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## An Animal which Heals Animals. The Medicinal Leech.

Veterinary alternative practitioners take care of animals as their patients. However, animals also can be helpful as therapy assistants, as seen with the medicinal leech (Fig. 1).



Fig. 1 *Hirudo medicinalis* (about 2.5 times the natural size). The posterior part (left side) is resting on a leaf of the Canadian waterweed (*Elodea Canadensis*), has wrapped around and cannot be seen. The sensory vesicles of the sensory rings (two arrows) can be plainly seen. Photograph: Carsten Morkel, ZAUG GmbH (since 2008 Biebertaler Blutegelzucht GmbH)

Examples of application fields in veterinary medicine are acute illnesses such as equine laminitis, traumatic arthritis, tendinitis, and bursitis. In dogs, leeches can be used in arthritis, hip-joint or intervertebral disc diseases, spondylodosis, and local pyoderma. With the particular technique of hirudinopuncture the leeches are positioned on selected acupuncture points (s. ATM-News 1/1995).

The striking benefit of these annelids (next relative is the earthworm) draws interest of many therapists in these archaic animals. These animals with their five pairs of eyes look back to more than 650 million years of successful evolution. This growing interest in leech therapy relates to the various indications as well as to the biologic foundation of their medical effectiveness, their general biology, and conditions of breeding, keeping, or hygiene.



Fig. 2 *Hirudo medicinalis* (about 2.5 times the natural size). The animal looks black due to the mirror illumination. The leech has attached itself with the sucker cup on a glass plate. The star-shaped positioning of the three jaws can be seen clearly. Photograph: Carsten Morkel, ZAUG GmbH (since 2008 Biebertaler Blutegelzucht GmbH)

At a brief glimpse, leeches look archaic. However, up to now, these animals are very successful due to their continuously improving biologic equipment. Their evolutionary refinements sometimes even brought them close to the edge of extinction. From the biologic point of view, there was always a balance between give-and-take. Today, with medicine mostly influenced by modern technology, many therapists consider the use of leeches as an irrational regression into the dark Middle Ages, superstition, or charlatany. Obviously, it is disregarded that the most subtle technical and chemical achievements originate from nature serving as a rich resource for the know-how of bionics and pharmaceutical

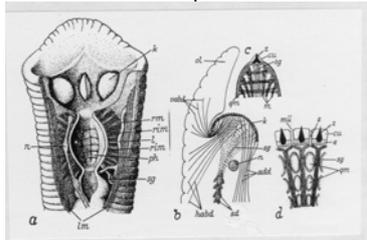


Fig. 3 *Hirudo medicinalis*.  
A) Open anterior part  
B) Longitudinal section with the top lip  
C) Cross section of a jawbone  
D) Longitudinal section of the upper part of the jawbone (add=adductor, cu=cuticula, e=epidermis, habd=posterior adductor, k=jaw, l=lacuna, lm=longitudinal muscle, m=muscles, mü=outlet of saliva ducts, n=nerves, ol=top lip, ph=pharynx, qm=transverse muscles, rim=ring muscles, rm=radial muscles, s=saliva collecting ducts, sd=saliva cells, sg=saliva ducts, vabd=anterior abductor.

companies (e.g. penicillin and others!). A nice example of the subtle natural technique is structure and function of the leech jawbone (Figs. 2-7).

Even if some people still regard leeches with archaic prejudices in mind, the effectiveness of leech therapy in various indications is documented unequivocally by many scientific publications. Leeches belong to the most ancient remedies bearing an immense treasure of empirical knowledge.

The leech bite induces double effects: at the same time injection of salutary substances (e.g. anticoagulants), as well as suction of liquefied thrombus. These features had triggered the comeback of leech therapy in 1987. In this year, the surgeon J. Upton used leeches in reconstructive surgery and salvaged the completely parted ear of a young boy. Initially, the transplantation looked successful. However, a complete grafting was not achieved due to venous congestion. The

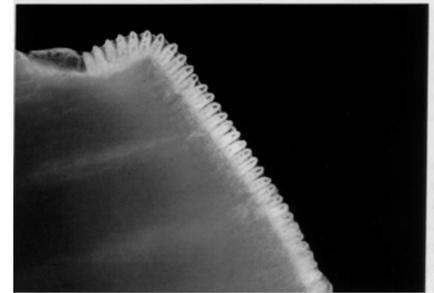


Fig. 4 *Hirudo medicinalis*. Lateral partial view of a jaw with the calcium teeth imbedded in callous muscle mass (with 225 x magnification). Photograph: Carsten Morkel, ZAUG GmbH (since 2008 Biebertaler Blutegelzucht GmbH)

This example shows the micro-surgical work mechanisms of the leech therapy: Following the attachment, the leech saws a Mercedes star shaped wound in a nearly pain-free way into the skin. Evolution has provided the leech for this work with an ingenious tool: the jaws located at the mouth sucker cup (Figs. 3,4,5,6,7,8). In the meantime, the leech injects a cocktail of active ingredients with its saliva from the vents in between the teeth (Figs. 4, 7, 8). The liquefied blood then is aspirated. The unbound small blood vessels and capillaries then had the chance to anastomose, the ear was reattached, and the leech had regained its license to practice medicine.

Nowadays, leeches are frequently used in reconstructive surgery of skin and tissue grafts due to their facilitation of the

reattachment of flaps. A brief summary of the ingredients of the leech saliva and their effects: There is no general difference between the human and veterinary use of leeches. The success of leech therapy results from blood-letting, aspiration, and the effects of the saliva ingredients cocktail released into the star-shaped wound (Fig. 3). As needed in the individual indication, these factors of efficiency contribute differently to the therapeutic effects.



Fig. 5 *Hirudo medicinalis*. Lateral view of the total jaw. The magnitude of the teeth decreases constantly from the interior (left) to the exterior (right) side (with 130 x magnification). Photograph: Carsten Morkel, ZAUG GmbH (since 2008 Biebertaler Blutegelzucht GmbH)

Three lens shaped jaw bars with 80 teeth each (Figs. 5, 6) saw concentric slots into the skin. In between the teeth the ducts of the separate saliva cells emerge (Figs. 4, 7, 8). The secretion of the saliva cells is injected efficiently deeper and deeper with the teeth movements into the dermal layers without considerable pain. It is controversially discussed if these analgesic effects are due to an anaesthetising substance of the saliva.

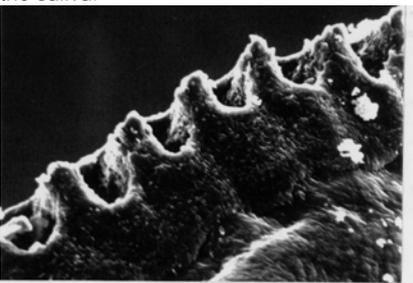


Fig. 6: *Hirudo medicinalis*. Lateral partial view of the teeth bar of a jaw. The saliva ducts are situated in the intermediate spaces between the teeth (2400 x magnification). Photograph: Carsten Morkel, ZAUG GmbH (since 2008 Biebertaler Blutegelzucht GmbH)

The efficacy of the injected saliva substances is multifaceted. The most popular substance is HIRUDIN. Hirudin induces a fast anticoagulation by inactivation of the coagulant thrombin. This fast anticoagulation is followed by an inhibition of the wound closure maintained by CALIN for about 12 hours. This is the reason for this long-lasting

after-bleeding. In the initial phase, HYALURONIDASE (known as "spreading factor" with the brand name "Orgelase") clears the way for further substances via mucolytic effects in the interstice.

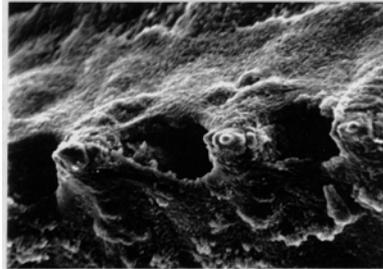


Fig. 7 Overhead shot of the jaw with the peaks of the teeth and saliva ducts. Photograph: Carsten Morkel, ZAUG GmbH (since 2008 Biebertaler Blutegelzucht GmbH)

The mucolytic activity of Hyaluronidase might also attack the mucous bodies of bacteria inducing antibiotic effects. This effect has not yet been proven. After the initial phase, the EGLINS a, b and c are injected into the tissue. These substances have effects on anti-coagulation, elastase and anti-inflammation. BDELLINS, APYRASE and COLLAGENASE play a not yet exactly defined role in anticoagulation, another histamine-like substance induces vasodilatation. There are a lot of further substances with not yet sufficiently defined modes of action. Future discoveries of new substances are likely.



Fig. 8: A few hours old cocoon of *Hirudo medicinalis*. The white exterior foam (consisting of hirudoine) has not yet stiffened. (3.5 x magnification). Photograph: Carsten Morkel, ZAUG GmbH (since 2008 Biebertaler Blutegelzucht GmbH)

The saliva glands are germless even if leeches might harbour parasites in their intestine. Experiments with highly contagious anthrax germs in the leech intestine showed no transmission with leeches properly attached to other animals (Bottenberg H "Die Blutegelbehandlung", Stuttgart 1983).

Eglins exhibit anti-inflammatory effects. The long-lasting after-bleeding due to Calin ensures the cleaning of the wound from secondary infections, and also causes a gentle bloodletting.

In modern ecology the term sustainability means the principle of mutual support. With this strategy we should use our short running resources. We might consider the leeches a good example for this principle.

In our breeding farm, we intend to enable this valuable species an enduring existence at the same time when we are using their therapeutic and pharmaceutical skills. In the 19<sup>th</sup> century, an unjustified overuse nearly exterminated the leeches. At this time, up to 100 leeches were attached to one patient! This method nowadays is called vampirism. Further contributions for extermination were ecologic changes, e.g. drainage of wetlands. In our leech breeding farm, we cultivate leeches but also import leeches from various countries. In our farm, the leeches are comfortable in continuously monitored perfect water conditions. In this environment, the leeches remain healthy, vital, and therapeutically efficient. Our long-term objective is to overcome any obstacles to build up an autarchic breeding farm. One of the obstacles is the feeding with blood which must comply with the legal and hygienic regulations and be well accepted by the leeches.



Fig. 9: Cocoon of the medicinal leech after stiffening of the exterior cover. The cocoon contains between 10 and 30 mature small leeches (5.5 x magnification). Photograph: Carsten Morkel, ZAUG GmbH (since 2008 Biebertaler Blutegelzucht GmbH)

In our breeding farm, the leeches live together with plants and animals of their natural habitat. The continuously monitored physical and chemical parameters are all in line with these requirements. These measures prevent that any of these parameters or germ populations

might get out of control as documented by microbiologic studies performed by an independent institute



Fig. 10: Leech ponds in the breeding farm.  
Photograph: Biebertaler Blutegelzucht GmbH

The breeding animals are raised in our farm for 2 to 3 years after they have deposited their cocoon (Figs. 8-10) at the border of our ponds. The leeches are sold at a weight of 2 to 4 grams. We deliver also smaller or bigger ones by request. The breeding animals are more expensive as compared to the import leeches. Accretion of discount is taken for granted. Postal and packaging accounts are charged in addition. The leeches go on their journey to you in humid sponge or aquatic plants wrapped in linen bags packed in a polystyrene box. They reach you within 1 to 2 days following your order.

At arrival, the animals have to be washed well and to be placed in chlorine-free water with some stones and aquatic plants. The stones and plants facilitate the rather frequent skinning of the leeches. It is important to close the receptacle tightly. Leeches tend to escape! We have constructed together with a pottery a special clay receptacle (Fig. 11)



Fig. 11 Leech receptacle. The external pot holds about 3 l of water, the perforated inner pot can store up to 50 leeches. The inner pot is covered with bayonet cap. The inner part is rough for the leech skinning. For the exchange of water, the inner pot is removed with the strap, the water of the external pot is changed, and the inner pot is placed back. The water pours out via the perforations.

This receptacle simplifies the water changes and keeps the animals secure in an appropriate environment. It is also possible to

keep the leeches in other receptacles, e.g. jelly jars. The need of leeches for high oxygen content is much less than expected: if necessary, the animals can switch to anaerobic respiration.

Some advices and handy tips:

1. The intestinal contents of the leech should never get in touch with the blood of the patient.

Leeches hold in their intestine the indispensable symbiosis bacterium *Aeromonas hydrophila*. This ubiquitous bacterium is not very harmful. However, if the leech vomits in the course of sucking -due to unprofessional squeezing or sprinkling of salt for a premature interruption of the sucking process- and the contents of its intestine gets in touch with the blood of the patient, there is a risk of -mostly harmless- infections. This risk holds in particular true in animals with immune deficiency. Since the leeches all are bundled together in their linen bags, contaminations of the leech surfaces with *Aeromonas hydrophila* cannot be avoided. As said before, the leeches should be washed carefully at their arrival. If possible, they should be kept for about 24 hours in clean, chlorine-free water. Stones and aquatic plants in the receptacle are suitable for the skinning of the leeches, taking place every 2 to 4 days. The skinning can be regarded as changing contaminated clothes. There are also positive features of *Aeromonas hydrophila*: this bacterium strengthens the immune defence and it produces an antibiotic substance to contain the rivals. It is assumed that saliva substances (Hyaluronidase) also have antibiotic effects. Anyway, germs have never been detected in the saliva.

2. Leeches should be used only once. As a prophylactic measure, leeches should only be used once. We certainly respect this rule and our suppliers confirm that the animals do not carry any diseases. It is not worth the effort to keep the animals for a second time use. The efforts to keep them are relatively high. However, if you want to keep the leeches as aquarist, we are happy to consult you.

Cleaning and covering of the wound  
The sites where the leeches are intended to be placed can (not in all cases) be shaved and cleaned with clear water. In the cold, hot water is

recommended. The temperature sensors of the leeches notify the optimum temperature to bite. Since they prefer warm-blooded creatures, they rather avoid cold skin areas. After the bite, an after-bleeding lasts for about 12 hours. The after-bleeding purifies the wound from secondary germs. Nevertheless the wound should be covered well to prevent any germ contamination of the wound. In addition, a good bandage absorbs well the oozing blood. The alternative veterinary practitioner Silke Mai recommends (written communication):

- a) To warm up the target area of the skin, rub it with a terry cloth;
- b) Do not cover the wound with a bandage immediately after the leech has fallen off. Keep the wound uncovered for about 30 minutes and clean off the skin area with a moist towel. This supports the blood flow being strongest during the first hour. Itching and inflammation are supposed to be less pronounced and the therapeutic effect is expected to be stronger. In addition, Silke Mai recommends using sterile compresses instead of cotton wool for covering the wound.

A leech ingests about 20 ml to 50 ml blood depending on its size. The same amount of blood is lost during after-bleeding. The leech is able to ingest about 6 to 10 times of its volume due to the skin shaped like accordion pleats.

Interesting scientific news at the end: Leech neurons have been integrated into computer circuits. They were able to solve simple arithmetic tasks. It was expected that further experiments might bring up future additional surprises. Can this be seen as a triumph of nature or of technology? Despite of all the fascination of these results: Which nature-technology chimeras are supposed to come?

#### Caution!

1. Leeches are not universal remedies. Their application is encouraging in well defined indications.

2. Leech therapy bears a certain risk in small animals with a body weight less than 10 kg.

3. Adverse reactions like allergies or wound infections induced by leeches or saprophytic flora are rare, but they might occur. The animal patients have to be watched by their owners carefully up to one week after treatment.