Biting in Orthoptera and their allies

BY

S. K. GANGWERE.

(Detroit) [1].

Orthoptera of some subfamilies bite when handled carelessly, while those of other subfamilies rarely do so. This behavior has not been reviewed, and the little that is known about it is recorded perfunctorily within reports on other topics. It is probably more common than is indicated by its scant literature; those who are sufficiently trained in entomology to report defensive biting are expert in handling the insects and not likely to be bitten. The vast majority of bites, therefore, go unrecorded. Whatever the extent of biting, it is of interest both in terms of its possible biological significance and because it hurts.

In the course of my studies on the mouthparts and feeding behavior of Orthoptera, I have, on occasion, been bitten or threatened by my test animals. Other entomologists have kindly informed me of similar experiences with various species, and I have carefully noted all records that I have found in the literature. This information is brought together in the following report, in which the biting behavior of the major groups of Orthoptera is assessed—admittedly on the basis of insufficient information. Inasmuch as even closely related species may differ in their tendency to bite, such generalizations as are made must be qualified. Nevertheless, on the whole the members of each group exhibit fairly consistent patterns of biting, which can be related to their mode of life, food habits, and mandibular structure.

SURVEY OF BITING IN THE GROUPS AND SPECIES.

Blattoidea. I have neither encountered literature records of defensive biting by cockroaches, nor have I suffered personal experiences of

[1] Contribution No. 155 from the Department of Biology, Wayne State University, Detroit, Michigan, 48202, U. S. A.

that type. My past research with these secretive orthopterans has been based largely on the wild genera *Ectobius, Parcoblatta,* and others of small size and innocuous habits; they would not be expected to bite. I have done more limited studies with *Blaberus, Blatta, Byrsotria,* and *Periplaneta,* four domestic genera of large size. The results here, too, were negative, even in the case of *P. australasiae,* which I deliberately prodded in an unsuccessful attempt to induce biting. W. J. Arnold, a colleague who specializes in blattid histology, has had somewhat different experiences. Arnold reports (personal communication) that he is often rasped by the mandibles as he handles *Blatta, Blaberus,* and *Periplaneta,* though their bite is unsuccessful, as they cannot grasp the skin. He has not detected this habit in *Parcoblatta.*

There is a second kind of biting by cockroaches that is actually a type of feeding behavior. It is the occasional gnawing of sleeping or incapacitated adults or helpless infants, which behavior was reviewed by Roth and Willis (1957). Their references document the fact that, in cases of heavy infestation, toenails, fingernails, and calluses of living humans may be nibbled; open wounds and blisters attacked; the thin skin of the face, ears, and other places bitten; and even the dead stripped of flesh.

Mantoidea. The few observations I have made on mantids enable me to say only that *Ameles* and certain other genera do not bite in response to repeated prodding. Crane, who published on the mantids of Trinidad (1952), has more extensive information. She found one type of defensive behavior *(viz.,* aggressive attack) that is of interest. Aggressive attack does not involve biting, but merely a lightning-like rake with the fore legs, that are extended, boxer-like, from their flexed position against the prothorax. Actual biting, when it occurs, comes as a last resort when the insect is teased repeatedly or seized by the head.

Phasmoidea. I have investigated comparatively few species of walking sticks, chiefly of the genera *Diapheromera* and *Leptynia,* none of which has attempted to bite even when prodded deliberately. This negative evidence, together with phasmids' mimicry, their autocatalepsy, the specialized nature of their mouthparts, and the lack of biting records in the literature, indicate that stick insects do not bite.

Acridoidea. Biting is uncommon in most grasshoppers. I know of no literature records of biting by Truxalinae [2], or slant-faced grass-

[2] Including the Oedipodinae, whose species most authorities now place under the Truxalinae.

hoppers, and in the course of studying many species of them in nature do not recall ever having been bitten. I have studied numerous species of Cantantopinae, or spine-breasted grasshoppers, most of which proved innocuous—so much so that not even the most injudicious handling elicited a bite; in contrast were a few species that tend to nip, though they are never aggressive. Based on my records and those of some colleagues, *Melanoplus bivittatus, M. confusus, M. d. differentialis,* and *Schistocerca lineata* are examples. Their bite, a pinching or rasping, is not capable of drawing blood but can be the object of discomfort. I have yet to study in nature a member of the Romaleinae, or lubber grasshoppers, but am assured by the orthopterist D. C. Rentz that these ponderous insects do not bite. He reported his continuing astonishment *(in litt.)* that the large-bodied genera *Brachystola, Dracotettix,* and *Romalea* never attempt to bite when collected. Much the same can be said for the Pamphaginae, another group of large, lubberly grasshoppers, several genera of which I have studied personally.

Grasshoppers' attraction to the human skin and articles soiled by it is a matter of record. This behavior may be more complicated than it appears superficially. The skin may not be the actual object of attack; its water, salts, and oils sometimes seem more attractive than it does. Salt seems particularly important, as discussed by Morse (1930). Whatever the attractant, the allure that human skin holds for grasshoppers becomes pronounced when the insects are in outbreak populations, the weather is hot and dry, and the human to be bitten is asleep, incapacitated, or perspiring profusely.

The nipping, under conditions outlined immediately above, seems more a case of attempted feeding than of biting. An example is found in a letter by Gen. A. Sully, published in the St. Paul Press, Minnesota, U. S. A., June 21, 1865. He wrote: "A soldier on his way here lay down to sleep in the middle of the day on the prairie. The troops had been marching all night. His comrades noticed him covered with grasshoppers, and woke him. His throat and wrists were bleeding from the bite of these insects." Some other reports are even more fantastic. Whiting (1915) reported from the Near East a documented case involving a peasant woman and her child. The woman had placed her tiny baby in the shade of a tree while vainly attempting to divert from her orchard an oncoming horde of locusts. Returning later, she found the child covered with locusts and its eyes consumed from their sockets. Another example, a supposedly accurate account of the death of the

eminent entomologist M. Kunckel Herculais, was described dramatically in a reputable scientific journal (Anonymous, 1891): "While examining a deposit of locusts' eggs at the village of Sidieral he (M. Kunckel Herculais) was overcome with fatigue and the heat, and fell asleep on the ground. While sleeping he was attacked by a swarm of locusts. On awakening he struggled desperately to escape from the flood. He set fire to the insect-laden bushes near him, but all his efforts proved ineffectual, and, when finally the insects left the spot, his skeleton was found, together with his hair, beard and necktie. The rest of him had been entirely devoured." The circumstances of his death, as outlined above, were questioned in certain other reports (Anonymous, 1891a).

Tettigonoidea. Almost all subfamilies of katydids bite and some are biters *par excellence.* Two subfamilies, the Phaneropterinae and Pseudophyllinae, are perhaps exceptions; negative results from my field work and a lack of biting records from my colleagues and the literature suggest that they do not bite to any great extent. Even so, at least two genera with which I am acquainted, *Pterophylla* and *Lea,* remain open to question because of their strong mouthpart structure.

I have investigated nearly a dozen species of Conocephalinae belonging to two genera, *Conocephalus* and *Orchelimum.* In the course of studying them I have yet to be bitten but recall having been threatened by *Orchelimum* spp. on several occasions. T. H. Hubbell informs me (personal communication) that *Conocephalus* sometimes bites and *Odontoxiphidium* and *Orchelimum* often do so. Rehn and Hebard (1907) reported that one species of *Orchelimum* clings so tenaciously when it bites that its head may be pulled from its body without causing relaxation of its jaws.

There is a habit related to biting that I have often observed in *Conocephalus* spp. The meadow katydids in question are attracted to the human skin, the surface of which they assiduously explore with their mouthparts whenever an opportunity is presented. In doing so they carefully work along the surface, rasping gently with the mandibles and "sponging" with the galeae, but causing no discomfort. The behavior is probably associated with obtaining perspiration, skin oils, or salt. It is not true biting.

I have no personal records of biting by Copiphorinae, or cone-headed katydids, though I have worked extensively with several species of *Neoconocephalus* and with one of the European genus *Homorocoryphus.* The most closely related behavior that I have found is the frequent ten-

dency of *N. ensiger,* when handled, to bare its wicked-looking mandibles in a threatening manner. Several biting records of other investigators show that *Belocephalus* and some *Neoconocephalus* do indeed bite, and in at least two instances the wounds inflicted were sufficiently severe to cause bleeding. So formidable are the jaws of cone-heads that this demonstration of their biting prowess is not unexpected; biting in the group as a whole is probably common.

The katydid subfamilies Decticinae, Ephippigerinae, Listroscelinae, and Tettigoniinae include species that, according to my records and the literature, bite viciously. The subfamilies Hetrodinae and Saginae are said to include biting species, and my experience with one species of Pycnogastrinae indicates that group, too, bites. Some Saginae and Decticinae are reputed to bite so severely as to cause bleeding. A typical bite was described by Tinkham (1944), who discussed graphically the capture of the decticine *Capnobotes bruneri:* "The evening meal had just been finished and darkness was fast approaching when some 'tzwks' sounded from the tops of nearby towering Western Yellow Pines. As the song was new to the writer, it was decided to make the ascent despite the setting and the arduous task facing the would-be hunter ... About fifty feet up the katydid, singing in the top of the pine, heard the hunter and stopped singing, whereupon the hunter sat on a limb a quarter of an hour for the song to recommence ... Suddenly, when the song seemed to be immediately overhead, it stopped ... There in a clump of long pine needles perched the troubador ... The pine top was gently swaying as the hunter wrapped his legs around the slender trunk for support. Then with the flashlight in his left hand, the hunter made a sudden grab at the katydid. As he extricated the katydid from the pine needles the creature responded with a vicious bite that caused an 'ouch' to resound through the tree-tops, and as the katydid chewed away on finger tissue the flashlight was replaced and the cyanide jar obtained and the lid unscrewed with the fingers of one hand holding it. Finally the katydid was ensconced within the jar and, trembling with the strain and excitement, a feeling of great relief came when two hands again gripped the tree."

The attack of these large, fiercely biting kaydids is usually defensive; they bite only when teased repeatedly or handled bodily. In at least one group, however, there are species so pugnacious as to go to the offensive before they are touched. That group, the Listroscelinae, includes a number of species of *Neobarrettia* formerly included in the

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genus *Rehnia*. Their aggression has been vividly described by Tinkham (1944), who wrote concerning *Rehnia cerberus* (= *Neobarrettia spinosa*): "Approaching the specimen I planned to catch it in my fingers for it was about five feet off the ground, and I did not have a net. When my hand was slowly approaching and about six inches away *Rehnia* suddenly assumed an interesting and menacing attitude. Its spiny forelegs were held high above its head, mantid-like, its antennae held back and its beautiful mottled pale green and black wings spread fan-wise to each side and its mandibles were bared. Suddenly without warning it gave a few 'tszicks', jumped to the end of my finger and gave me a vicious nip, then quickly dropped to the ground and crawled under a cactus plant growing in a clump of mesquite. Such aggressiveness took me completely by surprise as it was all over in a few seconds. The mouse had attacked the elephant, a katydid a man a thousand times his size."

Gryllacridoidea. The gryllacridids include both biters and non-biters. The stenopelmatine genera *Cratomelus, Stenopelmatus,* and others nip severely if given a chance, whereas the docile rhaphidophorine *Ceuthophilus* and its close relatives never even threaten to bite (Hubbell, personal communication).

Grylloidea. There is comparatively little information concerning biting in crickets, and evidence bearing on the subject is conflicting. The paucity of records suggests that crickets are not particularly disposed toward biting, but the pugnacious nature of certain crickets —that makes possible the well-known cricket fights of the Orient— indicates that they do bite. I have comparatively little personal information to offer. I have observed *Gryllus pennsylvanicus* individuals fighting over food (and biting one another) in nature, though this is not biting of man. I have also induced, by teasing, weak biting in *Acheta domesticus*. Howard and Marlatt (1902), also discussing *A. domesticus,* reported that it is very pugnacious and bites vigorously when captured. My colleague L. Levine, engaged in research on cricket physiology, does not feel that *Acheta* is aggressive, though he admits that the insect bites feebly (personal communication). He finds that *Gryllus pennsylvanicus* bites and is more aggressive that is *Acheta*. Two other species of *Gryllus, G. campestris* and *G. bimaculatus,* are well-known for their biting (E. Morales Agacino, personal communication). At least one cricket, *Brachytrypes membranaceus,* is known to bite so severely as to draw blood.

Major Types of Defensive Biting.

The Orthoptera and their allies exhibit several degrees of biting or its lack. The following is an artificial classification of the insects in terms of their biting behavior:

a. *Species That Do Not Bite.* Some species never attempt to bite even when threatened, prodded repeatedly, or handled roughly; they merely seek shelter. Examples of these docile Orthoptera are found among the camel crickets, the walking sticks, the truxaline and many cantantopine grasshoppers, and various small species belonging to a number of subfamilies.

b. *Species That Rarely or Occasionally Bite When Abused.* These insects bite sometimes —often as a last resort— when handled either roughly or repeatedly. Certain gryllines and cantantopines are examples.

c. *Species That Customarily Bite When Abused.* Insects of this type bite whenever the collector inadvertently exposes his flesh to attack. Examples are found among most katydids; they bite viciously, and occasionally (as with the sagines and certain decticines) they cause bleeding.

d. *Species That Attack and Bite When Threatened or Abused.* At least one genus, *Neobarrettia,* includes katydids that have a stylized display posture. The effect is impressive and sometimes sufficient to intimidate. If the posture does not dissuade the intruder, then the katydid leaps to the offensive, bites, and retires before its startled foe can regain composure. The attack may be from a distance of one-half foot. A similar display posture is used by mantids, but in this case it is bluff; it is not usually succeeded by biting.

Correlations Between Mandibular Structure, Biting, and Aggression.

Biting seems correlated with the degree of development of the mandibles. Those Orthoptera that seldom or never bite are rarely, if ever, aggressive, and their mandibles are most often adapted for phytophagy. Grasshoppers and walking sticks are examples. Even when the mode of existence is wholly carnivorous biting does not necessarily

occur. Mantids, for example, catch and hold prey by the use of raptorial fore legs; the jaws are correspondingly weak, the behavior comparatively non-aggressive, and biting almost non-existent. In contrast are the viciously biting katydids of such groups as the Decticinae, Listroscelinae, Saginae, Tettigoniinae, and others. Their mandibles —powerful organs armed with fang-like dentes— are used in catching prey, and their legs are non-raptorial. These groups tend toward aggression, and some are highly aggressive.

An Overview of Biting.

The mandibles of insects are sclerotized, opposable objects primarily concerned with handling food. Any rigid organ of opposable nature (including the mouthparts) is potentially capable of use in a number of ways. The non-feeding uses of the mouthparts in one or another species include digging; chewing leaves to facilitate oviposition; removing the spermatophore; grooming; spreading "spit" (regurgitated crop contents); displaying for protection or recognition; escaping from egg cases, exuviae, or other encapsulating structures; sound producing; and biting. Some of these functions (*e. g.,* grooming) are commonly practiced but others (*e. g.,* biting) only occasionally so. Wherever adopted, they convey to their possessors a certain selective advantage, which, in turn, can alter the course of evolution. Therein lies the significance of these habits —and that of biting.

Biting has the potential of startling or of hurting the intruder to the point that it ceases or delays its attack, during which the biter is able to make good its escape. It succeeds to varying degrees, sometimes permitting withdrawal but sometimes falling short of that objective. It is variously adopted in the Orthoptera, some species resorting to it rarely or not at all and others regularly. It is, of course, a natural tendency that can be directed against any opponent, whether invertebrate or vertebrate. It has here been discussed in light of a particular species of offender, man, but the conclusions drawn are applicable to other organisms. It is, therefore, of more than limited biological interest.

Finally, biting is but one phase of the general defensive behavior of Orthoptera and their allies. In most of these insects the defensive behavior involves one or more methods, as follows: they "freeze" and

try to take advantage of protective coloration or form; sidle around a stem, leaf, or other object to hide; or fly, jump, or fall to the ground in an attempt to find shelter. If caught, they kick violently with the legs (especially in the Saltatoria) and regurgitate their crop contents. Rarely they hiss, make other sounds, or release a foul-smelling substance. As a last resort some species bite. Other Orthoptera rely on a more complicated defensive behavior; they have a stylized display posture superimposed on the foregoing reflex activities preliminary to biting. Whatever the case, these defensive activities may well be hierarchical, each involving a given releaser mechanism. The precise nature of these mechanisms can only be surmised now, and could form the basis of a series of productive future researches.

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Appendix I*

Group	*Species*	*Authority*	*Remarks*
Blattoidea.	Various spp. of Blaberus, Blatta, Blattella, & Periplaneta.	W. J. Arnold, Wayne State Univ. **	Rasp at fingers when held but cannot grasp skin.
"	Various spp. of Blaberus, Blatta, Blattella, & Periplaneta.	Roth & Willis 1957: Smithsonian Misc. Coll., 134.	Numerous instances of biting defenseless humans; none of defensive biting.
"	Blatta orientalis?	Gangwere.	Bite on eyelid of sleeping human; not defensive biting.
Mantoidea.	Various spp., especially Catamusonia sp. & Stagmomantis carolina.	Crane 1952: Zoologica, 37.	Bite as a last resort when seized; preceded by alarm reaction.
Acridoidea.			
Cantantopinae.	Dichroplus bergi.	C. S. Carbonell, Univ. de Montevideo. **	Bites frequently.
"	Leiotettix sp.	C. S. Carbonell, Univ. de Montevideo. **	1 record of eating hole in perspiration-stained shirt, during which flesh was bitten.

* A tabulation of the Orthoptera and their allies that, to the author's knowledge, bite man. This incomplete list is based on the literature, unpublished records or comments of other entomologists, and personal records.

** Personal communication.

APPENDIX I (Cont.).

Group	*Species*	*Authority*	*Remarks*
Cantantopinae, cont.	Melanoplus bivittatus.	Gangwere.	1 record by nymph.
"	" "	J. K. Hiltunen, U. S. Fish & Wildlife Serv.**	Several records of bitten fingers.
"	" "	Parker 1954: Farmers' Bull., U. S. Dept. Agric., 2064.	Bites perspiring, non-moving humans to point of drawing blood; not defensive biting.
"	" "	Piers 1918: Trans. Nova Scotia Inst. Sci., 14.	Doughty fighter that tries to bite (humans?).
"	" "	M. Yacos, Wayne State Univ.**	Several records.
"	Melanoplus confusus.	Gangwere.	4 records.
"	Melanoplus d. differentialis.	Gangwere.	1 record
"	Melanoplus f.-r. femur-rubrum	Gangwere.	2 records.
"	Melanoplus s. scudderi.	Gangwere.	1 record.
"	Melanoplus spp.	Parker 1954: Farmers' Bull., U. S. Dept. Agric., 2064.	Often bite when picked up; occasionally when unmolested but given access to non-moving human.
"	Schistocerca gregaria.	Whiting, 1915: National Geogr. Mag., 28.	Author's son bitten on throat causing bleeding; not defensive biting.

** Personal communication.

APPENDIX I (Cont.).

Group	*Species*	*Authority*	*Remarks*
Cantantopinae, cont.	Schistocerca lineata.	W. A. Kaleva, Univ. Minnesota. **	1 record.
"	" "	M. Yacos, Wayne State Univ. **	Several records.
TETTIGONOIDEA.			
Conocephalinae.	Conocephalus spp.	T. H. Hubbell, Univ. Michigan. **	Sometimes bite.
"	Odontoxiphidium spp.	T. H. Hubbell, Univ. Michigan. **	Often bite.
"	Orchelimum molassum (= O. agile).	Rehn & Hebard 1907: Proc. Acad. Nat. Sci. Philadelphia, 59.	Jaws cling with bulldog-like tenacity even after head is pulled from body.
"	Orchelimum spp.	Caudell 1919: Ann. Rept. Smithsonian Inst., 1917.	Bite so severely as to almost draw blood.
Copiphorinae.	Belocephalus sabalis.	Rehn & Hebard 1914: Proc. Acad. Nat. Sci. Philadelphia.	Inflicts painful bite on tender portions of hand.
"	Belocephalus sleighti simplex (= B. sabalis simplex).	Hebard 1926: Trans. Amer. Ent. Soc., 52.	Inflicts painful bite.
"	Belocephalus subapterus peninsularis.	Hebard 1926: Trans. Amer. Ent. Soc., 52.	Inflicts painful bite.
"	Belocephalus sp.	Davis 1912: Jour. N. York Ent. Soc., 20.	Tough jaws that can nip incautious collector.

** Personal communication.

APPENDIX I (Cont.).

Group	*Species*	*Authority*	*Remarks*
Copiphorinae, cont.	Belocephalus spp.	T. H. Hubbell, Univ. Michigan.**	Bite fiercely.
"	Copiophora mucronata (= Copiphora mucronata).	Glover 1872: Rept. Entom., Rept. U. S. Dept. Agric., 1871.	Jaws remarkably strong and sharp; when handled carelessly bites and draws blood.
"	Neoconocephalus ensiger.	J. E. Lloyd, Cornell Univ. **	1 record.
"	Neoconocephalus triops.	I. J. Cantrall, Univ. Michigan. **	1 record; caused bleeding.
"	Neoconocephalus sp.	D. R. Cook, Wayne State Univ. **	1 record.
"	" "	A. B. Gurney, U. S. Nat. Mus. **	Bites painfully.
Decticinae.	Apote notabilis.	D. C. Rentz, Univ. California. **	Draws blood.
"	Atlanticus gibbosus.	Rehn & Hebard 1907: Proc. Acad. Nat. Sci. Philadelphia, 59.	Strongest orthopteran bite known to authors; causes bleeding.
"	Atlanticus testaceus.	Cantrall 1943: Misc. Publ. Univ. Michigan Mus. Zool., 54.	Bites severely.
"	" "	Gangwere.	Numerous records; does not draw blood.
"	" "	W. A. Kaleva, Univ. Minnesota.**	1 record.
"	Capnobotes bruneri.	Tinkham 1944: Amer. Midl. Nat., 31.	Bites viciously.
"	Capnobotes fuliginosus.	D. C. Rentz, Univ. California. **	Bites frequently.

** Personal communication.

APPENDIX I (Cont.).

Group	*Species*	*Authority*	*Remarks*
Decticinae, cont.	Cyrtophyllicus sp.	D. C. Rentz, Univ. California.**	Bites painfully.
"	Decticus verrucivorus.	Burr 1897: British Orthoptera, publ. by Huddersfield.	Used by Swedish peasants to bite and destroy warts, as indicated by trivial name; myth?
"	Olynthoscelis dalmaticus (= Pholidoptera dalmatica).	Burr 1906: Entomologist, 39.	Bites severely.
"	Pholidoptera griseoaptera.	Lucas 1928: Entomologist, 61.	Nips sharply.
"	Plagiostira gillettei.	La Rivers 1948: Amer. Midl. Nat., 39.	Feeble attempts at biting.
"	Zacycloptera atripennis.	Helfer 1963: How to know the grasshoppers, publ. by Brown, Dubuque, Iowa.	Bites viciously when disturbed; preceded by alarm reaction.
Ephippigerinae.	Callicrania miegi.	Gangwere.	Bites forceps (fingers?) when handled.
"	Ephippigera spp.	Bernard 1914: Tech. trait. Vigne, publ. by Bailliere, Paris***	Bite sleeping natives in vineyards.
"	Steropleurus spp.	Gangwere.	Bites forceps (fingers?) when handled.

** Personal communication.
*** Reference not located.

APPENDIX I (Cont.).

Group	*Species*	*Authority*	*Remarks*
Ephippigerinae, cont.	Various **spp.**	Burr 1910: Synop. Orthoptera W. Europe, publ. by Janson, London.	Endeavor to bite captor.
"	Various spp.	E. Morales Agacino, Inst. Español de Ent. **	All species bite.
Hetrodinae.	Eugaster fernandezi.	E. Morales Agacino, Inst. Español de Ent. **	Bite reinforced by irritation from latex of cactiform Euphorbia on which insect perches.
"	Various spp.	H. Weidner, Zoologisches Mus., Hamburg. **	Bite.
Listroscelinae.	Neobarrettia spp.	T. J. Cohn, San Diego State Coll. **	Numerous records; bite preceded by alarm reaction.
"	" "	Gangwere.	Several records.
"	Rehnia cerberus (= Neobarrettia spinosa).	Tinkham 1944 & 1948: Amer. Midl. Nat. 31 & 40, respectively.	Both sexes bite viciously and are aggressive to point of attacking from a distance; bite preceded by alarm reaction.
Pycnogastrinae.	Pycnogaster jugicola.	Gangwere.	Bites forceps (fingers?) when held.

** Personal communication.

Appendix I (Cont.).

Group	*Species*	*Authority*	*Remarks*
Saginae.	Clonia vittata.	Akerman 1932: Ann. Natal. Mus., 7.	Bites and draws blood.
"	Saga spp.	Burr 1900: Proc. S. London Ent. Soc. ***	Caused loss of flesh to Brunner.
"	" "	Burr 1910: Synop. Orthoptera W. Europe, publ. by Janson, London.	Powerful jaws able to give bite severe even to human.
"	" "	E. Morales Agacino, Inst. Español de Ent. **	Bite severely.
Tettigoniinae.	Acrida viridissima (= Tettigonia viridissima).	Laddiman 1879: Entomologist, 12.	Bites sharply when captured.
"	Tettigonia viridissima.	Gangwere.	Record of last-stage nymph biting; records of adults biting forceps (fingers?) when held.
"	" "	E. Morales Agacino, Inst. Español de Ent. **	Bites viciously.
Prophalangopsidae.	Cyphoderris monstrosa	D. C. Rentz, Univ. California. **	Said to bite with a vengeance.

** Personal communication
*** Rerefence not located.

APPENDIX I (Cont.).

Group	*Species*	*Authority*	*Remarks*
GRYLLACRIDOIDEA.			
Stenopelmatinae.	Cratomelus spp.	T. H. Hubbell, Univ. Michigan. **	Bite.
"	Deinacrida sonitospina.	Salmon 1950: Dominion Mus. Rec. Ent, 1.	Bites readily without drawing blood; aggressive.
"	Hemideina broughi.	Salmon 1950: Dominion Mus. Rec. Ent., 1.	Reported to bite viciously.
"	Macropathus filifer.	Richards 1954: Trans. R. Soc. N. Zealand, 82.	Mouthparts are small and bite is harmless; seldom elicited.
"	Stenopelmatus fuscus.	Davis 1927: Univ. California Publ. Ent., 4.	Struggles vigorously; may draw blood.
"	" "	Helfer 1963: How to know the grasshoppers, publ. by Brown, Dubuque, Iowa.	Bites hard.
"	" "	Hubbell 1922: Univ. Michigan Mus. Zool. Occ. Papers, 113.	Bites; erroneously assumed to be poisonous.
"	Stenopelmatus pictus.	Duncan 1923: Ent. News, 34.	Vigorously bites forceps (fingers?) after being teased.

** Personal communication.

APPENDIX I (Cont.).

Group	*Species*	*Authority*	*Remarks*
GRYLLOIDEA.			
Gryllinae.	Acheta domesticus.	Gangwere.	Bites forceps or nibbles fingers when held.
"	" "	Howard & Marlatt 1902: Bull. Div. Ent., U. S. Dept. Agric. (n. ser.), 4.	Bites vigorously when captured; pugnacious.
"	" "	W. A. Kaleva, Univ. Minnesota.**	Females bite when mishandled; often causes them to be dropped.
"	" "	L. Levine, Wayne State Univ.**	Bites ineffectively when held.
"	Brachytrypus membranaceus (= Brachytrypes membranaceus).	Wellman 1908: Ent. News, 19.	Sharp, powerful mandibles that can draw blood.
"	Gryllus bimaculatus.	E. Morales Agacino, Inst. Español de Ent.**	Bites.
"	Gryllus campestris.	Burr 1897: British Orthoptera, publ. by Huddersfield.	Retreats into burrow; when straw is inserted, seizes it and may be dragged into open; bites?
"	" "	E. Morales Agacino, Inst. Español de Ent.**	Bites.

** Personal communication.

APPENDIX I (Cont.).

Group	*Species*	*Authority*	*Remarks*
Gryllinae, cont.	Gryllus pennsylvanicus.	L. Levine, Wayne State Univ. **	Bites ineffectively when held; pugnacious.
"	Gryllus sp.	D. R. Cook, Wayne State Univ. **	Various records.
Gryllotalpidae.	Gryllotalpa hexadactyla.	Blatchley 1920: Orthoptera N. E. America, publ. by Nature Co., Indianapolis, Indiana.	Fight and mutilate one another; bite humans too?
GRYLLOBLATTOIDEA.	Grylloblatta campodeiformis.	Mills & Pepper 1937: Ann. Ent. Soc. Amer., 30.	Bites forceps (fingers?) when picked up.

** Personal communication.