1. Was the habitat inadequate (i.e., was the stream too small for the species)? The species grows quite large and may reach 100 mm or more in length.

2. Were they present but not collected?

3. Were they collected but transported elsewhere to be used as tools or ornaments?

None of the three possibilities can be ruled out; however, the first seems most likely. It does not seem likely that a larger species used at many other sites in southern Texas would have been ignored in favor of a small species (**T. parva**). It also seems improbable that tool or ornament usage would have not been evidenced at 41 JW 8 in view of the worked mussel and marine shells that were recovered. It may be significant that both of the previous studies were done in areas with much larger streams or rivers.

Lampsilis sp: Several small fragments were clearly **Lampsilis**; however, because there is a second species of **Lampsilis** possible in the area, no positive species identification could be made.

SUMMARY

Based on the recovered bivalves, the impression of the nearby stream (Chiltipin Creek) during the active period of site occupation is that it was a small (couple of meters wide), constantly running (possibly artesian source), shallow (a half of a meter deep) stream. The substrate bottom was probably mud or mud-sand base.

RADIOCARBON ASSAYS

Large samples of well-preserved wood charcoal were recovered from three horizontally and vertically discrete cultural features during the 1981-1982 season at 41 JW 8. Samples from each feature were submitted for radiocarbon assay. The resulting dates were expected to confirm the previous assays recovered from the site as well as the relative dating provided by stratigraphy and associated artifacts. The dates were expected to fall between A.D. 1200 and 1500 and average between A.D. 1300 and 1400. Unfortunately, the radiocarbon assays received range between A.D. 660 and 1570 (uncorrected midpoints) and are furthermore inconsistent within individual features. Thus, the radiocarbon assays present serious problems in interpretation as will be discussed.

Initially, four charcoal samples were submitted for assay; two samples (Features 6 and 8) were sent to the Center for Applied Isotope Research at the University of Georgia, and two (Features 5 and 6) were sent to the Radiocarbon Laboratory at The University of Texas at Austin. Two radiocarbon laboratories were used to provide crosschecks on the dating. The first dates were received from the Georgia laboratory. The sample from Feature 6 was assayed at 525 ± 65 B.P. (UGa-4541), which was in line with expectations. The sample from Feature 8 was assayed at 1290 ± 65 B.P. (UGa-4540), which is

more than twice as old as expected. In order to check this date a second charcoal sample from Feature 8 was submitted to the Austin laboratory.

The three assays received from the Austin laboratory only added to the problem. Feature 5 was assayed at 520 ± 90 B.P. (TX-4652), which is within the expected range. Feature 6 was assayed at 970 ± 60 B.P. (TX-4653), which is over 400 years older than the assay from the Georgia laboratory. Feature 8 was assayed at 500 ± 60 B.P., which is in line with our expectations but some 790 years younger than the comparable Georgia laboratory assay. Thus, on the two features dated by both laboratories the resulting assays differed by hundreds of years. Moreover, the differences were not consistent between laboratories; on Feature 6 the Georgia laboratory's date was much younger than the Austin laboratory's, while on Feature 8, the Austin laboratory's date was much younger than the Georgia laboratory's.

In order to resolve the problems Salvatore Valastro of The University of Texas at Austin and John Noakes of the University of Georgia agreed to obtain assays on additional samples from the two features in question at no additional cost. Valastro pointed out to the author that although the samples were from discrete features, therefore archaeologically identical, the charcoal sent to each laboratory cannot be considered scientifically identical unless a large sample from each feature is pulverized and split exactly. Valastro agreed to chemically pretreat and split samples from the two features in question and send half of each sample to the Georgia laboratory for additional assays.

The resulting assays only partially improved the situation: Feature 6 was assayed at 1090 ± 110 B.P. by the Austin laboratory (TX-4886) and 655 ± 70 B.P. by the Georgia laboratory (UGa-5289), while Feature 8 was assayed at 700 ± 80 B.P. by the Austin laboratory (TX-4887) and 380 ± 185 B.P. by the Georgia laboratory (UGa-5290). While the split assays from Feature 8 overlapped within the two-sigma level, the split assays from Feature 6 did not. John Noakes agreed to run one final assay on Feature 6 charcoal to attempt to resolve the problem. The resulting assay fell in line with the two Austin laboratory assays from Feature 6: 930 ± 70 B.P. (UGa-5280).

At the present time, then, 12 radiocarbon assays have been determined from charcoal samples collected from 41 JW 8. Table 14 summarizes all of the radiocarbon assays from 41 JW 8. These assays, with the exception of TX-2206, which has an extremely large error range, have been corrected by the calibration based on the consensus data of the 1979 radiocarbon workshop (Klein **et al.** 1982) and plotted in Figure 13. Table 14 and Figure 13 show the ambiguity of the assays and illustrate the problem of how to interpret these dates. Given the facts that the recovered charcoal samples were very well preserved, were from seemingly ideal contexts, and that two of the features have four or five radiocarbon assays each, the inconsistent results are particularly distressing. The following discussion will review some of the factors involved in the radiocarbon assay process in an attempt to explain why the resulting assays did not meet our expectations.

The field notes, plan maps, and photographs were carefully reexamined several times after the anomalous dates were received. As discussed elsewhere in this report, the stratigraphy and artifact associations strongly suggest that

TABLE 14. RADIOCARBON ASSAYS

Sample Number	Radiocarbon years B.P.	Years B.P. 5730 1/2-life	Provenience
Tx-2206	650 ± 1230	669 ± 1220	1975 "bone bed"
Tx-2207	580 ± 50	596 ± 50	1975 Unit H, Level 1
Tx-4652	520 ± 90	535 ± 90	Feature 5
UGa-4541	525 ± 65	540 ± 65	Feature 6
Tx-4653	970 ± 60	998 ± 60	Feature 6
Tx-4886	1090 ± 110	1122 ± 110	Feature 6
UGa-5289	655 ± 70	674 ± 70	Feature 6
UGa-5280	930 ± 70	930 ± 70	Feature 6
UGa-4540	1290 ± 65	1327 ± 65	Feature 8
Tx-4654	500 ± 60	515 ± 60	Feature 8
Tx-4887	700 ± 80	720 ± 80	Feature 8
UGa-5290	380 ± 185	391 ± 185	Feature 8

all of the cultural deposits in the Wagon Trail Area of the site represent an occupation closely related to the Toyah phase of central Texas (Jelks 1962; Prewitt 1982; Prewitt 1985) and thus can be expected to date to no earlier than A.D. 1300 in southern Texas. All three features were relatively undisturbed. Their proximity to the current ground surface and the degree of bioturbation noted at the site might explain minor contamination with more modern carbon-bearing materials but not with earlier materials. Deeper stratigraphic testing below the Toyah horizon occupation produced very little evidence of earlier occupations and little or no organic material. The only possible earlier evidence consisted of flakes and one comparatively deeply buried rock cluster (Feature 1) that had no charcoal whatsoever. Thus, a review of the field data suggests that the features in question should date to after A.D. 1300. Similar Late Prehistoric components at two sites in the Choke Canyon Reservoir area of south Texas, 41 MC 296 and 41 LK 201, have been radiocarbon dated well after A.D. 1300 (Hall, Black, and Graves 1982; Hall, personal communication).

The radiocarbon assays from 41 JW 8 were all run on chunk wood charcoal samples that are well suited for analysis. Chunk wood charcoal is subject to contamination in a limited number of ways. Fine rootlets may be present in the charcoal, however, most of these were removed prior to sending the samples to the radiocarbon laboratories, and the laboratories were advised of this possibility. Standard sample preparation procedures should have removed the remaining rootlets. In addition, rootlet contamination would yield later dates rather than earlier dates. A possible factor that could cause the dates to come out too old has been called "post-sample-growth error" (Ralph

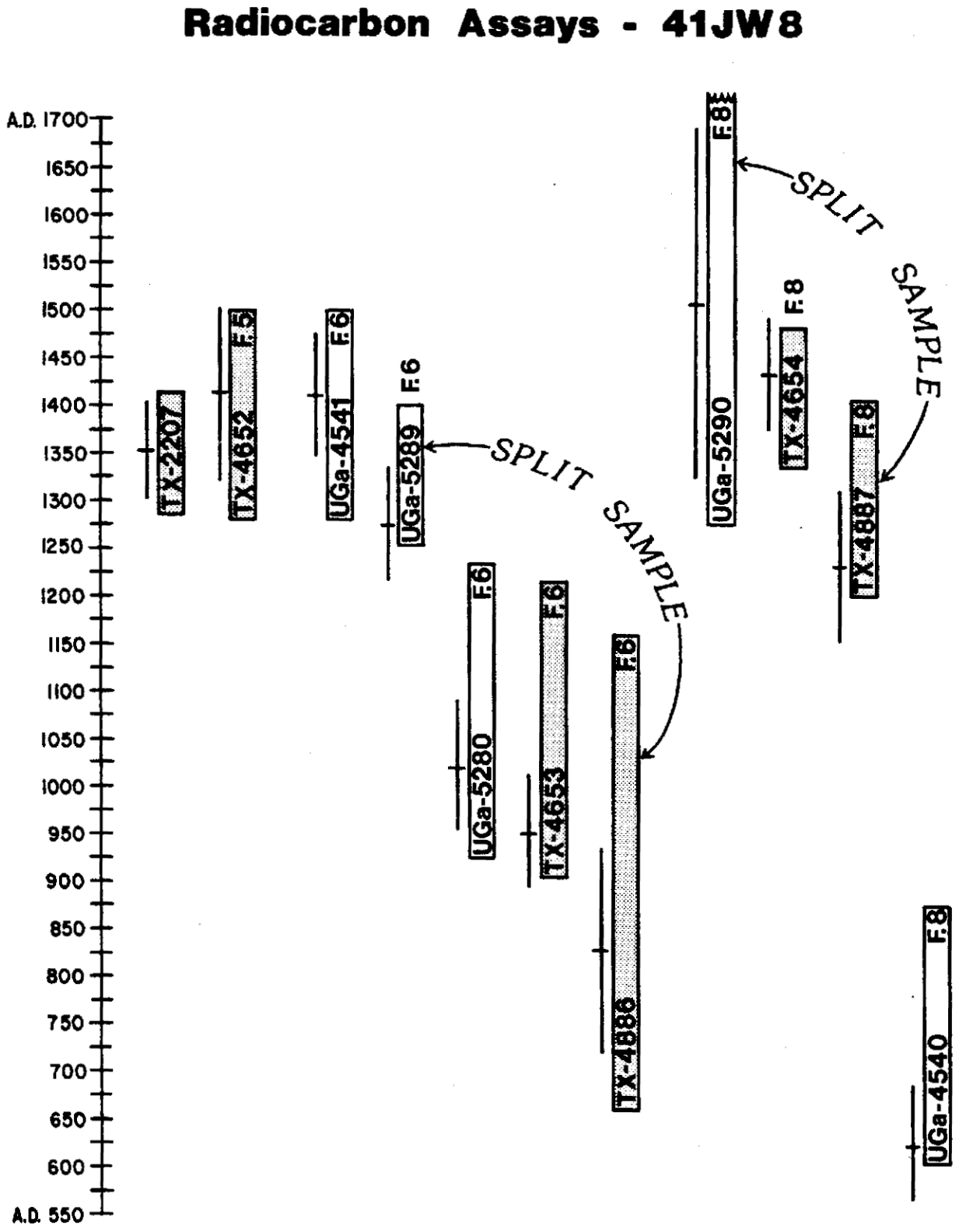

Figure 13. Radiocarbon Assays from 41 JW 8.

1971:4). This error occurs in cases where the dated wood is significantly older than the event being dated. This could occur if the heart wood from old trees had been burned in the fires that resulted in Features 6 and 8. In this part of south Texas, there are very few trees that live more than 100-200 years, hence this factor cannot likely explain why some of the dates are 400 to 800 years older than the associated artifacts.

Most of the other sources of radiocarbon assay error concern the mechanics of how the samples were processed in the radiocarbon laboratory. Erroneous dates can result from a number of stages in the processing, including sample pretreatment, equipment calibration, and sample counting time (Ralph 1971; Fleming 1977; Browman 1981). Several studies comparing dates run by different laboratories on replicative samples from well-dated contexts have shown significant variation between laboratories. Browman (1981:254) states that the major reason for discrepancies between samples less than 2000 years old is an error in the calibration of the reference standard. Clark (1975:252-253) analyzed 192 independent replicative observations by various laboratories on tree ring samples. He concluded: "There can be no doubt that on the average the variability between replicate observations is far in excess of the variability expected in view of the quoted standard errors" (**ibid.**:252). Recent comparisons of tree ring dates during calibration studies have shown systematic but comparatively small differences between comparatively small groups of cooperating laboratories (Klein **et al.** 1982; Stuiver 1982).

Within the last two decades, it has been demonstrated that the amount of carbon-14 present in the atmosphere has systematically varied over at least the past 7000 years (Browman 1981). Since the validity of radiocarbon dating has been based on the assumption that the amount of atmospheric carbon-14 is a constant, the systematic deviations have to be taken into account. A number of calibration curves and charts have been published, including Ralph, Michael, and Han (1973), Damon **et al.** (1974), Clark (1975), Klein **et al.** (1982), and Stuiver (1982). Each is based on a comparison between dendrochronogically dated tree ring samples and careful radiocarbon assays of these samples. All of the cited calibrations agree on most of the major deviations; they disagree to some extent on the minor deviations or "wiggles" present in some calibrations and the mathematical techniques used to "smooth" the curves (Browman 1981:256-257).

The calibration published by Klein **et al.** (1982) represents the most widespread effort to date to compile tree ring dates. As mentioned, this calibration is the result of a major workshop held in Tucson, Arizona, in 1979 (Michael and Klein 1979). This calibration should gain rapid acceptance over the next few years. Until now the archaeologist had to choose between several calibrations which varied significantly for certain date ranges. One very positive aspect of the new calibration is the ease with which a non-specialist can calibrate a date. Several of the available calibrations lack the clear cut tables and user instructions that accompany the Klein **et al.** (1982) calibration.

It is very important to note that a radiocarbon date is not a fixed absolute date but rather a statistical estimate of the absolute date range within which the actual or "true" date, a sample ceases to accumulate radioactive

carbon, occurs. Most authorities on the subject of radiocarbon dating stress the fact that radiocarbon assays are usually expressed with an error factor (plus or minus) of one standard deviation (one sigma). This means that the actual date has two in three (68%) statistical chances of falling within the error range given in the assay. This also means that the "true" date of one out of three radiocarbon assays will not fall within the one-sigma range. The use of a two-sigma error range will increase the statistical chance to 95%. The calibrated date ranges shown in Figure 13 reflect the 95% confidence level range.

Radiocarbon assays are normally reported using the Libby carbon-14 half-life of 5568 (by standard agreement). Conversion to the more accurate carbon-14 half-life of 5730 is accomplished by multiplying the reported radiocarbon date (years B.P. from the 1950 radiocarbon standard) by 1.029. For example, TX-4652 (520 ± 90) is converted to 535 ± 90 (520 x 1.029 = 535). The one-sigma range is then determined by adding and subtracting the one-sigma error. This is shown in Figure 13 by the horizontal bar (5730 half-life date midpoint) and the vertical line (standard one-sigma error range). Using the preceding example, the one-sigma range is 625 to 445 B.P. or A.D. 1325 to 1505. The B.P. date is converted to the Christian calendar by subtracting the B.P. date from 1950 (positive numbers are A.D. dates, and negative numbers are B.C. dates).

The Klein **et al.** (1982) calibration is calculated simply by looking up the standard assay (Libby half-life date B.P) in the calibration tables (dates in 10-year intervals) and reading the calibrated date range given for the closest sigma error (provided for 20, 50, 100, 150, 200, and 300 year errors). Although some rounding off is necessary, the table has been constructed to yield 95% confidence interval date ranges. The general effect of the calibration upon the 41 JW 8 assays (vertical bars in Fig. 13) is that the older dates are shifted somewhat later while the younger dates are shifted slightly earlier. These corrections do not negate the fact that something is drastically wrong with the suite of radiocarbon assays from 41 JW 8.

If one were to assume that all the dates are basically correct, then one would have to conclude that two discrete features (6 and 8) both had a mixture of charcoal dating to between A.D. 1300 and 1400 and some 300 to 700 years earlier. This seems highly unlikely, and it is therefore assumed that some of the dates are incorrect. The problem then becomes to try and decide which dates are incorrect.

If one assumes that all of the charcoal from the site was deposited during a single occupation, then this occupation can be dated by finding the time interval with the greatest number of overlapping dates. Seven of the eleven calibrated dates have error ranges that overlap between A.D. 1350 and 1400. This overlap falls within the expected range based on artifact association and stratigraphy. This possibility is considered most likely by the author. If true, this means that two dates were determined by each laboratory that were 300 to 700 years too old. In other words, the sample processing techniques at both laboratories were apparently inconsistent.

If, on the other hand, one assumes that the charcoal dated from the site was deposited over a longer time span or during several occupations, then each feature should be examined separately. The fact remains that the majority of the assays fit within the expected date range; hence at least one occupation dates to between A.D. 1350 to 1400. Feature 5, with only a single assay, appears to date to this occupation. Feature 8 has three out of four assays that fall within this same occupation. The fourth assay (UGa-4540) is clearly wrong. Feature 6 has two date clusters. The first two dates determined by the Georgia laboratory fit within the A.D. 1350 to 1400 occupation. The third, the Georgia laboratory assay, and both the Austin laboratory assays, overlap between A.D. 925 and 1150. By virtue of numerical superiority, one must assume that the earlier date range is applicable to Feature 6. However, there is no physical evidence that Feature 6 is any earlier than the other two features. In fact, Feature 6 is slightly higher in elevation (and closer to the surface) than either of the other two features and has some Toyah phase artifacts (pottery sherds, a small end scraper, and an arrow point fragment) that are clearly in direct association. In other words, the possibility that Feature 6 actually dates to between A.D. 945 and 1010 is considered very unlikely.

The conclusion about the radiocarbon assays from 41 JW 8 is that the radiocarbon laboratories did not use consistent, reproducible procedures. This conclusion is strengthened by an examination of the two pairs of samples that were sent to the Austin laboratory for pretreatment and splitting. In June of 1983, following the discovery of the initial inconsistencies, the author removed a large charcoal sample from the charcoal sample bags from both features in question (Features 6 and 8). These were properly packaged and sent to the Austin laboratory for pretreatment and splitting. Valastro processed and split the samples and sent one-half of each sample to the Georgia laboratory. Given the serious nature of the inconsistencies (both laboratories agreed to run additional samples without charge), one assumes that the samples were treated with more than normal caution to insure that comparable results were obtained. Therefore, both pairs of dates should have been close together. This was not the case. On Feature 8, the Austin laboratory dated the sample at 700 ± 80 while the Georgia laboratory dated the sample at 380 ± 185. This pair does overlap within the calibrated two-sigma range, however, this is only due to the very large error factor of the Georgia laboratory date. On Feature 6, the Austin laboratory dated the sample at 1090 ± 110 while the Georgia laboratory dated the sample at 655 ± 70. This pair does not even overlap at the two-sigma range (calibrated or uncalibrated).

An earlier draft of this section of the report was sent to both laboratories along with a request for additional information on how each sample was processed and for any suggestions for possible sources of error. The resulting responses may partially explain the discrepancies. The assays produced by each laboratory are examined below.

Four of the six valid assays from the Austin laboratory (TX-2206 not considered due to large error factor) overlap between A.D. 1350 and 1400 when calibrated. The remaining two dates, both from Feature 6, overlap between about A.D. 900 and 1150. It is significant to note that the assays determined by the Austin laboratory for each of the problematic features, 6 and 8,

are internally consistent. That is to say, both assays for each feature are statistically consistent (they overlap).

By contrast, the five assays from the Georgia laboratory are noticeably inconsistent. Of the three assays from Feature 6, two overlap between A.D. 1300 and 1400 (calibrated) while the third agrees with the older assays determined by the Austin laboratory. The two Georgia laboratory assays from Feature 8 are 350 years apart from overlapping. Thus, the Georgia laboratory assays are not internally consistent.

Both laboratories use the benzene method for sample preparation and a liquid scintillation counter for counting the radiocarbon. Both laboratories use the new NBS (National Bureau of Standards) oxalic acid RM 49 standard that is referenced to the old NBS standard. In addition, the Austin laboratory also periodically uses 12,000-year-old tree and modern tree (1840) samples from Arizona as reference crosschecks. Both laboratories report assays based on the Libby half-life (5568) and tied to the standard 1950 reference point. Thus, the two laboratories use similar basic processing techniques that should yield similar results.

The difference between the laboratories involves the sample preparation techniques that were used on the 41 JW 8 samples. The Austin laboratory used the same pretreatment procedure for each sample. First, the sample is examined, and obvious contaminants are removed (dirt, roots, etc.). Next, it is boiled in a 2% (0.2N) HCl solution for 30 minutes to one hour to remove calcareous material such as limestone. Next, the sample is rinsed and then boiled with a 2% (0.2N) sodium hydroxide solution to remove any humic acids which might be present. Then, the HCl boil is repeated, and the sample is rinsed a final time with distilled water. After thorough drying, the charcoal is picked piece by piece for the final sample. This procedure was used for all the assays sent to the Austin laboratory and also for the split samples assayed by the Georgia laboratory (UGa-5289 and UGa-5290). The length of counting time varies at the Austin laboratory from a minimum of 24 hours to 48 hours depending on the quality and age of the sample (i.e., an ample sample of a relatively young date is not counted as long as a small sample of an older date).

The Georgia laboratory used similar procedures for the 41 JW 8 sample with one seemingly significant exception--the alkali (sodium hydroxide) boil. Samples UGa-4540 and UGa-4541 were not boiled in an alkali bath "due to the well preserved nature of the charcoal" (Noakes 1984). Noakes went on to say: "This, I admit, may have been an error but repeated distilled water rinsing indicated that the samples were of a very clean condition." He also suggested that based on his past experience "the [41 JW 8] problem lies in the chemical preparation." The letter from John Noakes also revealed the reason for the large error factor for UGa-5290; a vacuum line ruptured during the chemical synthesis, and much of the sample was lost.

Valastro and Noakes both reported that they had checked their laboratory records and had double-checked their counting equipment and found no irregularities or indications of malfunctioning equipment. Therefore, we should expect consistent results for the samples which were pretreated with the full acid and alkali baths and in which no loss of sample occurred. The

split Feature 6 sample assays (TX-4886 and UGa-5289) meet this requirement as well as two of the other Feature 6 assays (TX-4653 and UGa-5280). As Figure 13 shows, while three of these assays are consistent and overlap when calibrated between A.D. 925 and 1150, the fourth assay (UGa-5289) agrees with the A.D. 1300 to 1400 expected range.

In the final analysis, the problem of inconsistent radiocarbon assays from 41 JW 8 cannot be solved based on the current data. Three out of four of the valid dates for Feature 6 are 150 to 375 years older than expected. Given recent confirmation of the fact that Toyah phase related materials in southern Texas date after A.D. 1300 (Prewitt 1985; Hall, Hester, and Black 1986), the Feature 6 dates are anomalous. One possible explanation for the anomalous dates is that they fall within or near one of the "flat" regions in the calibrated curves (Klein **et al.** 1982:114). The "flat" regions of the curve are "periods when the C-14 in the atmosphere has decreased at a rate greater than the 1.2 mil per 10 years" (**ibid.**). Based on the published data, the errors resulting from the "flat" region would not account for the magnitude of the Feature 6 anomaly.

FINAL CAVEATS

A recent in depth discussion of radiocarbon techniques concluded that: "Radiocarbon dating now has the potentiality of far surpassing even the most optimistic plaudits it received a quarter of a century ago" (Browman 1981:287). This author cannot agree. Numerous colleages have cited other examples of serious discrepancies between and within radiocarbon laboratories (including other laboratories not mentioned here) on comparable samples.

This problem has serious consequences for the archaeologist. It appears necessary to have a large number of assays for each occupational component or feature at a given site to be able to distinguish between good dates and erroneous dates and to get an accurate idea of the dating range. This effectively means that site components or features with only a limited number of charcoal samples cannot be confidently radiocarbon dated. The archaeological literature is repleat with examples of components, features, and even sites which are discussed as being firmly dated on the basis of a single radiocarbon assay. The use of single dates in such a confident manner is simply irresponsible.

Another common misuse of radiocarbon assays involves the quoted or calibrated assay midpoint. The midpoints of radiocarbon assays are frequently cited and discussed as if the midpoint is an accurate estimate of the actual date. In fact, the assay midpoint is only the central point in a much larger two-sigma range in which the true date can be expected to occur 95% of the time. Thus, radiocarbon assays should always be discussed as ranges or very clearly stated as rough approximations. The use of numerous overlapping assays is necessary to accurately define the date ranges of site components. An excellent example of this approach is provided by the George C. Davis site radiocarbon dating (Story and Valastro 1977).

The implication for archaeologists of the aforementioned problems is clear: **many (perhaps most) features, components, and sites cannot be accurately**

dated by radiocarbon dating alone. This is because of the nature of radiocarbon dating as a statistical approach and the lack of adequate samples of datable carbon from many (if not most) features, components, and sites.

Finally, this author would like to make some recommendations to archaeologists who rely on radiocarbon assays. One suspects that like the author, prior to the Hinojosa site experience, most archaeologists have never taken the time to understand how radiocarbon dating really works. Previously, this author used radiocarbon dates rather carelessly; if a date "looked right," it was used uncritically, if not it was ignored or explained away. In order for radiocarbon dating to live up to the "optimistic plaudits" mentioned, the tool of radiocarbon dating must be used for what it is rather than for what we archaeologists would like it to be. Toward this end the following suggestions are offered:

(1) Archaeologists should take time to carefully investigate the radiocarbon laboratories to which he or she sends samples. The pretreatment methods, equipment calibration standards, and counting times used by a given laboratory can seriously effect how the date will come out. If samples are to be split and sent to two laboratories, it behooves the archaeologist to make sure that both laboratories use essentially identical methods, or else the results are liable to be inconsistent.

(2) Archaeologists should work more closely with radiocarbon scientists at all stages of the process, from the field circumstances to the final interpretations. Each feature, component, or site is unique and should be treated as such.

(3) Radiocarbon laboratories should provide as standard information the processing details for each sample. Some laboratories make a standard practice of this, many others do not. Most information could be summarized in three to five pages. The pretreatment variation, the sample count times, and any problems in processing for each sample should be reported to the archaeologist.

(4) It is very obvious that a detailed comparative study needs to be made of the radiocarbon laboratories that provide data to archaeologists. This study would reveal which procedures are and are not producing reliable results and would provide a means to evaluate and compare data received from various radiocarbon laboratories.

PERDIZ ARROW POINT SPECIAL STUDIES

A comparatively large sample of **Perdiz** arrow points (100) and fragments of other arrow points (64; most of which are probably **Perdiz** fragments) was recovered from 41 JW 8. These were found in virtually all excavation units in most excavation levels except for the lowest nonproductive levels. The large arrow point sample was used for three special studies in addition to the wear pattern examination discussed in Section VI. These studies are an evaluation of a projectile point neck width dating formula hypothesis, a look at plow-damaged arrow point distribution, and a study of arrow point breakage patterns.