

PROTEIN CONTENT OF SOME EDIBLE INSECTS IN MEXICO

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ABSTRACT.—Of the 101 species of edible insects collected and studied in several Mexican states, 77 were analyzed for protein content and evaluated for protein quality. Percent protein varied from a low of about 10% to a high value of slightly over 81%. For many species of insects, protein quality, as evaluated by aminoacid profiles, compared favorably with those recommended for nutritional purposes by FAO/OMS. It is suggested that with appropriate technology and consumer acceptance, commercially produced insect food products would help alleviate hunger and malnutrition.

INTRODUCTION

Entomophagy, the consumption of insects by humans, has long been known, especially in regions where environmental conditions are often adverse (Ancona 1931, 1932, 1934; Blasquez 1870; Bodenheimer 1951; Conconi and Pino 1979; Figueroa 1968; Hoffman 1947; Lapp and Rohmer 1937; Ruddle 1973; Skinner 1910; Thompson 1954; Tihon 1946; Wallace 1852). In fact, in some areas they are a major food source and are even dried and stored in large quantities for consumption when food is scarce. Considering that in some regions different species of insects are available for consumption in different seasons and since the eggs, larvae, nymphs, pupae (grubs), and adults of, for example, butterflies, moths, bugs, flies, ants, bees, beetles, termites, grasshoppers, and dragonflies, are often eaten, a large number of different species of insects are consumed by humans on a worldwide basis.

That hunger and malnutrition is a problem in human populations in many parts of the world is well known. In some instances the problem may not be a sufficient supply of calories but a deficiency of high quality protein. And so the search for new food sources, including the identification and development of localized ethnic ones, continues.

In Latin America food resources are becoming increasingly scarce and the importing of foods is becoming more expensive. It is thus imperative to identify and develop indigenous food resources. In this report of preliminary research we have turned our attention to insects not only because of their abundance, biomass, and high quality protein, but also because of the time honored practice among many culturally diverse peoples of Latin America of consuming live, roasted, and fried insects, providing them with a nutritious protein source.

MATERIALS AND METHODS

Collection and identification.—The insects for which nutritional studies were conducted in this report were collected during field work in various parts of Mexico where people regularly use them as food. The stage of the insect life cycle which was eaten was noted in every case. A portion of the collection was preserved in acetone for later chemical analysis and the remainder was placed in alcohol for later taxonomic identification and as vouchers.

All specimens were identified at the Laboratory of Entomology, Institute of Biology, The National University of Mexico (U.N.A.M.) in Mexico City, through the use of the taxonomic literature and reference collections.

Chemical and nutritional analyses.—Aminograms were prepared by the Department of Nutrition Physiology of the "Salvador Zubiran" National Institute of Nutrition of Mexico. All other analyses were performed at the Laboratory of Nutrition and Biochemistry of the Veterinary Faculty of U.N.A.M.

Protein content was determined by the Kjeldahl method (Pearson 1970), with the results calculated on a dry weight basis. Aminoacids were measured with an aminoacid analyzer (Beckman CL 119) with the aid of a minicomputer (Beckman model 126 Data System) designed to integrate peak areas of chromatograms. Tryptophan measurements were obtained by the Spies and Chamber (1949) method. Aminoacid profiles were compared to those recommended by FAO/OMS (Patron 1973), and a "chemical score" of aminoacid profiles based on 100% was devised to give us an index of protein quality.

Trejo et al. (1974) interviewed scientists, chefs, and consumers in Mexico City to determine the acceptability of commercially produced insect food products.

RESULTS AND DISCUSSION

Conconi and Bourges (1977) reported in that year that 491 species of edible insects had been recorded on a worldwide basis. During our research in Mexico we recorded 101 species, eaten at various stages of development depending upon the species. These belonged to 31 families in nine orders and included dragonflies, grasshoppers, bugs, lice, treehoppers, cicadas, caddishflies, butterflies, moths, flies, ants, bees, and wasps (Appendix 1). The number of edible species per order varies from 30 in the Hymenoptera (mostly wasps) to only one in the Anoplura (lice). A couple of interesting facts, not apparent in Appendix 1, deserve special comment: eggs are the stage consumed in the aquatic bugs (Corixidae, Notonectidae, and Belostomatidae), and two of the three species of edible Diptera are flies of alkaline lakes.

Protein content, expressed as grams of protein per 100 g of sample, for the 77 species of insects we analyzed, is shown in Appendix II. The data is straight forward and one can readily note the range in nutritional values within and between insect taxa. It is worth highlighting, though, that protein values varied from a low of about 10% for two species of ants to a high of slightly over 81% for the wasp, *Polybia* sp. By way of summary, seven species in the low range had about 29% protein, 19 species fell within the range of 60% to 69%, 11 species from 70% to 77%, and one species had over 81% protein.

Several incidental but nonetheless interesting facts seem worth comment. Two species of butterfly in the family Helialidae utilize *Arbutus glandulosa* as a host tree and they exhibit the lowest (34.34%) protein values and the highest (71.60%) in that family. These values are for *Hylesia frigida* and *Eucheria socialis*, respectively. In the Hemiptera, the highest value is for the eggs of several bugs (71.52%), known as "ahuahutle" or Mexican caviar.

Protein quality, as related to human nutrition, is dependent upon the amino acid composition of the source, and we devised a chemical score (Table 1) from amino acid profiles to facilitate comparisons (see Methods). As noted, our profiles were compared to those recommended (for nutritional purposes) by FAO/OMS (Patron 1973). In general, values for Mexican edible insects obtained for the amino acids isoleucine, leucine, lysine, threonine, valine, phenylalanine and tyrosine surpass the recommendation by FAO. Some Mexican insects, however, had lower values for methionine, cysteine and tryptophan than those recommended by FAO/OMS. The highest score for Mexican insects was found in immature queens of *Liometopum apiculatum*, larvae of *Sciphophorus acupunctatus* and adults of *Hoplophorion monogramma* (Conconi and Bourges 1977, Table 1).

TABLE 1.—Chemical score of some edible Mexican insects.

<i>Atizies taxcoensis</i>	10%	<i>Sphenarium histrio</i>	60%
<i>Ephydra hians</i>	42%	<i>Cossus redtenbacheri</i>	60%
<i>Hylesia frigida</i>	45%	<i>Atta mexicana</i>	60%
<i>Parachartegus apicalis</i>	50%	<i>Sphenarium purpurascens</i>	65%
<i>Euchistus strennus</i>	56%	<i>Vespula squamosa</i>	70%
<i>Boopedon flaviventris</i>	56%	<i>Brachygastra mellifica</i>	70%
<i>Sphenarium spp.</i>	56%	<i>Brachygastra azteca</i>	70%
<i>Melanoplus mexicanus</i>	56%	<i>Polybia parvulina</i>	70%
<i>Trigona sp.</i>	58%	<i>Liometopum apiculatum</i>	80%
<i>Musca domestica</i>	58%	<i>Sciphophorus acupunctatus</i>	81%
<i>Pachilis gigas</i>	58%	<i>Hoplophorion monogramma</i>	96%

The conversion efficiency ratio is based on weight gain by the organism per gram of food eaten. For some edible insects this ratio ranges from 2.1:1 to 11.8:1. The average ratio for the edible insects studied is about 4 to 5:1. For comparison, the ratio for chickens is 2.6:1, for beef cattle 10:1, and for sheep 19:1 (Taylor 1975, DuFour 1981). In part this is because insects are poikilotherms and thus do not allocate a large proportion of food in maintaining body temperature.

As early as a decade ago Trejo et al (1974) interviewed 12,300 people (see Methods) concerning the acceptability of commercially produced insect food products and reported that in this survey 93% indicated that developing insects on a commercial scale was a good project considering that insects are, in general, a nutritious, economical, delicious, complete food, and "in the future."

The result of this study and the survey by Trejo and others suggests that with improved technology insects could be a valuable renewable natural resource. The establishment of massive culturing practices could result in the continuous production of a rich new protein source for the diets of people in the not too distant future.

Editor's note.—Although I would have liked a more detailed description of the methods used, I have decided to publish this paper because of the timeliness of the subject and because of its considerable social significance. I recommend that readers who would like details of methods and other procedures contact the senior author.

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APPENDIX 1.—*Edible insects in Mexico.*

Order/Family	Species	Stage Consumed	Place Consumed
Odonata (Dragonflies)			
Aeshnidae	<i>Anax sp.</i> ¹	nymphs	Sonora
Orthoptera			
Acrididae	<i>Ochrotettix cer salinus</i> Burm.		Oaxaca
(Grasshoppers)	<i>Tropinotus mexicanus</i> Brunner		Oaxaca
	<i>Osmilia flavolineata</i> De Greer		Oaxaca
	<i>Plectrotettra nobilis</i> Walk		Oaxaca
	<i>Schistocerca paranensis</i> ¹ Burm.		Veracruz, Tabasco, Campeche, Yucatan
	<i>Sphenarium spp.</i> ¹		Morelos, Puebla, Oaxaca
	<i>Sphenarium purpurascens</i> Charp.	nymphs	Oaxaca
	<i>Sphenarium histrio</i> ¹ Gerst.	adults	Oaxaca, Guerrero
	<i>Sphenarium magnum</i> Marquez		Oaxaca
	<i>Taeniopoda sp.</i> ¹		Morelos
	<i>Trimerotropis sp.</i> ²		Hidalgo
	<i>Melanoplus sp.</i>		Oaxaca
	<i>Melanoplus mexicanus</i> Sauss.		Oaxaca
	<i>Spharagemon aeguale</i> Say.		Michoacan
	<i>Schistocerca sp.</i>		Oaxaca
	<i>Boopedon flaviventris</i> Sauss.		Oaxaca
	<i>Boopedon sp. af. flaviventris</i> Sauss.	nymphs	Oaxaca
	<i>Arphia falax</i> Sauss.	adults	Oaxaca
	<i>Encoptolophus herbaceus</i> Sauss.		Oaxaca
Anoplura (Lice)			
Pediculidae	<i>Pediculus humanus</i> ¹ Linneo	adults	Oaxaca
Hemiptera (Bugs)			
Pentatomidae	<i>Euchistus crenator</i> ¹ Stal		Morelos, Estado de Mexico, Hidalgo, Veracruz, Guerrero
Common Name ("Jumiles")	<i>Euchistus lineatus</i> ¹ Walk		Morelos, Estado de Mexico, Hidalgo, Veracruz, Guerrero
	<i>Euchistus strennus</i> ¹ = (<i>E. zopilotensis</i>) Distant	nymphs adults	Morelos, Estado de Mexico, Hidalgo, Veracruz, Guerrero
	<i>Edessa mexicana</i> ¹ Stal.		Morelos
	<i>Edessa petersii</i> Stal.		Guerrero
	<i>Edessa conspersa</i> Stal.		Estado de Mexico
	<i>Atizies taxcoensis</i> ¹ Ancona		Guerrero
	<i>Atizies sufultus</i> Smith		Guerrero

APPENDIX 1.—*Edible insects in Mexico* (continued)

Order/Family	Species	Stage Consumed	Place Consumed
Coreidae	<i>Pachilis gigas</i> ¹ B.	nymphs adults	Queretaro, Guerrero, Hidalgo, Sn. Luis Potosi
Corixidae (Water Bugs)	<i>Krizousacorixa azteca</i> ¹ Jac.	eggs	Estado de Mexico, Guanajuato, Michoacan
Common name ("ahuahutle" "axayacatl")	<i>Krizousacorixa femorata</i> ¹ Guerin	nymphs	Estado de Mexico, Guanajuato, Michoacan
	<i>Corisella texcocana</i> ¹ Jac.	adults	Estado de Mexico, Guanajuato, Michoacan
	<i>Corisella mercenaria</i> ¹ Say		Estado de Mexico, Guanajuato, Michoacan
Notonectidae	<i>Notonecta unifasciata</i> ¹ Guerin	adults	Estado de Mexico, Guanajuato, Michoacan
Belostomatidae	<i>Lethocerus</i> sp. ¹	nymphs	Distrito Federal
	<i>Abedus ovatus</i> ¹ Stal.	& adults	Distrito Federal
Homoptera			
Membracidae (Treehoppers)	<i>Umbonia reclinata</i> Germar	adults	Puebla
	<i>Umbonia</i> sp.	nymphs	Morelos, Guerrero
	<i>Hoplophorion monograma</i> ¹ Germar	& adults	Michoacan, Guerrero, Estado de Mexico
Cicadidae (Cicadas)	<i>Proarna</i> sp. ²	adults	Hidalgo
Coleoptera (Beetles)			
Curculionidae	<i>Metamasius spinolae</i> ¹ Vaurie		Hidalgo
	<i>Rhynocophorus palmarum</i> ¹ Linneo		Tabasco, Guerrero, Veracruz
	<i>Sciphophorus acupunctatus</i> G.		Hidalgo, Estado de Mexico, Oaxaca
			Nayarit, Chiapas
Scarabaeidae	<i>Strategus</i> sp. ¹	larvae	Michoacan
	<i>Phyllophaga</i> spp. ¹		Chiapas
	<i>Xyloryctes</i> spp. ¹		Oaxaca
Crysomelidae	<i>Leptinotarsa decemlineata</i> Say	larvae	Oaxaca
Histeridae	<i>Homolepta</i> sp.	larvae	Oaxaca
Passalidae	<i>Oileus reinator</i> Trequi	larvae	Oaxaca
	<i>Passalus af punctiger</i> Lep. y Serv.	larvae	Oaxaca

APPENDIX 1.—*Edible insects in Mexico* (continued)

Order/Family	Species	Stage Consumed	Place Consumed
Cerambycidae	<i>Cerambyx</i> sp. ¹	larvae	Michoacan, Guerrero
	<i>Trichoderes pini</i> ¹ Chevr.	larvae	Guerrero, Michoacan
	<i>Stenodontes cer. maxillosus</i> Drury	larvae	Oaxaca
	<i>Aplagiognathus spinosus</i> N.	larvae	Oaxaca
Cicindelidae	<i>Cicindela curvata</i> ¹ Chevr.	larvae	Chiapas
	<i>Cicindela roseiventris</i> ¹ Chevr.	larvae	Chiapas
Trichoptera			
Hydropsichidae	<i>Leptonema</i> sp. ¹	larvae	Veracruz
Lepidoptera (Butterflies and Moths)			
Megathymidae	<i>Aegiale</i> (Acentrocneme) <i>hesperiaris</i> ¹ Kirby	larvae	Estado de Mexico, Hidalgo, Tlaxcala, Queretaro, San Luis Potosi, Oaxaca, Jalisco, Distrito Federal.
Geometridae	<i>Synopsia mexicanaria</i> Walk	larvae	Distrito Federal
Hepialidae	<i>Phassus</i> sp.	larvae	Oaxaca, Puebla
Noctuidae	<i>Heliothis zea</i> ¹ Boddie	larvae	Puebla, Hidalgo
	<i>Ascalapha odorata</i> ¹ Linneo	larvae	Oaxaca, Guerrero
	<i>Spodoptera frugiperda</i> S.	larvae	Estado de Mexico
	<i>Xileutes redtenbachii</i> ¹ Hamm	larvae	Estado de Mexico, Hidalgo, Tlaxcala, Queretaro, Puebla, San Luis Potosi, Oaxaca, Jalisco, Distrito Federal.
Cossidae			
Pyrilidae	<i>Laniifera cyclades</i> ¹ Druce	larvae	Hidalgo
Pieridae	<i>Eucheria socialis</i> ¹ Westwood	larvae	Distrito Federal, Chihuahua, Hidalgo
Saturnidae	<i>Catasticta teutila</i> Doubleday	larvae	Oaxaca
	<i>Hylesia frigida</i> Hubner	larvae	Oaxaca
	<i>Arsenura armida</i> Cramer	larvae	Puebla, Oaxaca, Veracruz, Chiapas
Diptera (Flies)			
Ephydriidae	<i>Ephydra</i> (<i>Hydropyrus</i>) <i>hians</i> ¹ (Say) Cresson	larvae	Estado de Mexico
	<i>Gymnopa</i> (<i>Mosilus</i>) <i>tibialis</i> ¹ Cresson	larvae	Estado de Mexico
Muscidae	<i>Musca domestica</i> Linneo	larvae	Nayarit, Veracruz

APPENDIX 1.—*Edible insects in Mexico* (continued)

Order/Family	Species	Stage Consumed	Place Consumed
Hymenoptera	<i>Liometopum occidentale</i> var. <i>luctuosum</i> W.	eggs	Michoacan, Puebla Zacatecas
		larvae	
		pupae	
Formicidae (Ants)	<i>Liometopum apiculatum</i> ¹ Mayr.	eggs	Estado de Mexico, Hidalgo, Tlaxcala
		larvae	
		pupae	
	<i>Myrmecosistus melliger</i> ¹ Llave (Luc)	adults	Tamaulipas, Hidalgo
	<i>Myrmecosistus mexicanus</i> ¹ W.		Yucatan, Campeche
	<i>Atta mexicana</i> ¹ Bourmeir	adults	Veracruz, Oaxaca, Guanajuato
Apidae (Bees)	<i>Atta cephalotes</i> ¹ Latr.		Chiapas, Guerrero
	<i>Apis mellifica</i> ¹ L.	honey	All Mexican Republic
	<i>Melipona fasciata guer-</i> <i>roenensis</i> ¹ Schw.	eggs	Guerrero
	<i>Melipona beeckei</i> ¹ Bennet	larvae	Yucatan
	<i>Trigona jaty</i> ¹ F.	pupae	Oaxaca, Tabasco, Campeche, Yucatan
	<i>Trigona nigra nigra</i> ¹ Cress		Oaxaca, Tabasco, Campeche, Yucatan
	<i>Partamona sp.</i> ¹		Campeche, Yucatan
	<i>Trigona sp.</i>		Oaxaca
	<i>Lestrimelita limao</i> ¹ Sm.	eggs	Campeche, Yucatan
		pupae	
		larvae	
Vespidae (Wasps)	<i>Brachygastra lecheguana</i> ¹ L.	eggs	Michoacan
		larvae	
		pupae	
	<i>Brachygastra mellifica</i> Say	immature stages	Oaxaca
	<i>Polybia spp.</i>	eggs	Oaxaca Michoacan
	<i>Polistes sp.</i>	larvae	Michoacan
		pupae	

APPENDIX 1.—*Edible insects in Mexico* (continued)

Order/Family	Species	Stage Consumed	Place Consumed
	<i>Polybia occidentalis bohemani</i> Holmgren		Oaxaca
	<i>Polybia occidentalis nigratella</i> B.		Oaxaca, Michoacan, Veracruz, Puebla
	<i>Polybia parvulina</i> Richards	immature	Oaxaca
	<i>Brachygastera azteca</i> Sauss	stages	Oaxaca
	<i>Mischocyrtarus</i> sp.		Oaxaca
	<i>Parachartegus apicalis</i> F.	immature	Oaxaca
	<i>Polistes canadensis</i> L.	stages	Oaxaca
	<i>Polistes major</i> B.		Michoacan
	<i>Anmophila</i> sp.		Oaxaca
	<i>Vespula squamosa</i> Drury		Oaxaca

¹Conconi, J. R. E. de and H. Bourges, 1977.²Conconi, J. R. E. de and J. M. Pino M., 1979.

APPENDIX 2.—Protein content of insects, expressed as a percentage of grams of protein per 100 grams of sample on a dry weight basis.

Species (arranged in orders)	Common Name, Stage Consumed Notes	Percent Protein
Hymenoptera (Ants, Bees, Wasps)		
<i>Myrmecosistus melliger</i>	"hormiga mielera"; "honey ant" ²	9.45%
<i>Myrmecosistus mexicanus</i>	"hormiga mielera", "honey ant"	10.5%
<i>Melipona beeckei</i>	"abeja que no pica"	28.95%
<i>Liometopum apiculatum</i>	"escamol", larvae	37.33%
<i>Liometopum occidentale</i> var. <i>luctuosum</i>	"escamol", adults	37.54%
<i>Liometopum apiculatum</i>	"escamol de obreras"	40.90%
<i>Liometopum occidentale</i> var. <i>luctuosum</i>	"escamol de reproductores"	41.68%
<i>Atta cephalotes</i>	"hormiga arriera" ²	42.59%
<i>Liometopum apiculatum</i>	"escamol", adults	45.06%
<i>Liometopum apiculatum</i>	"escamol", adults	45.53%
<i>Liometopum occidentale</i> var. <i>luctuosum</i>	"escamol de obreras"	48.28%
<i>Polybia</i> sp.	"avispa" larvae	51.50%
<i>Brachygastra mellifica</i>	"avispa, panal de castilla"	52.84%
<i>Liometopum apiculatum</i>	"escamol", pupae	53.32%
<i>Parachartegus apicalis</i>	"avispa ala blanca"	54.59%
<i>Polistes instabilis</i>	"avispa guitarrilla", pupae	57.75%
<i>Polistes major</i>	"avispa colorada", pupae	57.93%
<i>Atta mexicana</i>	"hormiga chicatana" ¹	58.3-42.59%
<i>Polistes instabilis</i>	"avispa guitarrilla", larvae	60.00%
<i>Polybia parvulina</i>	"avispa negra"	61.40-58.44%
<i>Polybia occidentalis bohemani</i>	"avispa rayada"	61.57%
<i>Brachygastra azteca</i>	"avispa cola amarilla"	62.74%
<i>Vespula squamosa</i>	"avispa panal de tierra"	62.85%
<i>Polybia occidentalis nigratella</i>	"avispa huevo de toro"	62.93%
<i>Polybia</i> sp.	wasps eggs, larvae, pupae	62.97%
<i>Liometopum apiculatum</i>	"escamol", larvae y pupae	66.90-47.94%
<i>Polistes major</i>	"avispa colorada" larvae	71.99%
<i>Mischocyttarus</i> sp.	"avispa negra con franjas"	74.51%
<i>Polybia</i> sp.	"avispa negra"	81.69%
Orthoptera (Grasshoppers,) "chapulines"		
<i>Sphenarium histrio</i> ¹		52.13%
<i>Plectrottetra nobilis</i>		58.31%
<i>Sphenarium histrio</i>		58.31%
<i>Sphenarium purpurascens</i>		58.31%
<i>Melanoplus</i> sp.		58.31%
<i>Sphenarium magnum</i>		59.63%
<i>Sphenarium histrio</i> = <i>bolivari</i> ¹		62.93%
<i>Trimerotropis</i> sp. ²		65.13%

APPENIX 2.—Protein content of insects, expressed as a percentage of grams of protein per 100 grams of sample on a dry weight basis. (continued)

Species (arranged in orders)	Common Name, Stage Consumed Notes	Percent Protein
<i>Sphenarium sp.</i>		69.97%
<i>Taeniopoda sp.</i>		70.92%
<i>Arphia falax</i>		71.35%
<i>Boopedon sp. flaviventris</i>		71.35%
<i>Sphenarium sp.</i>		71.35%
<i>Melanoplus mexicanus</i>		71.35%
<i>Encoptolophus herbaceus</i>		71.35%
<i>Melanoplus femur-rubrum</i>		75.30%
<i>Boopedon flaviventris</i>		77.13%
<i>Sphenarium spp.</i>		77.13%
<i>Melanoplus mexicanus</i>		77.13%
Hemiptera (Bugs)		
<i>Edessa conspersa</i>	“jumiles”	36.82%
<i>Atizies sufultus</i>		44.10%
<i>Edessa mexicana</i>	“jumiles”	44.10%
<i>Euchistus zopilotensis</i> = <i>strennus</i>	“jumiles”	44.10%
<i>Euchistus zopilotensis</i>	“jumiles” ¹	44.67-41.82%
<i>Edessa petersii</i>	“jumiles”	58.56%
<i>Pachilis gigas</i>	“chamoes”, nymphs ²	62.95%
<i>Pachilis gigas</i>	“chamoes”, adults ²	65.39%
<i>Abedus ovatus</i>	“cucarachon de agua”	67.69%
<i>Corisella mercenaria</i>	“axayacatl” ¹	68.70%
<i>Corisella texcocana</i>		69.94-54.44%
<i>Corisella mercenaria</i>		69.96-54.44%
<i>Notonecta unifasciata</i>	“axayacatl”	69.96-54.44%
<i>Krizousacorixa azteca</i>		69.94-54.44%
<i>Krizousacorixa femorata</i>		69.94-54.44%
<i>Atizies taxcoensis</i>	“jumiles de Taxco” ¹	70.30-51.25%
<i>Corisella texcocana</i>		71.52-58.25%
<i>Corisella mercenaria</i>		71.52-58.15%
<i>Notonecta unifasciata</i>	“ahuahutle”	71.52-58.15%
<i>Krizousacorixa azteca</i>		71.52-58.15%
<i>Krizousacorixa femorata</i>		71.52-58.15%
Homoptera (Treehoppers, Cicadas)		
<i>Umbonia reclinata</i>	Torito	32.73%
<i>Hoplophorion monograma</i>	periquito del aguacate	59.57-44.84%
<i>Proarna sp.</i>	chicharra ²	72.02%

APPENDIX 2.—Protein content of insects, expressed as a percentage of grams of protein per 100 grams of sample on a dry weight basis. (continued)

Species (arranged in orders)	Common Name, Stage Consumed Notes	Percent Protein
Diptera (Flies)		
<i>Ephydra (Hydropirus) hians</i>	"gusano del agua", larvae	35.90%
<i>Fam. Stratiomyidae y syrphidae</i>	"gusanos planos de maguey"	53.70%
<i>Musca domestica</i>	"gusano del queso," larvae	54.17%
<i>Ephydra (Hydropirus) hians</i>	"mosca del agua", adults	60.22%
<i>Musca domestica</i>	"gusano del queso", pupae	61.54%
Coleoptera (beetles)		
<i>Olleus reinator</i>	"ticoco"	20.91%
<i>Aplagiognathus spinosus</i>	"gusanos de elite podrido"	26.25%
<i>Passalus af. punctiger</i>	"bechano"	26.42%
<i>Phyllophaga sp.</i>	"gusano de la tierra"	29.68%
<i>Sciphophorus acupunctatus</i>	"picudo del maguey"	55.56%
<i>Metamasius spinolae</i>	"picudo del nopal" ²	69.05%
Lepidoptera (butterflies and moths)		
<i>Phassus sp.</i>	"gusanillo"	34.34%
<i>Xyleutes redtenbachi</i>	"gusano rojo de maguey"	37.10-71.00%
<i>Hylesia frigida</i>	"mariposa del madroño"	41.93%
<i>Heliothis zea</i>	"gusano de maíz" ²	41.98%
<i>Synopsia mexicanaria</i>	"pescaditos"	44.43%
<i>Laniifera cyclades</i>	"gusano del nopal" ²	45.83%
<i>Acalapha odorata</i>	"Mariposa del muerto"	50.83%
<i>Eucheria socialis</i>	"gusano del madroño", larvae ²	50.88%
<i>Aegiale (acentrocne) hesperiaris</i>	"gusano blanco de maguey" ²	51.00-30.28%
<i>Arsenura armida</i>	"gusano del jonote"	51.81%
<i>Catasticta teutila</i>	"gusano del muérdago"	66.58-59.78%
<i>Eucheria socialis</i>	"mariposa del madroño", pupae	71.60%

¹Conconi, J. R. E. de and H. Bourges, 1977.

²Conconi, J. R. E. de and J. M. Pino M., 1979.



De Conconi, J R E et al. 1984. "Protein content of some edible insects in Mexico." *Journal of ethnobiology* 4, 61–72.

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