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Entomotherapy in surgical practice in Ancient Egypt

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Background: Insects are the most diverse and numerous class of animals on earth. Their many species have been used for food and medicine worldwide for thousands of years. The best known is the honeybee and its products, honey, royal jelly and propolis, but many insects and their eggs, larvae, or pupae are also useful for medical purposes.
Materials and Methods: In the ancient Egyptian rational medical records, such as the papyri of Ebers, Hearst, and the Berlin or London medicinal papyri, we find medical recipes that include insects and insect products. We used philological, linguistic, ethnopharmacological and biochemical investigations to reseach their identities, and achieved a case study focusing on the bAybAy insect.
Results: Based on the analysis of ancient Egyptian written sources and medical research, the insects used by the ancient Egyptians for medical purposes are considered - beside the bees or hornets - beetles, ants, locusts or grasshoppers and flies, which are still used as medicines today. The paper also presents a case study of a hitherto unidentified insect, with philological and biochemical explanations.
Conclusion: Insects could be useful medical compounds for wound management, and even ants could be used for it those times.
Keywords: wound treatment; entomotherapy; ancient Egypt; material medica

I. Introduction

Ancient Egyptian medical texts are essentially prescriptions, except for some protocols (SsAw), mostly on the Smith papyrus and the Ebers papyrus. They usually treat trauma cases as a whole or in part. After presenting the patient's symptoms and complaints, the ancient Egyptian diagnosis is made, followed by treatment, mainly with medication. [20]

Research on the mummies shows that there were also real surgical interventions mainly on the extremities of the body or very rarely because of tumors. Such a procedure was called at that time "*knife treatment*" (Dw-a), but we only have a few descriptions of it, and even these are very brief, which means that we do not know how these operations were carried out in the reality. [47, 32]

Much more is known, however, about drug therapy, which is now an additional medical procedure or after-care. Today insect therapy is a dynamically developing trend in the medical and surgical sciences [7] and we wondered if surgical insect therapy had any ancient Egyptian predecessor(s), thus, we began to investigate, and our initial results [6] were further expanded.

II. Material and Methods

The first step was to collect the prescriptions containing insects. This appears to be a straightforward process, but the difficulty is, that many *materia medica* are still unidentified in the ancient Egyptian medical literature. In the ancient Egyptian writing system, a classifier at the end of a word usually determines the broad or narrow category of the word's meaning. So we often do not know what species the word means, however, we do know that it means a plant, a tree, a large animal, a beetle, a powder, a stone/mineral, or an airborne creature [39], i.e. a bird or a flying insect, or some sort of bee-like, grasshopper-like, cattle-like or other material. In addition, the words themselves can have broad or narrow meanings. A great example is the nht, which is the name of the sycamore tree, but in a broad sense, it could be used for any species, as a general term for the tree; or the jSd, which means the specific fruit of Balanites(?), but is also used as a general term for fruit.

This article aims to compare the role of insects in wound healing with the current knowledge based on the results of modern medicine by examining ancient Egyptian recipes. In particular, we have relied on the comprehensive review published in Current Medicinal Chemistry,[10] in which the authors have summarized all the research results available on insect therapy over the last few decades. This research has helped us to understand the efficacy of various insect compounds, ingredients considered magical in earlier works. We focused on insects/insect derivatives that could have been used by ancient Egyptian doctors for wound healing (by compounds, such as chitosan, sericin, bee venom, angiopoietin-1, serine proteases, etc.). Thanks to the more and more extensive new research trend, we now know many peptides and their effects in promoting wound healing, preventing infection and ensuring rapid regeneration, such as alloferon (antiviral), harmoniasin (antimicrobial), cecropin (antiviral, antifungal, antibacterial), drosomycin, heliomycin, thanatin (antifungal), etc. Based on this knowledge, we can give some hypothetical interpretations of the effectiveness of ancient insect therapy.

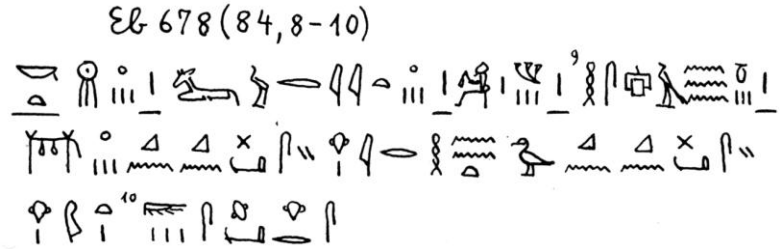
III. Results

We have made an overview of all the *materia medica* in the ancient Egyptian drug vocabulary,[16] categorized with the bird sign (G39 [21], which is written by the image of a pintail duck / *Dafila acuta* species), the beetle, the bee, the fly and any image that might represent an insect or airborne animal. Some words known from other sources, and already identified as de facto bird, were excluded. We could select as certain insects: the aff / fly, xprr / (dung)beetle, apSA.t / insect [4] and Hkwn / meaning unknown, but ending with the scarab sign. What remained are often *hapax*, so the given medical recipes are the only places the words are known from.

We further investigated the remaining bird/insect's names, namely: jrHnn.t, jdw, wjA.t, mSa, bAybAy (bjbjw in in the ancient Egyptian drug vocabulary [16]), Hkwn, Hwr, sHyH.t and gAbgw to select the birds. Since wjA. t has the bile, mSa the heart, gAbgw the spine, bone, egg and blood, they can only be birds. The *jdw* is questionable because it has excrement (Hs). As the same Hs-word is used with aff, which is a well-known insect also from different types of text, the identification of jdw with a bird, is uncertain, thus it cannot be excluded from insects.

For practical reasons, jrHnn.t is most likely an insect: the medicine was prepared on it, on its wings resp., and a stiff part of the body was bandaged with this mixture. A bird's wing would be too stiff and large, to use as a softening bandage. However, there is some uncertainty here: the Wörterbuch/TLA [19, 48] explains it as a bird, and so does Lutz Popko in his online translation [44]. Indeed, bird wings (or parts of them) could have been a good splinting instrument to fix a broken extremity. A limb could also be attached to a small branch (or to the other limb), and small animal bones could also be used as stiffeners. For example, a small bird's wing, could be used to fix a human hand or fingers, while a larger bird's wing could be used to fix and stabilize an arm. In such a case, it is likely that the arm was attached to the wing by some kind of binding material (tape, gauze, bandage, etc.). However, nxt.t was used here for "*softening the stiffness"* (gnn nxt.t), which is generally interpreted as arthrosis, and this recipe treats such a case felt anywhere in the body (m a.t nb.t). As it is a k.t-recipe, we can find this aim in a previous recipe (Eb675): k.t: gnn nxt.t. m a.t nb.t / *Another one to soften the stiffness at any body part*.

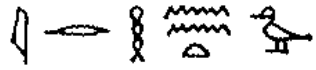
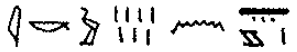
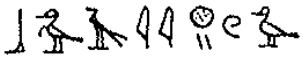
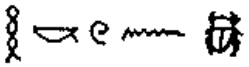
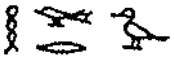
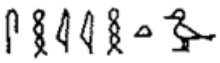
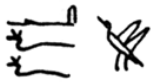
Recipe no. 678 in the Ebers papyrus, column 84, lines 8-10:



k.t: psD 1, jwry.t 1, Sps 1, HsA 1, jSd/jArr.wt(?) 1,
qnqn sy Hr jrHnn.t,
qnqn sy Hr Sw.wt=s,
wt Hr=s.
Another one: psD-powder 1, broad-beans(?) 1, Sps-plant (Cinnamomum camphora?) 1, mucus 1, Balanites/grapes(?) 1,
Crush them on jrHnn.t, crush them on its wings.
Bandage on it.

In the case of bAybAy (read as bjbjw in Drogenname as mentioned above), it is unlikely that a bird's nest was used mixed with honey, thus most probably this word means an insect. In the case of Hwr, the "*blood*" (znf) of

the animal was used together with the "*blood*" of the fly along with various vegetable substances. Because of parallelism with fly, this creature was most probably similarly an insect. In the case of sHyH.t, we can be sure that it is an insect since the whole animal was crushed in a mortar and the patient's leg sore (mr.t m rd) was bandaged in such a way that the pieces of the whole animal were placed in the paste covering the painful part. We also found that "*the* jkw *of the earth*" was an insect: parallel to the fly, 7 pieces were used to dry a wet tumor. Thus, we studied the ancient Egyptian medical papyri and found insects and/or parts of insects in several medical treatments. However, these recipes are unique: in almost all cases, only one application has survived. (See table below)

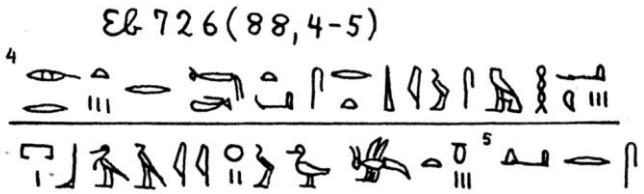
transliteration	hieroglyphic transcription	purpose	method for use	notes
jrHnn.t		Eb678: k.t cf. Eb675: sgnn nxt.t. m a.t nb.t „*to soften the stiffness in any body-part"*	wt Hr=s / "*to bandage it"*	
jkw (n tA)		Eb576: k.t cf. Eb565/H127: dr Sfw.t m a.t nb.t „*to eliminate the* Sfwt-*swelling in any part of the body*"	wt … Hr=s / "*to bandage it"*	Eb565: explains that it is a wound drier /„spw nw jn.t mw m Sfw.t"
jdw		Eb326: HAt-a m pXr.t n.t Sma gHw „*the beginning of medicines to kill* gHw (asthma?)"	swj r hrw 4 / "*drinking 4 days long"*	because it having excrement (Hs), it also might be a bird (Hs n jdw or Hs njdw?)
apSAy.t		Brl59: k.t cf. Brl58 dr aAa n nTr, nTr.t, mt.wt mwt, mwt.t, dr Hw rd-jb …. HAtj, Hna dr mhA.wt-jb *- to eliminate the aAa of the god and goddess, and the poison of the dead male and female,* *- to eliminate the flight of the jb-heart and the (stabbing?) of the HAtj-heart, and* *- to eliminate the forgetfulness of the jb-heart*	kpw s Hr=s / "*to smoke the patient on it"*	known also with a grasshopper-like classifier
bAybAy.w		Eb726: r Sd.t sr.t jw=s „*to pull out the thorn in the flesh*"	rdj r=s / "*to put on it*"	bjbjw reading is given in the Drogenname, p. 169. [16]
Hkwn		Eb817: k.t cf. Eb800: sfx.t Xrd m X.t n.t s.t „*to release a child in the woman's body*"	wt Hr=s / "*to bandage it"*	
Hwr		Eb860: HnHn.t n.t aD m axm=f "*For the fatty tumor on his neck*"	Dw-a + spw n.w srwx s m wt, sd twA.w / "*knife treatment"* + "*drug that treats it by bandaging, and crushing the protuberances"*	
xpr		H115: k.t cf. H114: *sgnn Sw.t m mtw „to soften the Sw.t-bundle in the* mtw."	mjt.t cf. H114: wt Hr=s / "*to bandage it"*	In the Drogenname [16], p. 395-396 xprr reading is given
xpr		Eb733 = H159: dr Hm.wt-zA.w „ *to eliminate the magic craft(?)*"	rdj swj s.t s / "*to let the patient drink it*"	In the Drogenname [16], p. 395-396 xprr reading is given
sHyH.t		Eb606: k.t, cf Eb605: dr mr.t m rd / „*to eliminate the pain in the leg*"	mjt.t cf. Eb605: wt Hr=s / "*to bandage it"*	
aff		will be discussed elsewhere: 14 with its excrement (Hs) 3 with its blood (znf)		in Ebers, Hearst, Berlin, Ramesseum and London medical papyri

IV. Discussion

Most of the recipes are included in the Ebers papyrus, which was written in Thebes before the 9th regnal year of Amenhotep I (c. 1515 BC), the second ruler of the 18th Dynasty (New Kingdom) of Egypt. This 110-page papyrus scroll preserved much older medical texts from several earlier periods. Other New Kingdom papyri contain some further insect-related recipes. For example, the Hearst papyrus, with roughly contemporary content, but probably written during the reign of Thutmosis III, also contains such texts. It was found in Deir el-Ballas, north of Thebes, and about a third of the recipes are parallel to those of the Ebers papyrus. The London medical papyrus (inv. no. EA 10059) and the Berlin medical papyrus (inv. no. 3038) contain some evidence of aff/fly use. The former is dated to the 18th Dynasty, the latter to the reign of Ramses II, and was found at Saqqara. Both are collection books for various treatments. Moreover, even a small fragment of the Ramesseum papyri from the Middle Kingdom (Ram III A.13) contains insects as evidence of the earlier use of insects or insect derivatives as active ingredients.

The bioactive compounds of honey are the most common active ingredients in these recipes although "*fly excrement*" (Hs aff) in 14 recipes including the necessity of its use and hemolymph (znf aff "*blood of the fly*") in 3 recipes, indicate that flies were an important component in the preparation of medicines. Other insects/insect parts were less popular. Their study is complicated by the fact that the exact interpretation of the ancient Egyptian words is often uncertain, and only broad classifications can be made. Precise species cannot be identified, but philological and etymological research can help with narrowing down the options for the interpretation. Even so, we cannot resolve identity. Moreover, we tried to maximize the possibility of identification: after a thorough analysis of the ancient Egyptian text, we collected ethno-medical cases to compare with the physical experiences and observations that could be made about the healing effects of insects. We have analyzed each ancient case separately and collected biomedical results in order to test the possible explanations for the efficacy as much as possible.

Case study: bAybAy
Jr.wt r Sd.t sr.t, jw=s m Ha.w:
pr bAybAy.w, bj.t; rdj r=s.
What is done to take the thorn out, which is in the flesh:
house of the bAybAy-*insects and honey; put on it*.



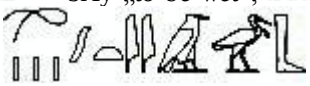
The interpretation of the expression pr bAybAy

The Ebers papyrus recipe number 726 mentions the „*house of* bAybAy (bjbj)". As far as we know, this is the only place where the word occurs, so only the context and etymology can help to determine its meaning. The bird symbol at the end suggests that the Egyptians regarded it as an airborne creature. Not surprisingly, one of the first publications of the papyrus translated it as a bird: "*per-baitbait-Vogel*". [35, 17] Since this recipe only lists the *materia medica*, without any indication of quantity, the separation of each word is indicated by the content and the classifier written at the end of the words. In this case, only the bird and the container after the next word refer to this. Thus, Heinrich Joachim, in the heroic age of Egyptology, understood the group of signs bAybAy as a common concept with the word pr "*house*"; since the birdhouse is a nest, he probably thought it inconceivable that a bird's nest mixed with honey would be placed on a wound to extract the thorn, thus he decided to have a bird name containing the word "*house*".

However, if we look more closely at the text, we see that the pr sign at the beginning of the list is a word sign, as indicated by the vertical line placed below it, so we are dealing with a kind of house. The direct genitive is well known in ancient Egyptian, where the owner follows the name of the object. In other words, in this case, it is still the house of an animal. Since the interpretation of the bird's nest seems really meaningless, bAybAy could be the name of another flying animal, i.e.  could be an insect. This possibility arose already in the very first publication, still in Latin, where the two words were treated as one (pr-bAybAy). [18] In the Egyptian Wörterbuch/TLA [19, 49], however, they were listed as two separate words:

pr and *bjbj* presumably as an insect, and added only as an explanation: "*Art Insekt (?), das ein ‚Haus' hat*". [19, 49] However, the reading of the word changed, and becoming bjbj, which has been used in the literature ever since. However, like Lutz Popko, we consider the reading bAybAy.w, i.e. the plural form of bAybAy, [44] to be correct, because next to the "b" foot hieroglyph (D56), we see the sign of the "bA" jabiru bird (G26, *Ephippiorhynchus senegalensis*) written separately and the drawing of the griffon vulture (G1, *Neophron percnopterus*) with the sound value A / alef. The accentuation of the aleph cannot be accidental, since it indicates the pronunciation of the sound A even in the case of syllabic writing.

Etymology of the word bAybAy

The Wörterbuch [19] enumerates several examples for this type of spelling:  bAbA „*spear*",  bAyw „*hole, waterhole*",  bAA „*eye*",  bAA.wt „*virility*",  bAy „*to be wet*",  bAy "*a kind of sweet cake*",  bAy „*malt*",  bAy.t which means probaly "*oracle"*,  bAy.t "*splendor of a city(?)* " and  bAw.t „*hill*", or  bAy, which is also cited in the Drogenname as a "*sort of fruit*", used in Brl51, with a sharp or bitter taste ("*scharf oder bitter Geschmack"*). [16] The root of the word is therefore "*bA*" or "bAy", which is understood as doubled because of the zp (O50) sign.

Interestingly, there is another animal with the root bA(y): jbAy.t/jAby.t  /  , later jby.t, whose name ends with a bird sign, [39] but in the Book of the Dead of Nebseni (b)bAy.t is written with an insect at the end:  and  . The former is taken as a kind of bird, the latter as an insect. [40] Meeks identified jbAy.t and its variations as a *lapwing (Vanellus vanellus* L.*)*. It hibernates in Egypt and moves with small jumps. [39] The picture of the insect in the Nebseni papyrus gave rise to the idea of identifying it with the praying mantis, but Meeks found that this insect was the ancient Egyptian qd.t, named for its character of turning (qd) its head in 180°. [39] The (b)bAy is attested in two chapters (76 and 104) of the Book of the Dead. The same word with different classifier  is written also in a Nile hymn on a Deir el-Medineh ostracon in the sentence, that they "*collect (*Hr smA*) the honey*", thus the word bj.t / bee is written there (in the masculine or by dropping the ending "t") this way. [39] (This also explains, why the Wörterbuch transcribes the word bAybAy.t as bjbj.) Based on this pronunciation, Meeks identifies the bAybAy word as "*bee*". [39]

Returning to the reduplication, it usually creates important variations in meaning: continuous, repeated or habitual actions, especially for violent movements, [21] so that based on the written form of the word, we can think that the name indicates a characteristic feature of the animal, connected to the stem bA(y). In several cases, this is associated with moisture, as the examples above show. We know the meaning of the reduplicated form of bA, bAbA,  as "*to tremble; to flutter*". However, the same word (bAbA) is also known to mean "*hole, cave*" when it ends with the circle sign  , and we also find it to mean "*to spread; to pour out*" and "*to gush; to flow in waves*". With a prefix H: HbAbA and striding legs classificator, it means "*waddle*" (for ducks). From this, we can conclude that originally the name could be a reduplicated perfective passive participle, a common feature at 2-lit. verbs, and it remained the name of an insect that usually comes out of some kind of cavity, and this movement perhaps looks like waving. It is even

possible that it is characterized by flapping its wings, so that it also might make some kind of sound or visual effect. In the latter case, this would have involved crushing the Elytron.

Interpretation of the expression pr bAybAy

In the case of a beetle or a bug, the "*house*" is difficult to decipher, as it is unlikely to be a real living space. It is more likely to be an abandoned chrysalis or the elytron of the beetle. Considering the latter solutions, the chitinous elytron seems the most likely from a medical point of view, as its chitosan content protects against infection and can be used to stop bleeding. Chitosan was first extracted from the shell of a crab. [8] Chitosan bandages were developed in the United States in 2001 and have been used to treat war victims in Iraq and Afghanistan. This hypoallergenic wound dressing method works by attracting negatively charged red blood cells with positively charged chitosan, to which platelets adhere, and this solidified jelly-like substance seals the bleeding wound and even stops arterial bleeding. [50] The addition of honey, which is not only easy to use but also has anti-inflammatory and antibacterial properties, enhances the effect. [41, 14, 3, 43, 2, 38] The recipe does not describe how the medicine was made, but logically the ingredients were mixed together. This would have involved crushing the Elytron.

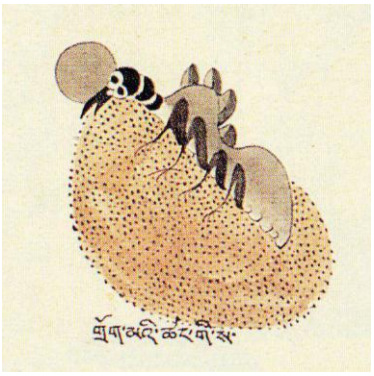
However, insects are a large and diverse category, of which beetles are only one order, and although it is not impossible to call their elythron a house, it is not really likely. We have not found any similar medicinal uses for bugs and butterflies/moths, so we have abandoned this possibility of interpretation. We have sought another solution, looking for Hymenoptera, leaving out flies, as there is the already mentioned ancient Egyptian word, aff, and bee, bj.t in ancient Egyptian, which are used *expressis verbis* in medicinal texts.

The identification of bAybAy

Herman Grapow and Hildegard von Deines pose the question "*Ob bjbj eine Wespenart?*", [16] and are followed by several other researchers. Taking this idea further, they also outline an iatromagical explanation. [16, 24] As Ghalioungui puts it [22]: "it probably does not denote a bird, but rather an insect, perhaps a species of wasp. If this assumption is correct, there may be a connection between the stinging insect and the thorn through sympathetic magic." The same translation is used by Westendorf and the TLA. [49, 52] The wasp's nest can be made of chewed wood, plant fibers and saliva, which is difficult to spray, but in Africa, the wasp's nests are often made of earth and are used for medicinal purposes [34]: the nest is crushed and mixed with water to make a paste, which is used against mumps, rheumatism, closure of the fontanel of babies, infections of the throat, sinusities, boils, ulcers and other inflammations; these last ways of application are attested from Burkina Faso: Mossi; Cameroon: Bamileke; CAR: Kari; Togo: Ewe; Zambia: Tonga. The minerals the mud contains are thought to be the medicine. [36] The wasp's nest is therefore a possible material, although the paste made from it differs from our recipe.

Since the bAybAy can emerge from a house on the ground, we looked for a more suitable flying insect, with an above-ground "*house*" that could also be used as medicine along with the honey. The possibility arose that bAybAy could mean a winged ant, and the house is the anthill. In Tibetan medicine a black ant, called *Formica fusca* L. is mentioned as *materia medica*. [13] The designation of this ant is given by Jampel Dorjé (1792-1855), because of the black colour. He also assumes that these ants emerge from the nest. The Indian ant mounds are large and this is how they are depicted. According to Sangyé Gyatso (1653–1705) [28] in his treatise translated as Blue Beryl and codified in 1687, a medicinal paste made from the soil of the anthill mixed with mustard and honey was used in Tibet to suppress the "*swelling of the flesh*". The case is also depicted in Tibetan medical paintings. [13, 42, 12] Olaf Czaja [13] suggests that the explanation for this method can be found in Ayurvedic medicine, as the 21st chapter the Ashtanghardaya treats the *vata* ("*wind*") disease in the same way. [13, 9] According to the ant-maps [54] or the Egyptian Ants web page compiled by Brian Taylor [53] this species is not proven to live in Egypt, but not all species of ants are necessarily discovered. As there are many different black species of ants, [1] the species may not be important. Furthermore, based on the general description of the ant in Tibetan medical texts, it is doubtful to make an accurate modern species identification. [13]

Compounds found in anthills, such as formic acid, chitosan, proteins and enzymes corresponding to the different developmental stages of ants, together with the active ingredients of honey (vitamins B2, B3, B5, B6, B9, C, chemical elements: Ca, K, Na, Fe, Mg, Zn and P, enzymes and flavonoids) [45, 5, 46], can have excellent disinfecting and wound healing effects.



Czaja 2019, fig.1: After Parfionovitch [42] (Parfionovitch *et al.* 1992, pl. 30)

Formica fusca worker (Wikipedia): https://commons.wikimedia.org/wiki/File:Grauschwarze_Sklavenameise_Formica_fusca_01_(MK).jpg

Formica fusca male (Wikipedia, https://commons.wikimedia.org/wiki/File:Formica_fusca_male_PICT8769.jpg, see also from the side at Gatty images: https://www.gettyimages.com/detail/photo/winged-ant-royalty-free-image/116856677)

Since every ancient Egyptian recipe had both rational and magical effects, [30, 31, 33] this recipe also needed one. We have no textual religious testimony concerning ants, but we can be sure that ancient Egyptians observed how diligently and effectively ants worked, so sympathetic magic could be used here, similar to the previous attempt to explain the use of the wasp nest.

Wound closing ants?

Another ant species that may be of interest in terms of ancient techniques when considering the use of surgical ants is *Dorylus gribodoi*, a soldier ant. These giant ants have been used as a wound closure tool for thousands of years in less developed areas of the world as a means of closing wounds, and are still used today. [55] The "water-drunk" army or legionary ants bite both edges of the wound, and the practitioner then separates the body of the ant from the head. It is considered a relatively safe method due to the antibacterial properties of chitosan, the water purification of the ants and the removal of wound exudate. This species of ant is native to West Africa, and the genus is found throughout Africa, including Egypt, and in south-east Asia, [53] but the *Dorylus gribodoi* species is now found only in tropical Africa. [53] However, we do not know whether it lived in Egypt in ancient times and became extinct there, as for example the Jabiru bird, which is no longer recorded in Egypt, [27] should have lived there at the beginning of the pharaonic culture, as we even have the hieroglyphic sign "bA" representing it.

There is also evidence of similar wound closing use of other ant species. According to E.W. Gudger, [26, 11] the mandible of another genus, the *Atta* sp. was also used to stitch wounds, among others in the Mediterranean region. He also states, that their mandibular glands produce bacteriocidal substances that prevent infection. Rolan Marie [37, 11] noted that the soldier termites *Termites bellicosus* (Smeathman) was used in Somalia for suturing wound. The method therefore seems to have been known in the region in the last century and has ancient roots. If so, this practice may have been a widespread technique that was considered unnecessary to describe in recipes, or it may simply have been, like circumcision, not performed by doctors. [32]

This process could have been carried out by specialists or even by ordinary people. The existence of this method in ancient Egypt requires, however, further research.

Soldier ant in work (https://hu.pinterest.com/pin/391109548883201945/)

V. Conclusion

Unfortunately, the insects in the ancient Egyptian medical applications are difficult to identify, so we tried to decipher these texts using microphilology, ethnopharmacological experience and modern results of biochemical research. We showed that insects were part of rational treatments in ancient Egyptian medical practice, albeit rarely. We pointed out that the recipe Eb726, where the substance next to honey, which was previously interpreted as a magical substance, could be either a wasp or more probably ant, but in both cases its use may have had real healing value. The possibility of the use of ants in medical practice has been raised in several ways. Although these are only possibilities, we nevertheless believe that they could indeed be useful.

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