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VALIDITY OF AGE DETERMINATION IN MICHIGAN DEER

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Introduction

We are approaching the point in Michigan deer herd management where we need rather precise estimates of local populations, survival rates, and huntable surpluses. An important part of this knowledge comes to us through examination of the age structure of the hunting season kill. It is time we took stock to see if our current age determination technique--based on mandibular tooth replacement and wear--is providing us with valid age ratios. Our assessment will be based on two approaches: (1) Is the technique valid and precise within tolerable limits? (2) Assuming the technique is basically adequate, can we apply it properly?

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Historical

The technique of aging animals by the teeth is an old one; for example, the remark, "Do not look a gift horse in the mouth" is credited to Saint Jerome of the 5th century. Certainly it has been common knowledge for generations that domestic animals could be aged by noting the development and wear of the teeth (Pope, 1934). It is not surprising, therefore, that early deer workers in this country turned to the dentition for separating age clases in the Cervids.

Cahalane (1932) classified 244 white-tailed (Odocoileus virginianus) deer skulls from Michigan's hunting season into four age classes by means of relative wear on the dentition. However, only one of his set was known-aged. McLean (1936) describes briefly the tooth replacement sequence in the genus Odocoileus, while Cowan (1936) presents it in some detail for black-tailed deer (Odocoileus hemionus). Park and Day (1942) indicate the progressive changes in the dental formula of the white-tailed deer up to 30 months of age, but they point out a study of a series of know-age jaws would be the only means of extending accurate aging beyond 30 months.

It remained then for Severinghaus (1949) and his co-workers to make an actual collection of mandibles from known-aged deer and to describe normal wear patterns and criteria for white-tailed deer age classes up through 10½ years, and later (Severinghaus and Tanck, 1950) to 16½ years. One should consult these two papers for details on the technique.

Subsequent studies based on known-age specimens and/or wear classes p11, #5. Rept #2279

It seems possible that there is a difference between Regions II + III if we could separate yearlings born to previous year's yearlings + exclude them from data. Since this group is born much later (see data on embryo lengths from car kills), and since virtually all members of this group are found in Region III, it seems that they must increase proportion c̄ milk premolars in Region III.

p12. This group of late-born deer in Region III should increase chances of placing deer in the younger-than-correct age class when misaging occurs (unless biologists are consciously compensating for this possibility). This makes the apparent lack of 2½'s and surplus of 3½'s even more disturbing.

What is proportion c̄ milk premolars among George Reserve deer collected ~ hunting season?

Average weights of 1½ yr old bucks in Region III are influenced by large numbers of late fawns born to yearlings.

Doubtless a given jaw produces a different image in the minds of different workers. In Michigan we must use many different individuals to man our checking stations. We need to know something of the variability we can expect between agers in order to interpret properly the data derived from examination of the kill. The alternative is a system of jaw collection to permit one or a few men to do all of the aging, but this would not be practical for us. Flyger (1958) has proposed a system of making impressions of the teeth with modeling clay and later positive casts from these molds so that a few men can thus do all of the aging.

Basically our test is made up of 50 jaws selected from each age class based on an annual survival of about 50 per cent (Table 1). These proportions are a compromise between those normally observed in the Upper Peninsula and northern Lower Peninsula. We assumed that the occurrence of each age class in the population determined its relative importance, and skill in aging should likewise follow the same pattern. In addition to the 50-jaw test, we initiated a 30-jaw test in 1957, more appropriate for our antlerless deer, composed of one-third fawns, and with more practice on "middle-aged" deer. This has consisted of seven 5-months-old fawns, three 6-months-old fawns, eleven or twelve 2½-year-olds, six or seven 3½-year-olds, and two 4½-year-olds. None of the jaws used on these tests are of known age. They are merely from deer killed in the fall, carefully assigned to age classes based on Severinghaus' criteria. Some of these Severinghaus or Tanck actually aged. We have tried to use only jaws that were "typical" and exhibited "normal" wear.

Both tests have been of the "open book" type. We have encouraged reference to the labelled, aged jaws present. Compared to working at checking stations on hunter-killed deer, these tests are conducted under ideal conditions. The jaws are clean, and one can pick them up and hold them in any position. All teeth are equally visable, lighting is good, hands are warm, and time is not a factor. It is difficult to believe a person can age deer more accurately in the field than he does on these tests. Consequently, we have used the results of the tests as a guide in selecting the most adept agers for each checking station unit.

From 1955 to 1959, we have 299 scores on the 50-jaw test (89 different individuals), and from 1957 to 1959, 180 scores on the 30-jaw test (85 different people).

Some of the individual jaws appeared in the tests every year, but we did make substitutions because of breakage or discovery of more representative examples. There is a slight possibility that some people could have remembered certain jaws from one year to the next, or at any rate remembered that there were only three 5½-year-olds, two 6½-year-olds, or one 7½-year-old. At some of the testing sessions the group knew that no jaws were older than 7½ years. These three age classes and older deer do not comprise a very large part of a herd where deer experience a high annual mortality, as in Michigan. Furthermore, tooth wear patterns become increasingly variable with increasing age. Fortunately, we can determine survival rates quite well using only the proportion of deer found in each age class up through 4½ years.

We had hoped that it would be possible to age deer consistently up through 4½ years old. The agers, however, tended to under-age 4½-year-olds (and older deer) and, to over-age 5-months fawns and, 1½ and 2½-year-old deer. Six-months fawns and 3½-year-old deer exhibited a fairly symmetrical distribution. Moreover there was a disturbing lack of consistency in assigning ages, particularly in the four older age classes.

In Table 2 the figures in each row show the distribution of ages recorded on the tests for jaws which we believe actually belong to the age classes listed at the left. For example, 93 per cent of the five-month-old jaws were correctly aged, six per cent were called six-month-olds, and one per cent were classed as 1½-year-olds.

Another way to view the results is to note the relative accuracy with which each age is determined. That is, when agers classed a jaw in a given age class, how often were they right? The answer will vary somewhat depending on the distribution of jaws in a given sample. Table 3 shows the averages for our tests. For instance, of all the jaws called 1½-years-old, about 98 per cent were actually that age.

Some misaging is normal, but what is important to us is how this affects the age ratios derived from a large number of observations. Table 1 implies that the mistakes made are not entirely compensating and very likely the ratios will not be very precise. Because we set up the 50-jaw tests so that the number of jaws in each age class would approximate a survival rate of about 50 per cent, differences between reported and known distributions here provide us with some notion of the errors likely in examining a sample of the kill. In every year there is a conspicuous shortage of 2½-year-old deer and a surplus of 3½ and 4½-year-old deer. Reported 1½-year-old deer and 5½-year-old and older deer, however, are near to the known distribution each year. Table 1 shows the number of times each age was recorded on the tests (Observed), and the number of times it should have been recorded had there been no errors in aging (Expected). There are some compensating errors here as indicated in Table 2.

Have we become more proficient at aging over the years? We would like to answer, "Yes," to this question, but our data does not support this conclusion. The number of errors per ager on the 50-jaw tests averaged 11, 11, 13, 11, and 11 for 1955 to 1959, respectively. Since there has been some turnover in personnel during these years, we have also compared the errors made by 22 individuals who took the 50-jaw test each of these 5 years. They averaged 10, 11, 11, 9, and 10 errors.

We have assumed that some people are innately better than others in application of this subjective technique, and we have appointed agers on the basis of test results. Using the records of the above-mentioned 22 agers, analysis of variance of tests scores indicated highly significant differences between individuals ($F = 6.44^{**}$ for 21 and 88 d.f.). A multiple range test applied to the data shows several apparent levels of proficiency. These tests confirm the need for carefully selecting a few people to do the bulk of the aging where possible.

Biological Data

When discussing the biological data, it is convenient to divide the state into administrative regions and districts used by the Conservation Department (Fig. 1) with one exception. We do not subdivide the south half of the Lower Peninsula, Region III, because of the small number of deer examined from this area.

Our situation in Michigan is unique in that 65 per cent of the deer hunters live in the southern Lower Peninsula, while less than 1 per cent of the deer do. Thus, we can examine a sample of the Upper Peninsula kill at the Straits of Mackinac, and a sample of northern Lower Peninsula deer at about 5 checking stations on major north-south highways near the south edge of the region. Virtually all of the Game Division takes part in this venture each fall. From 1951 to 1959, we examined 80,000 deer, or nearly 10 per cent of the deer killed by hunters in these years (Eberhardt and Fay, 1957, 1958, and 1959).

Our purpose here is a critical examination of a technique. Consequently we present only such biological data gained from its use, as will give evidence of its validity. In this connection we discuss briefly the rate of tooth replacement in yearlings and apparent survival rates derived from age records of adult bucks.

Dental terminology used here follows Riney (1951). This departs from Severinghaus (1949) in that Riney considers the first premolar to be vestigial and seldom found in deer. Thus the three premolars present are actually P2, P3 and P4. Furthermore the "corner incisors" are really incisorform canines. During its lifetime a deer has two complete sets of incisors, canines, and premolars, a set of permanent teeth replacing the original temporary, milk, deciduous, or baby teeth. There is only the one permanent set of molars. Molars and premolars collectively compose the "cheek" teeth. Figure 2 illustrates the location and appearance of tooth types and topography.

Yearling Tooth Replacement

In 1958 and 1959 we carried out a simple experiment to see if the tooth replacement rate differed in various parts of the state. This consisted of classifying all 1½-year-old deer examined into two groups, those with milk premolars remaining in either lower jaw (1½-), and those without milk premolars (1½+).

There was a very distinct difference between the Upper and Lower Peninsulas (Fig. 1). Table 4 presents the number of deer involved in the various samples. We used Chi-square tests of independence of these data to test the hypotheses that two given samples are randomly drawn from a common binomial population. Chi-square values are expressed as probability for a chance deviation as great or greater than the one computed. Those with probability between .05 and .01 will be considered "significant", while a probability less than .01 will be "highly significant".

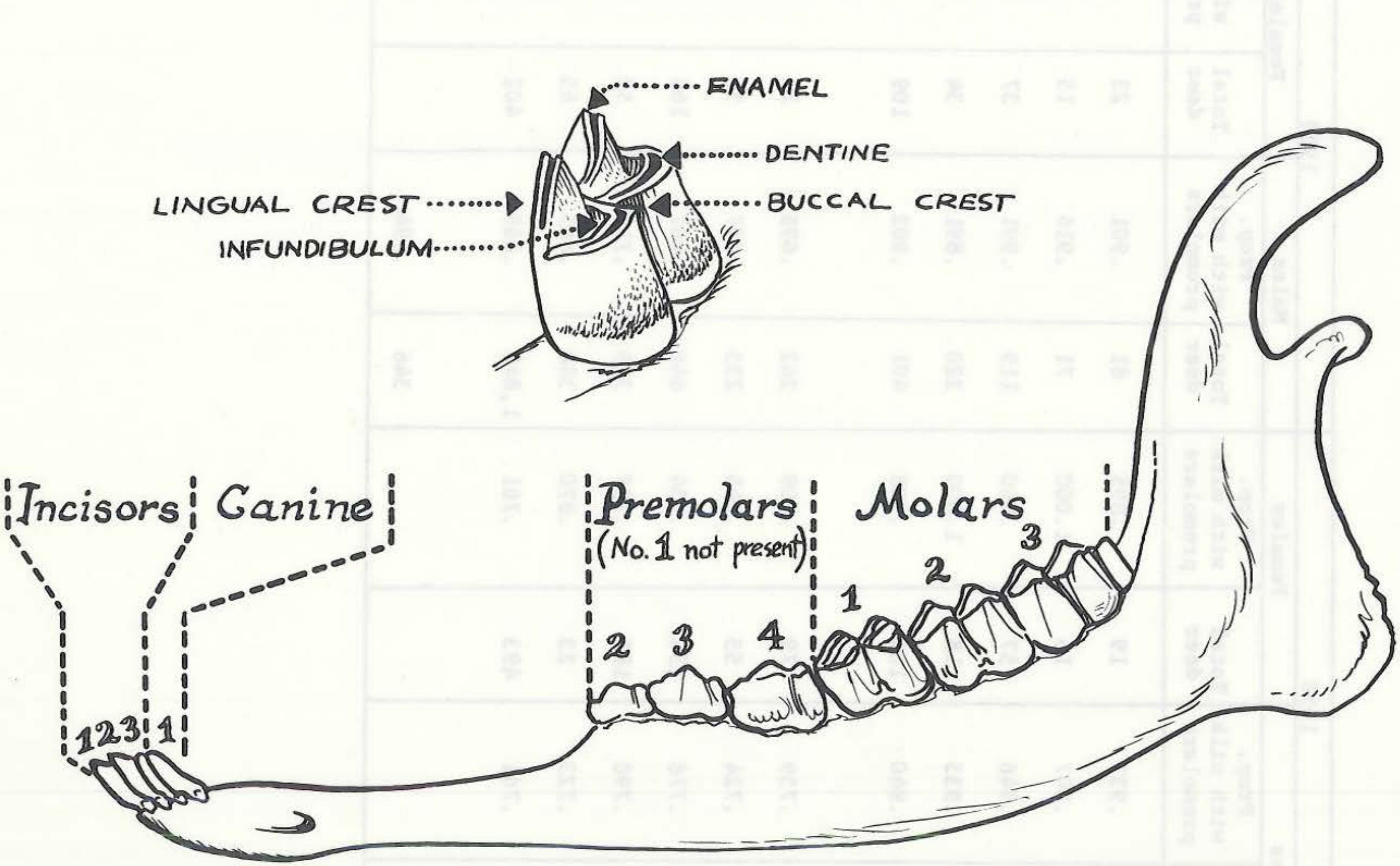

Figure 2. ADULT DEER MANDIBLE SHOWING DENTAL TERMINOLOGY.

Chi-square tests comparing various samples regarding the relative frequences of $1\frac{1}{2}$- and $1\frac{1}{2}$+ indicate the following:

1. No significant differences in either year for males between districts in Region I ($.80 < P < .90$).

2. A significant difference between Region II districts for males in 1958 ($.01 < P < .025$) but not in 1959 ($.05 < P < .10$).

3. Highly significant differences between years in both Regions I and II for males ($.001 < P < .005$ for Region I, $P < .0005$ for Region II).

4. Highly significant differences between Regions I and II males both years ($P < .0005$ both years).

5. No significant difference between Regions II and III males in 1959 ($.40 < P < .50$). Data insufficient for Region III in 1958.

6. No significant differences between males and females in either Regions I or II in either year ($.60 < P < .70$ for Region I, 1958; $.95 < P < .975$ for Region II, 1958; $.80 < P < .90$ for Region I, 1959; $.70 < P < .80$ for Region II, 1959).

We are not sure what is responsible for the marked difference between the Upper and Lower Peninsulas. We don't have any evidence that fawns are born later in the Upper Peninsula. We do have some indication from feeding studies that poor nutrition delays tooth replacement, a phenomenon noted by other workers (Hamerstrom and Camburn, 1950, Severinghaus and Cheatum, 1956 and Robinette, et al., 1957). However, if this was a factor here, then the poor food areas of the lower peninsula should be different from better food areas, but they aren't. A third possibility is that the deer are inherently different in their rate of tooth replacement. This is certainly possible, since the Upper and Lower Peninsula deer have been separated for several thousand years (Hibbard, 1951).

Differences between years within both Regions I and II could well be the result of differences in sampling. The extreme cold weather during the 1959 hunting season froze many deer carcasses so solidly that we were unable to open the jaws to determine age. We have no explanation, however, for differences found between districts in the 1958 data for Region II.

Survival Rates

Hayne and Eberhardt (1952) offer a graphical way of estimating survival rates from age distributions in deer based on Ricker's (1948) work on the dynamics of fish populations. You simply plot the logarithms of the frequencies by age class and draw a line through the points. This

The tooth replacement rate does not appear to be different. We find no significant differences in the pooled ratios of 1½- and 1½+ deer from Districts 6 and 8 compared to the remainder of Region II in either 1958 or 1959 (Chi-square probability between .70 and .80 for 1958 and 1959). Furthermore, as mentioned above, we found no significant differences in ratios between Region II and Region III for 1959.

If tooth wear were responsible, we would have to assume that once a deer has all of his adult teeth, tooth wear in these three areas was more rapid. We have no data to confirm or deny this, but we would expect the reverse to be true since food conditions in these areas average better than in the remainder of the state.

We also have no reason to believe that the vulnerability of 2½-year-olds is different in various parts of the state. Malnutrition does retard antler development, but this occurs primarily in 1½-year-old bucks. Reduced vulnerability of the 1½-year-old deer would tend to inflate 2½-year and older age classes, however, not reduce them.

The differences found are probably not due to differences among agers. Age ratios for Districts 6 and 8 from deer examined at three checking stations in the east half of the state apparently did not differ from those obtained at two others in the west half of the state (Chi-square $.40 < P < .50$ for District 6 in 1958; $.05 < P < .10$ for District 8 in 1958; $.30 < P < .40$ for District 6 in 1959; $.10 < P < .20$ for District 8 in 1959).

There remains then the possibility that over-all mistakes in aging are responsible. To test this, we plotted the kill curve for a theoretical population having a uniform annual survival rate of 20 per cent and a uniform recruitment each year - the "expected" curve in Fig. 3. On the same graph we also plotted data for the same population but assigned deer to age classes based on the distributions in Table 2. This curve exhibited an apparent shortage of 2½-year-olds and a surplus of 3½ and older deer, very similar to the lines of Districts 6 and 8 and Region III ("aging error" curve in Fig. 3). Actually in this example it happens that 2½-year-olds are close to the correct proportion while the 3½-year and 4½-year age classes are inflated. This, however, varies depending on the survival rate. Furthermore, under field conditions the difficulty of seeing the critical posterior teeth would cause more 2½-year-olds to be classed as 3½-year-olds.

We still have not accounted for the fact that kill curves from other areas are generally straighter at least from the 2½-year age class. The one difference between the two sets of areas that we can demonstrate involves winter food supplies and improved condition of deer. Yearling males from Districts 6 and 8 and Region III average larger antler beam diameters, more antler points, and greater body weight than those from other areas of the state (Eberhardt and Fay, 1959).

We can get a typical curve by assuming that only 80 per cent of the yearlings in our hypothetical population are vulnerable because of small antlers ("compound error" curve in Fig. 3). Again we assigned deer to age classes based on distributions given in Table 2. Note how much higher the apparent survival rate determined from this curve is than the actual 20 per cent.

Based on this evidence we must conclude at the present time that the survival rates we have observed in the kill are probably subject to some question simply on the basis of individual aging errors, and one must be careful in applying them too literally.

Known-Age Deer

Materials

Perhaps the most valuable source of information for evaluation of our current deer aging is our collection of jaws from deer of known age. Since 1950 we have obtained some 120 such mandibles. These are from three sources, (1) fawns trapped, tagged, and released when newborn or 6-10 months of age, largely from 1940 to 1953, and later recovered; (2) deer from deer management studies in a 647-acre enclosure consisting of natural year-around deer range, and (3) penned deer from controlled nutrition studies. The age of the deer is a matter of record, and we carefully label each known-age jaw with an age determined from trapping and autopsy records.

With two exceptions, all deer were originally trapped by the staff of the Cusino Wildlife Experiment Station in either T46N R17W, Alger County, or T46N R16W, Schoolcraft County, in the Upper Peninsula. These are a deer, aged 12½ years, tagged as a fawn in 1941 in Crawford County of the northern Lower Peninsula, and a fawn reared in captivity.

In our analysis of aging characters based on these jaws, we have eliminated all penned deer through 3½ years old. We have included five older specimens, since the available sample of these ages was necessarily small. Although there seems to be no consistent differences in tooth development or wear between penned deer and wild deer, individual animals sometimes develop abnormal wear from chewing the wire fencing, sand, or

TABLE 5

AVERAGE HEIGHT OF LINGUAL CRESTS ABOVE GUM LINE

Age	No. of Jaws	Milk Premolars 2	Milk Premolars 3	Milk Premolars 4	Adult Premolars 2	Adult Premolars 3	Adult Premolars 4	Molars 1	Molars 2	Molars 3	4*
5-6 mo.	12	4.0 (3-5)**	3.9 (3-5)	5.7 (5-7)				9.0 (8-10)			
7 mo.	1	3.5 (3-4)	3.5 (3-4)	5.0				9.0	1.0		
8 mo.	1	4.0	4.0	5.0				9.0 (8-10)			
8½ mo.	1	4.0	4.0	5.0				8.0	7.5 (7-8)		
9 mo.	2	4.0	4.7 (4-5)	6.0				8.7 (8-9)	5.0 (4-7)		
10 mo.	3	3.5 (3-4)	3.8 (3-5)	5.0 (4-6)				9.0 (8-10)	5.7 (3-7)		
1 year, 6-7 mo.	16	3.5 (2-5)	3.4 (2-5)	4.6 (3-7)				8.7 (7-11)	11.2 (9-13)	7.5 (4-11)	.2 (0-2)
2 yrs., 6-7 mo.	20				4.8 (4-6)	6.4 (5-8)	7.9 (6-9)	8.2 (6-11)	10.0 (8-11)	10.0 (8-12)	4.5 (3-7)
3 yrs., 6-7 mo.	14				5.2 (4-6)	6.2 (5-8)	7.8 (5-10)	7.6 (5-9)	9.7 (8-11)	10.2 (8-12)	5.8 (4-8)
4 yrs., 6-7 mo.	4(1)***				5.5 (5-6)	6.1 (5-7)	7.4 (6-9)	7.4 (6-9)	9.2 (8-10)	10.0 (8-11)	5.2 (4-6)
5 yrs., 4-8 mo.	5(2)				4.7 (3-6)	5.6 (4-7)	7.4 (6-9)	7.5 (6-10)	9.2 (7-11)	9.8 (8-12)	6.1 (5-8)
6 to 6½ yrs.	3(2)				4.8 (4-6)	5.0 (4-6)	6.8 (5-8)	6.3 (5-7)	8.7 (7-10)	8.5 (8-9)	5.8 (5-7)
7 yrs., 9 mo.	1				4.5 (4-5)	4.0	5.5 (5-6)	5.0	7.0	8.0	7.0
8½ yrs.	1				5.5 (5-6)	4.5 (4-5)	5.0	5.0	8.0	9.0	7.0
9½ yrs.	1				5.0	5.0	6.0	6.0	8.0	Broken	Broken
11 yrs., 10 mo. to 12½ yrs.	2				5.0	4.5 (4-5)	5.0 (4-6)	4.2 (4-5)	6.0 (5-7)	8.0 (7-9)	6.0 (5-7)
	87										

* 3rd. cusp. 3rd. molar

** Range

*** Penned deer included

Premolars

In Michigan all milk premolars are erupted fully long before a fawn reaches his first hunting season. In New York, a full set of temporary premolar dentition is typical before the third month. Normally, by November, 5-6 months of age, the third and fourth temporary premolars show moderate wear. The deer retain these teeth until about 1½ years old when permanent teeth gradually replace them. In New York, deer shed these teeth around the 18th month. In our sample all 14 known-age 1½-year-old deer collected during the November 15-30 hunting season retained temporary premolars. One animal taken the last of December retained a full set of temporary teeth, and a second taken in mid-December retained temporaries on one side and had lost them on the other, but new teeth had not erupted. A 20-month-old animal taken February 29 had completely replaced the premolars, but these showed only a little discoloration, suggesting they were of recent origin. We have already noted in the section on yearling tooth replacement that less than 10 per cent of the Upper Peninsula yearlings examined at checking stations had shed their milk premolars, while in the Lower Peninsula this has averaged 24 and 33 per cent for two seasons.

Premolar replacement offers the best single criterion for determining age of 1½-year-old deer. The temporary fourth premolar is 3-parted or lobed in contrast with its successor, a much larger 2-lobed tooth (Figs. 5 and 6). The temporary premolars at age 1½ normally exhibit extreme wear, especially P4. If premolar replacement has taken place, the new teeth may or may not have fully erupted. If erupted, there is little or no visible wear and generally they show less stain than the molar teeth. By 2½ years there is normally slight to moderate wear on P3 and P4; however, wear on both is variable. In over half the specimens examined there was no dentine visible on the anterior surface of P3.

The wear by 3½ years is extremely variable and in some instances P3 and P4 may be nearly flat, while other specimens show extremely little wear. A small to moderate dentine line on the anterior surface of P3 is the only constant premolar characteristic of this age group.

Beyond 3½ years, no constant wear pattern is discernible. The second premolar usually is not worn as much as P3 and P4. Even in the older age classes, wear on this tooth is not great (Table 5). Generally, by age 6½, most of the lingual crests of P4 are worn away, but in old age this tooth and the first molar exhibit extreme variations in wear.

Molars

Molar development in deer provides additional criteria for determining ages of fawns and yearlings. In 12 deer 6-months-old the first molar had fully erupted but M2 had not appeared. Two penned 6½-month-old deer both had second molars partially developed, but in our specimens from wild deer one 7-month fawn had M2 cusps barely visible and in one 8-month fawn they had not yet appeared. In six 8½ to 10-month-old wild fawns this tooth was in various degrees of partial eruption. Severinghaus (1949) reported

The criteria set up for the 7½-year class in New York readily fits our known-age 12½-year Michigan specimen. Furthermore our 12-year-old jaw still possessed lingual crests on M2 and M3, as well as well-defined infundibula. This particular specimen could easily fit the description for Severinghaus' 5½-year class. Pictures and descriptions in his paper of 8½-year and older animals certainly would be well over 12½ years of age in Michigan. Michigan deer with tooth wear similar to the 16-year specimen described by Severinghaus and Tanck (1950) could easily be 20 to 22 years old.

Comparison of lingual crest height above gum line in the various age classes (Table 5) for the two areas further substantiates our conclusion that wear is far less rapid in Michigan deer.

Individual Variation in Tooth Development and Wear

It is not within the scope of this paper to elaborate on the individual variation found in our known-age jaw collection. There is considerable latitude between the development and replacement of teeth in individual deer, but this variation does not affect the hunting season age determination.

The same is not true of tooth wear. Normally, careful scrutiny makes it possible to separate the 1½-year-olds with permanent premolars from the 2½-year group. But nearly a quarter of the known-age 2½-year jaws have most of the characteristics of 3½-year-old deer. Our sample of fourteen 3½-year jaws is relatively uniform. One appeared younger and at least one a year older. Nine jaws in the 4½-5½-year class were not as uniform. One 4½-year and two 5½-year deer possessed wear characteristics of 3½-year animals and one 5½-year jaw looked similar to a 6½-year-old jaw.

The five jaws in the 6½-8½ class are all reasonably consistent with the possible exception of one 6½-year specimen similar to those 4½-5½ years. A single 9½-year deer had the wear pattern of the 6½-year known-age specimens, but the two jaws 12 and 12½ years old were consistent with trends in wear.

Because of the variability found between agers on our yearly aging tests, we conducted a similar test using part of our known-age mandibles. We told agers only that these were known-aged jaws. They were to employ the usual age criteria in making their determinations. Several jawboards were available for comparison. In this test, 36 individuals aged 63 jaws from 1½ to 12½-year-old deer, but we tallied responses only on 57 jaws within one month of each half-year class. Table 7 compares the observed distribution with known ages. Compared to our other tests (Table 2), there was a greater tendency to under-age 4½-year-old and older deer as we expected, but there was also a somewhat greater spread of determinations for each age.

Discussion

Now that we have seemingly cast a large shadow of doubt over the validity of our current aging standard as well as our ability to employ the technique, we need to make some adjustments in our procedures.

In order to present information derived from our known-age mandibles in the most useful form we have developed a key for separating deer killed in November into eight age classes (Appendix). Use of the key in conjunction with the accompanying plates showing a typical jaw from each age class should serve to illustrate diagnostic characteristics. This, of course, cannot wholly substitute for actual visual comparisons with known-age jaws, which we believe is the most accurate procedure. Moreover under Michigan checking station conditions, where we have examined over 1200 deer at one station in one day, it is not practical to attempt more time-consuming methods. These include ratios of tooth measurements, which Robinette et al. (1957) employed for mule deer, and the use of several specific characters as utilized by Quimby and Gaab (1957) in aging elk. The latter workers concluded, however, that direct comparison with known-age jaws was the best method.

We feel we should use these new standards this coming deer season. There are no conflicts involved in employing these methods for the Upper Peninsula, but we do not have an equivalent collection of jaws from the Lower Peninsula. Moreover we have shown difference in rate of tooth replacement in both fawns and yearlings between peninsulas. Our strongest support comes from the single 12½-year-old jaw from Crawford County which fits wear sequences of Upper Peninsula deer and not New York. The other argument is simply one of spatial relationships-- we assume that deer in the two parts of Michigan are more closely related than deer from the Lower Peninsula and New York.

We need to emphasize characteristics of the 2½-year, 3½-year, and 4½-year age classes in our training sessions. We should terminate attempts to classify fawns into 5-months or 6-months. We should also make better use of personnel who demonstrate an aptitude for application of aging techniques.

Unless current attempts to use other methods for deer aging--such as eye lens weight--prove more exacting, we should trap and release wild deer in the Lower Peninsula or establish large enclosures in order to obtain a good sample of known age deer jaws.

Summary

We have presented an analysis of the use of tooth replacement and wear criteria for aging white-tailed deer in Michigan. Tests given to agers indicated a disturbing lack of consistency and showed a tendency to under-age 4½-year-old and older deer and to over-age 5-month fawns, 1½ and especially 2½-year-old deer. Aging errors apparently show up in kill curves plotted from examination of a sample of the kill as a shortage of 2½-year-olds, a surplus of 3½-year-olds and older deer, and survival rates which are higher than actual. We have found differences in rate of tooth replacement in fawns and yearlings between Upper and Lower Peninsula deer.

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APPENDIX

Key to the Age of Michigan Deer in November

(Based on Known-Age Dentition)

1. a) Temporary incisors entire or possibly center ones replaced by larger permanent teeth. First molar present, but rarely the second.-- Fawns, 5-6 months old, Fig. 4. 1/2

   b) All permanent incisors present, Fig. 4. Third molar erupted, although posterior cusp may not be visible.--1½ years old or older.--2.

2. a) Temporary premolars present (fourth premolar 3-parted), Fig. 5, or permanent premolars replacing temporary ones.--1½ years old. 1 1/2-

   b) All permanent premolars in position and fully erupted (fourth premolar 2-parted).--1½ years or older.--3.

3. a) No wear on permanent premolars. Posterior cusp of third molar generally not erupted. Little or no wear on crests of third molar and dentine, if showing, in a narrow line.--1½ years old, Fig. 6. 1 1/2+

   b) Greater wear indicated, last crest of third molar erupted.--2½ years or older.--4.

4. a) Wear absent or very slight on third premolar; slight on fourth, usually with only slight amounts of dentine showing on anterior surface. Lingual crests of all molars usually sharp, dentine line very narrow on third molar. Slight wear on last cusp of third molar. --2½ years old, Fig. 7. 2 1/2

   b) Wear further advanced.--3½ years or older.--5.

5. a) Last cusp of third molar flattened, hollowed-out or both. Third premolar with thin to moderate dentine line on anterior surface. Lingual crest of first molar blunt. Lingual crests of other molars sharp.--3½ years old, Fig. 8. 3 1/2

   b) Further wear indicated.--4½ years or older. It is difficult to determine the age accurately above 3½ years due to individual variation in tooth wear. However, certain wear characteristics are found in most jaws of each age group.

   Characteristics are listed below:

   4½ - 5½ years old: Lingual crests of first molar present but flat. Crests of second molar rounded as first molar in 3½-year group. Posterior cusp of third molar may be worn so it slopes laterally downward. Third and fourth premolars further worn. Second premolar may or may not show wear, Figs. 9 and 10.

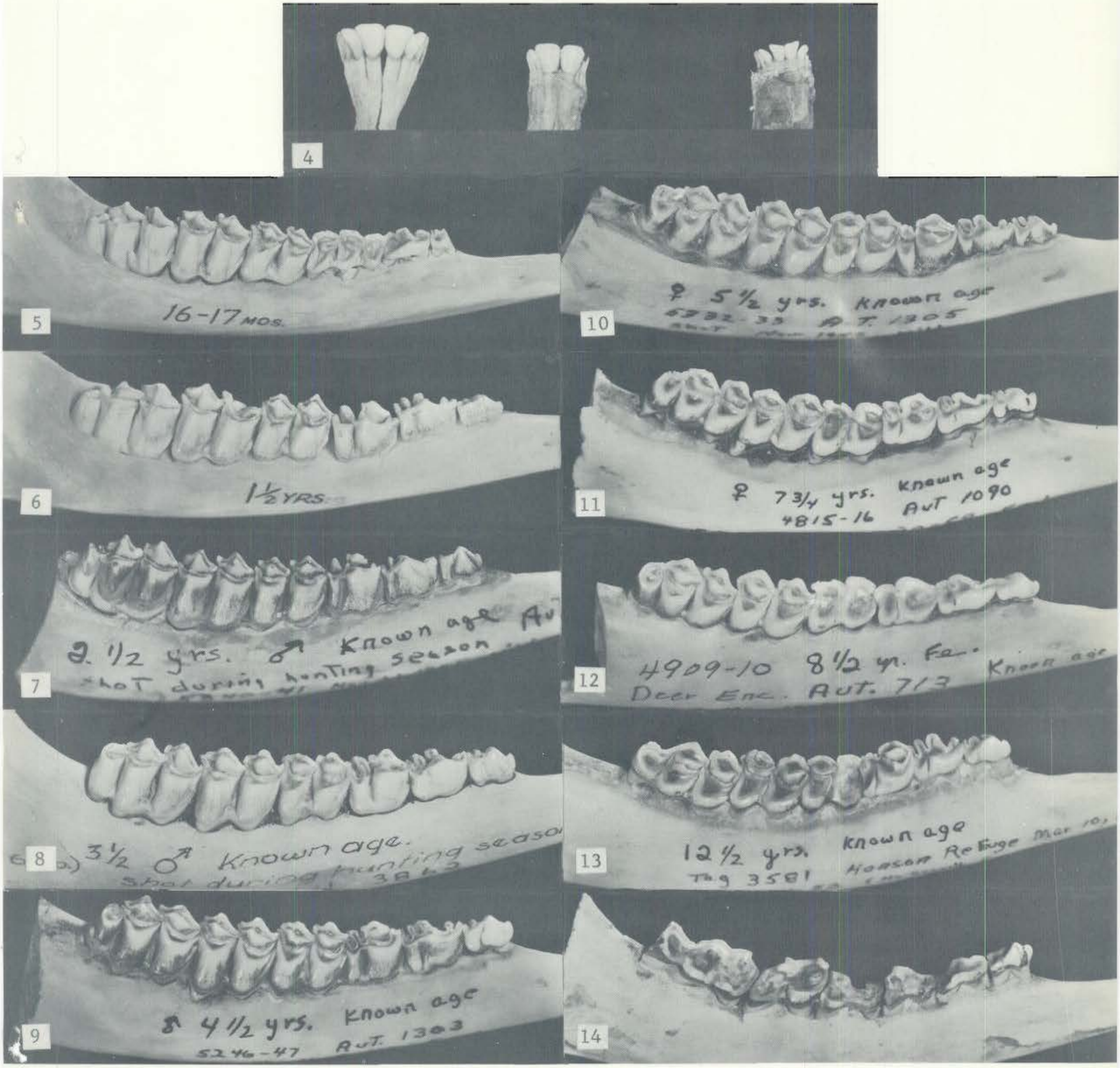

Figure 4. Incisors and canines, from left: all permanent, 1½-year old; I_1, permanent, remainder temporary, 8 months old; all temporary, 6 months old.

Figures 5-13. Known-age mandibles: 1½, 1½, 2½, 3½, 4½, 5½, 7 3/4, 8½ and 12½-years-old.

Figure 14. Man dible from "old" deer of unknown age.