The Great Age of the *Taschenmikroskop*

Part I

Yuval Goren (Israel)
R. Jordan Kreindler (USA)

Introduction

By the last quarter of the 19th century the traditional light microscope had obtained an extremely high level of performance, both mechanically and optically. Fit and finish were exceptional, especially in England, and numerous adornments such as live boxes, compressoria, and fish plates were common. These adornments often extended over two boxes of accessories. The high quality of these microscopes is exemplified by the Powell & Leland No 1. stand (Fig. 1). They were hand-made and so considerably more expensive than later mass produced factory microscopes.

Figure 1. Powell and Leland #1

These exceptional instruments with their long body tubes, and large and complex substage condensers were developed for rich aristocrats and other wealthy individuals. They were designed more for entertainment and display than scientific research. They were much too expensive and included too many unnecessary extras for general scientific use. The last Powell & Leland microscope was made in 1901 shortly before their business closed [i].

Soon, the growing demand for less expensive microscopes, coincident with the expansion of science, led to an increased demand for quality microscopes from scientists for their investigations. This culminated in the development on the European continent, primarily centered in Germany, of the 'Continental' microscope.

The Continental microscopes with their tell-tale, substantial horseshoe bases, while not as exemplary in terms of fit and finish as English 1st class instruments, met the requirements of scientists for reliability and cost. Their use soon became pervasive, although for a while at the turn of the Century some relatively new manufacturers in England, e.g., Watson, continued to make exceptional quality large 1st class instruments. However, the Continental microscope soon grew to be the ubiquitous instrument for scientists.

Although binocular microscopes, including the popular English Wenham binocular, were popular in the previous century, owing to cost considerations, the early Continental microscopes were initially monocular instruments.

Two decades after the turn of the century, the Continental benchtop microscope was the technological background against which the *taschenmikroskop* was developed.

Figure 2. Leitz 'Continental' Style Microscope c 1899

Overview

The years between the two world wars reflect the revival of the pocket microscope which, originally, was first invented by Benjamin Martin in the early-mid 18th century [ii]. As opposed to the folding or case-mounted microscopes, a "pocket microscope" (German: *taschenmikroskop*) is a miniaturization of the standard bench-top configuration of the compound microscope, preserving most or all of the basic features (base, limb, stage, tube and varying magnifications). As opposed to the miniscope (Fig. 3) [iii] which is basically just the full or partial optical system of a microscope miniaturized to pocket size, this feature makes the pocket microscope an interesting engineering challenge.

Figure 3. Miniscopes

As opposed to other categories of small microscopes, excluding some folded optics types, the pocket microscope is made to high quality standards for professional use by the mobile scientist. Therefore, the manufacturers of the examples discussed below were some of the best

optical makers of their time, some of whom still exist today and still produce high-quality instruments.

Figure 4. Drum Microscope

The heydays of the pocket microscope should be evaluated in their historical, social and economic context, rather than just from an object perspective. While in the late 19th century, small relatively inexpensive "drum microscopes" (Fig. 4) and miniscopes gained popularity both in Europe and the USA, these instruments did not serve professional microscopists and their mass production was intended for popular use.

The peak of success of the high-quality pocket microscopes covers approximately one decade, or slightly more, between the end of World War I and the Great Depression (i.e., roughly 1920 to 1930 and slightly later). Because this was mainly a German phenomenon, the rise of Nazi Germany in 1933 had a significant impact on the production of the *taschenmikroskop*, where production varied inversely with the growth of the German military.

This was an era of exploration, when expeditions into the interior of Africa, Asia and South America became common and field research under unorthodox conditions became more popular. For example, from 1921 and into the 1930s the Mount Everest Committee organized the first seven expeditions, all of which attempted to climb the north side of the summit [iv]. Missions into the Arctic and to Antarctica flourished, such as the Amundsen-Ellsworth North Pole Expedition [v], the Wilkins North Pole Expedition [vi], the Alaskan Geological Survey of the United States Department of Interior [vii], the Byrd Polar Expedition [viii], and more. Other parts of the globe were also surveyed, for example, by the African and Mongolian Expedition of the American Museum of Natural History, the Third Asiatic Expedition, the Smithsonian Chrysler Expedition to Africa and the Bering Sea Expedition [ix].

Small but powerful microscopes were essential to the explorer travelling in exotic countries. They were important for the ship's doctor or the mobile physician in remote regions, to enable immediate examination at the bedside of blood, urine, sperm, and bacterial tests or a syphilis diagnosis. Such conditions required high-quality microscopes that could occupy a minimal space without significantly compromising their optical quality and magnification power.

After World War I, most of the distinguished German optical makers were facing severe economic problems. The military prohibitions set on Germany in June 1919 by the Versailles Treaty brought the affluent military market with its demand for binoculars, telescopes, rifle scopes, periscopes etc, to an abrupt halt. Consequently, the optical companies were forced to seek new niches in the civilian domain. The obvious market lay in science and medicine. However, bench-top microscopes were already produced by many makers and the competition was harsh. German companies pushed their microscope divisions which, in response,

developed innovative solutions for the mobile civilian scientific market with the development of compact, effective, and high-quality travel microscopes of professional caliber.

A number of innovative microscopes were subsequently developed, primarily, by some of the top German optical makers (Ernst Leitz, Moritz Hensoldt & Sons, Carl Zeiss, Goerz, Georg Kremp, and Spindler *&* Hoyer). Some of these designs were copied by English (e.g., C. Baker) and American (e.g., Bausch & Lomb) makers. However this requirement of civilian applications diminished almost as abruptly as it started, when the economic crisis of late 1929 was followed by the rise of Nazi Germany, and the Nazi's disregard for the provisions of the Versailles Treaty [x]. This led to the renewal of military production by the same optical companies. After World War II the production of pocket-sized microscopes for professional scientists almost completely faded away and miniature microscopes were manufactured primarily as toys or for high school students.

Thus the decade from approximately 1920 - 1930 can be considered *"The Great Age of the Taschenmikroskop*".

The authors are both collectors of historical field microscopes and microscopists. One, RJK, is an engineer and scientist, and the other, YG, a microarchaeologist. Our combined collections contain many, if not most, of the significant field microscope models produced during this decade. In an attempt to understand the rise of the *tashchenmikroskop* and the reasons for its demise, in addition to their historic context, we attempted to test each one of these microscopes and review their advantages and pitfalls as seen by the eyes of today's users, with a view to what their contemporary users likely thought. In what follows, we present a short survey of some of the most significant, perhaps even, landmark microscope made and used during the *taschenmikroskop decade*. We will discuss their history, characteristics, cabilities and deficiencies.

The Microscopes

Model Designation: "Junior"

Manufacturer: Spindler & Hoyer
Location: Göttingen, Germany
Production: ~1920-25

In 1898 Julius Adolf Hoyer (1874-1943) joined with August Spindler (1870-1927) to establish the optical company of Spindler & Hoyer in Göttingen. The range of products of Spindler & Hoyer was unusually extensive, including many sorts of instruments. During the two world wars, it was the main supplier

Figure 5. Spindler & Hoyer "Junior", Travel Microscope - Assembled for Use

Figure 6. Spindler & Hoyer "Junior", Travel Microscope - Folded for Storage and in Case

of binoculars to the German army. This successful optical design and manufacturing company still exists today, but with a new name - Linos AG. The name change occurred after management acquisitions of other high-quality optical makers by Spindler & Hoyer.

Linos AG acquired the famous lens manufacturer Rodenstock GmbH in 2000.

To quote from a Linos 2008 press release

> LINOS AG is a manufacturer of sophisticated optical systems that operates all over the world. In line with the corporate principle “Photonics for Innovation“, LINOS is a development partner and supplier for customers in such growth markets as lasers, optical metrology, medicine, biotechnology and semiconductors [xi]

The “Junior” pocket tripod microscope with its three cylindrical legs fits compactly within a black enameled brass cylinder. It appears in the Billings collection, but with “maker unknown" [xii] at the time of Billings catalog publication, rather than showing Spindler & Hoyer as the maker.

Dimensions: Weight: 401 g (packed), 250 g (unpacked). Height: 135 mm (packed), diameter: 40 mm (packed).

Performance: This is a true pocket microscope in the sense that it folds into a small (135 X 40 mm) cylinder. The outer cylinder is made of solid brass, nicely coated with black enamel. Once assembled, the microscope is supported on three somewhat delicate legs. The objective is a three button lens, allowing three different magnifications. This rather anachronistic technique is more typical of late 19th century “drum" microscopes (Fig. 4) . Focusing is accomplished by sliding the body tube in a pressure fit sleeve. Because the tube is short and has no extension ability, total magnifications are low as compared with the equivalent models having a draw-tube (see Hensoldt Tami below). The field with the 3X ocular and three objectives at 50X is 1700µ.

While the optical quality is good, it's limited to magnifications lower than some other somewhat similar contemporaneous models. Although focusing by sliding the tube through its sleeve is rather robust, the microscope lacks fine focusing capabilities. Even at lower magnifications this ability would still be Helpful.

Figure 7. Spindler & Hoyer "Junior" stage, stage clips, and substage mirror

The main drawbacks of the “Junior”, besides its limited magnification is its lack of stability and its small circular stage, with slide holding clips. Its substage mirror is installed just below its tiny stage. The small stage does not allow for the use of standard RMS slides. In addition, slide movement is limited by the tripod legs.

The light weight of the microscope and the pointed tripod legs make it relatively unstable, and the examination of small objects is, arguably, painfully difficult. Changing magnifications requires the removal of the tube and the removal or addition of button objectives.

In summary, the Spindler and Hoyer “Junior” is an attractive small microscope with good optical quality, but the old-fashioned design (even for its era), low magnification, poor stability, and small stage mean that while it's an acceptable general instrument, it's quite unsuited for detailed professional scientific uses. Contemporary scientists would have used it for the gross examination of field samples for subjects to be brought back for further microscopic examination in the laboratory, but not for detailed field analysis.

Model Designation: "Tami "

Manufacturer: Hensoldt
Location: Wetzlar, Germany
Production Year : 1924

Figure 8. Hensoldt Tami

The “Tami" name [xiii] is an abbreviation for German "*taschenmikroskop*", i.e., pocket microscope. The Tami (Fig. 8) is the precursor of a family of pocket microscopes, produced in Germany during the 1920s and into the 1930s for mobile scientific applications. At the time of their production all had relatively high price tags. The cost of a Tami was, possibly, half a month's salary for a workman [xiv]. These pocket-sized instruments were manufactured to high quality optical and mechanical standards. Tamis were finely constructed of sturdy brass with a somewhat crinkled, easy to hold, black finish and adjusted by draw-tubes and knurled tube screw focusing.

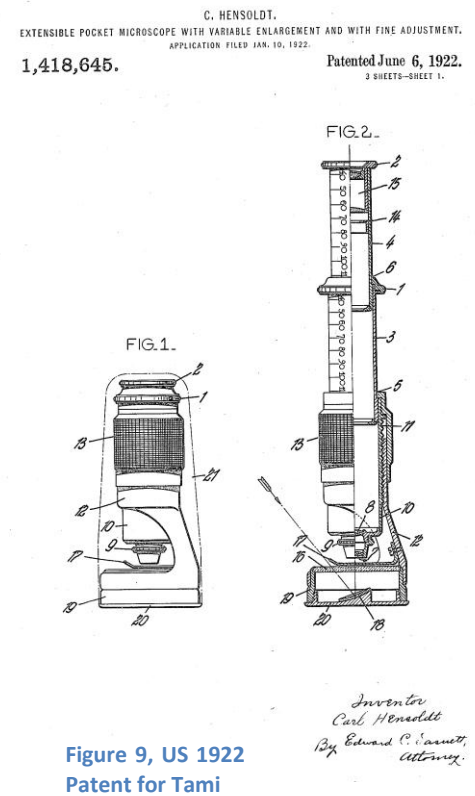

C. HENSOLDT.
EXTENSIBLE POCKET MICROSCOPE WITH VARIABLE ENLARGEMENT AND WITH FINE ADJUSTMENT.
APPLICATION FILED JAN. 10, 1922.
1,418,645. Patented June 6, 1922.
3 SHEETS—SHEET 1.
FIG. 1.
FIG. 2.
Inventor
Carl Hensoldt
By Edward C. Barnett,
Attorney.

Figure 9, US 1922 Patent for Tami

Established by Moritz Carl Hensoldt (1821-1903) as “Optische Werke Moritz Hensoldt & Söhne AG”, the company settled in Wetzlar in 1850. It specialized in the manufacture of binoculars and riflescopes and became a major supplier to the German army during World War I. After the war and with the limitations set on the German military, this production ceased for obvious reasons and the partners started looking for a new line of products for the civilian market.

A patent for the Tami was filed by Carl Hensoldt in Germany in 1921. The US patent dated June 1922 is shown in Fig. 9. The US patent shows an optional light source that can attached to either the base or body tube of the microscope. Tami production began somewhat after patent filing.

In the US patent application Hensoldt notes he has,

> *... invented certain new and useful Improvements in Extensible Pocket Microscopes with Variable Enlargements and with Fine Adjustments.*

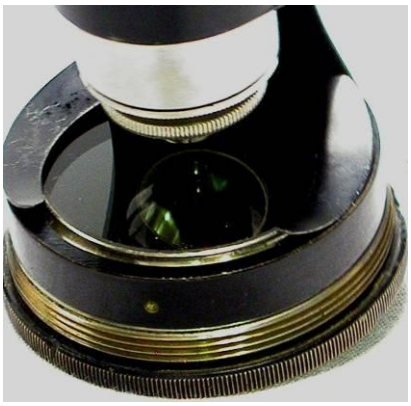
During the following years Hensoldt also produced, respectively, the more elaborate and heavier Metami and Protami models. In 1928, the company was acquired by Carl Zeiss but the brand name Hensoldt was preserved. Since 1964, Carl Zeiss has concentrated its binocular and riflescope production at Hensoldt AG in Wetzlar, Germany.

Today the riflescopes made by Zeiss-Hensoldt still have a worldwide reputation as some of the best of their kind.

The “Tami” is equipped with ocular, separable achromatic objective, glass stage, stage clips, rotatable and removable inclined concave mirror, and conical protective cover. It is marked "D.R.P.a" ("*Deutsches Reichs Patent angemeldet*", i.e., German Reich Patent announced). Using the two-stage telescoping draw-tubes, it has a total magnification range of 35X to 225X.

Dimensions: Weight: 431.5 g (packed), 313 g (unpacked). Height: 100 mm (packed), 200 mm (unpacked, tube fully extended), diameter: 45 mm (base).

Performance: The Tami concept is basically an improvement of the single pillar or “drum” microscope (Fig. 4).



The inconveniently changeable magnification of the older single pillar microscopes by the removal or insertion of button or single objectives is handled here by the manipulation of a draw-tube. The earlier friction based slide tube focusing is replaced by a knurled cylinder control. This concept is consistent throughout the “family”, and the difference between the models is, in the main, the complement of accessories: (1) in the Metatami - an optional higher magnification objective, stage and condenser, and rotatable mirror and (2) in the Protami, among other features, a three objective turret. The three models are increasingly heavy, large, and respectively more expensive.

The optical quality of the Tami is very good for a small microscope and changing the magnifications with the draw-tube is easy. The approximate magnifications are marked on the tube. The field of view is reasonable for the period, 1100µ at 100X. Folding the microscope into the salt shaker shaped cup is easy and the packed microscope is indeed pocket-sized, well protected inside its solid brass cover. However, some ergonomic weaknesses are readily apparent. First, while the tube focusing is sensitive enough for fine-tuning at high magnifications, changing magnifications from low to high with the draw-tube requires extensive

rotation of the focusing tube to achieve a sharp image. Packing the microscope can be done only when the tube is lowered and the objective nearly touches the glass stage. Packing and unpacking also requires extensive revolving of the focusing tube.

The main shortcoming of the Tami is related to its single pillar design. Because the Tami microscopes are cylindrical and cannot be tilted, the microscopist needs to look through the instrument from above. This is corrected in the, considerably more expensive, Protami which provides an accessory stand allowing inclination.

Note: This is Part I of a multi-part paper on *the Great Age of the Taschenmikroskop*.

The authors would appreciate any suggestions for corrections, improvement, or expansion. They can be can be contacted at,

R. Jordan Kreindler: leona111@bellsouth.net
Yuval Goren: ygoren@post.tau.ac.il

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