

FINAL REPORT

Archeological Evidence From Insects and their Work

by Samuel A. Graham

This report covers the field and laboratory studies made in 1961 of insects and their work in and about ancient Indian structures on Wetherill Mesa. The study was exploratory in nature and was designed to learn whether or not entomological evidence might have archeological implications.

Specimens of insects were recovered from debris, soil, and packed adobe by washing through a series of sieves. Trash accumulations of corn and other materials were searched for the remains of insects. All available structural timbers at both Long House and Mug House were examined for evidence of insect work. And collections were made of present-day insects and their work for comparison with ancient collections.

At The University of Michigan specimens that were collected during the summer have been further examined and have in part been identified to species, and in part to genus, family, or order. Identification of fragmented materials has proved to be slower and more difficult than anticipated. The insect remains from the ruins proved to be exceedingly fragile so that they could not be handled in a conventional manner. Instead, the insects both whole and fragmented were cemented to glass slides for detailed examination.

This report will be presented in four parts. The first will discuss the collections from trash and debris found in the ruins, including materials that were washed from packed adobe and soil. The second will present the results obtained from examination of structural timbers. In the third section

comments will be made about modern insects that were collected alive. And in the fourth section the results as a whole will be evaluated and suggestions for further entomo-archeological work will be made.

COLLECTIONS FROM TRASH AND DEBRIS

From Badger House.

A series of samples from the surface to the bottom of the trash pile at Badger House was carefully washed and sorted for insect remains. The results were very disappointing. Modern activities especially by cicadas were numerous. Several mole crickets and tarantulas were found during excavations, but evidence of arthropods that were definitely present during Indian occupancy was lacking. Most of the insect parts washed from the debris were unidentifiable fragments.

This area had been worked over by burrowing badgers and ground squirrels and most of the insect parts showed tooth marks of mice or voles. The activities of these animals had reduced much of the insect remains to an unrecognizable condition. Also walking over the surface by ancient residents had broken chitenoy's parts into tiny bits. We do not feel that the entomological evidence collected at Badger House has much archeological significance.

From the Caves: Long House and Mug House.

Some of the collections from trash and debris in the cave dwellings proved to be highly significant, especially materials that were so located that the places where they were collected could not have been reached by modern insects. Such places were a) Beneath walking surfaces; b) In buried jars; c) Associated with undisturbed human burials; d) In packed adobe clay. Insect remains found in such places must have been ancient, whereas those found in other places to which modern insects could have gained access might

be either ancient or modern.

Insects that feed upon organic debris were frequently encountered both in locations that were certainly ancient and in those that might either have been ancient or modern. Those that have been identified are included in the annotated attached list of arthropods and other organisms recovered from the ruins. A few of these deserve special comment in this report.

Evidence of dermestids was everywhere. These insects feed upon a wide variety of organic waste, food, and clothing. They would have continued to feed upon such substances long after the Indian residents had departed. They were undoubtedly abundant during occupancy and were important household pests while the Indians were living in the caves. Probably numerous species were present but parts of only two species belonging to two genera have been identified. (See annotated list.)

False wireworms of the tenebrionid genus Eleodes were recovered in both adult and larval stages. Numerous specimens came from places that were inaccessible to modern insects. Two species were found in the ruins but were not found alive in 1961. These were Eleodes snowii Blais and Eleodes nigrina Lec. Both of these are living at present in the Southwest and even though they were not collected alive in 1961, they are probably still living on Wetherill Mesa. The large number of specimens found in the ruins suggests that these insects were more numerous during Indian occupancy of the caves than they are now.

A third species was collected alive from under stones. This is Eleodes extricata (Say). This species seemed to be common but by no means numerous.

Relatively little is known about the false wireworms of the genus *Eleodes*. They are mentioned in literature as being pests of wheat in dry localities. They feed upon the germ of the grain and upon germinating seeds and roots. Their depredations are usually located near accumulations of vegetable trash where the adults hide during the day. Corn among other grains is mentioned among the plant species that they eat.

On the basis of this information we are led to suspect that these insects might have been pests of the Indian corn. Certainly they eat plant materials including roots, but whether or not the larvae can develop on dead material as well as on living tissues we do not know. Much more information is needed about these insects before their possible influence upon Indian life can be evaluated.

Another root eating insect deserves special comment. This is *Polypheyla crinata* Lec., a scarabaeid beetle that in the adult stage eats the foliage of certain woody plants. Among these are oaks and *Amalanchier*. The larvae are white grubs and feed upon living roots of both woody and herbaceous plants.

Specimens of this insect in the adult stage were found perfectly preserved beneath a packed adobe floor in Long House, Kiva G. They were in a position that proved that they must have been present during Indian occupancy.

In this Kiva three floors of packed adobe were found one above another. Between the middle and topmost floor was an accumulation of materials including ash, soil, and pieces of adobe bearing marks of the roof structure.

In this layer between the uppermost and the middle floor the insects were found during late summer of 1961. Five beetles were collected, all within a space of four square feet. The beetles undoubtedly transformed to the adult stage beneath the floor, could not emerge through the hard surface, and died immediately beneath the floor.

Clearly the floor beneath which the beetles were trapped had been laid while they were in an immature stage feeding on roots. This proves that between the time when the middle floor came into disuse and the time when the top floor was laid, ^{a long} enough period had elapsed to permit wind blown or water washed materials to fill the spaces between the chunks of adobe from the collapsed roof, and for plants to invade the area; certainly herbaceous and probably woody plants. This could not have happened in less than 15 or 20 years and an interval of a century or even more could have elapsed. This find proves that occupancy of Kiva G was not continuous, and raises the question as to whether or not occupancy of other parts of the cave was intermittent.

Other insects collected in the ruins may have archeological implications but so little is known about most of them that further studies must be made before their significance can be determined. The presence of an undescribed species of Niptus, a Ptinid beetle, in great abundance in the ruins is interesting. If it cannot now be found in the locality a faunal change is indicated. This small spider beetle was responsible for extensive tunneling in corn debris; leaves, stalks and cobs. At first the damage was thought to have been caused by an anobiid beetle, but later this proved erroneous. Another insect found in the ruins that may have

significant implications is the tenebrionid Cynaesus angustus (Lec.) The fact that it has appeared in recent years as a minor pest in Middle Western grain elevators suggests that it might have been a pest of the Indian's stored grain.

INSECTS AND STRUCTURAL TIMBERS

Examination of structural timbers from the ruins of Long House and Mug House revealed some interesting facts about the logging and barking practices employed by the Indians. Study of the timbers also revealed that much significant information about weather fluctuations and climatic changes, previous to and during Indian occupancy can probably be gained by more complete study of the timbers now available and by continued study of additional timbers as they are found in unexcavated ruins.

All available timbers were studied. Ninety five pieces were examined carefully for signs that they had been attacked by insects. In addition there were ten other pieces that had either been so badly eroded that the surface layers were destroyed or the surface had been so completely mined by termites that the mines of phloem or phloem-wood insects were obliterated. Also on three pieces of juniper, insitu, the exposed portions were smoked so heavily that possible insect tunnels were concealed. None of these thirteen pieces is included in the tabulations I to V inclusive because their condition could not be determined. The year when 24 of the 95 timbers had been cut had ^{previously} been determined by comparison of their ring patterns with the tree-ring calendar. They ranged from 1062 to 1278 A.D. No more than two had been cut in the same year. These dated pieces were all either pine or douglas fir.

Indian Logging Practices

Most of the timbers showed axe marks only at the knots and therefore could not have been barked in their entirely with the axe. This was true of 88 pieces. Eleven pieces showed axe marks at other places. On six, patches of bark had been chopped off. On two, one side had been barked with the

~~with~~ axe. And on three axe marks were visible over the entire timber. Three other pieces apparently had been cankered and were partly dead when cut. These were only partly barked. Only one timber was found that was entirely unbarked. Clearly the Indians habitually removed the bark from almost all of their timbers before using them. Furthermore, the range in age of the dated timbers shows that pieces from old structures must have been re-used in new construction. A large proportion of the timbers showed evidence of insect work.

In table I is summarized the proportion of timbers on which this ^{work} could be seen. Most frequent were tunnels made by several species of phloem-wood borers belonging to the families Buprestidae and Cerambycidae, although signs of Scolytidae were also numerous. The numerals in Table I represent the percentage of pieces of each tree species on which the work of each insect groups could be seen. In many instances timbers were infested with two or more kinds of insects.

TABLE I

Frequency percent of insect-scored timbers

	No. Pcs.	Buprestidae		Cerambycidae		Scolytidae			Total Scored	Carpenter ant	Termite
		Small	Large	Small	Large	Phleo- sinus	Ips	Others			
Tree species:											
Ponderosa Pine	15	67	60	34	60	0	40	13	100	6	13
Douglas Fir	20	65	25	41	20	0	0	30	100	15	15
Juniper	43	65	0	28	12	47	2	0	93	0	9
Pinon Pine	17	35	36	53	41	0	18	12	94	0	6
	<u>95</u>										

* Headings "large" and "small" refer to the size of the insect species that made the tunnels.

In barking the timbers the Indians evidently took advantage of the fact that phloem and phloem-wood insects loosen the bark of freshly felled trees. Marks made by one or more species of these insects were distinguishable on between 92 and 93 per cent of the structural timbers examined. These insects attack dec^oripit, dying, and recently cut trees while the phloem is still fresh. They cannot attack successfully if the inner bark has become darkened, or if the bark has been stripped from a felled tree.

The suggestion has been made that the Indians may have cut dead trees from which the bark had dropped or could easily be stripped. This seems unlikely for two reasons. First, the wood of dead trees seasoned on the stump would be much more difficult to cut than would green trees with the crude stone implements used by the Indians. Secondly, wood from such trees would almost invariably be perforated by both entrance and exit holes of wood boring insects. Entrance holes were visible on only about one fifth of the pieces from the ruins and on only a few pieces were recognizable exit holes observed. This indicates not only that the trees were felled while still living, but that, as a rule, the bark was removed before the phloem-wood borers had completed their period of feeding in the bark. One exception was observed. This was a dead branch that had been broken off a tree or log and, being of suitable size and length, was used in roof construction.

The Indians evidently failed to take advantage of the period of easy barking in spring and early summer. Then, as every woodsman knows, the bark separates readily from the wood and can be stripped off with relatively dull tools. Certainly the timbers from the ruins that were examined in 1961 were not so barked or their surfaces would not have been scored by insects. The period of easy barking in late May and June would conflict with the period

when the Indians were engaged in their most intense agricultural activity. Then they would be planting and cultivating corn and other crops. Such work could not be neglected and doubtless would take precedence over logging projects. This conflict provides a likely explanation of why logging and barking were not done simultaneously in the spring and early summer.

From the evidence described above the indication is strong that the Indians cut the trees for their structural timbers during the autumn, winter, or very early spring. The trees were then left on the ground, probably without limbing them until after the crops were planted and cultivation had for the most part been completed. Then, ^{during a slack period} about mid July or early August came the job of barking, limbing, and cutting the timbers to appropriate lengths. By that time the insects would have loosened the bark, but the majority of wood boring species would not have entered the wood.

Amount and Type of Infestation

Tables II, III, IV and V show the number of pieces of each tree species on which evidence of wood scoring by various insect groups was visible. An attempt was made to classify each insect group according to its relative abundance by assigning the amount of boring observed in each timber to an infestation class. This was only partly satisfactory because many timbers were heavily coated with smoke deposits or were eroded so that the surface was partly destroyed.

The classes used were as follows:

- 0 = no evidence of scoring by insects
- 1 = scattered tunnels; one to 25% of the surface
- 2 = medium infestation; 26 to 75% of the surface
- 3 = abundant infestation; 76 to 100% of the surface

When the evidence was partly obscured by erosion, smoke deposits, or

termite tunnels the infestation class assigned was that observed on the part of the timber where tunnels could be seen. Frequently the tunnels made by small buprestids or cerambycids were partially worn away so that very few tunnels remained visible. In such instances the infestation class was indicated as 1, although we feel sure that a heavier infestation should probably have been indicated. Thus the infestation class was always stepped downward in cases of doubt. In 21 of the cases indicated as infestation class I we felt that the infestation was probably much heavier.

Some bark-beetles do not score the wood appreciably, but confine their activities to the phloem. The presence of this kind of injury could not be recognized on the timbers. Undoubtedly some of these beetles must have worked in the phloem of certain timbers and probably were responsible for barking where neither axe marks nor insect tunnels could be seen. The surface of the wood under the bark in which these insects have worked is likely to be roughened without being scored. Such ^{rough patches} ~~areas~~ were observed on some timbers but were not recorded.

These procedures that were used in 1961 were exploratory. Undoubtedly they can be improved upon through special studies comparing the appearance of modern timbers known to have been barked by certain phloem eaters with the appearance of timbers from the ruins. Such a study would require rearing the various species under controlled conditions, ^{and} several years of research. ^{and the ability to identify the species} Because of the preliminary nature of the 1961 work, the quantitative values in tables II, III, IV and V are ~~also~~ tentative. They are, however, suggestive and indicate the need for intensive research tying together the studies of insects and the evidences of their abundance in the timbers with the dating of each timber. The result of a long-term study of this sort might well

produce evidence of the population fluctuations of certain species, such as Ips lecontei, for example, ^{This and a number of other species} which are known to be influenced by weather conditions. The archeological significance of such evidence seems obvious.

TABLE II

UTAH JUNIPER TIMBERS

Number of pieces showing injury in each
intensity of infestation class.

Infestation Class	No. Pcs.	Buprestidae		Cerambycidae		Scolytidae			Carpenter ant	Termites
		Small	Large	Small	Large	Phleosinus	Ips	Other		
0	3	15	43	31	38	23	42	43	43	39
1	10	9	0	10	4	16	1	0	0	2
2	8	10	0	2	1	2	0	0	0	1
3	12	9	0	0	0	2	0	0	0	1
	43	43	43	43	43	43	43	43	43	43

The tree species most frequently used by the Indians for construction was Utah Juniper. Forty three of the 95 pieces examined were juniper. A small buprestid, presumably Chrysobothris, several cerambycids, and a juniper bark-beetle, juniperi Sw. ~~belonging to the genus~~ Phleosinus were the insects most frequently encountered. A large number of juniper logs cut in the early summer of 1961 were also examined for comparison. They were all heavily infested by Chrysobothris larvae and a smaller number of Phleosinus juniperi ~~bark-beetles~~. Competition between these insects was keen and the more aggressive Chrysobothris larvae were materially reducing the food available to Phleosinus so that frequently the bark-beetles were unable to complete larval development.

Evidence of similar competition was evident on some of the timbers from the ruins. On those that had been heavily infested by Chrysobothris the Phleosinus tunnels were usually not numerous, and when Phleosinus tunnels were numerous Chrysobothris was scarce. The insect work on the timbers varied from piece to piece both in quantity and the kind of insects involved. From this we conclude that the different insects fluctuated in number from year to year and competed with one another in ancient times just as they do today.

TABLE III
DOUGLAS FIR TIMBERS

Number of pieces showing injury in each
intensity of infestation class

Infestation Class	No. Pcs.	Buprestidae		Cerambycidae		Scolytidae			Carpen- ter ant	Ter- mites
		Small	Large	Small	Large	Phleo- sinus	Ips	Other		
0	0	11	19	15	16	20	20	9	17	17
1	8	7	1	6	3	0	0	11	3	1
2	6	4	2	3	1	0	0	0	0	2
3	9	2	2	0	0	0	0	0	0	0
	20	20	20	20	20	20	20	20	20	20

Next to juniper, douglas fir timbers were found most frequently in the ruins. This is surprising in view of the scarcity of this tree on Wetherill Mesa today. As with juniper, douglas fir was attacked by buprestids, cerambycids and scolytids but we may safely assume that the species were not usually the same as on juniper. The genus Phleosinus was, of course, replaced

In freshly cut pinon pine timbers the insects most frequently present in 1961 were Ips lecontei Sw. and Monochamus sp. probably Monochamus maculosus Hald. for the most part. These insects competed with one another in much the same manner as Chrysobothris and Phleosinus in juniper. Monochamus scores the wood surface more deeply than Chrysobothris. Therefore its presence is less likely to be obscured by smoke or erosion. Furthermore, the egg galleries of Ips lecontei score the wood deeply so that they are not easily eroded away. Therefore, the information obtained from pine timbers is likely to be more precise than that from juniper.

Conditions causing Fluctuations in Beetle Numbers

The fluctuation of bark-beetles from year to year is known to be related to weather conditions. Monochamus and Chrysobothris abundance is influenced by the quantities of newly killed timber available to them. Several seasons of unusually dry weather are likely to be followed by an up-swing of Ips and Phleosinus. Such a condition prevailed in 1959 on Wetherill Mesa when an outbreak of Ips lecontei occurred in living trees weakened by drought. The trees that were killed by bark-beetles and drought provided an abundance of food suitable for Monochamus and Chrysobothris. As a result these insects increased in abundance.

The high/ populations in 1961 were an aftermath of the bark-beetle outbreak of 1959. The number of both Monochamus and Ips was still high, every freshly cut log examined being heavily infested. Ips was being reduced in number by competition, but was present in every log examined. Timber recently killed or severely damaged by fire is likewise conducive to the rapid increase of borer populations, and recent fires at Mesa Verde doubtless contributed to the large number of beetles present in 1961.

In other localities we have found that evidence of fires is registered in the annual rings of trees even though no fire scars are produced. Thus, in the annual rings both the effects of drought and fires can be recognized. Whether this would also be true at Mesa Verde can only be determined by further research. However, as a result of the exploratory study of 1961 the prospect seems good that much information concerning weather fluctuations and even long-term climatic changes can be gained through the intensive study of timbers from the ruins. Such research would involve: (1) Dating each timber, (2) examination of rings for abnormalities indicating fire, defoliation and other effects, (3) recording and evaluating insect work and (4) the study of present-day insects and their effects on the trees to provide standards of comparison to aid in the interpretation of conditions observed on the structural timbers. To gain the needed information about the insects would demand careful study of the life history, habits, and effects on the trees of common species and the interactions of these insects with one another. With the knowledge thus gained interpretation of conditions observed on timbers from the ruins could be interpreted with more precision than is possible with our present limited information. Such an entomological project could be set up as a short-term study of about three years. Research on the timbers would have to be on a long-term basis, in order that an amount of data adequate for conclusions be collected from numerous ruins.

Possible Changes in Forest Composition

From Table I we see that Douglas Fir timbers were second in abundance to juniper and that Ponderosa and Pinon pine timbers were present in the ruins under excavation in almost equal proportions; fifteen of the former compared with seventeen of the latter. Today there are very few of either Douglas firs or Ponderosa pines to be found in the locality. The number of timbers examined

in 1961, although they represent all that were available from the two ruins Long House and Mug House, was too small to justify drawing final conclusions. Nevertheless, they suggest strongly that ~~ponderosa pine~~ ^{douglas fir and} ~~was~~ ^{were} more numerous during Indian occupancy than today.

The difference observed between the proportion of species found in the ruins from the proportion currently growing on the Mesa certainly suggests that previous to and during Indian occupancy douglas fir and ponderosa pine were favored by a moister climate than exists today. Douglas fir is very scarce near Long House and Mug House. It occurs in the canyons in sheltered and relatively moist locations. Ponderosa pine is even less frequently encountered in Mesa Verde National Park and none was seen near the ruins. If they were no more abundant during Indian occupancy than they are at present the Indians would have been compelled to carry timbers of these species long distances. That they engaged in such arduous labor when an abundance of juniper and pinon pine was at their door-step seems unlikely.

Of course there may be another possible explanation of the present scarcity of both douglas fir and ponderosa pine. Because these species usually grow straighter and with fewer branches than either pinon or juniper, the Indians doubtless would have preferred them and might have eliminated them through their logging operations. This seems improbable, however, when the small number of timbers used in Indian structures is considered. Furthermore, the virtual elimination of any tree species from a locality to which it is adapted by men using stone axes is difficult to imagine. Therefore, the tentative hypothesis seems justified that these trees were more numerous during

and preceeding Indian occupancy than they are at present, and that their scarcity today is the result of changed climate from wetter to dryer conditions. This hypothesis should be tested by research. Douglas fir is highly sensitive to late spring frosts. Therefore, if a reduction in available moisture was accompanied by cooler weather ^{the} habitat would be even more unfavorable.

From the exploratory study of structural timbers used by the Indians in Long House and Mug House we may conclude tentatively as follows:

1. The Indians took advantage of the work of phloem and phloem-wood insects in barking their timbers.
2. The barking operations were performed in July or early August after the bark was loosened but before most of the phloem-wood insects had entered the wood.
3. The abundance of the various groups of insects varied from time to time as influenced by weather, fires, and other conditions.
4. The relative proportion of the four species of conifers indigenous to Mesa Verde was, during Indian occupancy, probably not the same as it is today. The relative scarcity today of douglas fir and ponderosa pine suggests that conditions are now less moist than formerly. There are, however, other possible explanations for the change. Therefore, further research is needed to test the climatic change hypothesis.
5. The intensive study of present-day insects combined with accurate dating of timbers, recording the evidence of insect effects on each, and peculiarities in growth and appearance of the rings of certain years give promise of yielding results of important archeological significance.

INSECTS LIVING ON WETHERILL MESA

During 1961 a limited collection of living insects was made. Identification of these has progressed slowly and therefore a detailed account cannot be included in this report. As information on the identity of various groups becomes available supplementary reports will be made, but this final report on the work of 1961 cannot await these identifications.

As far as can be judged at present the insect fauna is very similar to that living when Indians inhabited the structures now in ruins. This is certainly true of the insects attacking freshly cut timbers. This has already been discussed in the section on Insects and Structural timbers. Further study will doubtless reveal other species not observed in 1961 due to shifts in abundance of the various species from year to year.

In our collections Lepidoptera predominated. Most of these have not been identified but very few could have archeological implications. One species might have. This is a moth that we have tentatively identified as Coloradia pandera. This moth was flying in late summer instead of in June as observed for the species in other localities. Previously this species has been observed on ponderosa pine, sometimes causing severe defoliation. Possibly the moths on the Mesa may be a form especially adapted to pinon pine. One pupal case of this insect was found in the ruins. It had been opened by a mouse.

This species is eaten by the Indians now living in northern California and southern Oregon according to Miller, Essig and others. The larvae in the trees are collected by smoking them from the trees thus forcing them to drop to the ground where they are picked up and later roasted. The pupae

also are collected from the soil where they form their pupal cells, roasted, and eaten. Possibly this insect may at times have been numerous enough at Mesa Verde to be appealing to the ancient inhabitants.

Other insect groups that were most frequently represented were *Neuroptera* such as ant lions and lace wing flies, *Orthoptera* such as crickets and grasshoppers, and a variety of beetles of which the *Scarabaeidae* and *Tenebrionidae* seemed most numerous. Some of these may prove to have archeological implications.

The collections made in 1961 accomplished the purpose of the exploratory study in that they opened a broad field of entomo-archeology.

A TEAM APPROACH TO THE ENTOMO-ARCHEOLOGICAL PROBLEM

chief result of the

The exploratory study conducted during the summer of 1961 on Wetherill Mesa has proved that certain entomological evidence collected in the ruins of Indian structures ^{has} ~~have~~ archeological significance. The most significant evidence is to be found in locations that are subject to reasonably accurate dating and which would be inaccessible to present-day insects. Remains of burrowing insects found in trash piles and other loose surface debris have little significance, ^{as we have seen,} whereas remains washed from packed adobe floors or roof material which can be dated accurately would be highly significant. Also insect remains found beneath floors or other compacted walking surfaces that can be dated may provide useful archeological evidence. Marks of phloem and phloem-wood insects on the surface of ancient structural timbers provide useful information, especially when correlated with accurate dating from the annual ring patterns, and with other information that can be gained from the intensive study of the wood.

The full utilization of entomological evidence is restricted by our present lack of information about the identity and the biology of many common insects indigenous to Mesa Verde National Park. Without knowledge about these species, the interpretation of entomological evidence found in the ruins is limited. Entomological research concerning insect species observed in the ruins, and still living in the locality, would permit far more precise interpretations than is possible with our present limited knowledge about these insects.

A team approach to the entomo-archeological problems would almost certainly lead to rewarding results. Certain entomological information

has been and will continue to be collected by the archeologists working in the ruins. With the advice and assistance of the entomologist, the second member of the team, ~~their insect findings~~ ^{the collections made by archeologists} could be more useful archeologically than they have been. Needed biological facts about the insects involved could be discovered most effectively by the trained entomologist. The third member of the team would be the dendro-chronologist who, with the aid of the entomologist, would record and interpret information to be obtained from the study of ancient structural timbers that were cut and used by the Indians.

Some of the information that could be collected by a team including the archeologist, the entomologist and the dendro-chronologist may be outlined as follows:

I. The responsibilities of archeologists working in excavations.

1. Observe and keep records of all evidence of insects disclosed during excavations.
2. Distinguish carefully between modern and ancient evidence. For example, burrowing species might be either modern or ancient and unless found in a position that could not be reached by present-day insects, such species could have no archeological ^{implication.} significance.
3. Describe carefully the exact location of entomological evidence in reference to burials, walking surfaces, packed floors, vegetation that was present on the excavation site when excavation was begun, depth beneath the surface of soil or debris, and any other pertinent information that might disclose the age of the evidence.

4. Recent entomological specimens found in excavations have limited value archeologically and collection of such materials merely complicates evaluation of data. ~~Collect~~ only enough of these materials ^{needed} for identification. *should be collected*

5. In so far as practicable, specimens of living insects in and about the locations under investigation should be collected and preserved for identification, in order to disclose differences and similarities between ancient and modern faunas.

6. Wash through sieves samples of adobe floors and roof materials that can be dated in order to recover insect remains.

~~7. Preserve for identification the specimens of insects and their work~~

II The responsibilities of the entomologist.

1. Collect, preserve, and identify, or arrange for identification by specialists, present-day insects and their work.

2. Conduct biological studies of common species of insects, especially those that also have left evidence of their presence during Indian occupancy, and those that might have been pests of crops.

3. Mount on glass slides dissected specimens of common species to be used to aid in identifying chitinous fragments recovered from excavations.

4. Identify or arrange for identification by specialists all specimens of insects and their work *taken from the ruins.*

5. Keep complete records and summarize all information about insects that may be collected.

6. Aid and advise the archeologist on how to collect and preserve specimens found in the ruins, and how to recognize and describe evidence that cannot be collected so that later interpretation will be possible.

7. Work with the dendro-chronologist, advise him on entomological matters and aid him to develop procedures for collecting, recording and evaluating entomological information evident on or in the ancient timbers.

8. Provide the archeologist and the dendro-chronologist with specimens of common insects and their work, to aid them in recognizing the identity of insect evidence.

III The responsibilities of the dendro-chronologist.

Because only a limited number of structural timbers are available for study at any given time, the collection of data from ancient timbers must be continued over a considerable period as additional dated timbers become available. Therefore, the development of procedures and a recording system that can be followed over many years is essential.

1. Concerning the timbers themselves:

a. Collect cores or sections of all timbers available in the ruins and determine as accurately as possible when each was cut.

b. Examine the ring pattern for evidence of unusual growth periods that may indicate abundant or deficient moisture, defoliation, *fire*, and the effects of other factors.

c. Examine individual rings for abnormalities such as unusual relative width of early and late wood, frost rings, injury by fire, and overgrown insect tunnels.

d. Compare ^{*samples from*} different tree species to determine whether or not the peculiarities noted occurred during the same year or series of years in other trees of the same or different species.

e. Compare the growth rate at the same age of trees cut at different times in order to disclose the influence of possible climatic change.

2. Concerning marks by phloem and phloem-wood insects on the timbers:

- a. By comparison with specimens of recent insect work provided by the entomologist identify the insects or groups of insects responsible for marks on ancient timbers.
- b. Record for each timber available for examination the evidences of attack by phloem eating and wood boring insects. Arrange the data according to insect species and/or groups for each tree species according to a detailed plan to be developed cooperatively.
- c. Correlate the degree of infestation by each insect species or group of insects, with the year when each tree was cut. Differences in the amount of infestation from year to year should indicate population fluctuations, and indirectly, weather and other effects.
- d. Continue this examination of timbers until enough have been studied to provide an adequate basis for conclusions.

FUTURE PLANS

Recognizing the values that can be derived from the sort of entomological research discussed above, a request is being presented to National Science Foundation for financial support of a three year research project. If this grant is approved a trained entomologist and two assistants will work on the Wetherill Mesa during the summers of 1962, 1963, and 1964 and at the University of Michigan through the academic year of 1964-'65. They will work under the general supervision of Samuel A. Graham with the Collaboration of Douglas Osborn, Supervisory Archeologist, Wetherill Mesa Project.

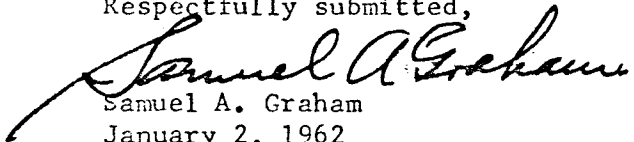
The entomologist, mentioned above, will conduct entomological stud-

ies of a taxonomic and biological nature as described in this section, and will directly supervise the two assistants. One assistant will be chiefly concerned with the detailed entomological aspects of the project whereas the other will conduct work more immediately associated with the ruins themselves, and especially studies of structural timbers.

All three of these men will be working toward advanced degrees under the direction of Fred B. Knight who has succeeded Samuel A. Graham as Professor of Forest Entomology at The University of Michigan. Dr. Knight has expressed great interest in the project and will be a helpful cooperator.

In the event that the request for support to National Science Foundation is rejected other plans for collecting entomological information by archeologists will be suggested later.

Respectfully submitted,


Samuel A. Graham
January 2, 1962

Annotated List of Arthropods Collected from the Ruins
of Long House and Mug House.

Coleoptera

Family Dermestidae. Anthrenus sp.

Attagenus sp.

The Dermestidae or skin beetles are scavengers that feed upon all sorts of plant and animal materials. They were doubtless household pests of the ancient residents of the caves ~~and ruins~~. Collections could either have been ancient or modern.

Family Scarabaeidae. Polyphylla crinata Lec.

The large white striped beetle collected from beneath the packed adobe floor of Kiva G. in Long House. Adults feed on leaves of woody plants, the larvae ~~on~~ **roots**.

Aphodius sp.

Dung beetles. Very likely these beetles fed upon accumulations of turkey droppings and other excrement.

Family Tenebrionidae. Eleodes negrina Lec.

Eleodes snowii Blais

These beetles feed upon the germ of grains, ~~upon~~ sprouting seeds, and on roots in dry localities. Injury to grain fields are reported in literature. The damage is usually centered around trash piles of vegetable materials.

Eleodes extricata (Say)

This beetle was not observed in the ruins but was collected from beneath stones on Wetherill Mesa.

Coneontis sp.

This tenebrionid was washed from adobe. Nothing seems to be known about its habits.

Platydema sp.

Probably feeds upon vegetable materials.

Cynaesus angustus (Lec.)

Said to occur in Arizona in debris about the base of yucca plants. It has become a minor grain pest in elevators throughout the Central U. S. and Canada. It probably was a pest of the Indian's grain in storage.

Family Ptinidae Niptus n. sp.

This beetle bored in corn debris; leaves, stalks, and cobs, and was very commonly encountered in the ruins. According to Brown it is undescribed. The cocoons at first incorrectly identified as being Lepidopterous, are those of this insect. Its work was thought at first to be that of an Anobiid.

Rhyncophora

Family Oteorhynchinae

Weevils of this family are root eaters in the larval stage. Some feed upon germinating seed. Adults of some species feed on foliage of roses and other plants. Strawberry root weevil is one of this family.

Family Histeridae. Saprinus sp.

Only one elytron was found. These beetles are predacious on other insects. They are found around dung and decaying organic materials, apparently attracted by the abundance of their prey there.

Diptera

Super Family Muscoidea, Family Calliphoridae

Probably Calliphora sp.

A number of blow fliespecies were probably involved in the decomposition of human bodies buried in summer.

Family Sarcophagidae or Flesh flies.

Puparia of these flies were frequently encountered.

Family Tachinidae

Probably Winthemia sp.

These flies are parasitic upon other insects, especially lepidopterous caterpillars and sawfly larvae.

Family Otitidae

Possibly Euxesta sp.

Family Otitidae or Longchaeidae

These flies feed on decaying organic materials or some of them are predatory upon the larvae of other insects. They are frequently encountered under loose bark of dead trees. Actually little is known about them.

Family Anthomyidae

Fannia probably femoralis Stein

Do not know the habits of this fly. Some of the family are plant pests, others are scavengers, and some are parasitic on other insects. Fannia scalaris (Fab.) is known as the little house fly and feeds on filth.

Arachnidae

Several egg masses with exuviae of small spiders were recovered from the ruins. They have little significance archeologically.

Because of their location in the ruins specimens of all the above listed species were almost certainly present in the caves during Indian occupancy. However, all the species are probably living at the present

time on the Mesa and therefore only specimens collected from places inaccessible to modern day insects can be considered ancient with full confidence.

The new species of Niptus (Family Ptinidae) is especially interesting and efforts should be made to find living specimens so that a series of specimens suitable for taxonomic description can be preserved. This is the only species on the list that we cannot say positively is living at present.

Other organisms not Arthropods

Succinea grosvenori (Lea)

From catchment basin at five inch level. A modern species ^{of snail}. Perforation probably not made by man because its position at the five inch level indicates that it found its way into the basin since the period of Indian occupancy.

Oreohelix stringosa depressa (Cockerell)

Accession no. 18472/703. These shells were apparently perforated for stringing by the Indians.

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significant implications is the tenebrionid Cynaesus angustus (Lec.) The fact that it has appeared in recent years as a minor pest in Middle Western grain elevators suggests that it might have been a pest of the Indian's stored grain.