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AGE GROUPS IN MICHIGAN OTTER

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IN 1940 an excellent opportunity arose to obtain data and specimens for the study of several phases of the life history of the river otter (*Lutra canadensis*). The Michigan Department of Conservation after maintaining complete protection of otter for the preceding fifteen years again established an open season. Regulations permitted each licensed trapper to take two otters and required him to turn in the carcasses to conservation officers at the time the pelts were presented for the official seal. The conservation officers obtained data on localities of capture from the trappers and forwarded this data with the carcasses to the Game Division Laboratory of the Conservation Department at Lansing. There in 1940 and again at the end of the trapping period in 1941 and 1943, Ostenson recorded weights, measurements, and other data and preserved certain parts of the carcasses for study. Stomachs and intestines were removed for an analysis of the food habits and have been reported by Lagler and Ostenson (1942). From a total of several hundred individuals handled, 131 skulls and partial skeletons were saved for the osteological collections of the University of Michigan Museum of Zoology. These form the basis for the present study, supplemented by thirteen specimens taken at various seasons of the year which were already available in the Museum's collections. All specimens reported here with the exception of not more than ten individuals, were collected in March or April in the legal trapping seasons as follows: In the Lower Peninsula, March 20 to April 10, 1940; March 20 to April 3, 1941; and March 15 to 31, 1943; in the Upper Peninsula, April 1 to 15 in each of the three years.

Although uniform as regards season of year, the study series is not strictly a random sample of the trapped population. When the carcasses were checked in Lansing, those for which there was incomplete, illegible, or no locality data were not saved. Badly crushed skulls and skulls with excessive damage to teeth and jaws from fighting the trap were likewise discarded. The selection of specimens with complete data was random as to age and sex, and a proportional number of each sex and age was probably retained in the sample, but the discarding of some crushed and tooth-damaged examples may have introduced an error. Excessive damage seemed to occur more frequently in larger and presumably older animals and especially in females. Our sample, therefore, has fewer older animals, especially older females. Moreover, it should be noted that a trapped population is not necessarily a good sample of a wild population. The trap and the trapper may be selective of age, sex, and physical condition. Nestlings would appear rarely in the sample because they are not readily available to either trap or trapper, and there are other factors which may warp the quality of the trapped sample. How much they have done so in this case, we do not know.

In the analysis of the sample we have used five dimensions of the skull and one measurement of the baculum. All dimensions were determined with dial calipers, calibrated to tenths of millimeters. Each dimension is accurate within $\pm$ 0.2 mm. The measurements, standard in systematic mammalogy, are as follows:

Condylobasal length. The length of the skull from the posterior border of the occipital condyles (condylions) to the anterior border of the premaxillae (gnathions).

Zygomatic breadth. The greatest spread of the zygomatic arches, measured at a right angle to the long axis of the skull.

Mastoid breadth. The greatest diameter across the posterior part of the skull, measured from one mastoid process to the other.

Interorbital breadth. The least diameter of the skull between the orbits.

Mandibular length. A chord length of the mandible, measured from the angular process anteriorly to the anteromost point on the ramus (the junction of the alveolus of the first incisor and the symphysis of the lower jaw).

Length of baculum. The greatest chord length of the bone.

Statistical calculations accord with current practice and formulas, as outlined by Snedecor (1946). The significance of the difference between two means has been judged by computing t and referring to standard tables of t for small samples (Snedecor, 1946 : 65). The 5 per cent level is considered the upper limit of significance. Differences at the 1 or 2 per cent level are believed to be highly significant.

We are grateful to H. D. Ruhl, chief of the Game Division of the Michigan Department of Conservation, for permitting us free access to the otter carcasses. G. W. Bradt has helped in several ways. Emil Liers of Homer, Minnesota, generously provided us with pertinent life history data and located examples of known age for us, an item of utmost importance in such a study as the present one. Clifford C. Gregg, of the Chicago Natural History Museum, J. Kenneth Doutt and Caroline Heppenstall, of the Carnegie Museum, and Don C. Quimby, of the University of Minnesota, kindly permitted us to examine specimens entrusted to their care.

PURPOSES

We have sought answers to the following questions: How many age groups can be recognized in the sample? What is their size and sex composition? How trustworthy in indicating age are some standard dimensions of the skull? Can tooth wear be used as a reliable criterion of age in wild-caught otter? What dental abnormalities are present? What size difference is present between males and females at the several age levels? Do the otter in the Upper Peninsula differ significantly in cranial characters from those in the Lower Peninsula?

COMPARISON OF SAMPLES FROM THE UPPER AND LOWER PENINSULAS

In some mammal kinds the populations north of the Straits of Mackinac in the Upper Peninsula of Michigan differ significantly in size of body parts from the populations of the same kinds in the Lower Peninsula. Before proceeding with the analysis of age groups and of size differences between sexes we needed to know whether our samples of otter from the two peninsulas could be safely grouped for our purposes as a single sample, or whether they differed statistically in the characters studied and should be treated separately. A series of nineteen males from the Upper Peninsula was compared with a series of thirty-five males of similar age from the Lower Peninsula.

The mean, standard error, and range of each variable for the two samples of males and the t value for the difference between the two means are given in Table I. Two series of females were also compared, and results similar to those for the males were obtained. As was expected from the close correspondence of the means and ranges of each cranial measurement, the calculated values indicate that the means are not significantly different. Only in the length of the baculum is the difference probably significant. This measurement is put to limited use in this study. If there are differences between the otter of the two peninsulas, the differences are either in other features than those used in detail in this study, or, if in the characters used, they are so small that they are not clearly demonstrated.

TABLE I

MEASUREMENTS OF SKULL AND BACULUM OF MALE OTTER FROM THE UPPER PENINSULA AND LOWER PENINSULA OF MICHIGAN

Measurement	Upper Peninsula		Lower Peninsula		
	Specimens	Mean, Standard Error, and Range (in mm.)	Specimens	Mean, Standard Error, and Range (in mm.)	*t* Value and Probability
Condylobasal Length	18	109.3 ± 0.64 104.6—114.3	32	107.8 ± 0.69 100.2—115.2	1.444 < .01
Mandibular Length	19	69.0 ± 0.56 64.3— 72.7	33	67.6 ± 0.46 61.6— 72.8	1.891 < .01
Zygomatic Breadth	19	73.9 ± 0.57 68.3— 78.0	33	73.3 ± 0.46 68.8— 78.6	0.805 < .01
Mastoid Breadth	19	66.1 ± 0.65 60.8— 71.6	33	65.9 ± 0.45 61.0— 71.8	0.257 < .01
Interorbital Breadth	19	23.7 ± 0.45 20.2— 26.8	33	23.8 ± 0.26 21.7— 27.3	0.205 < .01
Length of Baculum	18	99.4 ± 1.34 86.0—106.0	16	94.9 ± 1.22 84.0—103.0	2.455 < .02

LIFE HISTORY NOTES

There is a dearth of published material on the breeding habits and early life of the otter, and some of that available is conflicting, indicating a need for a complete and careful study of the life history of this animal. Although incomplete the following information provides a basis for the interpretation of certain data accumulated in the present study.

Much of our information on sexual maturity and activity came from Mr. Emil Liers (*in litt.*). River otter kept by him under semiwild conditions in Minnesota attain sexual maturity and mate when two years old, but do not become prime breeders until four or five years old. In succeeding years, after the first breeding, females mate soon after dropping a litter (December to February). Females are in heat for forty-two to forty-eight days. G. W. Bradt (*in litt.*) provided the following notes on breeding activities as observed by personnel at Potter Park in Lansing, Michigan: Adult otters were observed to mate on January 11. Mating took place both above and below the surface of the water. In February the female became irritable and would not permit familiarity on the part of the male. From March to early September their life was again serene, and mating was observed several times. In October the female again became quarrelsome and in November was observed to have gained weight. She fought the male at all times in December, and on January 22 gave birth to a single young. Both reports agree that, in the areas concerned, otter breed in midwinter. They may do so at other times of the year. Exactly when fertilization occurs and embryonic development begins is not known. In the Sacramento Valley of California the breeding season appears to extend throughout the spring and summer and even into the fall months of the year (Grinnell, 1937: 237).

Reports vary on the duration of pregnancy. Hunt (1847) indicated that the gestation period of the English otter (*Lutra lutra*) is four to five months. Cocks (1881) reported it as sixty-one days. Most published statements concerning the length of gestation in the river otter apparently follow Cocks's data for the English otter and are not based on first-hand observation. Liers stated that the period of gestation in the otter he raised varied from ten months and seven days to twelve months and fifteen days, which is twice to three times that reported for the English otter. Additional data, obtained under controlled conditions, are needed.

Litter sizes vary from one to five; but usually there are two to four young (Liers, *in litt.*). Whelping season may begin in midwinter or in spring and may continue for a few months or most of the year; the onset and duration apparently vary with climates. In California the season extends through spring to fall months (Grinnell, 1937). In Alabama young are active outside the nest in late April. A young specimen at hand from Baldwin County, Alabama, was born in late March or early April. In Minnesota young are born both in the wild and in captivity in December, January, and February, and perhaps earlier and later. The period may be later and perhaps longer in Michigan. A young otter in a zoological park in Lansing was born on January 22. As judged from the conditions of the uteri in carcasses examined by Ostenson, it is estimated that the whelping season in Michigan extends from January to May, with the peak of the season in March or April. Many specimens examined had uterine scars or other evidence of recent pregnancy. In others, embryos of varying sizes were present, some at term size, others in early stages of development. Of the fetuses 85 per cent measured 85 to 130 mm. crown to rump. (These data will appear in a subsequent report.)

We have no complete data on the size of otter at birth. The animal from Alabama, mentioned above, was one of six young taken from a hollow log den on April 16 to 17 and presented to the Museum by Frederick S. Barkalow, Jr. It and two others were killed by dogs which located the den. The remaining three, kept in captivity, opened their eyes on April 30. If the eyes are opened approximately one month after birth (see below), then our specimen probably was born about April 1 and is approximately fifteen days old. It measures about 110 mm., crown to rump, and about 240 mm. in total length. To judge from these meager data the Michigan fetuses over 110 mm. in crown to rump length were approximately at term.

Young otters open their eyes when twenty-eight to thirty-five days old (Liers, *in litt.*). They develop slowly and remain with their mother until they are about a year old (Grinnell, 1937). They have few natural enemies and unless killed by man probably stand a good chance of attaining maximum age. They may live to the ripe age of fifteen to twenty years. Liers now has otters eleven years old and in good health. One otter died of pneumonia when twelve years old. Another wild-trapped male, judged to be three years old when caught, died at the age of fifteen years.

AGE GROUPS

When this study was begun, no specimens of known age were available for comparison with our material. Therefore, our initial aim was merely to arrive at a system whereby relative age would be indicated. Using characters known to indicate relative age of mustelid mammals we assembled the skulls by sex in four groups. The characters used for determining age were sufficiently fine to permit recognition of four groups, but no more. The characters are some of those currently employed by mammalogists for analysis of variation in crania of mammal kinds, namely, the amount of closure of sutures between bones, the prominence of ridges and processes for muscle attachment, the rugosity of the brain case, and the density and solidity of the bones. No clear-cut characters were found which would identify all the various year classes which are probably represented in the sample.

The four groups are moderately distinct, but as might be expected in a species as individually variable as the river otter, the groups intergrade. Group 1 includes the youngest animals and Group 4 the oldest animals. As regards age criteria the groups may be described as follows: In Group 1 the skulls are comparatively smooth, the bones are porous and fragile, the sutures are incompletely closed, and the sagittal and lambdoidal ridges are slight or lacking. The squamosal-jugal suture is open throughout its length, the nasal sutures are clear-cut, and the jugal-maxillary suture is visible. In Group 2, ossification is more advanced in the skull. The bones are denser and smoother, the sutures on the dorsal and lateral parts of the skull are scarcely visible, the sagittal ridges are slight or absent, and the lamboidal ridges are low and blunt. The squamosal-jugal suture and the nasal sutures are closed, yet the lines of fusion are still easily visible. The jugal-maxillary suture is obliterated. In Group 3, the skulls are characterized by denser, more rugose bone, completely coalesced jugal and squamosal on the zygomatic arch, invisible or but faintly visible naso-maxillary sutures, and a prominent lambdoidal crest, strongly keeled dorsally but diminished to a slight ridge laterally near the mastoid processes. In Group 4, the skulls are comparatively angular and massive, the bones are dense and solid, the sutures on the zygomatic arches and the dorsal part of the skull are obliterated, the lambdoidal ridge is sharply keeled and is continuous between the mastoid processes; a sagittal crest and other prominences are often present, and the brain case is rugose.

The four categories, and the characters employed for delimiting each, are accurate and useful for appraisal of relative age of the individuals in the sample, but they give no idea of actual age. To determine accurately the age in years of the constituents of each group would require a large series of specimens of known ages, representing the gamut of ages. No such series is available. Through the interest and efforts of Mr. Emil Liers, however, we have at hand four skulls accompanied by age data for each. By comparing the four groups with these four skulls and by utilizing pertinent life-history data we can estimate the absolute age of each group.

Of the four of known age, the youngest specimen, a male, was about nine months old at death. For seven of the nine months the animal was kept by Liers in Minnesota under semiwild conditions, after which it was sent to a zoological park. In age characters it resembles the younger individuals in Group 2. Two older males were, respectively, twenty-four months and forty months old at death. The younger of the two lived in a zoological park for some months; the older was reared by Liers. Both of the skulls are assignable to Group 3. The fourth specimen, an unusually small female, was about seven years and fourteen weeks old at death. Obtained as a cub from a trapper, it is one of the smallest females raised by Liers. It, too, died in a zoological park. The skull is stunted and slightly malformed. Abnormal local outgrowths and decayed areas are present on some of the bones, perhaps evidencing malnutrition. In size the specimen resembles individuals in Groups 1 and 2, but on the basis of age characters it unquestionably belongs in Group 4.

To judge from these few specimens of known age and from the life-history data given above, Group 1 includes animals a few months old. In Michigan young are born in winter months, and of our sample almost all were collected in March and April. Very few young of the year, therefore, would be expected in the sample. Few would be active outside the nest and likely to be taken by the trapper. Few would be saved for the official seal. Group 2 includes the first-year and second-year classes, which in our sample probably consist of animals about ten to fifteen months old. Group 3 is composed of the third-year and fourth-year classes. Group 4 includes older animals, some of which may be as much as ten to fifteen years old.

The count of each sex in each age group is given in Table II. The relative number of breeding and nonbreeding animals in the sample is noteworthy. Breeding animals are two years old or older (Groups 3 and 4). More than one-half (58 per cent) of the sample is made up of breeding individuals. Probably, most of the females in that segment either were pregnant when captured or would have conceived soon after, since otters mate shortly after producing a litter. The total catch per season by trappers in Michigan presumably runs relatively higher in numbers of breeding individuals, particularly of breeding females, than our sample indicates. As can be noted from Table II, fifty-eight of the ninety males, or 64 per cent, are from the breeding-age Groups 3 and 4. The twenty-three breeding females represent only 46 per cent of the total females in our sample. This difference in age composition of the two sex groups may be due to several causes. Breeding females, either pregnant or with young in

TABLE II

DISTRIBUTION OF OTTER SKULLS BY SEX AND AGE

	Age Group				Totals
	1	2	3	4	
Males	4	28	38	20	90
Females	5	21	16	7	49
Totals	9	49	54	27	139
Percentages of total sample	7	35	39	19	100

the nest, probably travel less extensively than do the nonbreeding individuals and thus may have less chance of being caught. Excessive skull damage in old females may have caused their skulls to be discarded. A three to one ratio of sexually mature animals to nonbreeding juvenile animals probably would be a close estimate of the relative number brought to market by the trappers.

A sample of March- or April-caught otter probably should contain more young than are present in our sample. It is true that at the time of the trapping season, in March and April, most of the young of the year either are still in the nest or are yet unborn. Young remain in the nest at least until they open their eyes, which is about twenty-eight to thirty-five days after birth (*fide* Liers, *in litt.*), and may remain for several days thereafter. Few of the animals born in February would be active outside the nest by March or April. Those brought off in January (as indicated earlier, some otter are born in the wild in Minnesota as early as late

December) would be just active enough to blunder into a set trap. In view of this fact and the fact that the number per litter averages two to three, one might expect a larger ratio of youngsters to adults than nine to eighty-one, which occurs in the sample. One reason that few young of the year were represented in the sample may be that the trapper does not report the young animals. Under regulations which permit him to market legally only two animals per season, the trapper logically would prefer animals of profitable size, and youngsters essentially valueless as fur might well be discarded. The scarcity of young in the sample suggests that such a procedure takes place.

An earlier trapping season would seem to be in better accord with the available life history information. An open season in December, for example, would have similar results as regards reduction, or wastage, of young in the population. The main difference is that embryos rather than young in the nest would be destroyed with each pregnant female. That, in itself, is an improvement. More important to the trapper is that December pelts are essentially fully prime; March and April furs are no longer in first-class condition and bring a lower price on the market. This is true of beaver as well as otter, which makes it an even stronger argument for an earlier season, because the trapper now has a much greater financial interest in beaver. The low-valued otter rates a poor second and is taken as an incidental adjunct to beaver-trapping. If, as now appears, the interests of the nature lover and of the trapper can be better served by an earlier season —beginning as early as the ponds and ground are frozen— a change in the trapping regulations would seem warranted.

DENTAL DAMAGE

Broken and badly eroded teeth occur so frequently in the sample as to warrant mention of the types of damage and the causes of them. In a series of skulls of forty-nine females and ninety males, 73 per cent of the females and 68 per cent of the males have damaged teeth. By damaged teeth we mean those which are excessively worn, broken, or otherwise damaged in such a way as to effect malfunction of the dentition. The frequency of tooth damage in males and females in the four age groups is given in Table III. The teeth of the

TABLE III

FREQUENCY OF DAMAGED DENTITION IN TRAPPED MICHIGAN OTTER

	Males					Females					Totals, Both Sexes
	Age Group				Totals	Age Group				Totals	
	1	2	3	4		1	2	3	4		
Damaged	0	13	30	18	61	3	14	14	5	36	97
Undamaged	4	15	8	2	29	2	7	3	1	13	42
Totals	4	28	38	20	90	5	21	17	6	49	139

older animals are more frequently damaged than those of the youngsters. Of the males and females of Groups 3 and 4, judged to be two years old or older, 83 per cent have damaged dentition, but only 65 per cent of the females and 41 per cent of the males of Groups 1 and 2, those under two years, are damaged. The extent, as well as the frequency, of the damage is also roughly correlated with the age of the animal. The injuries in the older animals often involve most of the dentition and even the adjoining bones. Damage in the young animals is usually slight and involves one or two teeth. In the category of slight injuries are comparatively minor fractures of the canines and of a few cusps of the cheek teeth. In almost all of the skulls at least one of the canines is chipped or broken to expose the root canal and in scarcely fewer skulls at least one of the cusps of the cheek teeth is fractured. More serious and extensive damages are present in many of the skulls. In fifty-seven specimens, at least one premolar is crushed or has been completely torn out; in forty-seven specimens, two or more teeth are eroded to the jawbone; in twelve specimens, the canines and several premolars are reduced to stubs; and in fifteen other specimens, the canines, premolars, and molars have been eroded almost or quite to the gum line.

Most of these injuries obviously date from the capture of the animal. The crushed premolars, the splintered cusps, the jagged stubs of canines, carnassials, and lateral incisors, the freshly abraded jawbone, and the toothless sockets are evidences of a battle with a trap. They illustrate eloquently to what ends an otter will go in its attempts to escape.

Some of the injuries are not definitely caused by the trap, but are the result of normal wear and tear in the life of the animal. Intense bilateral erosion of canines and molars results from normal use. In the instances before us, of most severe injury, the teeth are reduced to barely functional flat plates. Some of the chipped or broken teeth mentioned above probably also result from normal use. The older animals, in general, evidence more of this normal erosion and breakage than do the young. Enough young animals have excessively worn teeth to suggest that some other factor, possibly diet, may be involved. Certainly, an otter that feeds largely on shell-covered animals, such as crayfish and mussels, subjects its teeth to greater stresses and wear than does one that relies on a diet of fish and frogs. Crayfish, mussels, fish, and frogs are all eaten by the otter (Merriam, 1884: 88; Seton, 1926: 679; Lagler and Ostenson, 1942: 247). Significantly, the calcareous exoskeleton of crayfish is well chewed (Grinnell, 1937: 281; Lagler and Ostenson, 1942: 246), and the mussel shells are crushed (Seton, 1926: 680). The varying amounts of normal erosion and breakage of the teeth to be seen within an age level may indicate differential diets and perhaps individual diet preferences in otter.

Dental decay is absent in the specimens, insofar as we can determine by gross examination. Injury and decay of the bone at the base of the teeth do occur. In seven specimens the bone around a tooth is recessed and decayed—evidence of an injury in varying stages of repair. In some specimens the root of the tooth is exposed, and the adjoining bone is porous and spongy. Old injuries are marked by growth of the bone over and around the site. In three specimens the growth has been excessive and prominent knob-shaped exostoses are formed. In our series these growths occurred only at the canines, an upper in two skulls and a lower in five.

VARIABILITY

The mean and its standard error, the range, and the coefficient of variability of each of the five measurements in male and female otter are given in Table IV. The probable statistical significance of the differences in means between males and females at four age levels is given in Table V. Group 1 is omitted from the table because the sample is inadequate, but it should be pointed out that a size difference between sexes is also indicated for that group.

The skulls of males average significantly larger than those of females in condylobasal length, mandibular length, and zygomatic breadth. As indicated in Table V there is small chance—less than one in one hundred—that the compared samples were drawn from populations with identical means in each of these three measurements. In mastoid breadth as well, the skulls of males average larger than those of females. The difference in means is significant at about the 2 per cent and 3 per cent levels, respectively, in Groups 3 and 4. In Group 2, however, the difference is not clearly significant.

If the populations of males and females are distinct in interorbital breadth, that distinction is not clear in the samples at hand. The values of t indicate high probabilities—one in twenty-five in Group 3, one in eight in Group 4, and about one in two of Group 2—that the samples were drawn from populations with identical means. It seems reasonably clear that much of the variation in interorbital diameter is that occurring among individuals irrespective of sex or age.

In each measurement, except possibly interorbital breadth, the difference in means increases absolutely and relatively from the lower to the higher age levels (Tables IV and VI).

TABLE IV

SEX AND AGE VARIATION IN FIVE CRANIAL MEASUREMENTS OF MICHIGAN OTTER

Measurement	Sex	Age Group	Specimens	Mean and its Standard Error (in mm.)	Range (in mm.)	Coefficient of Variability, in Per Cent
Condylobasal Length	Males	1	3	102.2 ± 1.42	100.3–105.0	2.4
		2	27	106.9 ± 0.70	97.3–113.0	3.4
		3	33	106.6 ± 0.56	100.2–112.1	3.0
		4	19	111.2 ± 0.57	107.8–115.2	2.2
	Females	1	5	102.2 ± 1.30	98.9–105.8	2.9
		2	22	104.1 ± 0.54	98.2–107.4	2.4
		3	17	102.7 ± 0.57	98.0–106.5	2.3
		4	5	105.2 ± 1.09	102.1–108.2	2.3
Mandibular Length	Males	1	3	63.1 ± 1.32	61.3– 65.7	3.6
		2	28	66.2 ± 0.44	61.5– 69.4	3.6
		3	39	67.2 ± 0.40	61.6– 72.4	3.7
		4	18	70.2 ± 0.35	67.1– 72.8	2.1
	Females	1	5	61.7 ± 0.86	58.3– 62.8	3.1
		2	22	64.3 ± 0.38	60.4– 66.6	2.7
		3	17	64.4 ± 0.40	61.9– 67.0	2.6
		4	5	66.8 ± 0.48	65.4– 68.4	1.6
Zygomatic Breadth	Males	1	3	67.0 ± 0.68	65.7– 68.0	1.8
		2	27	69.2 ± 0.33	65.1– 73.5	2.5
		3	35	72.3 ± 0.31	68.8– 75.4	2.6
		4	20	75.7 ± 0.43	71.8– 78.6	2.5
	Females	1	5	65.3 ± 0.75	63.0– 67.0	2.6
		2	21	67.7 ± 0.40	64.9– 71.8	2.7
		3	15	69.5 ± 0.43	66.5– 72.1	2.4
		4	6	72.6 ± 0.75	71.0– 75.3	2.5

Mastoid Breadth	Males	1	3	63.0 ± 1.52	61.2– 66.0	4.2
		2	27	63.7 ± 0.50	58.8– 67.9	4.1
		3	34	65.0 ± 0.39	60.8– 70.0	3.5
		4	19	68.1 ± 0.54	64.1– 71.8	3.5
	Females	1	5	60.5 ± 1.26	57.4– 63.9	4.6
		2	21	62.8 ± 0.37	58.9– 66.5	2.7
		3	16	63.2 ± 0.63	58.7– 67.4	4.0
		4	6	65.4 ± 1.06	61.6– 68.7	4.0
Interorbital Breadth	Males	1	3	23.2 ± 0.68	22.3– 24.5	5.1
		2	27	22.8 ± 0.25	20.0– 25.0	5.7
		3	39	23.3 ± 0.22	21.5– 26.8	6.0
		4	17	24.8 ± 0.39	20.7– 27.3	6.5
	Females	1	5	21.7 ± 0.50	19.9– 22.8	5.2
		2	21	22.5 ± 0.26	21.0– 25.1	5.4
		3	16	22.4 ± 0.32	20.0– 24.0	5.8
		4	6	23.5 ± 0.70	21.9– 23.9	7.3

TABLE V

PROBABILITY OF SIGNIFICANT CRANIAL DIFFERENCES BETWEEN MALE AND FEMALE OTTER

Measurement	Age Group 2		Age Group 3		Age Group 4	
	t-Value	Probability in Per Cent	*t*-Value	Probability in Per Cent	*t*-Value	Probability in Per Cent
Condylobasal length	2.956	1.0	4.450	0.1	4.831	0.1
Mandibular length	3.173	1.0	4.260	0.1	4.825	0.1
Zygomatic breadth	2.979	1.0	5.081	0.1	3.424	1.0
Mastoid breadth	1.338	12.0	2.504	2.0	2.407	3.0
Interorbital breadth	0.786	45.0	2.129	4.0	1.668	12.0

TABLE VI

PERCENTAGE DIFFERENCE IN CRANIAL MEASUREMENTS BETWEEN MALES AND FEMALES

Each of the following values expresses, in per cent, the ratio of the mean of the females to the mean of the males for each measurement and age group.

Measurement	Age Group			
	1	2	3	4
Condylobasal length	100	98	96	95
Mandibular length	98	97	96	95
Zygomatic breadth	97	98	96	96
Mastoid breadth	96	99	97	96
Interorbital breadth	94	99	96	95
Average per cent	98	98	96	95

The values for mandibular length will suffice to illustrate the point. In Group 1 the mean mandibular length of the females is about 2 mm. less than, and 98 per cent of, that of the males. In Group 2, the difference again is about 2 mm., but the females are 97 per cent as large as the males. In Group 3 the values are 3 mm. and 96 per cent, and in Group 4, 4 mm. and 95 per cent. Such disproportionate increase in size in the sexes is well known in many animals. From these data on otter it may be inferred that in length of cranium, length of mandible, and breadth of skull across the zygomata and mastoids, on the average, one-year-old female otter (Group 2) are about 1–2 per cent smaller than first year males, two- and three-year females (Group 3) are 2–3 per cent smaller than males of the same age, and older males exceed older females by 4 per cent or more.

If animals of approximately similar age are compared, variability in skull dimensions appears to be greater among the males than among the females. In most measurements and most age groups both the range between extremes of measurements and the coefficient of variability are greater among the males than among the females. These differences in variability seem most clear in the longitudinal measurements—condylobasal length and mandibular length—and less evident in the transverse dimensions—zygomatic breadth, mastoid breadth, and interorbital breadth.

Interorbital breadth appears to be more variable than any other of the five skull measurements. The coefficient of variability for both sexes of otter exceeds 5 per cent at all age levels. Latimer and Riley (1934) and Latimer (1937) found that the interorbital diameter in skulls of muskrats and skunks was more variable than some other cranial dimensions. The interorbital diameter varies from individual to individual and shows little if any correlation with age. The range of extreme measurements is almost as great for one sex within any age group as it is for the entire sample of that sex. Of these five skull measurements, interorbital breadth seems least reliable as a criterion of age. In contrast, the other four skull dimensions increase quite uniformly with age and show less variability within age groups, so that as a consequence they should be more reliable criteria of age.

The length of the baculum (penis bone), like the interorbital diameter, varies greatly at an age level. Twenty-two bacula, associated with skulls, are available. The range of the sample extends from 61.0 mm. (one specimen in Group 1) to 106.4 mm. (Group 4). The average, in millimeters, of four specimens in Group 2 is 79.5 and of 5 in Group 4 is 96.9. The largest sample, twelve individuals of Group 3, was analyzed in more detail. The range of the twelve specimens is 83.2–102.7. They average 92.7 ± 1.62 and have a coefficient of variability of 6.1 per cent. As judged by that coefficient, variability in the length of the baculum in animals of approximately the same age is greater than in any of the five dimensions of the skull except that of interorbital breadth.

SUMMARY

The skulls of 139 otter and the bacula of twenty-two otter from Michigan were measured. Grouped according to four age levels the central tendencies of five measurements of the skull were studied. In these measurements the sample from the Upper Peninsula of Michigan is not significantly different

from that from the Lower Peninsula. Males are slightly more variable and significantly larger than females in most of the measurements and at most age levels. This size difference is progressive with age. The interorbital breadth of the skull and the length of the baculum vary considerably from individual to individual and are less reliable than the other measurements for use in a comparison of populations from two areas or for indicating relative age of otter. The condylobasal length, mandibular length, mastoid breadth, and especially the zygomatic breadth are less variable at an age level and are more trustworthy in indicating age. The amount of wear of the teeth is of limited use as an index of age.

The teeth of the otter are relatively free from decay. There are seven instances of decay of the bone at the base of the canines. Injuries of a sort to effect malfunction of the dentition are evident in about 70 per cent of the specimens. Most of these are trap damages, but some no doubt result from normal wear and tear in the life of the otter.

Sexually adult animals make up more than one-half of the sample, and the representation of young-of-the-year may be disproportionately low for the population. It is suggested that the trapping season in Michigan be advanced several months.

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