feel that it exceeds my power, but I don't want to give up'.

In the event, no further communications were produced. At his last conference at Uppsala in 2001 Radomír was visibly tired, no doubt in part due to his increasingly poor health, the events of 2002 had clearly taken their toll, and his priority was now to finish the second volume of *Iron in Archaeology*. In October 2004 he reported that 'I can't fulfil the function of the secretary of the CPSA – it is beyond my power now. I have about one metre of new literature but I am not able to abstract them in a proper way. I have much work to do with finishing my book'. This was a typically brave and honest decision, which must have been particularly difficult for Radomír to make after so many years of nurturing the CPSA.

The following year Janet Lang, who had for many years providing an abstracting service for *Historical Metallurgy*, became secretary. Unfortunately the lack of activity since 2002 meant that the impetus of the CPSA had declined and attempts to revive it met with little success. At the 2007 conference at Plas Tan y Bwlch, the 40th anniversary of the CPSA, a long plenary discussion was held to explore ways in which the CPSA might develop. This led to the creation of a website by Xander Veldhuijzen, hosted by the Institute of Archaeology in London, but there proved to be too many practical difficulties in maintaining this. Janet then created another website, but with a similar result and the CPSA became quiescent. There seem to have been several underlying reasons: firstly that few people had been invited to become a corresponding member since 1997, so a generation of scholars had been lost; secondly that, to some degree, the role of the CPSA had been replaced by the rapidly growing utility of the internet; and finally that many of the existing membership had themselves become less active, with some of the older ones not being comfortable with the use of the internet.

As a result of preparing this Celebration of Radomír's life and work, is was decided to make another effort to revive the CPSA, but in a new format more suitable for the 21st century. Jiří Hošek is now the secretary and, once more, the secretariat is based at the Institute of Archaeology in Prague (hosek.cpsa@gmail.com). The new mechanism for the modern CPSA is through the Academia.edu site, which can be accessed by the link https://independent.academia.edu/cpsa. At the time of writing this page is in a preliminary format but is being actively developed. All the *Communications* have already been uploaded and are freely available, thus providing a valuable archive. It is hoped that in the near future developments will include the uploading of Radomír's primary publications, to make them available to new generations of scholars, and ways are being examined

Radomír at Uppsala 2001

The new CPSA logo 2015

to make the CPSA site more pro-active and more useful as a forum for the study of early ironworking. At present about 25 existing members of the CPSA have their own Academia pages, and new corresponding members will be invited to join the CPSA and to help develop this initiative.

We all owe a very great deal to Radomír Pleiner for his inspiration in creating the CPSA and it would be a fitting tribute to him for each of us to help maintain his legacy.

Peter Crew and Jiří Hošek

References

The list below includes only the works relevant to this Celebration. A full list of the books and papers of Radomír Pleiner is printed in Hošek, Cleere and Mihok 2011, 7–28 and is available online at https://academia.edu/12303535.

Andrieux P 1991, 'Introduction à l'étude thermique des éléments de construction des fourneaux métallurgiques et de leur relation avec les productions expérimentales' and 'Préparation et expérimentation d'un fourneau burgonde avec le professeur Bielenin', in Bielenin (ed), 71–78 and 119–122.

Andrieux P 1995, 'Les témoins archéologiques et leur restitution expérimentale dans l'étude de la gestuelle at des conceptions culturelles: Les liens possibles entre l'objectivité et la sensualité', in Benoit and Fluzin (eds), 65–69.

Arab R and Rehren T 2004, 'The Wertime Pyrotechnological Expedition of 1968', *IAMS* 24, 29–34.

Benoit P and Fluzin P (eds) 1995, *Paléométallurgie du fer et cultures,* Belfort-Sévenans conference 1990 (Belfort).

Bielenin K (ed) 1991, *From bloom to knife*, Kielce-Ameliówka conference 1989 (Kraków: *Materiały archeologiczne* 26).

Bielenin K and Suliga I (eds) 2007, *50-lecie Badań nad Starożytnym Hutnictwem Żelaza w Górach Świętokrzyskich* [50 years of research on ancient metallurgy in the Holy Cross Mountains] (Kraków).

Bocoum H, McIntosch R J and McIntosch S K 1995, 'La réduction directe et ses rapports à l'environnement dans la moyenne vallée du fleuve Sénégal des origines au XVIe siècle', in Tomas i Morera (ed), 491–501.

Caldwell J R (ed) 1967, *Investigations at Tal-i-Iblis* (Illinois: State Museum Preliminary Report 9).

Cleere H 1971, *Iron smelting experiments in a reconstructed Roman furnace* (London).

Cleere H 1981, The Iron Industry of Roman Britain, unpublished PhD thesis, University College London. Available online at http://www.wealdeniron.org.uk/HCleereThesis.pdf

Cleere H 2011, 'Radomír Pleiner: The Magister Ferrararium at 80', in Hošek, Cleere and Mihok (eds), 3–6.

Cleere H, Crew P, Hošek J, Lang J, Souchopová V and Scott B 2015, 'In Memoriam: prof. PhDr. Radomír Pleiner, DrSc., Magister Ferrararium, 1929–2015', *The Crucible (HMS News)* 88, 10–11.

Crew P and Crew S (eds) 1997, *Early ironworking in Europe: archaeology and experiment*, Plas Tan y Bwlch conference 1997 (Maentwrog).

Crew P, Crew S, Gilmour B and Urteaga M 1997, 'Split blooms and pointed bars from the Ria Oria wreck: Trade iron from the Basque Country', in Crew and Crew (eds), 100–101.

Cuomi di Caprio N and Simoni C (eds) 1991, *Dal basso fuoco all'alto forno*, Valle Camonica conference 1988 (Varese: Sibrium 20).

Englund L-E 2002, *Blästbruk: Myrjärnskanteringens förändringer i ett långtidsperspectiv* (Stockholm: Jernkontoret bergshistoriska skriftserie 40).

Espelund A (ed) 1993, *Bloomery ironmaking during 2000 years,* Vols I–III*,* Budal conference 1991 (Trondheim).

Forenius S, Hjärthner-Holdar E and Risberg C (eds) 2008, *The introduction of iron in Eurasia*, Uppsala conference 2001 (Uppsala).

Fluzin P, Beranger G and Coddet C (eds) 1983, *Journées de paléométallurgie*, Compiègne conference 1983 (Compiègne).

Fluzin P 1983, 'Notions élémentaires de sidérurgie', in N Echard (ed), *Métallurgies Africaines: Nouvelles contributions* (Paris: Mémoires de la Société des Africanistes 9), 13–44.

Fluzin P and Morin D 1998, *La métallurgie ancienne : fer, fonte, acier* (Cannes: Bibliothèque de Travail 1097).

Fluzin P 1999, 'Il processo siderurgico: evoluzione storica e indizi archeometrici', in C Cucini Tizzoni and M Tizzoni (eds), *La miniera perduta: Cinque anni di ricerche archaeometallurgiche nel territorio di Bienno* (Bienno), 61–92.

Galili E, Bauvais S, Rosen B and Dillmann P 2015, 'Cargoes of iron semi-finished products recovered from shipwrecks of the Carmel coast, Israel', *Archaeometry* 57(3), 505–535.

Gömöri J (ed) 1999, *Traditions and innovation in the early medieval iron production*, Sopron-Somogyfajsz conference 1997 (Sopron).

Guyan W U, Pleiner R and Fabešová R (eds) 1973, *Die Versuchsschmelzen und ihre Bedeutung für die Metallurgie des Eisens und dessen Geschichte*, Schaffhausen conference 1970 (Schaffhausen).

Haefner H and Pleiner R (eds) 1981, *Das Frühes Eisen in Europa*, Schaffhausen conference 1979 (Schaffhausen).

Hošek J, Cleere H and Mihok L (eds) 2011, *The archaeometallurgy of iron: Recent developments in archaeological and scientific research* (Prague).

Hošek J and Zavyalov V I 2014, 'Nozhi so vstavkami damasskoy stali na territorii Chekhii i Drevney Rusi' [The knives with damascene insets from Czechia and Ancient Russia], *Rossiyskaya arkheologiya* [Russian Archaeology] 1, 148–157.

Hoyland R G and Gilmour B 2006, *Medieval Islamic swords and swordmaking: Kindi's treatise 'On swords and their kinds'* (Oxford).

Iaroslavschi E 1997, *Tehnica la Daci* (Cluj-Napoca, Bibliotheca Musei Napcoensis: Muzeul Naţional de Istorie a Transilvaniei 15)

Joosten I 2004, *Technology of early historical iron production in the Netherlands* (Amsterdam: Vrije University Geoarchaeological and Bioarchaeological Studies 2).

Karbowniczek M, Orzechowski S and Suliga I (eds) 2014, *Kazimierz Bielenin: twórca polskiej archeometalurgii* [K B: the creator of Polish archaeometallurgy] (Kraków).

Keesmann I (ed) 1988, *Archäometallurgie von Kupfer und Eisen in Westeuropa*, Mainz conference 1986 (Mainz: *Jarbuch des Römisch-Germanischen Zentralmuseums Mainz* 35).

Kolchin B A and Krug O Yu 1965, 'Fisichoskoye modelirovaniye syrodutnogo processa proizvodstva zheleza' [Physical modelling of the bloomery ironmaking process], in B A Kolchin (ed), *Arkheologia i estestvennyye nauki* [Archaeology and natural science] (Moscow), 196–215.

Kuna M 2012, 'Intransigent archaeology. An interview with Evžen Neústepný about his life in archaeology', *Archaeological Dialogues* 19(1), 3–28.

Lang J 2011, 'The Celtic sword: a source of practical inspiration', in Hošek, Cleere and Mihok (eds), 263–272.

Loud G 1936, *Khorsabad Part 1*: *Excavations in the Palace and at the City Gate* (Chicago).

Lyngstrøm H 2014, 'Experimental archaeology in Denmark 1960–1990, as seen through the letters of Robert Thomsen', in J R Flores and R Paardekooper (eds), *Experiments past: Histories of experimental archaeology* (Leiden), 189–204.

Lyngstrøm H 2015, *En meget maerkelig mand: Jarnforskeren Robert Thomsen* [A very unusual man: The iron researcher Robert Thomsen] (Varde).

Mangin M (ed) 1994, *La sidérurgie ancienne de l'est de la France, dans son context européen*, Besançon conference 1993 (Besançon: Annales littéraires de l'Université de Besançon 536).

Mangin M, Fluzin P, Courtadon J-L, Fontaine M-J. *et al* 2000, *Forgerons et paysans des campagnes d'Alésia: la terre, le fer, la route en pays mandubien (Haut-Auxois, Côte-d'Or)* (Valbonne: Monographies du CRA 22).

Mangin M (ed) 2004, *Le fer* (Paris).

Magnusson G 1985, *Medieval iron in society*, Norberg conference 1985 (Stockholm: Jernkontorets forskning H34 and H39).

Magnusson G 1986, *Lagteknisk järnhantering i jämtlands län* [Bloomery iron production in the county of Jämtland] (Stockholm: Jernkontorets berghistoriska skriftserie 22).

Magnusson G 1995, *The importance of ironmaking: Technical innovation and social change*, Norberg conference 1995 (Stockholm: Jernkontorets bergshistoriska utskott H58 and H62).

Motyková K and Pleiner R 1987, 'Die römerzeitlische Siedlung mit Eisenhütten in Orech bei Prag', *Památky archeologické* 78(2), 371–448.

Müller-Wille M and Struve K W (eds) 1983, *Vor- und frühgeschichtliche Eisengewinnung*, Sankelmark conference 1980 (Neumünster: *Offa* 40).

Nørbach L C (ed) 2003, *Prehistoric and medieval direct iron smelting in Scandinavia and Europe: Aspects of technology and society*, Sandbjerg conference 1999 (Aarhus: Acta Jutlandica 76).

Ohrenberger A (ed) 1977, *Archäologische Eisenforschung in Europa*, Eisenstadt conference 1975 (Eisenstadt: Wissenschaftliche Arbeiten aus dem Burgenland 59).

Paquier M and Mangin M (with the collaboration of A Jockenhövel, F Lassus, R Pleiner, J-L Rémy and V Serneels) 1992, *Bibliographie mines et métallurgie anciennes, Le fer* (Besançon).

Pleiner R 1955, *Výroba železa ve slovanské huti u Želechovic na Uničovsku* [Production of iron in a Slavonic furnace at Želechovice] (Prague).

Pleiner R 1958, *Základy slovanského železářského hutnictví v českých zemích. Vývoj přímé výroby železa z rud od doby halštatské do 12. věku* [Fundamentals of Slavonic iron metallurgy in Bohemia. Development of direct production of iron from the Hallstatt period to the 12th century AD] (Prague).

Pleiner R 1962, *Staré evropské kovářství* [Ancient European Blacksmithing] (Prague).

Pleiner R 1967, 'Preliminary evaluation of the 1966 metallurgical investigations in Iran', in Caldwell (ed), 340–405.
Pleiner R 1969, *Iron working in ancient Greece* (Prague).
Pleiner R 1969, 'Experimental smelting of steel in early medieval furnaces', *Památky archeologické* 60, 458–487.
Pleiner R 1979, 'K vývoji slovanské nožířské techniky v Čechách' [On the development of the Slavic cutlery technology in Bohemia], *Archeologické rozhledy* 31(3), 245–256.
Pleiner R (ed) 1989, *Archaeometallurgy of iron 1967–1987*, Liblice conference 1987 (Prague).
Pleiner R 1991, 'Professor Ronald Frank Tylecote 1916–1990. In Europe …', *Historical Metallurgy* 25(1), 4–5.
Pleiner R 1993, *The Celtic Sword* (Oxford).
Pleiner R 1994, *Minilexikon k dějinám lodí a námořní plavby* [Minilexicon of the history of ships and shipping] (Prague).
Pleiner R 1995, 'Small-scale rural ironmaking in Migration period Bohemia', in Magnusson (ed), 115–123.
Pleiner R (tr) 1998a, *Ponorky útočí: ofenziva německých ponorek 1914–1945* (Prague), translation of V E Tarrant 1989, *The U-boat offensive, 1914–1945* (London).
Pleiner R 1998b, 'A celtic bronze-coated iron sword blade from Manching', in T Rehren, A Hauptmann and J D Muhly (eds), *Metallurgica Antiqua: In honour of Hans-Gert Bachmann and Robert Maddin* (Bochum: *Der Anschnitt* Beiheft 8), 163–170.
Pleiner R 2000, *Iron in archaeology: The European bloomery smelters* (Prague).
Pleiner R 2006, *Iron in archaeology: The early European blacksmiths* (Prague).
Pleiner R 2008, 'Iron in the Eurasian Bronze Age', in Forenius *et al* (eds), 177–186.
Pleiner R and Bjorkman J 1974, 'The Assyrian Iron Age: The history of iron in the Assyrian civilisation', *Proceedings of the American Philosophical Society*, 118(3), 283–313.
Pleiner R, Fluzin P, Mangin M, Billon M, Dillmann P, Vega E and Rabeisen É 2004, 'Lingots et couteaux en fer d'Alésia, études archéométriques de pièces inédites', *Revue Archéologique de l'Est* 52, 91–130.
Pleinerová I 1986, 'Experiments with building old Slavonic houses and living in them', *Památky archeologické* 77, 104–176.
Radwan M and Pleiner R 1963, 'Polnische-tschechoslowakische Schmelzversuche in den Rennöfen der römerzeitlichen Bauarten' [Polish-Czechoslovak experimental smelting in bloomery furnaces of Roman-period construction], *Archeologické rozhledy* 15, 47–71.
Rostoker W and Bronson B 1990, *Pre-industrial iron: Its technology and ethnography* (Philadelphia: Archeomaterials Monographs 1).
Salin E and France-Lanord A (eds) 1956, *Le fer à travers les âges: hommes et techniques*, Nancy conference 1955 (Nancy: Annales de l'Est 16).
Serneels V and Mangin M 1996, 'Sidérurgie ancienne Âge du Fer – Moyen Age : les zones productives principales entre le Rhin et les Pyrénées', *Revue Archéologique de l'Est* 47, 193–198.
Serning I 1979, 'Prehistoric iron production', in H Clarke (ed), *Iron and man in prehistoric Sweden* (Stockholm), 50–98.
Scott B G and Cleere H (eds) 1987, *The crafts of the blacksmith*, Belfast conference 1984 (Belfast).
Scott B G 1991, *Early Irish ironworking* (Belfast: Ulster Museum Publications 266)
Smith C S, Wertime T A and Pleiner R 1967, 'Preliminary reports of the metallurgical project', in Caldwell (ed), 318–326.
Souchopová V 1978, 'Velkomoravská hutnická dílna v polesí Olomučany' [Great-Moravian bloomery ironworks in the forest of Olomučany], *Sborník Okresniho Musea v Blansku* 10, 10–16.
Sperl G (ed) 1988, *The first iron in the Mediterranean – Il primo ferro nel Mediterraneo*, Populonia-Piombino conference 1983 (Strasbourg: *PACT* 21).
Tizzoni C Cucini and Tizzoni M (eds) 2000, *Il ferro nelle Alpi – Iron in the Alps: Deposits, mines and metallurgy from antiquity to the 16th century*, Bienno conference 1998 (Bienno).
Tholander E 1987, *Experimental studies on early iron-making* (Stockholm).
Thomsen R 1973, 'Remelting of iron in a forge', in Guyan *et al* (eds), 81–83.
Tomas i Morera E (ed) 1995, *La farga catalana en el marc de l'arqueologia siderurgica*, Ripoll conference 1993 (Andorra).
Wagner D B 1990, 'Ancient carburisation of iron to steel: A comment', *Archeomaterials* 4, 111–117.
Wertime T A 1968, 'A metallurgical expedition through the Persian desert', *Science* 159, 927–935.
Zavyalov V I and Ratkin M A 2009, 'Opyty po modelirovaniyu syrodutnogo processa: itogi poslednikh let' [Experiences with the bloomery-process modelling: results of recent years], *Verkhnee Podon'e: Arkheologiya Istoriya* 4 (Tula), 110–117.

The Cover

Radomír Pleiner through the decades: 1962 in Russia, 1970 Eisenstadt conference, 1987 Liblice conference, 1999 Sandbjerg conference, 2005 Prague, 2011 Prague