



REVIEW ARTICLE

Patterns in Orthoptera biodiversity. II. The cultural dimension

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Abstract: The relationship between orthopterans and humanity has multiple faces. They are excellent subjects of research in all areas of biology, but they may be from a mild nuisance to formidable enemies as in the case of plague locusts. However, many species have been since long ago, providers of aesthetic pleasure, nutrition and folk medicine practices. In this review, I explore three subjects that fall within the fields of ethnoentomology and cultural entomology namely, the use of orthopterans as food, their medicinal utilisation, and their role as pets and entertainment.

Key words: Cricket fighting, cultural entomology, entertainment, entomophagy, entomopharmacology, grasshopper, katydid, sound production.

*Here comes the Wottenwood Weta
Out of the Wottenwood tree
Oh dear, it's the Wottenwood Weta
And I think that he's looking for me*

The Wottenwood Weta, New Zealand children's folk song by Dave Hollis

Introduction

"Life is a song - happy, gay. So let's have some music. Come on! What do you say?" Jiminy Cricket, 1947 (in Walt Disney's "Bongo")

Edward O. Wilson (1984) defined *biophilia* as "*the connections that human beings unconsciously seek with the rest of life.*" Although this is certainly true, humans have also consciously sought relationships with animals and this is the subject of ethnozoology (Alves 2012), and specifically of ethnoentomology or cultural entomology (the latter being

sometimes treated as a subdivision of the former) in the present case (Hogue 1980; Posey 1986). In this review, I explore three subjects that fall within the fields of ethnoentomology and cultural entomology namely, the use of orthopterans as food, their medicinal utilisation, and their role as pets and entertainment.

The Cultural Dimension

Six-legged delicacies

"These of them you may eat: the locust in its kinds, and the devastating locust in its kinds, and the cricket in its kinds, and the grasshopper in its kinds." Leviticus 11: 22

Cultural entomology studies the influence of insects and other terrestrial arthropods in literature, languages, music, the arts, interpretive history, religion, and recreation (Hogue C. 1987; Cherry 2008; Hogue J. 2009). Notably, for some reason, this definition does not include the consumption of insects as food (entomophagy) which was, and still is, a common practice in many human societies [perhaps, the category 'folklore' mentioned in Hogue (1980) could include these practices]. In this review, I consider entomophagy as a cultural practice. Entomophagy is simply, the use of insects as human food (Bodenheimer 1951; De Foliart 1989, 1999, 2009; Misuhashi 2008; van Huis 2011). Orthopterans have been used as food by humans and their kin since very ancient times (Raubenheimer & Rothman 2013), and recent reviews strongly support this practice both as a cultural activity deserving respect (Bodenheimer 1951; Ramos-Elorduy *et al.* 2012), and as a means of boosting nutrition in emergent societies (Bize 1997; Paoletti 2005; Ramos-Elorduy & Montesinos 2007; Choudhary & Bhargava 2009; Durst *et al.* 2010; Chakravorty *et al.* 2011; Teo 2011; Gahukar 2012; van Huis *et al.* 2013), despite Western prejudice against them (DeFoliart 1999; Yen 2009). Insects have also been suggested as useful species for space-based agricultural schemes (Katayama *et al.* 2008).

The use of Orthoptera as food by humans is described several times both in the Old and New Testaments, for example: in the Leviticus where the people of God is authorised to eat locusts and grasshoppers (but not other insects; Leviticus, 11: 23), and in the description of the diet of John the Baptist (locusts and wild honey; Matthew, 3: 4). However, this is not surprising, since locusts were a common item in the diet of desert nomads (Hope 1842) as shown by several ancient Middle East texts (excellently summarised by Bodenheimer, 1951). Herodotus (c. 484 BC-c. 425 BC), Diodorus of Sicily on the first century BC, and Pliny the Elder (23 AD-79 AD) described a people in Ethiopia, which Diodorus called Acridophagi (Diodorus Siculus 1814), whose diet consisted of locusts: "...which fed on locusts that came in swarms from the southern and unknown districts " (Herodotus 2008), and "*In certain parts of Ethiopia the People live on Locusts only, which they preserve with Salt, and hang up in Smoke to harden, for their yearly Provision;...*" (Pliny 1847-1848). Arabs were reported to make a kind of flour out of dried and grinded locusts in epochs of scarcity of corn, or to stew them in butter and make a "*kind of fricassée*" (Simmonds 1859). Many references on the use of Orthoptera as food among the American natives were reported in historical, natural history and travel books since the beginnings of the European exploration of the New World (López de Gomara 1555; Sloane 1707; Cowan 1865; Simmonds 1859, 1885; Bodenheimer 1951; Capinera 2008c). For example, crickets and locusts were important items in the diet and commercial transactions of the aborigines of Jamaica (Lopez de Gomara 1555; Sloane 1707).

Eating orthopterans is a common cultural activity today in many parts of the world (Morris 2004; Paoletti 2005; Durst *et al.* 2010; Chakravorty *et al.* 2011; van Huis *et al.* 2013).

Ramos-Elorduy (2005) lists 267 species of edible orthopterans in the whole world (although she includes cockroaches among the Orthoptera). This number of species is only superseded by edible Coleoptera (468) and Hymenoptera (361), and slightly higher than that of the Lepidoptera (253). If we exclude the few edible cockroach species, the number of consumed orthopteran grasshoppers, locusts, katydids and crickets represents about 1% of the extant described species, contrasting with that of ants, bees and wasps (0.24%), beetles (0.12%), and butterflies and moths (0.15%). This widespread consumption of grasshoppers and allies has prompted the study of their nutritional value and the perspectives of using them as a more important source of food than they are today, when only very recently they have raised Western interest (Ramos-Elorduy *et al.* 1998; Costa-Neto & Ramos-Elorduy 2006; Mbah & Elekima 2007; Finke 2008; Ramos-Elorduy *et al.* 2012). In fact, in recent years, several insect-based cookbooks that include many orthopteran dishes have been published (Ramos-Elorduy 1998; Gordon 2013; van Huis 2014) and canned grasshoppers or desiccated katydids now appear as relatively common items in supermarkets (Fig. 1).



Figure 1. Commercial edible orthopterans for humans and pets. **a**, Desiccated salted female katydidis (coneheads= Conocephalinae) from Thailand. The sellers claim: “*Giant katydidis can be eaten alone as a snack, typically flavored with soy sauce, chili, and pepper, or lemon grass and kaffir lime leaf.*” **b**, Canned crickets “*Ideal for most lizards, turtles, fish, birds and small animals. Also, great for fishing!*” **c**, “Chapulines” the Mexican common name for grasshoppers and below in French, “*Sauterelles grillés au piment*” (grilled peppered grasshoppers). **d**, Grasshoppers in red curry.

Many edible orthopterans are captured either manually or by the use of nets or other devices and we know the annual captured biomass for some of them (between 5 and 10

ton/years, see Ramos-Elorduy 2009). In several parts of the world, some orthopterans are cultured or proto-cultured for human food. For example, in Mexico these practices include the crickets *Acheta domestica* (Linnaeus, 1758) and *Gryllus assimilis* (Fabricius, 1775), and the pyrgomorphid grasshopper *Sphenarium purpurascens* Charpentier, 1842 (Ramos-Elorduy 2009). In sub-Saharan Africa, at least 69 species of Orthoptera of both suborders and several families have been reported as edible (van Huis 2003). However, in these cases insect harvesting is mostly done manually by women; therefore, it is highly advisable to develop rearing methods, which would allow a continuous supply (not only seasonal harvesting), and could help alleviate the problem of protein deficiency in many parts of Africa (Fasoranti & Ajiboye 1993; van Huis 2003; Morris 2004).

The incredible healing power of cricket legs

"Crickets are used to fortify weak sight, the liquid substance being expressed and put into the eyes." Friedrich Christian Lesser, *Insecto-Theology*, 1799 p. 209.

The relationship of insects to human health is two-fold: on one side, insects may be the direct or indirect causes of a large number of human diseases; on the other side, a number of species may provide cures to human health problems (Lesser 1799). Regarding the first issue, as old and new treatises on medical entomology show, the Orthoptera do not count as specially noxious insects (Patton & Cragg 1913; Riley & Johanssen 1915; Lane & Crosskey 1993; Mullen & Durden 2009). However, this does not imply they are completely harmless: they may be allergenic or vectors or reservoirs of cholera and the vesicular stomatitis virus (Showler 1996; Nunamaker *et al.* 2003; Hill & Goddard 2012; Pener 2014). Nevertheless, a great number of healing properties have been attributed to orthopteran species since ancient times, as summarised by Cowan (1865) and Weiss (1947). For example, Pliny the Elder (1847) explained that cricket (possibly *Acheta domestica*) was good for catarrhs and inflammations of the amygdalae, for earache (if applied jointly with soil in which it lived), for weak sight, and it also had diuretic properties (Weiss 1947). The famed Roman physician of Greek origin, Pedanius Dioscorides Anazarbeus (c. 40 AD-c. 90 AD) wrote in Book II of his *Materia Medica* (Dioscorides 1547): "...grasshoppers in a suffumigation relieve under a dysuria especially such as is incident to the female sex", and that *Locusta Africana* (?) is a good antidote for scorpion poison. In the article on 'locust' of Smith's (1893) "Dictionary of the Bible", it is reported that Hebrew women used the eggs of the "chargol" locust to prevent earache (the identity of the "chargol" is debatable although it is possible that the name refers to the katydid *Tettigonia viridissima* (Linnaeus, 1758)). Despite the apparent common use of Orthoptera in the Levant in ancient times, a recent paper (Lev 2003) does not report a single orthopteran species used in modern times' traditional medicine. A very curious medicinal use of an orthopteran is that of *Decticus verrucivorus* (Linnaeus, 1758), a tettigoniid widespread in Europe and Asia. As its name implies, it was employed by peasants to bite the warts on their hands; the black fluid which it emits from its mouth being supposed to possess the power of making these excrescences vanish (Cowan 1865; Weiss 1947).

The importance of entomotherapy has been growing steadily in recent years, as entomologists and ethnologists continuously uncover insect species used in folk medicine, added to the ever-increasing technology that allows the identification of active principles. Orthopterans are present in most medicinal species lists of different parts of the world (Chang 1982; Ramos Elorduy & Pino Moreno 1988; Pemberton 1999; Costa-Neto 2005b, 2011; Costa-Neto & Marques Pacheco 2005; Costa-Neto *et al.* 2006; Feng *et al.* 2009). Some species show surprising multiple uses. Just to mention a single example, in many parts of Brazil, the hind legs of the common cricket, *Acheta domestica* are variously used to treat:

dandruff, asthma, eczema, ear ache, vomits in children, intestinal parasites, fever, rheuma, children that urinate in bed, children slow in talking, urine retention, oliguresis, pterygium, etc. (Costa-Neto *et al.* 2006).

The potential of insects', including Orthoptera, use in folk medicine is enormous. That is why we should emphasise the statement made by Costa-Neto (2005a): "*Drug companies [...] have been methodically testing animals and medicinal plants for decades without paying anything to countries where these genetic resources were found. The biodiversity treaty recognizes that, as custodians of the biosphere, indigenous people should receive some reward if, say, a [...] firm develops a product based on traditional resources or wisdom. However, pharmaceutical companies rarely pass on a fair share of their profits to the countries that provide the raw genetic material.*".

At play with hopping and singing friends

"Whenever the autumnal season arrives, the ladies of the palace catch crickets in small golden cages. These with the cricket enclosed in them they place near their pillows, and during the night hearken to the voices of the insects." T'ien Pao i Shi (Affairs of the Tien Pao period), AD 742-756

"The Singing cricket chirps throughout the long night, tolling in the cloudy autumn with its rain. Intent on disturbing the gloomy sleepless soul, the cricket moves towards the bed chirp by chirp." Bei Ju-Yi, Tang dynasty, AD 618-907

The practice of keeping singing insects (especially crickets and katydid) in cages for the pleasure of hearing their musical sounds is long established in Asia, especially in China and Japan (Wotono *et al.* 1634; Cowan 1865; Laufer 1927; Allard 1929; Jin 1994; Pemberton 1990, 1994; Hogue CL 1987; Hogue JN 2009; see below), and it was also recorded in Europe, for example in eighteenth-century Hamburg (Kevan 1975; Costa-Neto 2003; Coleman 2008). Crickets were also a source of amusement to the Chinese as fighters (Laufer 1927; Raffles 2011). Singing Orthoptera were also considered as pets in classical Greece where special tiny cages were constructed for keeping them (Weidner 1994). Poets and poetesses from ancient Greece mentioned this practice, such as Erinna (possibly a disciple of Sappho of Lesbos; ca 600 BC), Theokritos of Syracuse (316 or 310-260 or 250 BC), Aristodikos of Rhodes (ca 400 BC), Simias of Rhodes (ca 300 BC), Leonidas of Tarentum (mid 3rd Century BC), Nicias (3rd Century BC), and Longus (or Longos) of (presumably) Lesbos, author of the famous bucolic poem "Daphnis and Chloe" (mid 200 AD) (Weidner 1994). That the practice of caging orthopterans and other insects for entertaining also occurred in colonial India (and is probably very ancient) is shown by a passage in Kipling's (1910) "The Jungle Book"; when describing the activities of the boys that herded buffalo in the chapter entitled "Tiger! Tiger!" he wrote: "*Then they sleep and wake and sleep again, and weave little baskets of dried grass and put grasshoppers in them; or catch two praying-mantises and make them fight;...*".

In South America, a reference by Henry Walter Bates (1862, 1863) to the tananá katydid *Thliboscelus hypericifolius* (Stoll, 1813) (Pseudophyllinae), seems to be the first one made of this practice among Brazilian natives (Bidau 2014a). Costa-Neto (2003) acknowledged this but for some reason he attributed the practice to natives of Guiana (the distribution of the species reaches the Guianas, the type specimen being from Surinam). According to Bates: "*... they keep it in a wicker-work cage for the sake of hearing it sing. A friend of mine kept one six days. It was lively only for two or three, and then its loud note could be heard from one end of the village to the other. When it died he gave me the specimen, the only one I was able to procure.*" This observation was of much interest to

Darwin who cited the case of the tananá when discussing the role of sexual selection in the evolution of orthopteran acoustic communication (Darwin 1871; Bidau 2014a). In Brazil, this practice is still in use as in Alagoas State (Costa-Neto 1998).

The appreciation of Japanese and Chinese cultures for the singing of crickets and katydidids as a form of aesthetic pleasure was wonderfully described by two notable men of widely different fields: the famous international writer and expert in Japanese culture, Lafcadio Hearn (Koizumi Yakumo 1850-1904) (Kennard 1912), and the notable US anthropologist and orientalist Berthold Laufer (1874-1934) (Latourette 1936) (both works are available online but have also been reprinted in Ryan 1996).

In his beautiful book of essays “Exotics and Retrospectives” Hearn (1898) included a long chapter entitled “Insect-musicians” in which he described and analysed the ancient Japanese custom of keeping singing insects as pets, and how this practice was also the origin of a profuse millenary literature of delicate beauty, as well as a regular and profitable trade. Night singing Orthoptera (crickets and katydidids) were not only caged to hear their “songs” at home, but some centuries ago, several Japanese districts were famous as pleasure-resorts because of the possibility of listening to the choruses of crickets and katydidids. Furthermore, different places were noted for their different musical species (i.e. Arashima, near Kyōto for *matsumushi*; Ogura-Yama, in Yamashiro, for *suzumushi*; Sagano, in Yamashiro, for *kirigirisu* [an excellent summary of the orthopteran species of the Japanese and Chinese cultures can be found at http://www.bolingo.org/cricket/crickets_nametable.htm]).

Interestingly, although the Japanese also loved and respected other singing insects such as cicadas (*Sémi*), these were not caged because they were not considered singers but “chatterers” (Hearn 1900). Hearn (1898) traces back the first literary references to singing Orthoptera to the XIth century in works such as “The Tale of Genji” by Lady Murasaki Shikibu, although the first reference to the caging of singing insects seems to be that in the “Kokon chōmon shū” (“Collection of Ancient and Modern Tales” compiled by Tachibana no Narisue starting in the early Kamakura period. 1254 AD). By the XVIIth century day- and night-hunts of crickets and katydidids were a very popular diversion as shown by a letter of the poet Teikoku (d. 1653) included in “Teikoku Bunshū”, his collected works, in which he invites a friend to go insect-hunting at night (Hearn 1898).

The most ancient known poem about a singing cricket appeared in the “Kokinshū”, a compilation made by Tsutayuki in 905 AD (Rodd & Henkenius 1996). It is about the *matsumushi* or “waiting insect” (Table XX). The translation by Hearn (1898) reads:

*“With dusk begins to cry the male of the Waiting-insect;
I, too, await my beloved, and, hearing, my longing grows.”*

Another beautiful poem, in this case about the *emma-korogi* appears in another collection of poems, the “Manyōshū” of middle VIIIth century (Honda 1967):

*"Showers have sprinkled the garden-grass.
Hearing the sound of the crying of the korogi,
I know that the autumn has come."*

As Hearn (1898) put it: “Surely we have something to learn from the people in whose mind the simple chant of a cricket can awaken whole fairy-swarms of tender and delicate fancies.”

The former consideration can easily be applied to the relationships between the Chinese and the Orthoptera. The people of China not only share the Japanese’s love for the singing of these insects, but also cultivate the unique ancient “sport” of fighting crickets (Laufer 1927; Jin & Yan 1988; Suga 2006; Raffles 2011; Rothenberg 2013). There is an

expression in Chinese which characterises the old traditions of raising and keeping small plants and animals for pleasure: *hua niao yu chang* (flowers, birds, fish, insects) (Suga 2006). The cricket culture should be interpreted within this ancient tradition. For the Chinese, this culture has a spiritual dimension which goes beyond the mere keeping of household pets. According to Laufer (1927): “*In their relations to crickets the Chinese have passed through three distinct periods: during the first period running from the times of early antiquity down to the T'ang dynasty, they merely appreciated the cricket's powerful tunes; under the T'ang (A.D. 618-906) they began to keep crickets as interned prisoners in cages to be able to enjoy their concert at any time; finally, under the Sung (a.d. 960-1278) they developed the sport of cricket-fights and a regular cult of the cricket.*”

The appreciation of crickets as entertaining has produced an abundant literature on the subject. The oldest known compilation of the cricket practice is the “Tsu chi king” (Book of Crickets) written by minister-of-state Kia Se-tao, a great cricket fancier, in the XIII century during the Sung dynasty. Later books with titles such as “Records of Crickets” or “Treatise of Crickets” borrowed extensively from the “Tsu chi King”, which is available even today (Laufer 1927; Suga 2006; Raffles 2011).

The earliest collection of Chinese poetry and popular songs, the Shih king (Legge 1879; Anonymous 1900) contains several mentions to the cricket's song in many cases in a nostalgic form as in the “Odes of Chou and the south”, where the wife of a great officer bewails his absence:

*“Shrill chirp the insects in the grass;
All about the hoppers spring.
While I my husband do not see,
Sorrow must my bosom wring.
O to meet him!
O to greet him!
Then my heart would rest and sing.”*

Chinese cricket fighting (“Quixing” or “Dou Cuzhi”) (Fig. 2) is based in the male aggressive behaviour that occurs in many gryllid species in relation to mating (Loher & Dambach 1989; Judge & Bonanno 2008; Judge *et al.* 2010). While Jin (1994) listed 31 species of fighting and singing orthopterans commonly used in China (22 crickets and 9 katydids), the number of traditional forms varies between 130 and 180, most of them local varieties of a species (Jin & Yen 1998). These forms are classified according to an ancient folk taxonomy that uses characters such as colour, size, body form, type of sound, loudness of chirping, and especially in fighting crickets, the size of the male's head (Hsu 1929; Jin 1994; Jin & Yen 1998; see below). Cricket fighting as a sport, is also an ancient practice: although the first reliable data date back to the twelfth century (Song dynasty), the practice was already highly sophisticated being more an art than a simple amusement (Suga 2006). Therefore, some theories propose that the beginnings of cricket fighting may be much older (VIIIth century AD during the Tang dynasty when Xuan Zong was emperor) (Anonymous 2014; Suga 2006). However, the first known handbook on rearing and training crickets is that of general Jia Sidao (1127-1278 AD) which shows that it is a complex and systematised activity which also involves specialised equipment (Hammond 1983; Ho *et al.* 1989). Be as it may, this important cultural aspect of Chinese life is not only a flourishing leisure activity, but a very important trade (see below). It is out from the scope of this review to deal extensively with Chinese cricket fights which have been excellently described in a series of old and modern publications to which the interested reader is referred (e.g. Laufer 1927; Ho *et al.* 1989; Suga 2006; Raffles 2011). I will only mention some interesting and unique aspects of this fascinating sport.

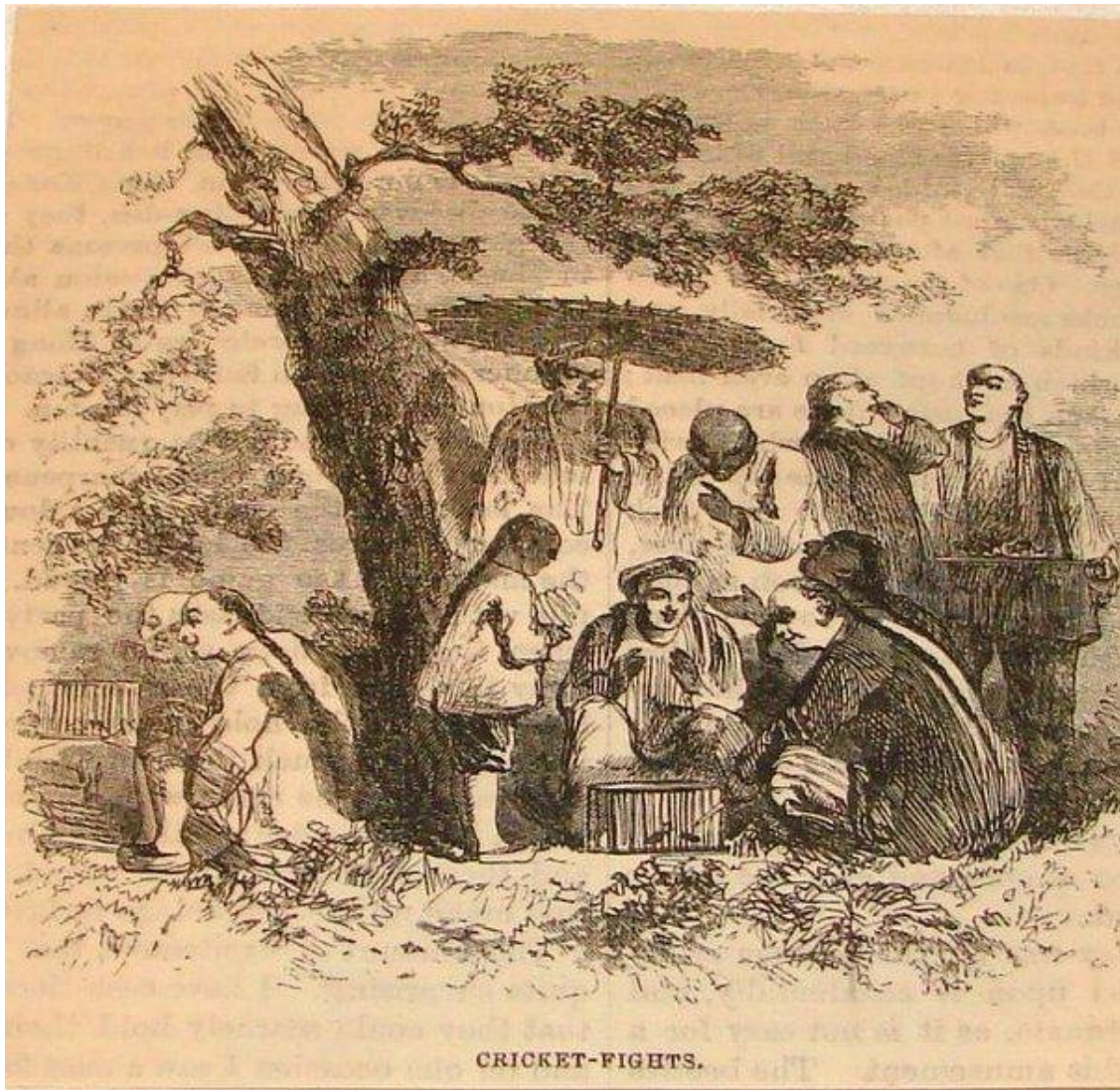


Figure 2. Quixing or cricket fighting. Chinese engraving, 1879.

First, the magnitude of the interest in cricket fighting is clear from the number of enthusiasts which in Shanghai alone amounts to 300,000-400,000 people while active societies exist in all major cities of China (Jin & Yen 1994; Raffles 2011). Although in the origins of this sport crickets were directly collected in the field, it later became an important business activity; fighting crickets are reared and sold in flower and pet markets not only in continental China but also in Hong Kong, Taiwan and even Mongolia (Jin & Yen 1994; Suga 2006). Nevertheless, crickets are still being captured in the field which has raised concerns about their conservation (Jia & Yen 1994). The other serious problem is related to betting in cricket fights. “Pathological gambling” is considered a serious problem among the Chinese and a lot of this gambling involves cricket fights (Tse *et al.* 2010).

It is interesting to note that in a recent experimental study of male weaponry in *Gryllus pennsylvanicus* Burmeister, 1838 (used for fights among the Philadelphia Chinese community), produced the first evidence that the size of the head capsule and mouthparts are under positive selection via male-male competition in field crickets (Judge & Bonanno 2008) which, as the authors state, “...provide scientific validation of this ancient cultural knowledge.”

Finally, I will mention that there is another form of entertainment in which orthopterans have a role although quite different from those described above: grasshoppers and crickets are used as live bait for fishing in fresh water as many old treatises on angling show (Best 1974; Salter 1815; Rhead 1916). For example, in Rhead's (1916) book on American insects used for trout fishing, one reads in page 147: book "*If you hook one and float it alive—nay, if you do so half a dozen times—you will see how cleverly the fish nip the grasshopper off without touching the hook.*" and "*The advantage of grasshopper fishing is that none but large fish will go for it.*"

Conclusion

"Have you ever wondered what it's like to be a grasshopper, hopping through meadows and leaping through the air?" Erin M. Hovanec, *I Wonder what it's Like to be a Grasshopper*, 2000

The knowledge of the cultural aspects of the relations between humankind and different group of living beings, is an essential part of the understating of nature. The basic biology of Orthoptera is well known due to extensive research during the past three centuries but frequent new discoveries in all areas of biology surprise us continuously (Bidau 2014b). However, orthopetrans have much more to tell with respect to their cultural impact that has, as shown in this paper, a venerable tradition. Despite some of its species being agricultural pests a larger number produce aesthetic pleasure, are important sources of nutrition in times of uncontrolled human population growth, and may be a reservoir of unknown drugs that could alleviate many human ailments. Furthermore, orthopterans are fundamental components of most ecosystems and their conservation should be priority (Samways 1997; Samways & Looockwood 1998; Sergeev 1998; Kati *et al.* 2003). A conjunction of biological knowledge and cultural entomology of this extraordinary group of insects will not only broaden our understanding of nature's workings but will also help preserve for posterity these beautiful singing evolutionary companions.

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