

Bats as materia medica: an ethnomedical review and implications for conservation

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Abstract. Animal-derived remedies constitute an important branch of traditional medicine (TM) in many parts of the world, particularly for people with limited or no access to Western biomedical services. The use of bats as medicine is reviewed from antiquity to the modern times in different parts of the world, attesting that it is still widespread especially in India and China. The oldest occurrence of bat in medicine is in the Papyrus Ebers (1500 BC). A new medical use of bats could arise from a substance (desmotepase) present in the saliva of the common vampire bat *Desmodus rotundus* and now in clinical trials. Traditionally, exploitation of wild animals in TM has no consideration for its sustainability with regard to populations of the animals in the wild, but recently a new awareness aims to initiate new partnerships between the TM communities and the conservationists about public health, conservation and management of faunistic resources and ecosystem protection. Some comments about the popular use of bat dung in TM are reported in order to investigate the effectiveness of this kind of singular therapy.

Chiroptera, ethnomedicine, traditional medicine, vampire bat, desmotepase, chitin

Introduction

Animal use by human beings dates back to the ancient times. Animals, their parts and their products have constituted a particular sector of medicinal substances in several cultures and such practices continue to play an essential role in world health care (Chivian 1997, Lev 2003, Alves & Rosa 2005, in press, Lev 2006, Newman et al. 2008, Jaroli et al. 2010).

“Ethnobiology is the scientific study of dynamic relationships among peoples, biota, and environments. As a multidisciplinary field, ethnobiology integrates archaeology, geography, systematics, population biology, ecology, mathematical biology, cultural anthropology, ethnography, pharmacology, nutrition, conservation, and sustainable development.” (Society of Ethnobiology); see also Sinha & Sinha (2005) and Anderson et al. (2011). Ethnomedicine is the study of traditional medicines (TM) that have relevant written sources, e.g. Traditional Chinese Medicine (TCM), Siddha, Unani, Ayurveda, but also those whose knowledge and practices have been transmitted orally (Scarpa 1980, Willem et al. 2006, Erickson 2008). Ethnopharmacology is “l’étude scientifique interdisciplinaire de l’ensemble des matières d’origine végétale, animale ou minérale, et des savoirs ou des pratiques s’y rattachant, que les cultures vernaculaires mettent en oeuvre pour modifier les états des organismes vivants, à des fins thérapeutiques, curatives, préventives, ou diagnostiques.” (Fleurentin et al. 1991). “The objectives of ethnopharmacology are to rescue and document an important cultural heritage before it is lost, and to investigate and evaluate the agents employed.” (Holmstedt & Bruhn 1983). Ethnozoology is the study of relationships between the human societies and the animal resources around them. Zootherapy is an important area of ethnozoology, i.e. the healing of human ailments by using therapeutics based on medicines obtained from the animal body, from products of its metabolism (corporal secretions and excrements) or from non-animal materials (nests and cocoons). Every human culture which presents a structured

medical system uses animals as medicines (Costa-Neto 1999, 2005, Jaroli et al. 2010). More than a half of the world's modern drugs are derived from biological resources (Grifo & Rosenthal 1997, Singh 2002, Newman et al. 2008). In TCM more than 1,500 animal species have been recorded and used as medicinal materials (Chan 2005).

Medicinal Use of Bats

“Vespertilio est animal volatile, incertae naturae (It. pipistrello, nottola; Fr. chauve-souris; Hisp. Murciélago; Germ. Die Fledermaus; Angl. A bat or rear-mouse); est enim mediae cuiusdam inter avem et murem speciei, ut mus alatus dici possit. Volat enim pellitis alis, sed inter volucres non est habendus, quod quatuor pedibus graditur, pullosque parit, non ova, quos et lacte nutrit” (Forcellini 1940).

[The bat is a flying animal, of uncertain nature. It has an intermediate shape between the bird and the mouse, so it could be called a winged mouse. It flies with the help of skinny wings, but it should not be considered as one of birds because it moves on four limbs, and it does not lay eggs but gives birth to its young that it feeds on milk” (translation by Marciniak 2001).

Bats have always been an enigma to the naturalists of antiquity in doubt whether they are birds or mammals (Dawson 1925, 1930); they were recognized as mammals only in 1635 by J. Swan. Among the animals employed as materia medica, bats have been in use from the early times and their employment has survived until today.

There is historical evidence that ancient people used plants, animals and minerals for combatting diseases. TM was and still is practised in several parts of the world not only where large ethnic communities live. In Africa up to 80% of the population uses TM, in China the percentage is around 40%. There is also a growing interest in many developed nations: 48% of people in Australia, 70% in Canada, 42% in USA, 38% in Belgium, 75% in France have used TM at least once (WHO 2002).

Africa

Ancient Egypt

The oldest occurrence of bat in medicine is in the Papyrus Ebers, a 110-page scroll, about 20 meters long; it was discovered in a tomb at Thebes in 1862 and it is the longest of the Egyptian medical texts. This papyrus was written in 1500 BC but it is believed to have been copied from texts that date back to 3400 BC (Bryan 1930).

Diseases of the skin.

If the Itch was confined to the Neck, a Chopped-up Bat applied to it as a poultice healed it at once.

Diseases of the eyes to drive out trichiasis

Myrrh	I	[= 1 part]
Lizard's Blood	I	" "
Bat's Blood	I	" "

Tear out the Hairs and put thereon in order to make him well.

To prevent the hair [eye-lashes] growing into the eye after it has been pulled out

Bat's Blood	I	[= 1 part]
Rim-of-a-new-hennu-vessel	I	" "
Honey	I	" "

Powder and place where the Hair has been pulled out.

We can also find the bat in another medical papyrus, the “Demotic Magical Papyrus of London and Leiden”, discovered at Thebes in the early 19th century and dated back to the 2nd century AD (Griffith & Thompson 1904).

You put a night-jar's blood into his eye; then he is blinded.
You put a bat's blood; this is the manner of it again.

A subsequent medical text dealing with bats was found at Mashaich (Lepidontopolis), opposite Girga, in 1892–1893; this Coptic papyrus roll (IX–X sec. AD) is now deposited in the French Archaeological Institute in Cairo (Chassinat 1921).

In the 194th prescription, the urine of a bat, well mixed with the gall of the fish *Cyprinus niloticus*, together with the juice of wild rue, is directed to be used to cure dimness of sight.

(Dawson 1925).

Algeria

The Algerian medical writer Abd al-Razzaq (*1695 – † after 1748) mentions the bat in his book *Kachefer-roumouz* [*Révélation des énigmes*] in the list of Materia Medica but without any specific details about its use.

Khouffach. Chauve-Souris. C'est l'*ouathouat*, l'oiseau de nuit.

Note. – La chauve-souris se dit généralement en Algérie *their ellil*, oiseau de nuit.

(Abd al-Razzak Ibn Muhammad 1874)

Senegal

While undertaking a roost search at Fadial, in the Joal-Fadiouth region, of Senegal on the 5th December 2010, we found a cavity in a Baobab (*Adansonia digitata*) which houses a colony of about 1,200 *Rhinolophus fumigatus* Rüppell, 1842 ... From discussions with local people around the roost, we learnt that a marabout (traditional healer), living about 1 km from the roost, sometimes used bats from this colony in his traditional medicine. The marabout, Mr Famara Sarr, who accepted an interview with us, confirmed that he often uses bats from this colony for potions, which are administered to patients with mental illnesses. His reasoning, to include bats as part of the potion for mental illness, is they have night-flying ability, which infers a symbol of orientation. Patients, who have mental illness, have, according to Mr Sarr, orientation problems. Therefore, the ingestion of certain parts of bats can recover their mental orientation. Depending on the seriousness and type of illness, he uses only the head of the bats, but in serious cases of disorientation, the whole body is utilized.

(Lelant & Chenaival 2012)

Benin

Percentage of traders (N=110) recorded to sell mammal species in the Benin traditional medicine market, with indication of conservation status of the traded species.

Scientific names: *Rousettus aegyptiacus* (E. Geoffroy, 1810); Frequency of traders selling the species (%): 49.1; IUCN Red list: LC [Least Concern]; Benin Red list: VU [Vulnerable].

(Djagoun et al. in press)

Nigeria

Traditional healing existed in Africa long before the advent of more orthodox, modern medicine, and the people depended largely on traditional medicine as their only source of health-care. Traditional medicine as practised today continues to live side-by-side with modern medicine, and continues actively in Nigeria in the face of new discoveries.

(Adeola 1992)

Composition of Wild Animals' Use by Nigerian Farmers for Medicinal Purposes in 1986.

Species: Straw-coloured Fruit-bat (*Eidolon helvum*)

savanna zone n. 240 farmers		deciduous zone n. 120 farmers		rain-forest zone n. 120 farmers	
Nos	%	Nos	%	Nos	%
–	–	–	–	1	8

(Adeola 1992)

Europe

Roman Empire

Gaius Plinius Secundus (* 23 – † 25 August 79; died in the eruption that destroyed Pompeii), better known as Plinius Senior (Pliny the Elder), was a Roman naturalist and natural philosopher. Pliny's last work was the *Historia Naturalis* [Natural History], an encyclopedia into which he collected much of the knowledge of his time. The *Natural History* consists of 37 books, pharmacology being covered in books from XXVIII to XXXII and here we find both magical and medical use of the bat.

Book 29, Cap. 26 (Remedies derived from other birds)

cuius generis prope videri possint quae tradunt et de vespertilione, si ter circumlatus domui vivus super fenestram inverso capite adfigatur, amuletum esse, privatimque ovilibus circumlatum totiens et pedibus suspensum super limen. sanguinem quoque eius cum carduo contra serpentium ictus inter praecipua laudant

(Pliny the Elder 1906, Teubner)

What they tell us, too, about the bat, appears to belong to pretty much the same class of stories: if one of these animals is carried alive, three times round a house, they say, and then nailed outside of the window with the head downwards, it will have all the effects of a countercharm: they assert, also, that the bat is a most excellent preservative for sheepfolds, being first carried three times round them, and then hung up by the foot over the lintel of the door. The blood of the bat is also recommended by them as a sovereign remedy, in combination with a thistle, for injuries inflicted by serpents.

(Pliny the Elder 1855, Bostock)

Book 29, Cap. 27 (Remedies for the bite of the phalangium. The several varieties of that insect and of the spider)

Muris aranei morsus sanatur coagulo agni e vino potio, unguis arietinae cinere cum melle, mustelae catulo ut in serpentibus dictum est. si iumenta momorderit, mus recens cum sale inponitur aut fel vespertilionibus ex aceto.

(Pliny the Elder 1906, Teubner)

The bite of the shrewmouse is cured by taking lamb's rennet in wine; the ashes of a ram's foot with honey; or a young weasel, prepared in manner already mentioned by us when speaking of serpents. In cases where a shrewmouse has bitten beasts of burden, a mouse, fresh caught, is applied to the wound with oil, or a bat's gall with vinegar.

(Pliny the Elder 1855, Bostock)

Book 29, Cap. 29 (Remedies derived from various insects)

Est et formicarum genus venenatum, non fere in Italia. solipugas Cicero appellat, salpugas Baetica. his cor vespertilionis contrarium omnibusque formicis. Salamandris cantharidas diximus resistere.

(Pliny the Elder 1906, Teubner)

There is a kind of venomous ant, by no means common in Italy; Cicero calls it "solipuga," and in Baetica it is known as "salpuga". The proper remedy for its venom and that of all kinds of ants is a bat's heart. We have already stated that cantharides are an antidote to the salamander.

(Pliny the Elder 1855, Bostock)

Book 30, Cap. 46 (Various kinds of depilatories)

Vespertilionum sanguis psilotri vim habet, sed alis puerorum inlitus non satis proficit, nisi aerugo vel cicutae semen postea inducatur; sic enim aut in totum tolluntur pili aut non excedunt lanuginem. idem et cerebro eorum profici putant; est autem duplex, rubens tique et candidum. aliqui sanguinem et iocur eiusdem admiscunt. quidam in III heminis olei discocunt viperam exemptis ossibus, psilotri vice utuntur, evolsis prius pilis, quos renasci nolunt. fel irenaei psilotrum est, utique mixtum vespertilionis cerebro et lacte caprino, item per se cinis. lacte canis primiparae, prius evolsis pilis vel nondum natis, perunctae partes alios non sufficiunt.

(Pliny the Elder 1906, Teubner)

Bats' blood has all the virtues of a depilatory: but if applied to the cheeks of youths, it will not be found sufficiently efficacious, unless it is immediately followed up by an application of verdigrease or hemlock-seed; this method having the effect of entirely removing the hair, or at least reducing it to the state of a fine down. It is generally thought, too, that bats' brains are productive of a similar effect; there being two kinds of these brains, the red and the white. Some persons mix with the brains the blood and liver of the same animal: others, again, boil down a viper in three semisextarii of oil, and, after boning it, use it as a depilatory, first pulling out the hairs that are wanted not to grow. The gall of a hedgehog is a depilatory, more particularly if mixed with bats' brains and goats' milk: the ashes, too, of a burnt hedgehog are used for a similar purpose.

(Pliny the Elder 1855, Bostock)

Book 30, Cap. 48 (Provocatives of sleep)

Somnos adicit oesypum cum murrae momento in vini cyathis II dilutum vel cum adipe anserino et vino myrrite, avis cuculus leporina pelle adalligatus, ardiolae rostrum in pelle asinina fronti adalligatum. putant et per se rostrum effectus eius esse vino collutum. e diverso sumnum arcet vespertilionibus caput aridum adalligatum.

(Pliny the Elder 1855, Teubner)

As a soporific, wool-grease is employed, diluted in two cyathi of wine with a modicum of myrrh, or else mixed with goose-grease and myrtle wine. For a similar purpose also, a cuckoo is attached to the body in a hare's skin, or a young heron's bill to the forehead in an ass's skin: it is thought, too, that the beak alone, steeped in wine, is equally efficacious. On the other hand, a bat's head, dried and worn as an amulet, acts as a preventive of sleep.

(Pliny the Elder 1906, Bostock)

Book 30, Cap. 49 (Aphrodisiacs and antaphrodisiacs)

mirum et de stelionis cinere, si verum est, linamento involutum in sinistra manu venerem stimulare, si transferatur in dextram, inhibere, item vespertilionis sanguinem collectum flocco subpositumque capiti mulierum libidinem movere aut anseris linguam in cibo vel potione sumptam.

(Pliny the Elder 1906, Teubner)

A singular thing, too, is what is told about the ashes of a spotted lizard – if indeed it is true – to the effect that, wrapped in linen and held in the left hand, they act as an aphrodisiac, while, on the contrary, if they are transferred to the right, they will take effect as an antaphrodisiac. A bat's blood, too, they say, received on a flock of wool and placed beneath a woman's head, will promote sexual desire; the same being the case also with a goose's tongue, taken with the food or drink.

(Pliny the Elder 1855, Bostock)

Italy

Ulisse Aldrovandi (*1522 – †1605) was an Italian naturalist; he was considered the father of modern natural history studies by Linnaeus and Buffon. Like in Gesner (see below) most of the accounts of animals derives from ancient sources, in particular Aristotle, Pliny and the Old Testament, combined with folklore and with information from medieval scholars such as Albertus Magnus. A wide section under the chapter “De Vespertilione” is entitled “Medica” and it is full of indications about the use of bats or their parts coming from older authors; several of these usages are similar to those of Gesner (see below). A prescription about trichiasis (misdirection of eyelashes toward the globe) (Aldrovandi 1599):

Ad trichiasin, qua oculi palpebraru pilis infestantur, Archigenes apud Galenum Vespertilionis sanguine alijs quibusdam miscet, vt & Ant

Collectio Salernitana is a four-volume compilation of medical writings of the school of Salerno, published by Salvatore De Renzi (*1799 – †1872) between 1852 and 1859.

Remedy for hair removal

Cap. 3. De diversitatibus psilotri. [Psilòthrum: substance causing loss of hair, a depilatory]. Pundos ad equale sanguis vespertilionis Et sanguis veteris hirci: prestantior illo sanguinis est pulvis.

(De Renzi 1856)

Another prescription for the same indication:

De pilis evulsis ne iterum crescant. Ne crescant iterum loca qaelibet unge pilorum, Verbene succo mixto vespertilionis Sanguine

(De Renzi 1856)

England

Saeger (1896): his book presents in a convenient form for reference a collection of the quaint theories about Natural History accepted by Shakespeare and his contemporaries. The plan of the book is to give some illustration of each word mentioned by Shakespeare ... All the quotations inserted in this book are from works which were the standard authorities in Shakespeare's time

Bat. All the charms
Of Sycorax, toads, beetles, bats, light on you.
Tempest, i. 2, 339–40.

Wool of bat, and tongue of dog.
Macbeth, iv. i, 15.

The rermouse [i.e. Bat] hating light flyeth in the eventide with breaking and blenching and swift moving, with full small skin of her wings. And is a beast like to a mouse in sounding with voice, in piping and crying. And he is like to a bird, and also to a four-footed beast; and that is but sold found among birds. Reremice be blind as moles, and lick powder [dust] and suck oil out of lamps, and be most cold of kind; therefore the blood of a rermouse [a]noointed upon the eye-lids suffereth not the hair to grow again.

Bartholomaeus Anglicus [Bartholomew] (*1203–†1272) – *De Proprietatibus Rerum* [*On the Order of Things*] is an encyclopedia dating from the 13th century.

Bartholomew [Berthelet], bk. xii. § 38. [*Rermouse* is derived from the Anglo-Saxon *raeran* “to raise” or “rise up” (Dawson 1930)]

Albertus Magnus (*ca.1206 – †1280) – Alberti Magni, *De Secretis Mulierum libellus, ... de mirabilibus mundi, ...* 1553.

If you wish to see anything submerged and deep in the night, and that it may not be more hidden from thee than in the day, and that you may read books in a dark night, – anoint your face with the blood of a Bat, and that will happen which I say.

(Seager 1896)

Sir Theodore Turquet de Mayerne [or Mayenne] (*1573 – †1655) was the physician to French and English kings.

Mayenne's “Balsam of Bats,” an unguent for hypochondriacal persons, composed of adders, bats, sucking-whelps, earth-worms, hog's grease, the marrow of a stag, and the thigh-bone of an ox.

(Ditchfield 1974)

The bat is still mentioned in the western Pharmacopoeia of the 18th century.

Vespertilio, Offic. The Bat, or Flitter Mouse. It appears in Summer Evenings, but in the Winter lies hid in Rocks and Caverns. The Flesh and Blood of this Animal are used; the first of which, being prepared, is good for a *Scirrhus*, and the Gout; and the Blood cures an *Alopecia*.

(James 1747)

Sweden

Peter Forskål (*1732 – †1763) was a Swedish explorer, orientalist, naturalist and a student of Carl Linnaeus. His important work *Descriptiones animalium* ... was published twelve years after his death.

Vespertilio. Adfta. Arabes e desertis adferunt stercus Vespertil. quod frequenti usu medico adhibetur interne. Externe aceto mixtum tumoribus imponitur.

(Forskål 1775).

... the desert Arabs gather the substance [dung] for frequent medicinal use, taking it internally; mixed with vinegar, it was applied externally upon tumors

(Allen 2004).

Switzerland

Historiae animalium, published at Zurich in 1551–1558 and 1587, is an encyclopedic work of zoology by Conrad Gesner (*1516 – †1565). It is the first modern zoological work that attempts to describe all the animals known; the five volumes of natural history of animals consist of more than 4500 pages. A recipe for a bat oilment for the cure of rheumatism: take twelve bats, St. John wort, rancid butter, aristolochia and castor, and boil together until it becomes an unguent (Allen 2004).

Arthriticis doloribus utile est oleum vespertilionu,quod ita paratur. Accipe vespertiliones duodecim: fucci almarmacor (marmacor vel marmauzi est herba quam Veneti vulgò appellant herbam S. Ioannis, cuius semen est seme maru, Bellunensis. Monachi qui Mesuae compositiones interpretantur, marmacor ab alijs aliter exponi docent,ipsi melissophyllon esse potissimum approbant, negant autem esse herbam quae herba S.Ioannis dicatur in ditione pontificis Rom. quam ipsi eupatorium Mesuae faciunta vulgo quidem in diversis regionibus diversae herbae S. Ioannis appellantur) & olei veteris(ana)libras. Aristolochiae, castorei,ana drach.iiij. Costi drach.iiij.Decoquantur simul ut consumatur aqua (succus herbae) & remaneat oleum, Avicenna

(Gesner 1555)

Several more prescriptions are mentioned in *Historiae animalium* under the chapter “De Vespertilione”; they are usually taken from earlier authors with particular reference to Pliny.

Asia

Middle East

In Assyrian medicine the bat was used to turn grey hair black and also for making hair grow.

Assyrian medical texts from Ashurbanipal’s library – 7th century BC (Campbell Thompson 1923):

thou shalt take the head of a male *issur hurri* [bat], boil, . . . apply, and the grey hair shall turn black.
prescribes the head of a bat boiled in oil, for making hair grow

Syrian anatomy, pathology and therapeutics or *The Book of Medicines*. The English text of the great Syriac Book of Medicines, drawn from a rare manuscript probably of the 12th century BC, was published for the first time by Budge (1913):

Another, for dimness of vision and stoppage of the flow of water...

Another, which is good for [these] ailments. Burn the heads of young swallows (or, bats), and pound them, and work up together with honey, and smear on the eyelids.

Another, which cleanseth filminess, and filleth the cracks, and removeth scabies of long standing.

sugar of the axe (i.e., rock sugar)	1 drachm
sepia	2 drachms
dross of brass	2 "
white lead	2 "
fine flour	3 "
unpierced pearls	3 "
cassia	1 drachm
Alexandrian glass	4 drachms
castoreum	2 "
bats' dung	2 "
gum Arabic	1 drachm
tragacanth	1 "
Persian gum (sarcocolla)	1 "
lizard's dung	1 "
starch	1 "
ointment of lye ashes	1 "
Bumt brass	4 drachms

Rub down to a powder very carefully, and use dry as *kohl*. [ancient eye cosmetic]" [1 drachm ~ 4 g]

Antidote which is good for the spleen, and stomach, and liver ... kill a bat, dry it, pound it, and administer as much as will lie on the top of the [thumb] nail in hot water.

A medicine to make the hair grow ... cut off a bat's head, and boil it in olive oil, and rub it on the piace where thou wishest the hair to grow, and it will grow.

A medicine for destroying the hair ... smear the blood of bats on the place where thou wishest the hair not to grow, and it will not do so.

(Budge 1913)

Lev (2003) reports the still existing use of the bat in the Middle East:

Present-day medical uses of animals in the Levant.

Scientific name (Unidentified), Common name (Bat), Extract/product (Flesh smoke, brain, blood), Sources and main medicinal uses – ethnopharmacology (AR, BY [medicinal uses of animals among the Bedouins in Israel – AR and among Israeli Jews of Iraqi – BY] fever, eye disease, prevents hair growing)

One of the most famous Arabic books in *Materia Medica* was written by Ibn Al Baytār (*ca. 1190 – †1248) in 1240–1248. This book is entitled *Al-Jāmi li-Mufradât al-Adwiyah wa-l-Aghdhiyah*, i.e. *The Collection Regarding the Simple Drugs and Nourishments*. Al-Jāmi enumerates alphabetically 1,400 animal, vegetable and mineral medicines; the main contribution of Ibn al-Baytār was the systematization of the discoveries made by Arabs during the Middle Ages, which added between 300 and 400 medicines to the thousand known since antiquity (Ibn Al Baytar 1987). A detailed section is devoted to the bat. For the translation to French of the original Arabic text see Ibn Al Baytar (1987).

A bat, killed and rubbed on the pubic region of children prevents the browth of hair. Cooked in Sesame oil, it is an embrocation for sciatica. The belly is relaxed and pain in the loins are assuaged by by its decoction. Another embrocation for gout, paralysis, and asthma is made by cooking a bat in oil of jasmine, and allowing it to macerate in a metal pot. It assists difficult labour and promotes delivery immediately, if its gall is applied to the vulva: this is stated to have been tried by experience. Boiled in water, and its decoction applied to the organ, it assists urination, and the same decoction, in a bath, cures paralysis. Bat's brain, pounded and boiled is used as a collyrium for leucoma of the eyes, and, mixed with onion-juice, the brain is used as a collyrium for cataract. If a bat's head be put under a man's pillow without his knowledge, he is a victim to insomnia. The bat's heart has the same properties. If the head of a bat be buried near a dove-cote the birds will not forsake it, and if put in a mouse-hole the mice will instantly quit. ... the dung of a bat, or its urine, dissolves stones in the bladder, and cures leucoma of the eyes.

(Dawson 1925).

Afghanistan and Pakistan

I was told that in the NWFP [North-West Frontier Province, Pakistan] and the Punjab magicians (jadūgār) would frequently use bat bones to prepare their concoctions. In Mardan [Pakistan] a villager acquainted with magical knowledge assured me that, by orally taking sweat or grease from the bat's wingpits, the intelligence of a person would grow considerably (which sounds like a distant echo of Greek thoughts about the association of the bat with learning) ... In Burushaski [Pakistan] bat droppings are called badāa naghé ..., a word denoting natural bitumen which is "sweated out" by rocks in high mountain areas and widely used as a folk medicine.

(Frembgen 2006)

India

In India nearly 15–20% of the Ayurvedic medicine is based on animals or animal-derived substances. The Unani medicine recognizes about 200 drugs of animal origin which are claimed to be useful for the treatment of several medical disorders (Mahawar & Jaroli 2008).

A bit of bat's bone tied round the ankle is a specific for rheumatism.

(Crooke 1881)

Some women rub the blood of the small garden-bat, which has well-developed ears, into the artificially dilated lobes of their ears, so as to strengthen them. The wings of bats are highly prized as a hairwash. They are crushed, and mixed with coconut oil, and other ingredients. The mixture is kept underground in a closed vessel for three months, and then used to prevent the hair from falling out or turning grey."

(Thurston 1912) [The mentioned bat is probably *Pipistrellus abramus* (Dawson 1925)].

The Indian subcontinent represents one of the greatest emporia of ethnobiological wealth and Western Ghats represents the second hotspot in India [after *Indo-Burma*, Myers et al. 2000]. Animal drugs used by tribes of Attappadi hills: *Pteropus giganteus* (Brunnich, 1782) – Flying fox – Cooked flesh is eaten to relieve asthma and chest pain.

(Padmanabhan & Sujana 2008)

Asthma is the most frequently cited disease of the tribes. As such, a number of drugs are available for the treatment. The most commonly used animal medicine for asthma by all the tribes was honey followed by ... flesh of bat (2/9 tribes).

(Solavan et al. 2004)

Use of Wild Animal Products in Ethnomedicine. Bat: Flesh of Bats are eaten by ethnic people of Assam, Bihar, Gujarat, Maharashtra, Manipur & Rajasthan in asthma, breathing trouble and night blindness.

(Sinha & Sinha 2005)

...the use of bats for asthma cure in the Nicobar Islands ...

Fruit bats are also eaten in Australia by aboriginals to cure breathing disorders. That two such widely separated geographic regions have reached the same conclusion about the use of bats for asthma related disorders is fascinating ...

(Walker 2005)

There is superstition in Assam (N.E. India) that, "meat of flying fox may cure asthma and other diseases". Therefore regularly few people kill these bats and sell them for Rs. 50/ animal (About US\$ one).

(Walker 2005)

I recollect watching some people collecting bats under the caves of Raj period buildings near Ulsoor in Bangalore, India nearly two decades ago. When enquired, the collectors informed us about the 'medicinal' importance of bat flesh in curing asthma.

(Walker 2005)

Fruit bats (*Pteropus giganteus*) are used to cure asthma/breathing disorders and for curing menstrual problems in women in a few villages around Mysore in Karnataka. In this case only the meat is consumed. When we interviewed the villagers,

we were told that the local allopathic doctors prescribe bat meat for such problems. ... Similarly, in Bangalore, I used to know some people who hunted *Cynopterus* sp. for medicinal purposes and as food.

(Walker 2005)

Animals/animal products used to cure various ailments. *Pteropus* sps – Bat [English name], Chimgadar [local name] – *Pteropus* sp is hunted and washed in water and KMnO₄ [potassium permanganate] solution. Decoction of bat is given orally to the patient suffering from rheumatoid arthritis.

(Jain et al. 2008)

List of animals used for medicinal purposes in different parts of India.

category	scientific name	English name	Red data list	CITES
mammal	<i>Myotis lucifugus</i> (LeConte, 1831)	bat	conservation dependent	
mammal	<i>Cynopterus sphinx</i> (Vahl, 1797)	bat	least concern	
mammal	<i>Pteropus giganteus</i> (Brünnich, 1782)	Indian flying fox	near threatened	II

(Mahawar & Jaroli 2008)

Indigenous knowledge on the use of animals and their products in primary health care system. Ailments: Cough; English name: Bat; Local name: Chamchiki; Scientific name: *Cynopterus sphinx*; Part used: Flesh; Method of preparation and medicinal use: Raw flesh having blood is rubbed on the external injuries for healing and also eaten to treat whooping cough and asthma. Traditional Knowledge about Ethnozoology. Ailments: Alcohol/drug addiction; English name: Flying fox; Local name: Badur; Scientific name: *Pteropus giganteus*; Part used: Droppings; How medicine is prepared and used: Droppings are fed to patient

(Ghosh 2009)

The Mount Abu wildlife sanctuary is located in the Southwestern Rajasthan ... Fidelity levels (FL) demonstrate the percentage of respondents claiming the use of a certain animal for the same ailments. The uses of animals that are commonly known by the Garasiya informants have higher fidelity level than less common known. The flesh of bat (*Cynopterus sphinx*) used to relieve cough and fever has the highest FL (N=24.96%) ...

(Jaroli et al. 2010)

This ... study has been designed to report the ethnozoological uses of animals to treat common diseases on the basis of field surveys and taxonomic identification of animals. ... Documentation on zootherapeutical practices can assist in protecting traditional knowledge, and in ensuring that future users recognize the contributions made by traditional communities, the current custodians of traditional knowledge. ... Ethnozoological inventory in and around Bhitarkanika National Park. Zoological name, authors, family/order and local name: *Pterocarpus giganteus* Jacq, (Chiroptera), 'Badudi'; Parts used: Meat; Diseases: Asthma and Bronchitis; Mode of application: Prepared meat is given to the patient.

(Mishra & Panda 2011)

Ethno zoological inventory of Similipal Biosphere Reserve.

Zoological name, family and local name: *Pterocarpus giganteus* (Chiroptera) 'Badudi'; Parts used: Meat; Diseases: Asthma and bronchitis; Mode of application: Prepared meat is given to the patient. "Ethnozoological inventory of Similipal Biosphere Reserve.

(Mishra et al. 2011)

Nepal

There is widespread anecdotal evidence for the use of bats as food and medicine among various central Himalayan communities. ... dried bats, sold as the key ingredient in *cika lapa wasa*, "bat oil medicine". ... As bat oil is prepared in the same way regardless of the condition it is intended to treat, we will review its concoction and ingredients before considering the uses to which it is put. ... The procedure is as follows: catch a 'house bat' and kill it, or find one recently dead within the house. Dry it and roll it up into a tightly tied bundle rather like a cigar. Take mustard oil and heat it until it is very hot. Decant the oil into a smaller jar, to which add the dried and rolled house bat. Seal the container and leave it until it gives off a distinct and unpleasant smell. The oil is now ready for use as a medicine. ... the bat used for bat-oil must be a 'house bat' rather than a 'tree bat' ... the most common bat utilized would have been *Hipposideros armiger* Hodgson, though other members of the Hipposideridae and Rhinolophidae are almost certainly used as well. ... Therapeutic Uses. – Reported uses of *cika lapa wasa* fall into three distinct clusters: as eardrops to expel an earbug, as a topical baldness

cure, and as an antiparalytic ... The January 2005 issue of the newsletter of the Chiroptera Conservation and Information Network of South Asia featured a page of correspondence from various members on the medicinal use of the flesh of fruit bats, usually as a remedy for 'asthma' (Walker 2005). A brief article on the Ao Naga (Kakati et al. 2006) suggests that the flesh of *Rhinolophus* spp. are used for asthma, while fruit bat urine is used for kidney stones, and an article on the Lushai of Mizoram (Lalramnghinglova 1999) reports that children who wet the bed are fed roasted bat flesh.

(Tuladhar-Douglas 2008)

English name: Bat; local name: "Chamero"; Binomial nomenclature: *Myotis* spp, *Scotophilus* spp. Medicinal use: These are kept preserved in cooking oil and the decanted oil is applied regularly at the scalps in the head region for rapid hair growth. (Lohani 2011)

Viet Nam

Medicinal purpose and cost of medicinal fauna. Animals may be sold whole (with the viscera removed) or in specific parts, depending on the medicinal products required. For example, animal skin, bone, gall bladder, penis or shell (in the case of turtles) may be sold for different medicinal purposes. ... In some cases animal products are sold – for example the faeces of a number of species of bat *Hipposideros armiger*, *Pipistrellus javanicus*, ... One pharmaceutical company in the north of Viet Nam reported importing 50t of the faeces of *Rhinolophus* bats. This may have important conservation implications considering over 50 species of *Rhinolophus* worldwide are considered globally threatened (Anon., 2004c) [2004 IUCN Red List of Threatened Species. <http://www.redlist.org>]. Importation of this material is potentially a significant threat to the conservation of these species and requires further investigation. ... Complete list of the medicinal animal species found from the survey conducted in traditional medicine markets in southern Viet Nam in 2006.

scientific name	family	parts used
<i>Hipposideros armiger</i> Hodgson	Hipposideridae	excrement
<i>Pipistrellus javanicus</i> Gray	Vespertilionidae	excrement

Restricting exploitation and use for commercial purpose
Mammalia, Chiroptera, *Pteropus vampyrus*

(Nguyen & Nguyen 2008)

Indonesia

...many Sulawesians hunt and eat fruit bats without regard for the bats' future. The consumption of bats is common in the non-Muslim and Chinese populations, found mainly in northern Sulawesi. In other areas, bats are used in traditional medicine as cures for asthma or kidney ailments. In southern Sulawesi, we met a prominent Muslim businessman who regularly eats bat kidneys to treat his asthma.

(Heinrichs & Zahnke 1997)

Pteropus vampyrus are used for curing breathing disorders in some villages on the outskirts of Medan, Sumatra. (Walker 2005)

The majority of vendors considered that people bought flying foxes for nutritional reasons (80%), though a substantial proportion (29%) also believed people purchased these bats due to alleged medical properties for chest ailments (respondents were permitted to select more than one option). One vendor stated that flying foxes were "obat meruyan": medicine used to treat sick women after giving birth.

(Harrison et al. 2011)

China

Frederick Porter Smith (*1833 – †1888) was a botanist and a missionary in China. As the author writes in the preface "This work [*Contributions towards the Materia Medica & Natural History of China*, 1871] has been the employment or the leisure of some two years, spent in the examination of the native works on the Chinese Materia Medica and Natural History, and in the collection of the best native drugs."

Bat. (*Pien-fuh*), (*Tien-shu*), (*Fuh-yih*). This animal is very common in China, being a frequent visitor of foreign houses in quest of mosquitoes, which it devours most satisfactorily. As it is supposed to feed upon the stalactites which are frequently met with in the caves which it is wont [*sic!*] to hyemate in, its medicinal properties are rated at considerable value by the Chinese. From its asserted extreme longevity and its excellent sight, this curious creature is credited by the Chinese with the power of conveying these desirable qualities to those who consume the disgusting preparations made from all parts of its body.

Bats' dung. (*Jé-ming-sha*), (*Tien-shu-shi*), (*Shu-fah*). This is a dark brown, coarse powder, looking something like tea-dust, and consisting of debris of the Mylabris insect, dirt, bats' dung, and other extraneous substances. As bats fly by night, the Chinese name this composition, which according to the Pen Ts'au was formerly much better made, "night-bright sand," and apply it to the eyes, as a powder or as a wash, in tinea tarsi, opacities of the cornea, &c. They profess to detect the eyes of the mosquitoes on which the creature feeds in this excrement, which is given internally in ophthalmic affections, otorrhoea, ague, cough, infantile dyspepsia, tabes, offensive perspirations, &c. It is applied, with sugar, to foul ulcers, a practice which the writer strongly recommends, minus the bats' dung. It is curious that here the Chinese seem to have awkwardly imitated the western practice of using cantharides in the treatment of chronic diseases of the eye.

(Smith 1871)

J. Léon Souberain (*1827 – †1892), scientist and traveller, and M. Dabry de Thiersant (*1826 – †1898), French consul in China, wrote *La Matière Médicale chez les Chinois* to raise awareness about the therapeutic agents and the medical ideas of China.

Chauve-souris, *fou-y*, Pen-tsaio; *pien-fuh*, *t'ien-shu*, *fuh-yih*, F. P. S. [Frederick Porter Smith]. Les chauves-souris passent auprès des Chinois pour posséder de hautes propriétés thérapeutiques. On emploie surtout leurs excréments, *ou-lin-tse*, *ye-ming-cha* (*ie-ming-sza* , Tatar., 225 [Aleksandr Alekseevič Tatarinov (*1817 – †1886). Russian physician and botanist who spent many years working in China. He wrote "Catalogus medicamentorum Sinensium, quae Pekini comparanda et determinanda curavit Alexander Tatarinov, Doctor medicinae, medicus Missionis Russicae Pekinensis spatio annorum 1840–1850". Petropoli, 1856.]; *ye-ming-sha*, *tien-shu-shi* , *shu-fah*, F. P. S.), qui se présentent sous forme d'une poudre grossièrebrun foncé , et consistant en débris d'insectes , qu'on donne à l'intérieur dans les ophthalmies, la carie, etc. On en fait des applications sur les ulcères. Cette poudre est presque toujours mélange d'une grande quantité de débris de mylabres.

(Soubeiran & De Thiersant 1874)

Bernard Emms Read (*1887 – †1949) was a British pharmacist who worked in China. He was a director of the Lester Institute of Medical Research, Shanghai. Born in Brighton, England, he was trained in pharmacology at the London College of Pharmacy before moving to China in 1910 where he developed his expertise in Chinese medicine. Among Read's publications there is the series *Chinese Materia Medica* (1931–1939) where "The Bat" and "The Flying Fox" are mentioned. Read gives a list of bat species probably used in China as *Materia Medica*. To attain the correct identification of the nomenclature reported in his text, a list of the species mentioned by Read is correlated with the present ones based on Simmons (2005) and Smith & Xie (2008); for some particular cases more references are added.

Vesperugo noctula, Schreb, syn. *Nyctalus noctura* (*sic!*)

Rhinolophus ferrum-equinum

R. ferrum-equinum nippon

R. luctus

R. pearsonii

Myotis pequisius [*sic!*]

M. moupinensis

M. myosotis ancilla

M. ikonnikovi

M. daubentoni [*sic!*]

Vespertilis [*sic!*] *murinus*

V. superans

V. fimbriatus

Nyctalus noctula (Schreber, 1774)

Rhinolophus ferrumequinum (Schreber, 1774)

Rhinolophus ferrumequinum nippon Temminck, 1835

Rhinolophus luctus Temminck, 1834

Rhinolophus pearsonii Horsfield, 1851

Myotis pequinius Thomas, 1908

Myotis muricola moupinensis (Milne-Edwards, 1872)
[Benda 2010]

Myotis blythii ancilla Thomas, 1910 [Corbet 1978]

Myotis ikonnikovi Ognev, 1912

Myotis daubentoni (Kuhl, 1817)

Vespertilio murinus Linnaeus, 1758

Vespertilio sinensis (Peters, 1880) [Horáček 1997]

Myotis fimbriatus (Peters, 1871)

V. laniger
V. imbricatus
V. abramus
V. molossus
Miniopterus schreibersi [sic!] *chinensis*
M. blepotis
Pipistrellus abramus
P. savii pulveratus
Murina huttoni fuscus
M. leucogastra [sic!]
M. ussuriensis
M. hilgendorfi
Plecotus ariel
P. sacrimontis
Eptesicus [sic!] *scrotinus* [sic!]
E. scrotinus [sic!] *palleus* [sic!]
Megaderma Gra. [sic!]
Phyllorina aurita
Vesperugo borealis
Tadarida latouchei
Dysopes ruppelii
Scotophilus pumiloides
S. temminckii
S. hcathii [sic!]
S. ornatus

Myotis laniger (Peters, 1871)
Hypsugo imbricatus Horsfield, 1824
Pipistrellus abramus (Temminck, 1838)
Nyctalus aviator (Thomas, 1911)
Miniopterus schreibersi chinensis Thomas, 1908
Miniopterus schreibersi blepotis Temminck, 1840
Pipistrellus abramus (Temminck, 1838)
Hypsugo pulveratus (Peters, 1871)
Murina fusca Sowerby, 1922
Murina leucogaster Milne-Edwards, 1872
Murina ussuriensis Ognev, 1913
Murina hilgendorfi (Peters, 1880)
Plecotus austriacus ariel Thomas, 1911
Plecotus auritus sacrimontis Allen, 1908
Eptesicus serotinus (Schreber, 1774)
Eptesicus serotinus pallens Miller, 1911
Megaderma lyra sinensis Andersen et Wroughton, 1907
Hipposideros fulvus Gray, 1838
Eptesicus nilssonii (Keyserling et Blasius, 1839)
Tadarida latouchei Thomas, 1920
Tadarida teniotis Rafinesque, 1814 [Kock & Nader 1984]
Pipistrellus abramus (Temminck, 1838)
Scotophilus kuhlii temminckii Horsfield, 1824
Scotophilus heathii (Horsfield, 1831)
Scotomanes ornatus Blyth, 1851

FU YI. The Bats. Chiroptera.

The bat in Li Shih-Chen's time was ashed. The old prescriptions had special preparations roasted to dryness. [Li Shizhen, Wade-Giles romanization Li Shih-chen (b. 1518 – d. 1593), Chinese scholar of the Ming dynasty and author of the most important medical work of ancient China, the Bencao Gangmu (Compendium of Materia Medica), which described 1,892 drugs.] It was saline, bland, and nonpoisonous. The ash was given for a chronic cough of 10 or 20 years standing, to children for convulsions, and slow convulsions (symptoms resemble epilepsy). Given with an ashed cat's head and beans for chronic scrofula, and internally to stop excessive bleeding from knife wounds. Filled with red clay, then wrapped in yellow mud and burnt, it is powdered and made up with the secretion from snails to make a paste used both externally and internally for axillary bromidrosis. Given for anemia and as an abortifacient. The roasted animal is used for chronic malaria, and fevers.

Nao. Bat's Brains.

Applied to the face by women to remove comedones, and taken internally to cure forgetfulness.

Hsileh Chi Tan. Blood and Bile of the Bat.

Dropped in the eye the patient will not be sleepy and it enables one to see objects in the dark.

T'ien Shu Shih. Bat Dung.

Pungent, cooling, nonpoisonous. Washed with water to remove lime and earth, the small lumps like finesand are sundried and used. Taken with pig's liver for all kinds of internal and external fleshy growths and membranes over the eyes. Taken with oxgall and other drugs for blindness. For hemeralopia in children, chronic malaria, malaria during pregnancy, chronic cough. Applied with salted bean to axillary bromidrosis, to otitis media, and to a broken abscess full of pus. Held in the mouth for toothache. Taken to expel a dead foetus. Ashed it is given for scrophula. Applied to comedones &c. Analyses by D.R. Fung and S. C. Wang show: Ash 63%. total nitrogen 3.28%, ammonia 0.47%. urea 0.52%, uric acid 0.33%.

Flesh of the Flying Fox.

Sweet, warming, nonpoisonous. Eaten as a general tonic. Used for making the classical prescriptions, *Shih Hsiao San* the powder which cures the sickness and produces smiles; and *Tzu Chin Wan*, the purple gold pills, and *Ling Chih San* the potent fat powder. It is not a blood former but it is a circulatory stimulant entering the liver very rapidly. The commonly seen eye troubles with fleshy growths and constant movement is due to deficiency disease (the blood is weak). The sight is dependant upon the liver circulation and the effect of the blood upon the liver. Eye diseases are not correctly treated unless one treats the blood first. In snake bite poisoning when the patient has been unconscious for a long time flying fox dung should be given. Eight grams (of a mixture of the dung 2 parts with one part of antimony sulphide) rubbed up with wine and decanted for internal use, and the solid residue is applied locally with instant effect and with return of consciousness.

It is a blood medicine, acting on the peripheral and central areas of the circulations curing all kinds of pain. For malaria, convulsions, indigestion, and removing phlegm, anthelmintic and a cure for the “Kan” diseases; for blood stasis and conjunctivitis, all of which are liver diseases. For retained placenta with coma, abdominal pain after childbirth, neuralgia, sudden epigastric pain, abdominal pain due to parasites, abdominal pain from round worms in children, menorrhagia, dysmenorrhoea, prolapse of the rectum, hematemesis, diabetes, hemiplegia, coldness and numbness in the extremities due to stasis of the circulation. Applied to swollen fractures, and compound fractures. For intermittent fever with the diseases, cough with emphysema, for bloody sputum, jaundice due to alcoholism, for false membranes on the cornea, swollen painful tongue, toothache. Applied as a styptic to a bleeding mole. For anemia with good appetite but unable to speak and the hair stands out like wire. Applied to leprotic sores, snake and insect bites.

Analyses by D. R. Fung and S. C. Wang showed: Ash 8.96%, total nitrogen 2.58%, ammonia 0.81%, urea 0.118%, uric acid 0.29%.

(Read 1932)

Bat dung is mentioned as medicine in a recent handbook on TCM (Chen & Chen 2004):

Ye Ming Sha (Excrementum Vespertilionis Murini)

The book *A Materia Medica for Chinese Medicine: plants, minerals and animal products* (Hempen & Fischer 2009) describes 400 of the most important plants, minerals and animal substances, including bat faeces, currently used as treatments by Chinese medical practitioners.

Vespertilionis faeces

Ye ming sha

Family: Vespertilionidae

Standard species: *Vespertilio murinus*

Variation: Vespertilionis murini excrementum

German: Fledermausexkremete

English: bat faeces

Temperature

cold

Taste

pungent

Organ relationship

liver

spleen

Direction of action

descending

Site of action

Head, eyes

Actions/Indications

Cools heat

Reddened eyes, injected sclera

Clears the eyes and head

Night blindness, cataract, glaucoma, improves vision, clears the eyes

Breaks up and dissolves concretions

Haematomas, especially around the eyes, following injuries, falls

Breaks up blood stagnation

Haematomas, especially around the eyes

Harmonizes and tonifies the Liver

Improves vision, cools the Liver

Tonifies and harmonizes the Spleen

Childhood nutritional disorder

Commentary once or twice daily dosage of 1.5 g of the powdered herb with warm water clears redness in the eyes and was shown to be more effective in resistant cases than standard treatment.

Dosage 3–9 g

Cooking time 20 minutes, wrapped in a muslin cloth

Combinations

• Blurred, obstructed vision → *Haliotidis concha* (*shi jue ming*)

- Night blindness → pig or beef liver
- Childhood nutritional disorder → *Atractylodis macrocephalae rhizoma* (*bai zhu*), *Picrorhizae rhizoma* (*hu huang lian*) p. 182, *Citri reticulatae pericarpium* (*chen pi*)

Compatibility antagonizes *Cynanchi atrati radix* (*bai wei*)

Contraindication use with care in patients with eye disease without signs of blood stasis

Pregnancy use with care

- very marked
- distinct
- mildly distinct

(Hempfen & Fischer 2009)

The “*Encyclopedia of Traditional Chinese Medicines*” presents a comprehensive and integrative work on surveying TCM plant sources, chemistry, pharmacology and medicinal effects and indications in a systematic manner.

T6732 *Vespertilio superans* (Vespertilionidae); YE MING SHA; Bat Dung.

Used part: dried feces. TCM Effects: To clear heat and brighten eyes, dissipate blood and eliminate accumulation.

TCM Indications: Clear-eye blindness, night blindness, internal or external obstruction and screen, scrofula, *gan* accumulation [disease of the spleen], malaria.

Isolated compounds: 3585 [Cholesterol], 22246 [urea], 22251 [uric acid].

(Zhou et al. 2011)

North America

John Lawson (*1674 – †1711) was a British explorer and naturalist. He played an important role in the history of colonial North Carolina, South Carolina and Georgia; he published an account of his expeditions in the book “*A New Voyage to Carolina*” (1709).

The Bat or Rearmouse, the same as in England. The Indian Children are much addicted to eat Dirt, and so are some of the Christians. But roast a Bat on a Skewer, then pull the Skin off, and make the Child that eats Dirt, eat the roasted Rearmouse; and he will never eat Dirt again. This is held as an infallible Remedy. I have put this amongst the Beasts, as partaking of both Natures; of the Bird, and Mouse-Kind.

(Lawson 1709)

Lyon M.W. Jr. reports the efficacy of bats in rheumatism:

While collecting in the southern part of Indiana, in 1930, I visited the justly celebrated Marengo Cave, in Crawford County, on September 2. ... The guide told us that one man who had visited the cave a few years back, had asked him to collect a large number of bats, which he did. He said this person had tried out the oil and used it for rubbing on his rheumatic joints. The treatment was so successful that he had written in for a second supply of bats.

(Lyon 1931)

Latin America

Medicinal animals and its respective uses in popular medicine in Latin America.

family, species

conditions to which remedies are prescribed

mammals [Chiroptera]

Molossidae, *Molossus molossus* (Pallas, 1766), Pallas’ free-tailed bat (Bat)

asthma

Noctilionidae *Noctilio leporinus* (Linnaeus, 1758), greater bulldog bat

unspecified

Phyllostomidae *Artibeus jamaicensis* Leach, 1821, bat

cyst

(Alves & Alves 2011)

So far a general survey was given on the use of bats as medicine in antiquity and also in the modern time but a new medical use of bats could be possible. Three bat species, the vampire bats,

feed entirely on blood: the common vampire bat (*Desmodus rotundus*), the hairy-legged vampire bat (*Diphylla ecaudata*), and the white-winged vampire bat (*Diaemus youngi*); the small wounds inflicted by their razor sharp superior incisors continue to bleed for hours after the bats have ceased to feed because bat saliva contains substances (researched in *D. rotundus*) which cause inhibition of the haemostatic mechanism of the victim (Bier 1932, Hawkey 1967): several powerful proteins including *draculin* (Basanova et al. 2002), and various plasminogen activators that ensure that the blood does not clot within a few minutes. Of the plasminogen activators, *desmotepase* has been selected for clinical development; it has the effect of catalysing the conversion of plasminogen to plasmin, which is the enzyme responsible for breaking down fibrin blood clots. Desmotepase seems able to extend the treatment for patients with acute ischemic stroke up to 9 hours (only up to 4.5 hours by the drugs currently in use). This would allow more ischemic stroke patients to receive active thrombolytic treatment, including patients who were delayed in getting to the hospital for neurological assessment (Petersen 2007, Medcalf 2012). “There is little doubt that other unique substances remain to be discovered in the vampire bat that might offer new opportunities for basic research and potential therapeutic development.” (Medcalf 2012).

Discussion

Many animal species have been overexploited as sources of medicines for the TM and animal populations have become depleted or endangered. For this reason sustainability is now required as the guiding principle for biological conservation. According to the IUCN Guidelines (Prescott-Allen & Prescott-Allen 1996), the use of a particular species is likely to be sustainable if: (a) it does not reduce the future use potential of the target population or impair its long-term viability; (b) it is compatible with maintenance of the long-term viability of supporting and dependent ecosystems; and (c) it does not reduce the future use potential or impair the long-term viability of other species (Costa-Neto 2005). Biodiversity loss reduces the availability of raw materials for drug discovery and biotechnology and also makes easier the spread of human diseases; e.g. deforestation in the Amazon Basin has likely contributed to the re-emergence of vampire bat rabies in humans (Kuzmin et al. 2011).

Several animals have been hunted in order to satisfy the needs of the fast growing trade of TCM. As most of this hunting and trading is illegal, it is difficult to estimate the real contribution of the market to the species decline. The demand created by the fast growing TCM trade is a major cause of the overexploitation of the wild population of numerous animal species. Disappearance of any species of living organism represents a serious loss for future generations (Chivian & Bernstein 2008). It is estimated that only a small fraction of the species or organisms has been examined for natural products that might serve as medicines and it is possible that many potentially life-saving drugs have been lost even before being discovered (Balick et al. 1996, Grifo & Rosenthal 1997, Still 2003).

Lack of proper information makes assessing the status of bat populations difficult in order to develop appropriate conservation measures. The IUCN Red List can be useful but some species considered not to be threatened are on the contrary vulnerable in some countries where the TM trade is significant (Djagoun et al. in press). Although the hunting, slaughtering and trading of wild animals have been prohibited in Brazil by federal law since 1967, they continue to be used both nutritionally and medicinally in a clandestine way (Costa-Neto 2005). TM practitioners should never purchase preparations containing animals (or their parts) protected by law.

Species extinction is not only due to habitat loss. Overharvesting of medicinal species of plants and animals also contributes to species loss. This is particularly notable in the matter of

Traditional Chinese Medicine where crude drugs of plant and animal origin are used with increasing demand. People involved in TCM sometimes seek chemical and biological alternatives to endangered species because they realize that plants and animals lost from the wild are also lost to medicine forever (Guo et al. 1997, Lee et al. 1998, AA.VV. 1999). In 1995 representatives of the oriental medicine communities in Asia met with conservationists at a symposium in Hong Kong, organized by TRAFFIC, the wildlife trade monitoring network (*Proceedings of the Seminar on International Trade in Endangered Wild Fauna and Flora 1995*, in Chinese). The two groups established a clear willingness to cooperate through dialogue and mutual understanding. This has led to several meetings, including the 1997 First International Symposium on Endangered Species Used in Traditional East Asian Medicine, where China was among 136 nations to sign a formal resolution recognizing that the uncontrolled use of wild species in traditional medicine threatens their survival and the continuation of these medical practices. Many animal species used in TCM are listed by the Convention on International Trade in Endangered Species of Wild Animals and Plants (CITES) (Still 2003, UNEP-WCMC 2011). The resolution drawn up by CITES aims to initiate new partnerships in conservation (Call 2006).

“There is a need to educate and enlighten the Traditional Medical Practitioners and the end users on the real essence of biodiversity conservation with emphasis on the implications of local extinction of any species for the human health care delivery system ... There is also a need to incorporate indigenous knowledge systems and enjoin the effective participation of local communities in policy making and implementation concerning the sustainable use and conservation of biodiversity resources” (Soewu 2008).

Conclusions

TM represents a still poorly explored field of research in terms of therapeutic potential or clinical evaluation. All sorts of vegetable, animal and mineral remedies used in TM are capable of producing serious adverse reactions. It is well known that numerous infectious diseases can be transmitted from animals to humans and the possibility of transmitting infections from animal preparations to the patient should be always considered with great attention (Alves & Rosa 2007).

Placebo effect has a strong cultural dimension and it can probably be involved in the efficacy of TM like it happens in biomedicine (Kienle & Kiene 1997, Waldram 2000). For a general overview about TM efficacy see also Anderson (1992) and van der Geest (1995).

In ancient times bats were much used as amulets or as ingredients of magical potions becoming part of the *materia medica*. In folk traditions the distinctive peculiarities of bats were believed capable of transference through the use of their body or parts of it either alone or as ingredients. One of the specific ability of the bats is to see in the dark, another is the absence of hair on the wings; hence many traditional prescriptions are directed to improve or to treat vision problems and as depilatory. Curiously the opposite may also be required, using the same stuff, i.e. for making hair grow. Other purposes for which bats were used medicinally have less obvious reasons (Allen 2004).

The various uses of bats as medicine could be regarded as rather strange. How can bat dung be effective in treating so different diseases as dissolving stones in the bladder, curing leucoma of the eyes, tumors, tinea, ophthalmic affections, otorrhoea, ague, cough, infantile dyspepsia, tabes, chronic malaria, malaria during pregnancy, chronic cough, toothache, menorrhagia, dysmenorrhoea, prolapse of the rectum, hematemesis, diabetes, hemiplegia and many other ailments and disorders? It should be noted that insectivorous bat faeces are mainly composed of chitin, the hard material that makes up the external skeleton of their insect prey (Emerson & Roark

2007). One very useful derivative of chitin is chitosan, a partially deacetylated chitin produced by boiling chitin in concentrated base. Chitin can be degraded by chitinase, found in intestines of few mammal species, including bats (Whitaker et al. 2004; Alwin Prem Anand & Sripathi 2004). A wide variety of medical applications for chitin and chitin derivatives have been reported: (a) Antimicrobial Activity; (b) Immune Effects and Anti-Inflammatory Activity; (c) Antioxidant Activity; (d) Anticancer Activity; (e) Blood Coagulation Effects; (f) Antidiabetic Activity; (g) Neuroprotective Activity; (h) Wound Healing; (i) Obesity; (l) Dyslipidemia; (m) Dental Plaque; (n) Renal Failure (Musumeci & Paoletti 2009, Khoushab & Yamabhai 2010, Sarmento & Das Neves 2012). In light of the mentioned data, the use of bat guano as remedy could be seen as less odd than it might appear at first sight. In any case it seems to be a topic worth further consideration.

References

- AA.VV., 1999: *Healthy People – Healthy Wildlife. Proceedings of the Second Australian Symposium on Traditional Medicine and Wildlife Conservation*. Environment Australia, Canberra, 68 pp.
- ABD AL-RAZZAK IBN MUHAMMAD, 1874: *Kachefer-roumouz (Révélation des énigmes) d'Abd Er-Rezzaq Ed-Djezaïry, ou, Traité de matière médicale arabe d'Abd er-Rezzaq l'Algérien*. Baillière, Paris, 396 pp.
- ADEOLA M. O., 1992: Importance of wild animals and their parts in the culture, religious festivals, and traditional medicine, of Nigeria. *Environmental Conservation*, **19**: 125–134.
- ALDROVANDI U., 1599: *Ulyssis Aldrovandi Ornithologiae hoc est De avibus historiae libri 12*. Bononiae: apud Franciscum de Francis Senensem, 1599–1603, 893 pp. + Index (unnumbered pages).
- ALLEN G. M., 2004: *Bats. Biology, Behavior and Folklore*. Dover Publications, Inc., New York, x+368 pp. [originally published by Harvard University Press, 1939].
- ALVES R. R. N. & ALVES H. N., 2011: The faunal drugstore: Animal-based remedies used in traditional medicines in Latin America. *Journal of Ethnobiology and Ethnomedicine*, **7**: 9.
- ALVES R. R. N. & ROSA I. L., 2005: Why study the use of animal products in traditional medicines? *Journal of Ethnobiology and Ethnomedicine*, **1**: 5.
- ALVES R. R. N. & ROSA I. L., 2007: Biodiversity, traditional medicine and public health: where do they meet? *Journal of Ethnobiology and Ethnomedicine*, **3**: 14.
- ALVES R. R. N. & ROSA I. L. (eds.), in press: *Animals in Traditional Folk Medicine. Implications for Conservation*. Springer-Verlag, Berlin, xv+491 pp.
- ALWIN PREM ANAND A. & SRIPATHI K., 2004: Digestion of cellulose and xylan by symbiotic bacteria in the intestine of the Indian flying fox (*Pteropus giganteus*). *Comparative Biochemistry and Physiology Part A: Molecular & Integrative Physiology*, **139**: 65–69.
- ANDERSON R., 1992: The efficacy of ethnomedicine: research methods in trouble. Pp.: 1–17. In: NICTHER M. (ed.): *Anthropological Approaches to the Study of Ethnomedicine*. Gordon and Breach Science Publishers, Yverdon, Switzerland, xxii+259 pp.
- ANDERSON E. N., PEARSALL D., HUNN E. & TURNER N. (eds.), 2011: *Ethnobiology*. Wiley-Blackwell, Hoboken, 420 pp.
- BALICK M. J., ELISABETSKY E. & LAIRD S., 1996: *Medicinal Resources of the Tropical Forest: Biodiversity and Its Importance to Human Health*. Columbia University Press, New York, 440 pp.
- BASANOVA A. V., BASKOVA I. P. & ZAVALOVA L. L., 2002: Vascular-platelet and plasma hemostasis regulators from bloodsucking animals. *Biochemistry (Moscow)*, **67**(1): 143–150.
- BENDA P., 2010: On a small collection of bats (Chiroptera) from western Sabah (North Borneo, East Malaysia). *Vespertilio*, **13–14**: 45–76.
- BIER O.-G., 1932: Action anticoagulante et fibrinolytique de l'extrait des glandes salivaires d'une chauve-souris hématophage (*Desmodus rufus*). *Comptes Rendus des Séances de la Société de Biologie et de ses Filiales*, **110**: 129–131.

- BRYAN C. P. (trans.), 1930: *The Papyrus Ebers*. Geoffrey Bles, London, 167 pp.
- BUDGE E. A. W., 1913: *Syrian Anatomy Pathology and Therapeutics or "The Book of Medicines"*. Oxford University Press, London. Vol. 2 [English translation. Index], 804 pp.
- CALL E., 2006: *Mending the Web of Life: Chinese Medicine & Species Conservation*. IFAW/AHPA-ERB Foundation, 282 pp.
- CAMPBELL THOMPSON R., 1923: *Assyrian Medical Texts from the Originals in the British Museum*. Humphrey Milford Oxford University Press, Oxford, 107 pp.
- CAMPBELL THOMPSON R., 1926: Assyrian Medical Texts. *Proceedings of the Royal Society of Medicine*, **19**: 29–78.
- CHAN K., 2005: Chinese medicinal materials and their interface with Western medical concepts. *Journal of Ethnopharmacology*, **96**: 1–18.
- CHASSINAT M. E. (trad.), 1921: Un Papyrus Médical Copte. *Mémoires Publiés par les Membres de l'Institut Français d'Archéologie Orientale du Caire*, **32**: 1–15+1–395.
- CHEN J. K. & CHEN T. T., 2004: *Chinese Medical Herbology and Pharmacology*. Art of Medicine Press, City of Industry, 1336 pp., 1150 ill.
- CHIVIAN E., 1997: Global environmental degradation and biodiversity loss: implication for human health. Pp.: 7–38. In: GRIFO F. & ROSENTHAL J. (eds.): *Biodiversity and Human Health*. Island Press, Washington DC, 379 pp.
- CHIVIAN E. & BERNSTEIN A. (eds.), 2008: *Sustaining Life. How Human Health Depends on Biodiversity*. Oxford University Press, Oxford, 568 pp.
- CORBET G. B., 1978: *The Mammals of the Palearctic Region: A Taxonomic Review*. British Museum (Natural History), London & Ithaca N.Y., 314 pp.
- COSTA-NETO E. M., 1999: Healing with animals in Feira de Sanatana City, Bahia, Brazil. *Journal of Ethnopharmacology*, **65**: 225–230.
- COSTA-NETO E., 2005: Animal-based medicines: biological prospection and the sustainable use of zootherapeutic resources. *Anais da Academia Brasileira de Ciências*, **77**(1): 33–43.
- CROOKE W., 1881: Notes on Indian Folk-Lore. *The Folk-Lore Record*, **4**: 133–137.
- DAWSON W. R., 1925: Bats as Materia Medica. *Annals and Magazine of Natural History*, Series 9, **16**: 221–227.
- DAWSON W. R., 1930: *The Bridle of Pegasus. Studies in Magic, Mythology and Folklore*. Methuen, London, 203 pp.
- DE RENZI S., 1856: *Collectio Salernitana. Vol. 4*. Tipografia del Filiatre-Sebezio, Napoli, 623 pp.
- DITCHFIELD P. H., 1974: *Country Folk: A Pleasant Company*. EP Publishing Limited, Wakefield, 256 pp. [Facsimile of 1923 edition]
- DJAGOUN C. A. M. S., AKPONA H. A., MENSAH G. A., NUTTMAN C. & SINSIN B., in press: Wild Mammals Trade for Zootherapeutic and Mythic Purposes in Benin (West Africa): Capitalizing Species Involved, Provision Sources, and Implications for Conservation. Pp.: 367–382. In: ALVES R. R. N. & ROSA I. L. (eds.): *Animals in Traditional Folk Medicine. Implications for Conservation*. Springer-Verlag, Berlin, xv+491 pp.
- EMERSON J. K. & ROARK A. M., 2007: Composition of guano produced by frugivorous, sanguivorous, and insectivorous bats. *Acta Chiropterologica*, **9**: 261–267.
- ERICKSON P. I., 2008: *Ethnomedicine*. Waveland Press, Inc., Long Grove, Illinois, 124 pp.
- FLEURENTIN J., CABALION P., MAZARS G., DOS SANTOS J. & YOUNOS C. (eds.), 1991: *Ethnopharmacologie. Sources, Methodes, Objectifs*. ORSTOM Editions, Bondy, 493 pp.
- FORCELLINI A., 1940: *Lexicon totius latinitatis. Secunda impressio anastaticae confecta quartae editionis a. 1864–1926 Patavii typis mandatae cum appendicibus qui bus aucta est prima anastatica impressio a. 1940 edita*. 6 vol., 5816 pp.
- FORSKÅL P., 1775: *Descriptiones animalium avium, amphibiorum, piscium, insectorum, vermium; quae in itinere orientali observavit Petrus Forskål. Post mortem auctoris edidit Carsten Niebuhr. Adjuncta est materia medica Kahirina atque tabula maris rubri geographica*. Officina Molleri, aulae Typhographi, Haunia, 1–20+i–xxxiv+1–164 pp., 1 map.

- FREMBGEN J. W., 2006: Embodying Evil and Bad Luck. Stray Notes on the Folklore of Bats in Southwest Asia. *Asian Folklore Studies*, **65**: 241–247.
- GESNER C., 1555: *Conradi Gesneri Tigurini medici & Philosophiae professoris in Schola Tigurina Historiae animalium Liber III. qui est de Avium natura*. Vol. 3. Tiguri [Zurich] apud Christoph. Froschoverum, anno M.D.LV.
- GHOSH A. K., 2009: *Ethnobiology: Therapeutics and Natural Resources*. Daya Publishing House, Delhi, 204 pp.
- GRIFFITH F. L. & THOMPSON H., 1904: *The Demotic Magical Papyrus of London and Leiden. Vol. 1*. H. Grevel & Co., London, 207 pp.
- GRIFO F. & ROSENTHAL J. (eds.), 1997: *Biodiversity and Human Health*. Island Press, Washington DC, 379 pp.
- GUO Y., ZOU X., CHEN Y., WANG D. & WANG S., 1997: Sustainability of Wildlife Use in Traditional Chinese Medicine. In: China Council for International Cooperation on Environment and Development (ed.): *Conserving China Biodiversity. Reports of the Biodiversity Working Group (BWG)*. China Council for International Cooperation on Environment and Development (CCICED), Beijing, URL: www.zd.brim.ac.cn/bwg-cciced/english/bwg-cciced/tech-34.htm.
- HARRISON M., CHEYNE S., DARMA F., ANGAN D., LIMIN S. & STRUEBIG M. J., 2011: Hunting of flying foxes and perception of disease risk in Indonesian Borneo. *Biological Conservation*, **144**: 2441–2449.
- HAWKEY C., 1967: Inhibitor of platelet aggregation present in saliva of the vampire bat *Desmodus rotundus*. *British Journal of Haematology*, **13**: 1014–1020.
- HEINRICH S. & ZAHNKE K., 1997: The fruit bats of Sulawesi. *BATS Magazine*, **15**(3): 11–15.
- HEMPEN C.-H. & FISCHER T., 2009: *A Materia Medica for Chinese Medicine: Plants, Minerals, and Animal Products*. Churchill Livingstone, Edinburgh, 1007 pp.
- HOLMSTEDT B. & BRUHN J. G., 1983: Ethnopharmacology – a challenge. *Journal of Ethnopharmacology*, **8**: 251–256.
- HORÁČEK I., 1997: Status of *Vesperus sinensis* Peters, 1880 and remarks on the genus *Vespertilio*. *Vespertilio*, **2**: 59–72.
- IBN AL BAYTAR, 1987: *Traite des Simples. Traduction de Lucien Leclerc. Notices et extraits des manuscrits de la Bibliothèque nationale et autres bibliothèques 23–25*. Institut de monde arabe, Paris, 478+492+483 pp. [Reprint of the a translation publiée en 1877–1883].
- JAIN A., KATEWA S. S., GALAVA P. & NAG A., 2008: Some therapeutic uses of biodiversity among the tribals of Rajasthan. *Indian Journal of Traditional Knowledge*, **7**(2): 256–262.
- JAMES R., 1747: *Pharmacopoeia Universalis: or, A New Universal English Dispensatory*. J. Hodges, London, 836+54 pp.
- JAROLI D. P., MAHAWAR M. M. & VYAS N., 2010: An ethnozoological study in the adjoining areas of Mount Abu wildlife sanctuary, India. *Journal of Ethnobiology and Ethnomedicine*, **6**: 6.
- KHOUSHAB F. & YAMABHAI M., 2010: Chitin Research Revisited. *Marine Drugs*, **8**: 1988–2012.
- KIENLE G. S. & KIENE H., 1997: The Powerful Placebo Effect: Fact or Fiction? *Journal of Clinical Epidemiology*, **50**: 1311–1318.
- KOCK D. & NADER I. A., 1984: *Tadarida teniotis* (Rafinesque, 1814) in the W-Palaeartic and a lectotype for *Dysopes rupelii* Temminck, 1826 (Chiroptera: Molossidae). *Zeitschrift für Säugetierkunde*, **49**: 129–135.
- KUZMIN I. V., BOZICK B., GUAGLIARDO S. A., KUNKEL R., SHAK J. R., TONG S. & RUPPRECHT C. H., 2011: Bats, emerging infectious diseases, and the rabies paradigm revisited. *Emergency Health Threats Journal*, **4**: 7159 (17 pp).
- LAWSON J., 1709: *A New Voyage to Carolina; Containing the Exact Description and Natural History of That Country: Together with the Present State Thereof. And A Journal of a Thousand Miles, Travel'd Thro' Several Nations of Indians. Giving a Particular Account of Their Customs, Manners, &c*. London, 258 pp.
- LEE S., HOOVER C., GASKI A. & MILLS J., 1998: *A World Apart? Attitudes Toward Traditional Chinese Medicine and Endangered Species in Hong Kong and the United States*. Traffic & WWF, 80 pp.

- LELANT V. & CHENAVAL N., 2012: Note on a meeting with a marabout from Fadiol, Senegal, Western Africa, who uses bats in his medicine. *African Bat Conservation News*, **28**: 15–16.
- LEV E., 2003: Traditional healing with animals (zootherapy): medieval to present-day Levantine practice. *Journal of Ethnopharmacology*, **85**: 107–118.
- LEV E., 2006: Healing with animals in the Levant from the 10th to the 18th century. *Journal of Ethnobiology and Ethnomedicine*, **2**: 11 (9 pp).
- LOHANI U., 2011: Traditional uses of animals among Jirels of central Nepal. *Ethno Med*, **5**(2): 115–124.
- LYON M. W. Jr., 1931: Bat oil for rheumatism. *Journal of Mammalogy*, **12**(3): 313.
- MAHAWAR M. M. & JAROLI D. P., 2008: Traditional zootherapeutic studies in India: a review. *Journal of Ethnobiology and Ethnomedicine*, **4**: 17.
- MARCINIAK K., 2001: The winged mouse – Bats in ancient literature. *Eos*, **88**: 307–314.
- MEDCALF R. L., 2012: Desmoteplase: discovery, insights and opportunities for ischaemic stroke. *British Journal of Pharmacology*, **165**: 75–89.
- MISHRA N. & PANDA T., 2011: Zootherapeutic Uses of Animal Diversity in Coastal District of Orissa, India. *British Journal of Pharmacology and Toxicology*, **2**(3): 154–158.
- MISHRA N., ROUT S. D. & PANDA T., 2011: Ethno-zoological studies and medicinal values of Similipal Biosphere Reserve, Orissa, India. *African Journal of Pharmacy and Pharmacology*, **5**(1): 6–11.
- MUSUMECI S. & PAOLETTI M. G. (eds.), 2009: *Binomium Chitin-Chitinase: Recent Issues*. Nova Biomedical Books, New York, 457 pp.
- MYERS N., MITTERMEIER R. A., MITTERMEIER C. G., DA FONSECA G. A. B. & KENT J., 2000: Biodiversity hotspots for conservation priorities. *Nature*, **403**: 853–858.
- NEWMAN D. J., KILAMA J., BERNSTEIN A. & CHIVIAN E., 2008: Medicines from nature. Chapter 4. Pp.: 117–161. In: CHIVIAN E. & BERNSTEIN A. (eds.): *Sustaining Life: How Human Health Depends on Biodiversity*. Oxford University Press, New York, 542 pp.
- NGUYEN D. N. V. & NGUYEN T., 2008: *An Overview of the Use of Plants and Animals in Traditional Medicine Systems in Viet Nam*. TRAFFIC Southeast Asia, Greater Mekong Programme, Ha Noi, Viet Nam, 92 pp.
- PADMANABHAN P. & SUJANA K. A., 2008: Animal products in traditional medicine from Attappady hills of Western Ghats. *Indian Journal of Traditional Knowledge*, **7**(2): 326–329.
- PETERSEN K. U., 2007: Thrombolytics. A Field in Development. *Rivista Italiana di Neurobiologia*, **53**(1): 7–14.
- PLINY THE ELDER, 1855: *The Natural History*. John Bostock (trans.). H.T. Riley, London.
- PLINY THE ELDER, 1906: *Naturalis Historia*. Teubner (ed.). Karl Friedrich Theodor Mayhoff. Lipsiae.
- PRESCOTT-ALLEN R. & PRESCOTT-ALLEN C. (eds.), 1996: *Assessing the Sustainability of Uses of Wild Species – Case Studies and Initial Assessment Procedure*. IUCN, Gland, Switzerland & Cambridge, UK, iv+135 pp.
- READ B.E., 1932: Chinese Materia Medica. Avian Drugs. *Peking Natural History Bulletin*, **6**(4): 1–112.
- SARMENTO B. & DAS NEVES J. (eds.), 2012: *Chitosan-Based Systems for Biopharmaceuticals. Delivery, Targeting and Polymer Therapeutics*. Wiley, 556 pp.
- SCARPA A., 1980: *Etnomedicina. Verità scientifiche, strane credenze e singolari terapie, meritevoli di verifica, delle medicine tradizionali dei popoli*. Franco Lucisano Editore, Milano, 559 pp.
- SEAGER H. W., 1896: *Natural History in Shakespeare's Time: Being Extracts Illustrative of the Subject as he Knew it*. Elliot Stock, London, 358 pp.
- SIMMONS N. B., 2005: Order Chiroptera. Pp.: 312–529. In: WILSON D. E. & REEDER D. M. (eds.): *Mammal Species of the World. A Taxonomic and Geographic Reference. 3rd Edition*. The Johns Hopkins University Press, Baltimore, xxxviii+744 pp.
- SINHA R. K. & SINHA S., 2005: *Ethnobiology (Role of Indigenous and Ethnic Societies in Biodiversity Conservation, Human Health Protection and Sustainable Development)*. Surabhi Publications, Jaipur, xv+335 pp.

- SINGH J. S., 2002: The biodiversity crisis. A multifaceted review. *Current Science*, **82**(6): 638–647.
- SMITH F. P., 1871: *Contributions Towards the Materia Medica and Natural History of China: For the Use of Medical Missionaries and Native Medical Students*. American Presbyterian Mission Press, Shanghai, 248 pp.
- SMITH A. T. & XIE Y. (eds.), 2008: *A Guide to the Mammals of China*. Princeton University Press, Princeton, 576 pp.
- SOEWU D. A., 2008: Wild animals in ethnozoological practices among the Yorubas of southwestern Nigeria and the implications for biodiversity conservation. *African Journal of Agricultural Research*, **3**: 421–427.
- SOLAVAN A., PAULMURUGAN R., WILSANAND V. & RANJITH SING A. J. A., 2004: Traditional therapeutic uses of animals among tribal population of Tamil Nadu. *Indian Journal of Traditional Knowledge*, **3**: 198–205.
- SOUBEIRAN J. L. & DE THIERSANT M. D., 1874: *La Matière Médicale chez les Chinois*. G. Masson, Paris, 319 pp.
- STILL J., 2003: Use of animal products in traditional Chinese medicine: environmental impact and health hazards. *Complementary Therapies in Medicine*, **11**: 118–122.
- SWAN J., 1635: *Speculum Mundi. Or A Glasse Representing the Face of the World; Shewing Both That It Did Begin, and Must Also End: the Manner How, and Time When, Being Largely Examined. Whereunto Is Joyned an Hexameron, or a Serious Discourse of the Causes, Continuance, and Qualities of Things in Nature; Occasioned As Matter Pertinent to the Work Done in the Six Dayes of the Worlds Creation*. Printed by the printers to the Universitie of Cambridge.
- THURSTON E., 1912: *Omens and Superstitions of Southern India*. McBride, Nast & Company, New York, 320 pp.
- TULADHAR-DOUGLAS W., 2008: The use of bats as medicine among the Newars. *Journal of Ethnobiology*, **28**(1): 69–91.
- UNEP-WCMC, 2011: *Checklist of CITES Species*. CD-ROM. CITES Secretariat, Geneva, Switzerland, and UNEP-WCMC, Cambridge, United Kingdom.
- VAN DER GEEST J. D. M., 1995: The efficacy of traditional medicine (and biomedicine). Pp.: 360–365. In: VAN DER VELDEN K., VAN GINNEKEN J. K. S., VELEMA J. P., DE WALLE F. B. & VAN WIJNEN J. H. (eds.): *Health Matters: Public Health in North-South Perspective*. Koninklijk Instituut voor de Tropen / Royal Tropical Institute, Amsterdam, 472 pp.
- WALDRAM J. B., 2000: The efficacy of traditional medicine: current theoretical and methodological issues. *Medical Anthropology Quarterly*, **14**: 603–625.
- WALKER S., 2005: Some informal correspondence on local people's medicinal uses of Fruit bats. *Bat Net Newsletter. Newsletter of the Chiroptera Conservation and Information Network of South Asia*, **6**(1): 6.
- WHITAKER J. O. JR., DANNELLY H. K. & PRENTICE D. A., 2004: Chitinase in insectivorous bats. *Journal of Mammalogy*, **85**: 15–18.
- WHO, 2002: *Traditional Medicine Strategy 2002–2005*. World Health Organization, Geneva, 74 pp.
- WILLEM J.-P., JADE COSTA J.-P., FLEURENTIN J. & VANDECASTEELE M., 2006: *L'Ethnomédecine, une alliance entre science et tradition*. Jouvence & Biocontact, Paris, 121 pp.
- ZHOU J., XIE G. & YAN X., 2011: *Encyclopedia of Traditional Chinese Medicines. Molecular Structures, Pharmacological Activities, Natural Sources and Applications*. Springer-Verlag, Berlin, xxvi+3934 pp.

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