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OBSERVATIONS ON THE PRIMENESS OF A FALL COLLECTION OF MUSKRAT, ONDATRA Z. ZIBETHICA.

By

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INTRODUCTION

The significance of the degree of primeness in the valuation of raw muskrat pelts is without question. This fact has been reiterated in numerous reports concerned with fur-bearing mammals and the fur industry. Yet beyond a recognition of the importance of this characteristic of a raw fur, a startling paucity of investigational data of either a biological or a descriptive nature exists in the literature.

We know from general observations that in Michigan the muskrat is most unprime in midsummer and that it may be expected to progress to a fully prime condition by late winter, early in the next calendar year. When do the first evidences of primeness appear? When is the earliest date that muskrats, in a given area, may be expected to be fully prime, and when does this date fall in relation to the legal trapping season? Do all muskrat in a population display the same or a differing degree of primeness on any given date? Does the degree of primeness at any time in a population differ with sex or age? Are certain sequent patterns of prime and unprime areas on the pelts characteristic of each age class? Can the sequences of priming be synthesized from a periodic collection of pelts?

All of these questions are of some biological, economic or administrative importance, yet none have been answered satisfactorily. Kellogg (1946) examined a large series of raw muskrat pelts in what was apparently an effort to answer some of these questions. The results of his study are somewhat obscure and may possibly have been rendered so by the widespread localities from which his material was obtained (Louisianna, Wisconsin, California). Is it possible, then, that the patterns, the sequence, and other related phenomena of priming are characteristic of the muskrats of a limited region or even of a single watershed? The present study was undertaken in an effort to ascertain if this last question was so and to place on record data that would aid in ultimately answering some of the fundamental questions here-to-for proposed.

Between October 13 and December 9, 1946, sixty-four muskrat were trapped by conventional methods and pelted. Sixty-one specimens were taken in the Huron River or elements of the Huron River drainage in the vicinity of Ann Arbor, Michigan. The remaining three specimens were taken in other watersheds in nearby Oakland County. The data obtained from the examination of these pelts is primarily descriptive in character and to this end is illustrated with a large series of photographs. The total sample is far too small to permit elaborate interpretations. Those interpretations that are presented are <u>suggestive</u> rather than <u>conclusive</u> and are designed as such to

encourage further investigation. Certain techniques developed in the present problem are described in detail to facilitate further study. No effort has been made to correlate degree of primeness with any environmental or organic factor. Certain data are presented as a matter of record in the event that they may prove useful in such a correlation at some future date.

THE AREAS SAMPLED

The sixty-one muskrats collected in the Huron River drainage were taken at four locations along the Huron River itself and in one system of impounded, tributary lakes. Trapping was done in the river in Sections 17 and 27, Ann Arbor Township, and Section 2, Scio Township, Washtenaw County. Further trapping was done in the river in Section 20, Green Oak Township, Livingston County. Two artificial lakes were intensively trapped. These lakes are separated only by a dam which renders one tributary to the other and are connected by a very short overflow with the Huron River. They are located in Loch Alpine subdivision and are immediately adjacent to the area trapped in the Huron River in Section 2, Scio Township, Washtenaw County.

Without exception, the areas utilized for trapping in the Huron River may be classified as poor, or, at best, fair, muskrat habitat. At the various sampling locations the river varied from 50 to 75 feet in width and ranged to depths of six feet. A strong to moderate current was always present in midstream. Common muskrat foods were erratic in distribution and

were nowhere abundant. Typically, some cattail (Typha) was present in a narrow fringe along the banks and grew in somewhat denser patches in the small backwaters and sloughs along the watercourse. Close to the banks in the occassional backwaters were yellow cow lilies (Nuphar). Submerged aquatics were water weed (Anachris) and coontail (Ceratophyllum). These were the dominant aquatics and, in some areas, the only forms present. Suggestive of the scarcity of food in these areas were the signs of large numbers of mussels eaten and direct evidence of feeding on the bark of the red osier dogwood and that of exposed tree roots in the river bank. Although lakes and ponds are generally conceded to be superior to streams and rivers as muskrat habitat, the two artificial lakes utilized in this study were an exception to the rule. They differed only in size, one being approximately 12 acres and the other approximately 18 acres in extent. Both were characterized by narrow, hard sand and gravel shoals supporting few, if any, submergent or emergent aquatic plants. A small slough and an inlet estuary in each lake provided suitable habitat for sparse stands of cattail and wild iris (Iris) and good growths of coontail and water cress (Nasturtium). After a preliminary investigation indicated that the majority of the muskrats in the lakes were coming to these areas to feed, the bulk of the trapping was done in these restricted areas.

The foregoing discussion is intended to show that although sampling was done in both lentic and lotic environments, the character and suitability of all areas sampled were similar.

The evaluation as a whole may feasibly have some bearing on primeness. It has been noted by some non-technical observers that an apparent correlation exists between the abundance of muskrat foods in a certain habitat and the degree of primeness of the muskrat in that habitat. The habitat data presented may then have some significance when used for comparative purposes in future studies.

METHODS AND TECHNIQUES

The ordinary muskrat trappers' techniques were followed in the collection of the sample. Victor Oneida single spring No. 1 steel traps were used. Occasional baiting with apple or ear corn was attempted as was the use of anise oil scent. Neither of these practices produced results that warranted their continued use. Sets were made in both open water and under shell ice and in numerous dry or wet channel bank runs. For all types of sets, and particularly the latter type mentioned, the use of non-twist traps is strongly recommended. The writer lost many specimens that might have been retained by the non-twist style of trap. All of the muskrats were pelted as if intended for sale as raw fur and stretched on either shaped shingles or wire pelt stretchers. All pelts were tagged with an identifying number.

Field and laboratory data were collected on a prepared blank form designed for the purposes of this study (Figure 1). Date, location, weather and habitat data were entered in the field unless severe weather or darkness prevented this practice.

The lower portion of the form was completed in the laboratory during the examination and pelting of each muskrat. Weights were taken in English measure to the nearest half ounce on a Chatillon scale balance (20 lb. capacity, Industrial type). All linear measurements were made with a large size fisheries-type measuring board graduated in inches and tenths. Measurements are accurate to the nearest tenth of an inch.

Since raw fur cannot be stored indefinately, some permanent record of the appearance of the flesh side of the pelts was desired. Tracings of the pelts that could be rendered into pen and ink drawings were time-consuming beyond all practical value. After considerable experimentation, excellent records were obtained by photography. Superpan Press film packs and cut film ($3\frac{1}{4}$" by $4\frac{1}{4}$" and $3\frac{1}{2}$" by 4 3/4") were used in a Voightlander camera. The pelts were placed flat, in groups, on a dead white, soft finish cardboard background. Identification numbers were prepared from a standard Movie Title Set. The camera was supported perpendicularly above the objects by a vertically adjustable wall support. The difficulties accompanying the proper lighting of the objects were never completely eliminated. The majority of the cased pelts, when removed from the stretchers, become quite uneven and never fail to glisten from the ever present grease. The combination of these two factors, under floodlighting, produce numerous "reflections" in the negatives. Best lighting results were obtained by placing two floodlights approximately 30 inches above the pelts and directing their beams downward at a 45 degree

MUSKRAT

FIGURE 1

SPECIMEN NUMBER:_____

AREA NO._____ TRAP No._____ DATE:_____

TRAP LOCATION:_____ TIME:_____

WEATHER

_____ SKY:_____

_____ PRECIP:_____

TYPE SET:

Bank den_____ Runway set_____ WIND:_____

House set_____ Bait_____

Open set_____ Scent_____

WATER

HABITAT DESCRIPTION: OPEN_____

Lake____, Pond____, or Stream_____. ICE_____

Dimensions & description_____

_____

Shore habitat_____

_____

Dominant aquatic vegetation_____

_____

Bottom type_____

General notes_____

_____

_____

LABORATORY DATA:

Total length_____ Tail length_____ Foot length_____

Weight_____ Sex_____ Apparent condition_____

_____

Mutilation ?_____

General remarks_____

_____

_____

Stomach saved_____ Skull saved ?_____

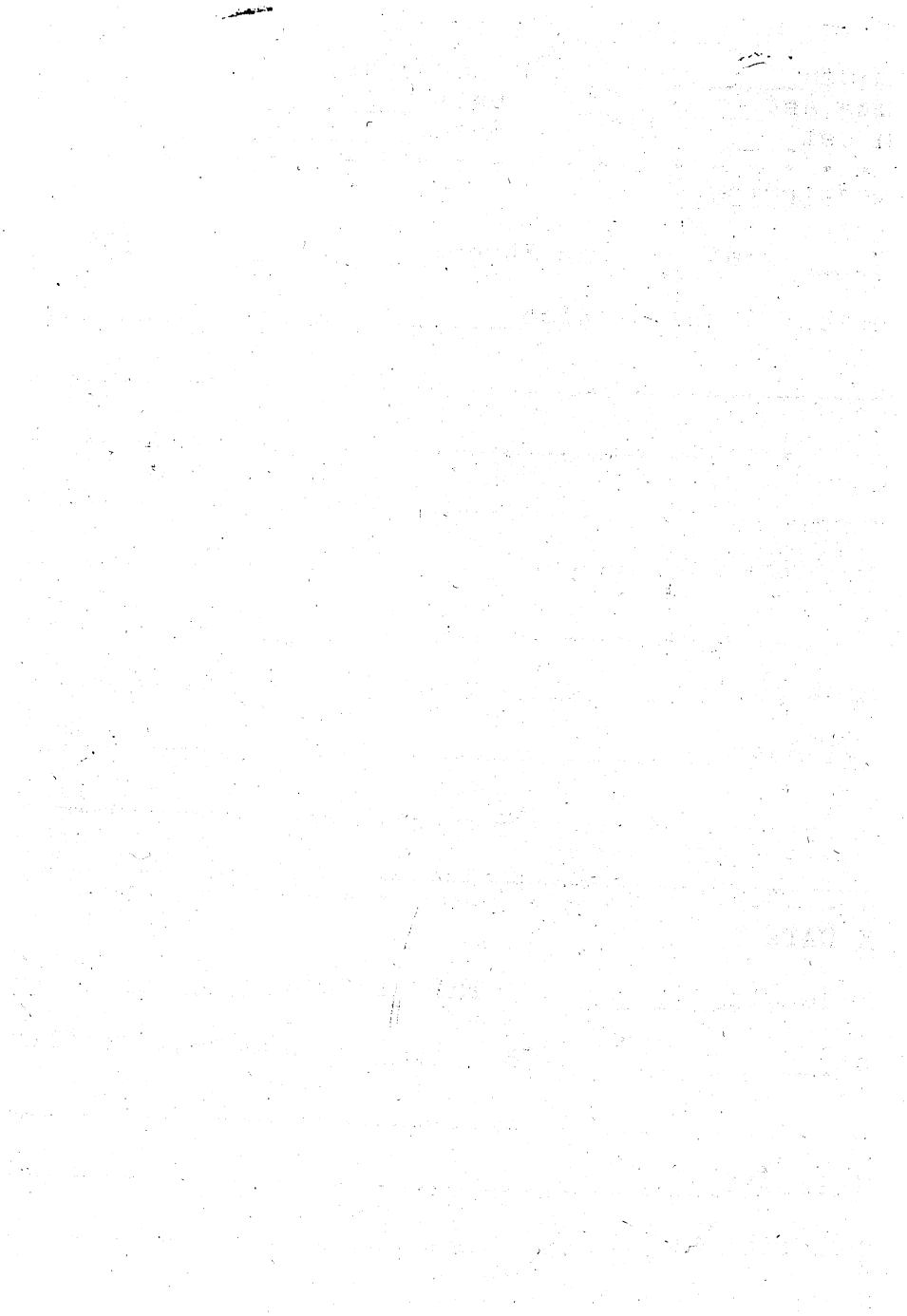
CERTIFICATION_____

HE
7-46

AGE CLASS

DOR. PR.

VENT. PR



angle towards each other along the long axis of the pelts. All photographs were enlarged to 8 by 10 inches on projection paper designed for negatives of low or extremely low contrast. Kodabromide F-4 photographic paper was used for all negatives of pelts displaying relatively large amounts of unprime coloration and Kodabromide F-5 photographic paper for negatives of the pelts that were most prime (relatively little coloration). The results of this method are embodied in the prints that illustrate the later portion of this report. Orthochromatic film will not produce satisfactory results in this technique. On the other hand, any panchromatic film of high color sensitivity, developed and printed to produce the greatest contrast, will undoubtedly produce equally as satisfactory results as those described.

MORPHOMETRIC AND BIOLOGICAL DATA

The morphometric and biological data for each specimen collected and examined has been itemized in Table 1. The specimen numbers designated in this table were assigned at the time of capture and are consistent in all references, either text or photographic, throughout this report.

All muskrat were initially assigned to two age classes, subadults (one year old) and adults (two years and older), according to the method for age determination described by Baumgartner and Bellrose (1943). This method, based on an examination of the condition and/or development of the external genitalia, is evidently quite reliable and, since it has

Table 1.--Summary of all muskrats collected and the data derived from the laboratory examination of each specimen.

Specimen #	Date of Coll. (1946)	Locality	Sex	Age Class [1]	Weight	Length in inches Total	Tail	Foot	Apparent Condition [2]	Mutilation [3]
1.	10/13	Clinton R., Drayton Plains, Oakland County	M	Subadult	2 lbs, 3 oz.	21.10	9.00	3.1	Fat	None
2.	10/13	do.	F	Subadult	2 lbs, 0 oz.	20.75	8.60	2.8	Mod. fat	None
3.	10/18	Huron R., Washtenaw County	M	Subadult	1 lb., 14 oz.	20.75	9.50	3.2	Sparse fat	None
4.	10/18	do.	F	Adult	2 lbs, 11 oz.	22.10	9.75	3.4	Fat	None
5.	10/20	do.	M.	Subadult	2 lbs, 2 oz.	20.00	9.75	3.1	Mod. fat	None
6.	10/20	do.	M.	Subadult	1 lb, 12 oz.	19.25	9.10	3.2	Mod. fat	None
7.	10/20	do.	M	Adult	2 lbs, 10 oz.	21.75	9.00	3.2	Very fat	None
8.	10/23	Deep Lake, Oakland County	F	Subadult	2 lbs, 0 oz.	20.75	9.00	3.00	Fat	None
9.	10/27	Huron R., Washtenaw County	M	Subadult	1 lb, 9 oz.	17.75	8.30	3.0	Mod. fat	None
10.	10/27	do.	F	Subadult	2 lbs, 11 oz.	21.10	9.50	3.1	Very fat	Tear; rt. shoulder
11.	10/27	do.	M	Subadult	1 lb, 11 oz.	18.20	7.75	3.0	Sparse fat	None
12.	10/27	do.	M	Subadult	2 lbs, 2 oz.	20.75	8.75	3.2	Mod. fat	Tear; left shoulder
13.	10/27	do.	M	Adult	2 lbs, 13 oz.	23.25	10.50	3.2	Mod. fat	None
14.	10/27	do.	F	Adult	2 lbs, 11 oz.	21.60	9.20	3.0	Sparse fat	None
15.	10/28	do.	M	Subadult	2 lbs, 8 oz.	23.00	9.50	3.2	(pelt not examined)	
16.	11/4	do.	F	Subadult	2 lbs, 4 oz.	21.00	8.70	3.3	Mod. fat	None
17.	11/4	do.	M	Subadult	2 lbs, 10 oz.	21.60	9.50	3.3	Mod. fat	Tears; neck, hindquarters
18.	11/10	Loch Alpine Lakes, Washtenaw Co.	F	Subadult	2 lbs 2 oz.	20.50	9.00	3.0	Very fat	None
19.	11/10	do.	F	Subadult	1 lb, 14 oz.	20.10	8.90	2.9	Mod. fat	None
20.	11/11	Huron R. Washtenaw County	M	Subadult	2 lbs, 12 oz.	21.25	9.75	3.2	Mod. fat	None
21.	11/11	do.	F	Adult	2 lbs, 5 oz.	20.40	9.25	3.1	Mod. fat	None
22.	11/11	Loch Alpine Lakes, Washtenaw Co.	F	Subadult	2 lbs, 0 oz.	19.50	9.00	2.9	Sparse fat	None
23.	11/11	do.	M	Subadult	2 lbs, 6 oz.	20.00	8.75	2.7	Very fat	None
24.	11/11	do.	F	Subadult	1 lb, 6 oz.	16.6	6.80	2.7	Mod. fat	None
25.	11/11	do.	F	Subadult	2 lbs, 4 oz.	20.00	8.80	3.0	Very fat	None
26.	11/11-	do.	M	Subadult	2 lbs, 4 oz.	21.00	9.25	3.2	Sparse fat	None
27.	11/11	do.	M	Adult	2 lbs, 11 oz.	21.00	8.80	3.1	Sparse fat	None
28.	11/11	do.	F	Subadult	2 lbs, 3 oz.	20.80	9.50	3.1	Mod. fat	None

29.	11/11	do.	F	Subadult	2 lbs, 4 oz.	20.90	9.10	3.2	Very sparse fat	None
30.	11/11	do.	F	Subadult	1 lb., 14 oz.	20.00	9.60	3.1	Very sparse fat	None
31.	11/12	do.	F	Adult	2 lbs, 7 oz.	20.75	8.75	2.9	Mod. fat	None
32.	11/12	do.	M	Subadult	2 lbs, 1 oz.	20.40	9.00	3.0	Fat	None
33.	11/12	do.	F	Subadult	2 lbs, 5 oz.	21.50	9.60	3.1	Sparse fat	None
34.	11/12	do.	M	Subadult	2 lbs, 3 oz.	21.20	9.50	3.2	Very fat	None
35.	11/12	do.	F	Subadult	1 lb, 14 oz.	19.50	8.90	3.1	Mod. fat	None
36.	11/13	do.	F	Adult	2 lbs, 4 oz.	20.00	8.50	3.0	Very fat.	None
37.	11/13	do.	F	Subadult	2 lbs, 3 oz.	20.50	9.10	3.0	Mod. fat	None
38.	11/13	do.	F	Subadult	1 lb, 15 oz.	19.80	8.40	2.9	Mod. fat	None
39.	11/13	Huron R., Washtenaw County	M	Subadult	2 lbs, 9 oz.	22.80	10.10	3.2	Mod. fat	None
40.	11/14	Loch Alpine Lakes, Washtenaw Co.	M	Subadult	2 lbs, 1 oz.	21.75	9.50	3.1	Very sparse fat	Tears; left fore leg, rt. side, and back
41.	11/14	do.	F	Subadult	2 lbs, 0 oz.	21.00	9.40	3.0	Very fat	Tears; on legs
42.	11/15	do.	F	Subadult	1 lb, 14 oz.	19.90	9.50	3.0	Sparse fat	None
43.	11/16	do.	F	Subadult	1 lb, 12 oz.	19.60	8.50	3.0	Mod. fat	None
44.	11/17	do.	M	Subadult	1 lb, 4 oz.	18.75	8.10	3.0	Very sparse fat	None
45.	11/17	do.	F	Adult	2 lbs, 8 oz.	23.50	10.10	3.1	Sparse fat	None
46.	11/17	do.	M	Subadult	2 lbs, 1 oz.	20.25	8.50	3.0	Mod fat	None
47.	11/24	do	M	Subadult	2 lbs, 2 oz.	22.25	10.1	3.1	Sparse fat	None
48.	11/24	do.	M	Adult	2 lbs, 2 oz.	21.40	9.50	3.2	Mod. fat	None
49.	11/25	Huron R., Washtenaw County	M	Adult	2 lbs, 13 oz.	21.90	9.50	3.2	Very fat	None
50.	11/25	do.	F	Subadult	2 lbs, 3 oz.	20.60	9.25	3.2	Fat	None
51.	11/25	do.	F	Subadult	2 lbs, 0 oz.	20.10	8.75	3.1	Fat	None
52.	11/25	do.	F	Subadult	1 lb, 15 oz.	20.10	9.00	3.2	Very fat	None
53.	11/26	do.	M	Subadult	2 lbs, 2 oz.	20.50	9.00	3.1	Very fat	None
54.	11/28	do.	M	Subadult	1 lb, 7 oz.	18.50	8.00	2.9	Very fat	None
55.	11/28	do.	F	Adult	2 lbs, 6 oz.	21.50	9.00	3.0	Mod. fat	None
56.	11/28	do.	F	Subadult	1 lb., 12 oz.	18.60	7.80	3.0	Fat	None
57.	11/29	do.	M	Adult	2 lbs, 7 oz.	21.60	8.60	3.1	Very fat	None
58.	11/29	do.	F	Adult	2 lbs, 8 oz.	22.30	9.80	3.2	Sparse fat	None
59.	11/29	do.	F	Adult	2 lbs, 7 oz.	21.50	9.10	3.2	Mod. fat	None

60.	11/29	do.	F	Subadult	1 lb. 4 oz.	17.60	7.60	2.8	Very sparse fat	None
61.	12/7	do.	F	Subadult	2 lbs, 8 oz.	22.70	10.00	3.3	Mod. fat	None
62.	12/9	Huron R., Livingston County	M	Subadult	1 lb, 11 oz.	19.80	9.00	3.2	Sparse fat	None
63.	12/9	do.	F	Subadult	1 lb, 9 oz.	19.40	8.40	3.0	Sparse fat	Tears; mid-dorsal and belly(Mink?
64.	12/9	do.	F	Subadult	1 lb, 10 oz.	20.60	9.10	3.1	Sparse fat	None
65.										

1/ Age classes established according to Baumgartner and Bellrose, 1943.

2/ Based on visual estimates. Estimates are not absolute but relative within the total sample examined and do not provide any basis for comparison with the material of other workers.

3/ Recorded to determine the proportion of trapped muskrats attacked by predators and other muskrats. No injuries inflicted by traps tabulated.

received a wide recognition, needs no further description here. The writer was able, as will be subsequently described, to subdivide further the subadults into two groups based partly on size, but primarily on certain characteristics of the patterns of prime and unprime pelt. These two groups will be referred to as (1) Smaller subadults or "Kits" which are believed to be second litter or late litter subadults, and (2) Larger subadults which are believed to be early or first litter subadults. This division of the subadults is not clear cut from a morphometric standpoint and was affected principally as an aid in presenting the descriptive material relative to primeness. A complete series of intergrades in weight and length does exist between the two groups, and the only biological justification for their division lies in the characteristics of their patterns of priming.

The minimum, average, and maximum weights of the small and large subadult and adult muskrat collected were computed and are incorporated in Table 2. On the average, the males were slightly heavier than the females. The three age classes utilized by the writer are quite distinct in their average weights. Small subadults averaged one pound and seven ounces; large subadults, two pounds and one ounce; and adults, two pounds and eight ounces. However, the ranges in weight of all age classes tended to overlap widely. Total length, tail length and length of hind foot were recorded. Both tail and foot lengths appear to vary widely even among muskrat of comparable age, weight, and computed body length.

Table 2.--Minimum, average, and maximum weights of muskrat collected in the Huron River drainage.[1]

Age class and sex	Number of spec.	Weight in pounds & ounces Min.	Aver.[3]	Max.
Small subadults				
Males	4	1 - 4	1 - 8	1 - 11
Females	3	1 - 4	1 - 7	1 - 12
Males and females	7	1 - 4	1 - 7½	1 - 12
Large subadults				
Males	17	1 - 11	2 - 3	2 - 12
Females	22	1 - 9	2 - 1	2 - 11
Males and females	39	1 - 9	2 - 2	2 - 12
Adults[2]				
Males	6	2 - 7	2 - 10	2 - 13
Females	7	2 - 6	2 - 8	2 - 11
Males and females	13	2 - 6	2 - 9	2 - 13

[1] Does not include 3 subadults taken in Oakland Co. drainages.

[2] Does not include 2 specimens considered incorrectly aged as adults.

[3] To nearest half ounce.

The sex ratio of the muskrats collected showed a slight preponderance of females in the populations sampled in all age classes. This data is presented in detail in Table 3. Generally, the total collection, all age classes combined, consisted of approximately 46 percent males and 54 percent females. The age composition of the sample was 79.7 percent subadults (one year old) and 20.3 percent adults (two years and older).

Notes were made at the time of pelting of any mutilation that might have been inflicted on the muskrat by predators or other muskrat while the muskrat was held in the trap. This information is itemized in Table 1. Six specimens, or 10 percent of the total sample, showed pelt damage of this nature. This may be a partial measure of the damaged pelts that a trapper may anticipate in this locality.

The column headed "apparent condition" in Table 1 refers to the amount of sub-dermal adipose tissue that was apparent on the carcass or pelt during the skinning process. This data was collected in an unsuccessful attempt to correlate the amount of fat present, either directly or inversely, with the degree of primeness. These data are based entirely on visual estimates and are not absolute, but relative within the total sample examined. They do not provide any basis for comparison with the material of other workers.

Table 3.--Sex ratios of muskrat collected in the Huron River Drainage.[1]

Location	Age class	Number		Percent	
		Males	Females	Males	Females
Huron River (all sample locations)	Subadults (small & large)	13	10	[2]	[2]
	Adults	4	5	"	"
Loch Alpine Lakes	Subadults (small & large)	8	15	"	"
	Adults	2	2	"	"
Total sample	Subadults (small & large)	21	25	45.7	54.3
	Adults	6	7	46.2	53.8
(All age classes combined)		27	32	45.8	54.2

[1] Does not include 3 subadults taken in Oakland Co. drainages.

[2] Sample too small for figures to be significant.

OBSERVATIONS ON PRIMENESS

The conventional method of determining the prime and unprime areas on the flesh side of a muskrat pelt is a visual one. The blue-black or black pigmented areas are unprime and the creamy-white unpigmented areas are prime. The dark pigmentation of the unprime areas is due to the concentration of the pigment granules of the hair in the hair root and the deeper location of the hair roots in the dermis. With increasing primeness the pigment granules move from the hair root into the distal portions of the hair, and the hair roots themselves progress to the shallower layers of the dermis. As these two phenomena occur, the flesh side of the pelt assumes a creamy-white appearance. The histological basis of the phenomena of primeness has been amply described by Gunn (1932). The validity of this visual method of determining primeness is well recognized and has been utilized to a greater or lesser degree by other workers (Kellogg, 1946; Hamilton and Cook, 1946).

In the interpretation of the material at hand, the characteristic patterns of primeness, the sequence of priming, and to a certain extent the degree of primeness are all closely inter-related from a descriptive standpoint. As such, they cannot be treated as individual topics of discussion. Therefore, in-so-far as the data permit, these points will be treated under discussions of each age class.

The justification for examining the data in this fashion lies in the observer's ability to sort the pelts into age

classes on the basis of primeness patterns alone. Kellogg (1946), in terminating his report, voiced a suspicion that a certain pattern of primeness was characteristic of the adult age group (two years and older). When sixty pelts had been accumulated, the writer attempted to sort the pelts into three age classes: (1) small subadults; (2) large subadults; and (3) adults. This sorting was done on the basis of random observations, made during the sampling and pelting of the muskrats, of an apparent relationship between size and age and the patterns of primeness. No previous sorting or comprehensive examination of the pelts had been made. Size of pelt was not conciously permitted to influence the sorting, and the pelts were identified with nothing but a serial number. The results of this test were as follows: of the 60 pelts handled, 58 were sorted correctly into the aforementioned age classes. Two "adult" females were incorrectly classified as subadults. A close check of the records indicated that there was some doubt as to the age of these specimens at the time of capture. Since they may have been improperly aged, they were discarded from the series (Plates 53 and 54).

Should this technique prove valid and applicable over wider regions than a single drainage system, certain applications seem possible in spite of the methods' inutility during periods of full primeness or complete unprimeness. Knowing the characteristic patterns of the several age classes in a given locality or region, it would be possible to sort the large stocks of pelts in local fur houses to determine the age com-

position of the local or regional muskrat crop. Such information might be utilized to forecast trends in the future stocks on the trapping grounds and to reflect past conditions that might influence the enactment of either restrictive or more liberalized trapping laws.

THE ADULTS

Thirteen adult muskrat were examined. All were characterized by a mosaic pattern of prime and unprime areas ("spotting pattern" of Kellogg, 1946). This pattern was characteristic of both the dorsal (back) and ventral (belly) sides of the pelts. Typical specimens illustrating this pattern are displayed in Plates 1 and 2. The degree of primeness of each specimen was visually estimated, and the results are incorporated in Table 4.

There is only a general correlation of increasing primeness with time. Such a progression is obscured by the fact that, during the period when collections were made, specimens of widely varying degrees of primeness were present in the sampled population on any given date. One example may be cited. Of three adults taken in one locality in mid-October, two quite unprime specimens were taken a week later than the third which was considered a prime specimen (Table 4). This phenomena was also present among the larger subadults. No sexual difference in the degree of primeness of adult muskrat was apparent.

No clear cut sequence of priming could be synthesized due to the limited number of specimens and the apparently irregular disappearance of the unprime "spots". However, from an inspection of the plates and Table 4 it seems evident that ventral priming probably precedes dorsal priming. The adult muskrats were generally more prime on the belly than on the

back. The mid-dorsal areas are apparently the last portions of the pelt to become prime.

Without reference to date of collection, the specimens were arranged in order of increasing degree of primeness and are presented in that sequence in Plates 3 to 12.

PLATE 1

Adults Dorsal

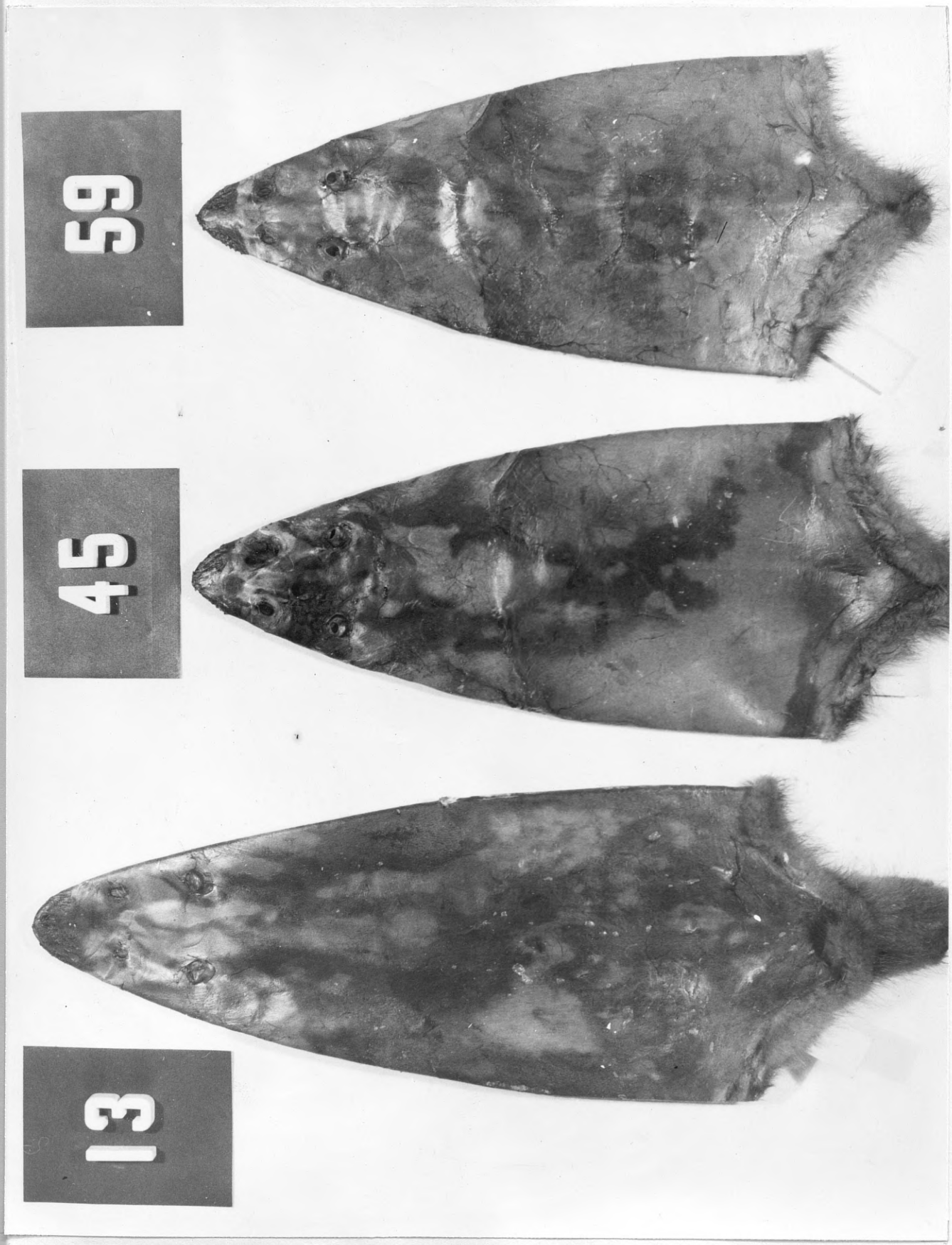


PLATE 2

Adults Ventral

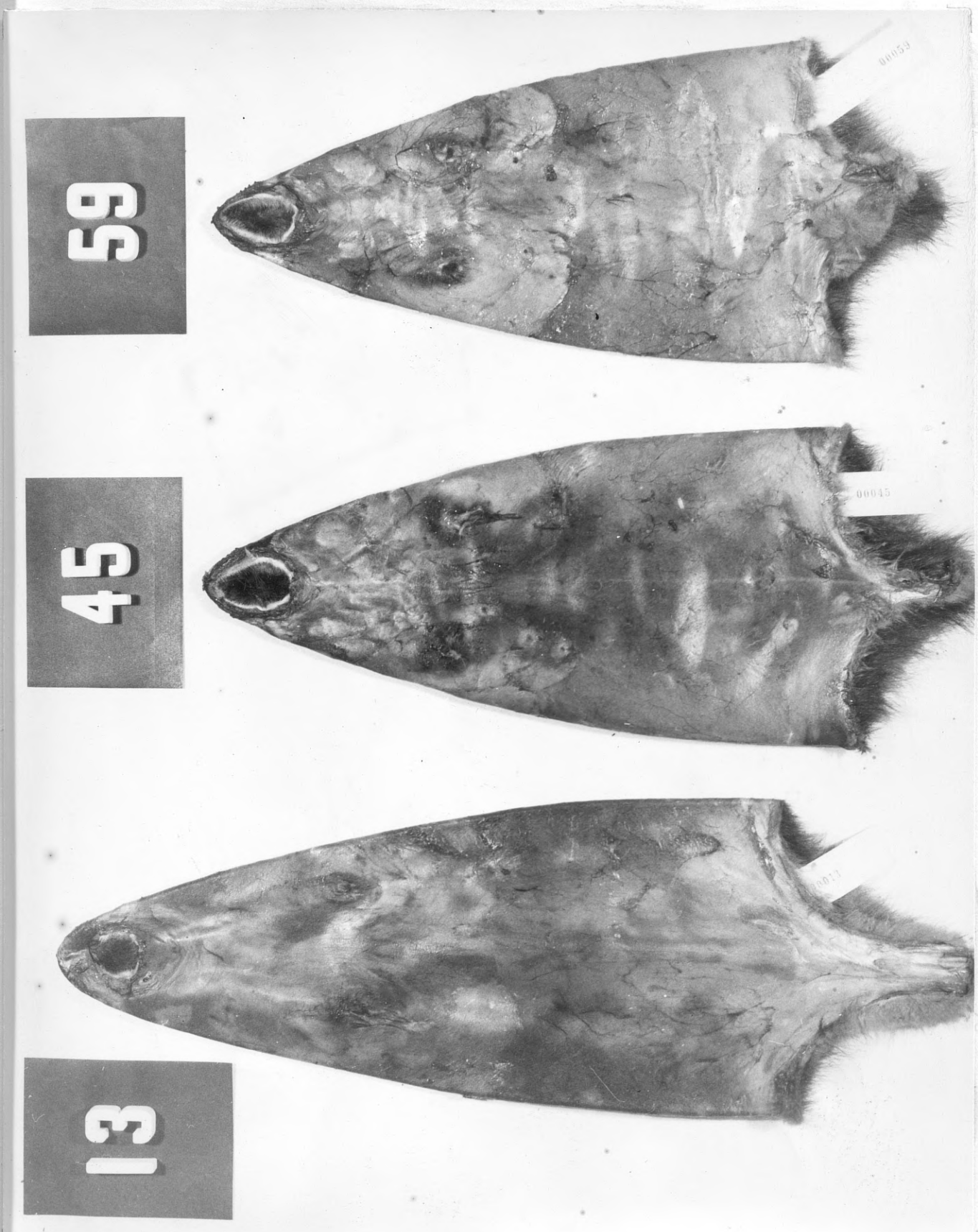


PLATE 3

Adults Dorsal

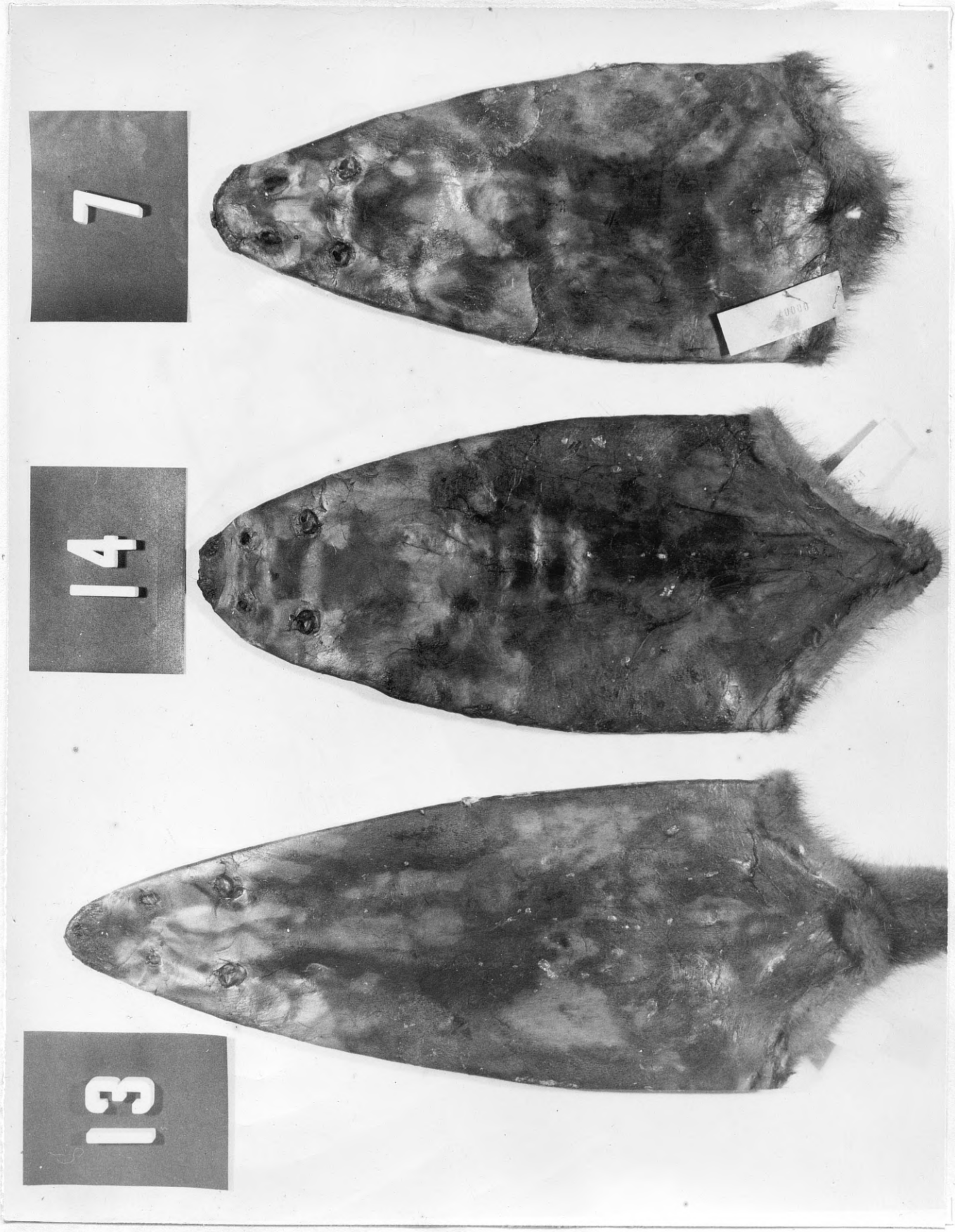


PLATE 4

Adults Ventral

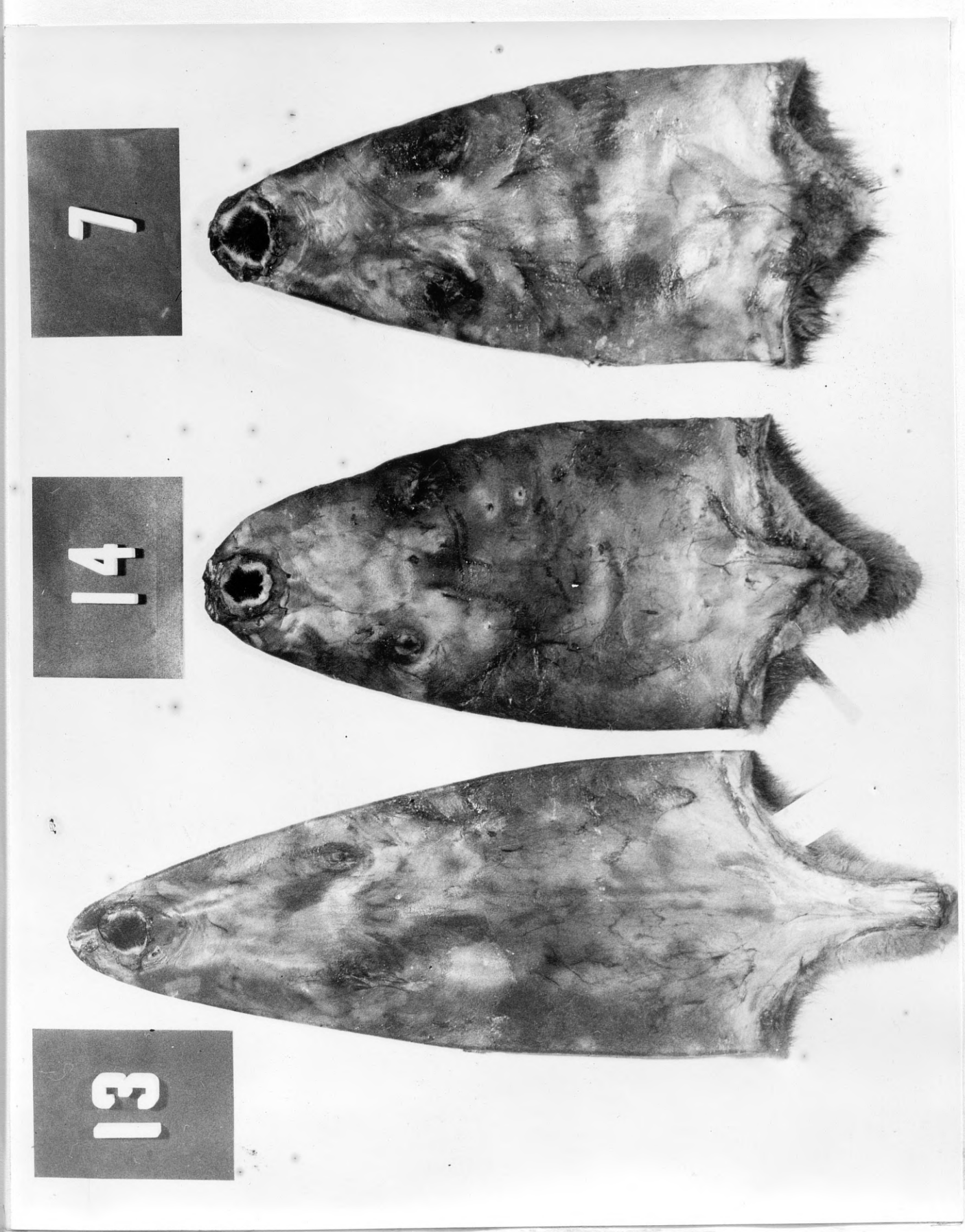


PLATE 5

Adults Dorsal

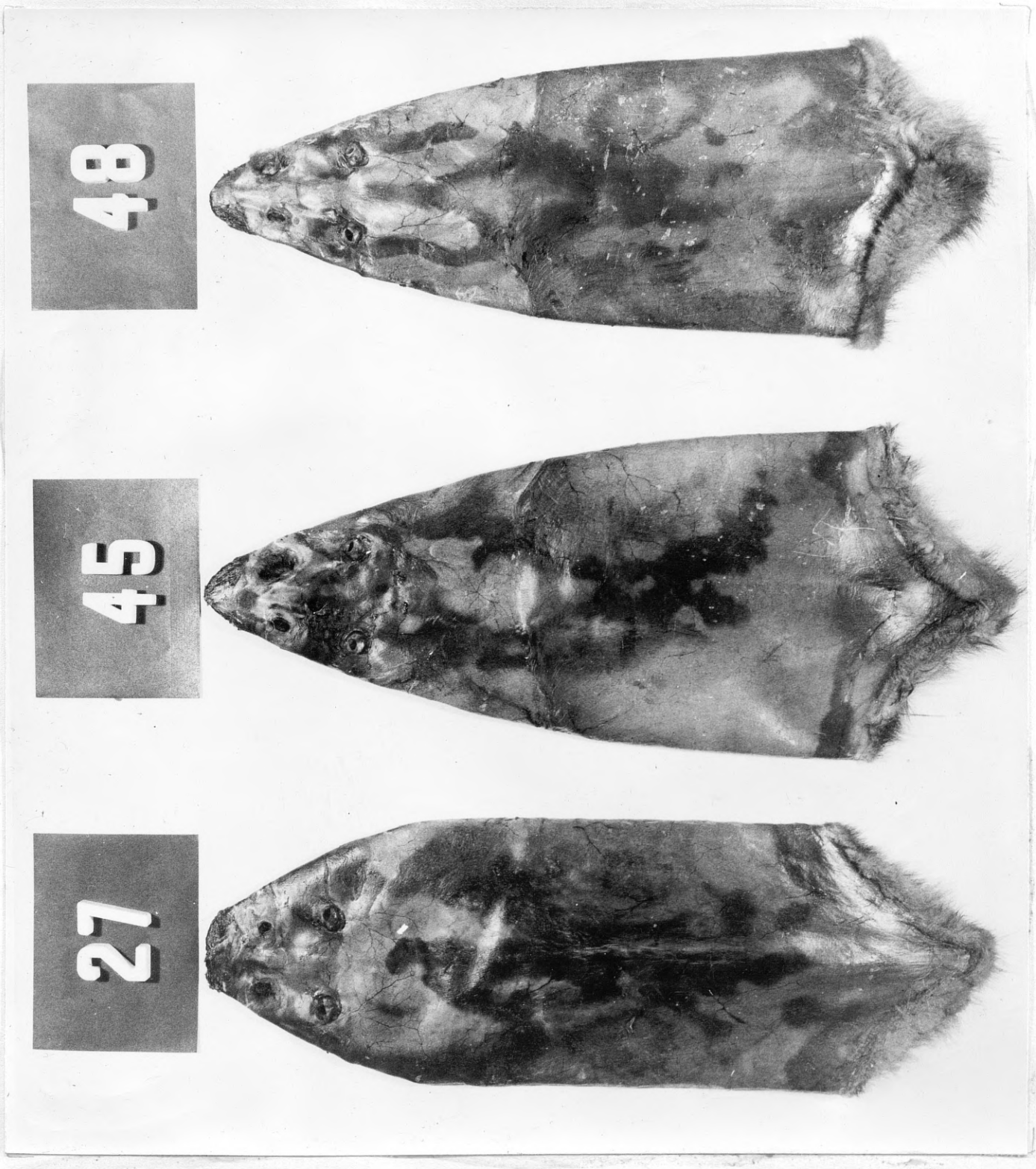


PLATE 6

Adults Ventral

PLATE 7

Adults Dorsal

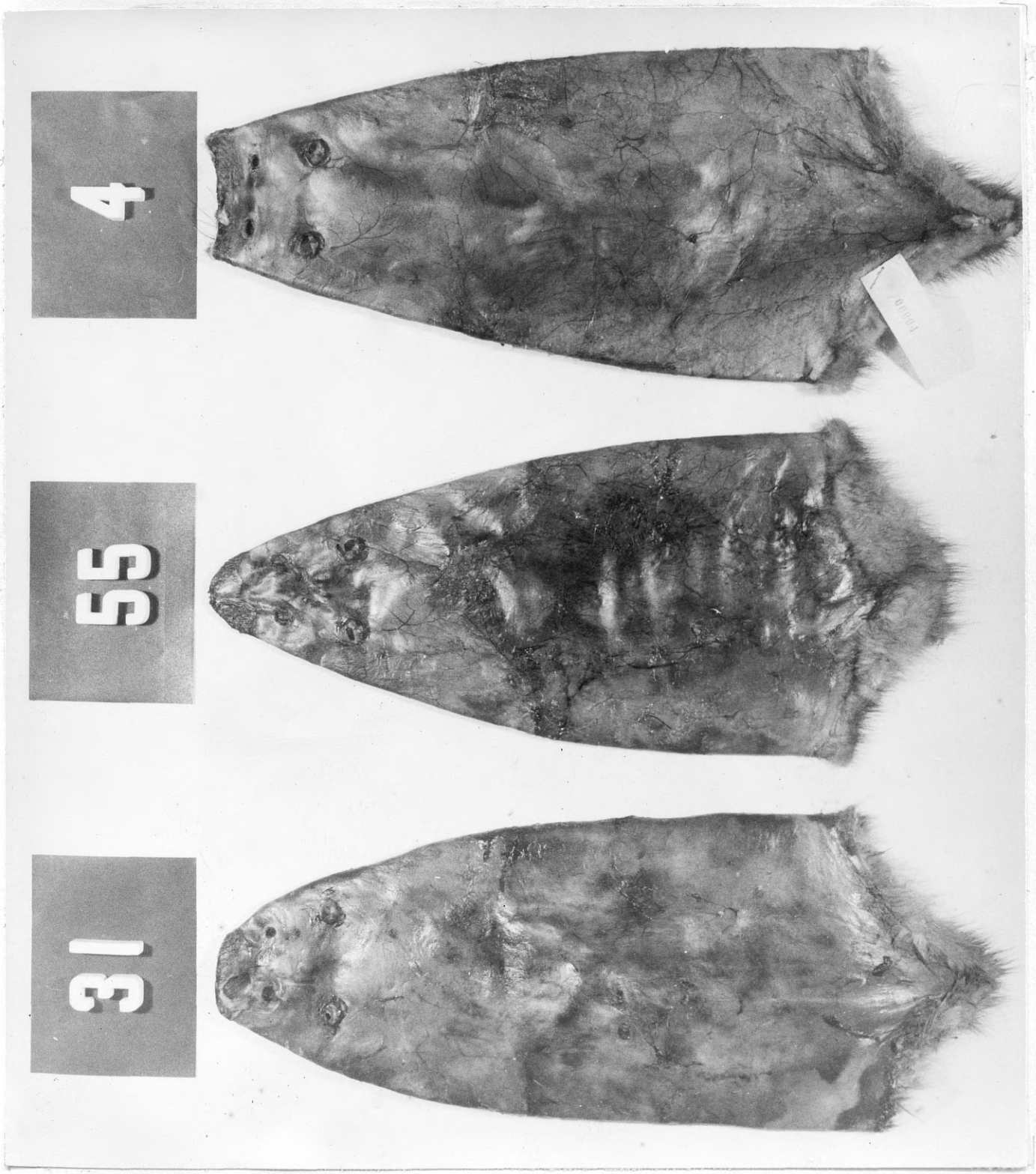


PLATE 8

Adults Ventral

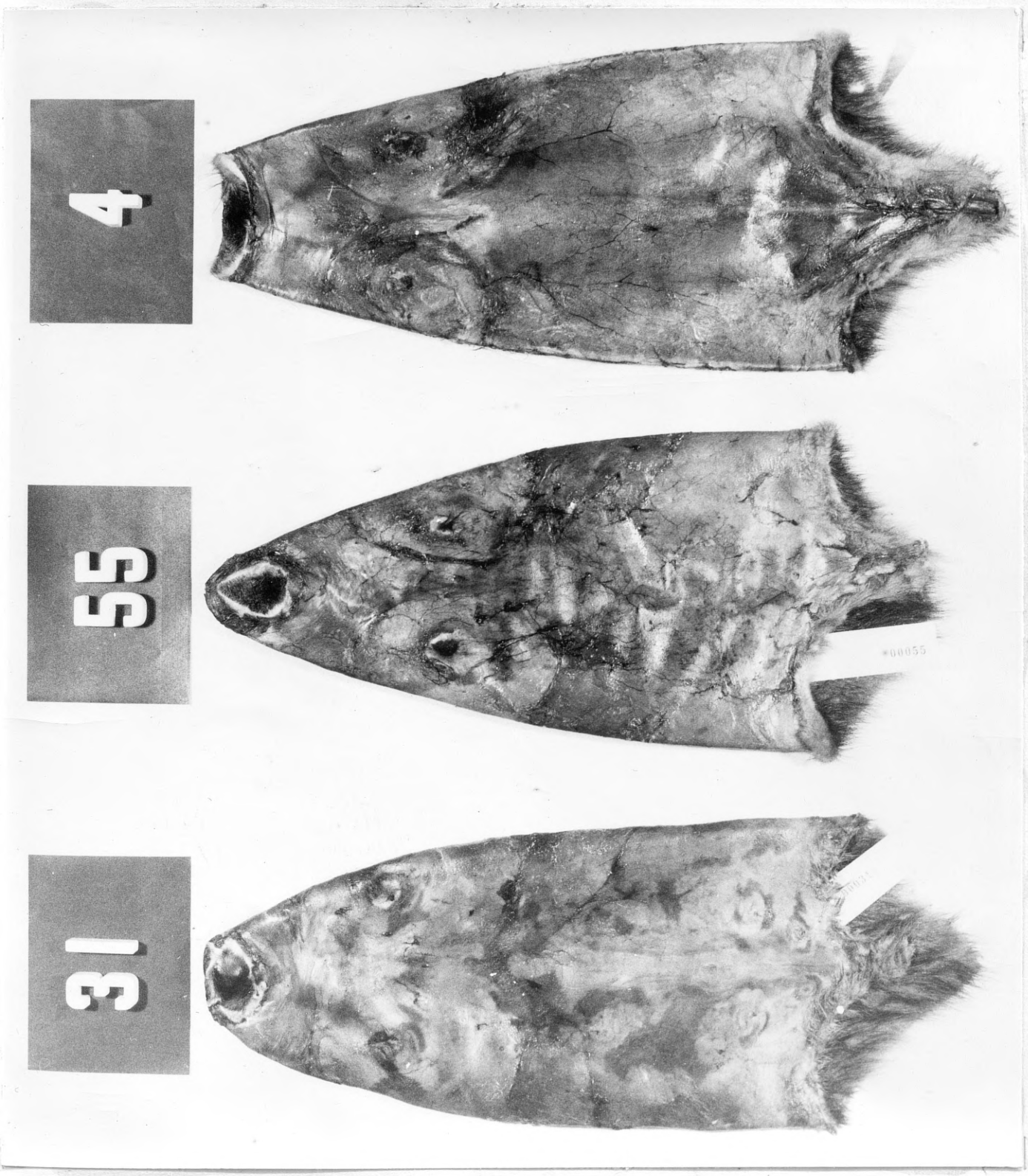


PLATE 9

Adults Dorsal

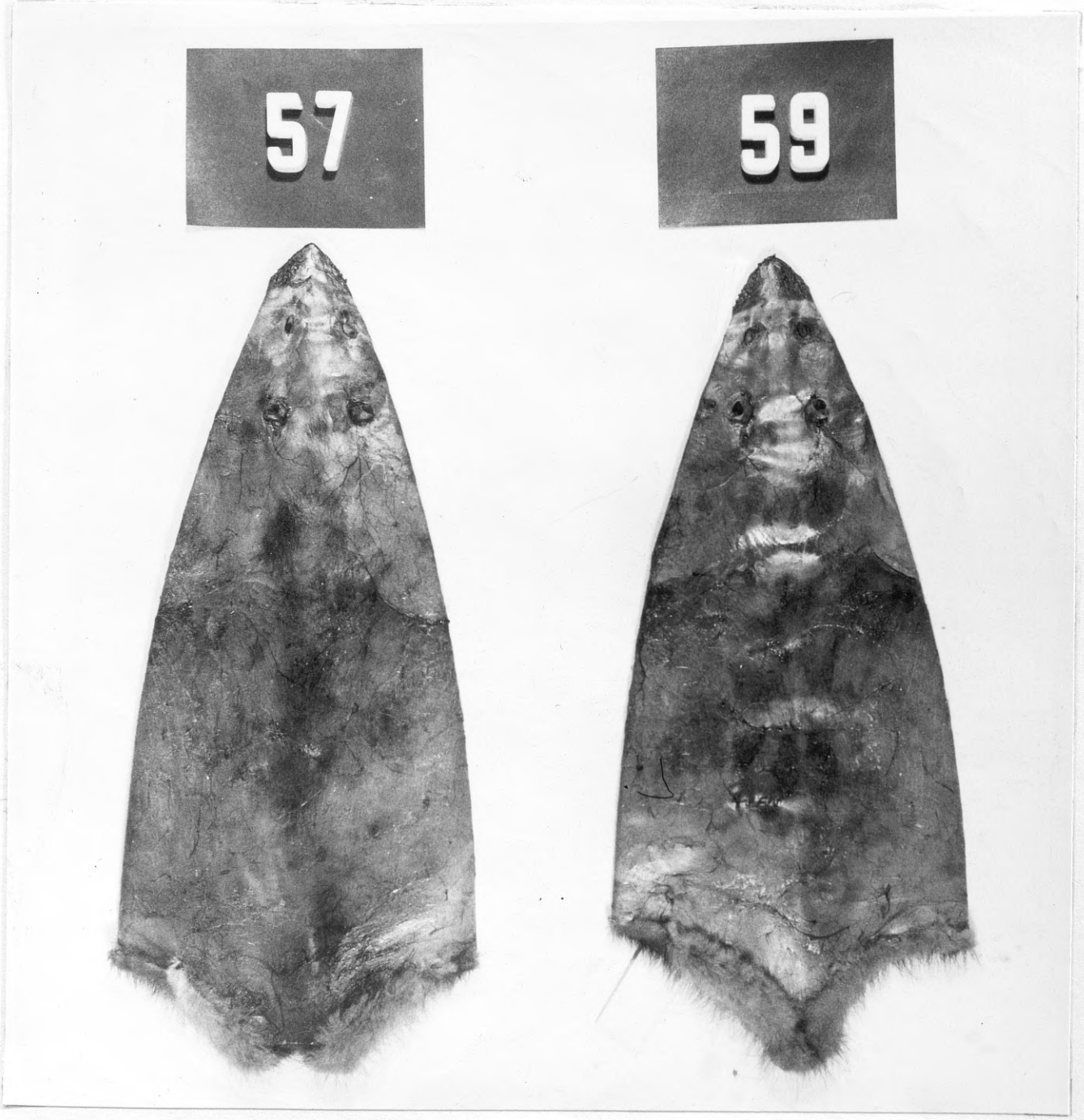


PLATE 10

Adults Ventral

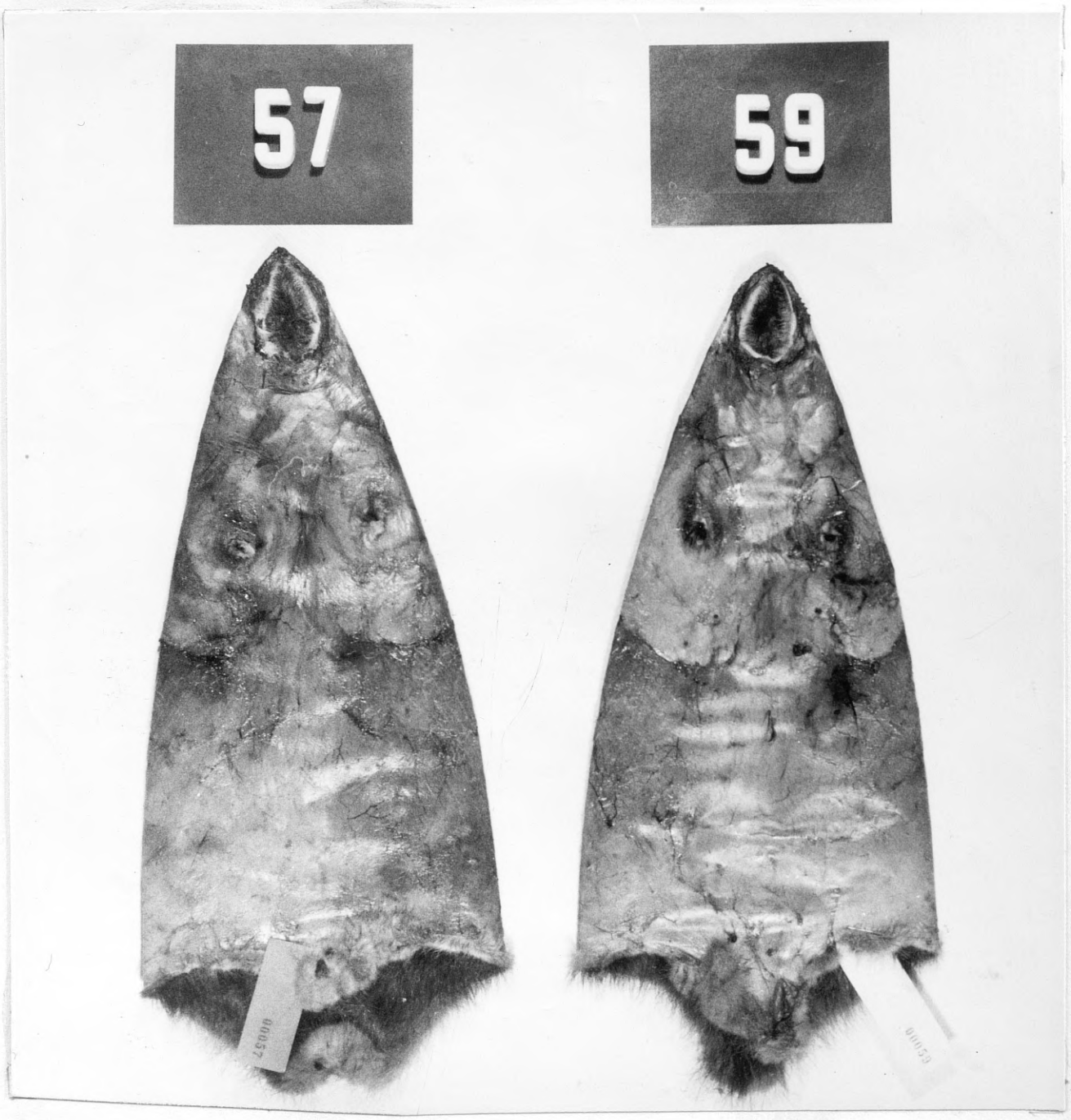


PLATE 11

Adults Dorsal

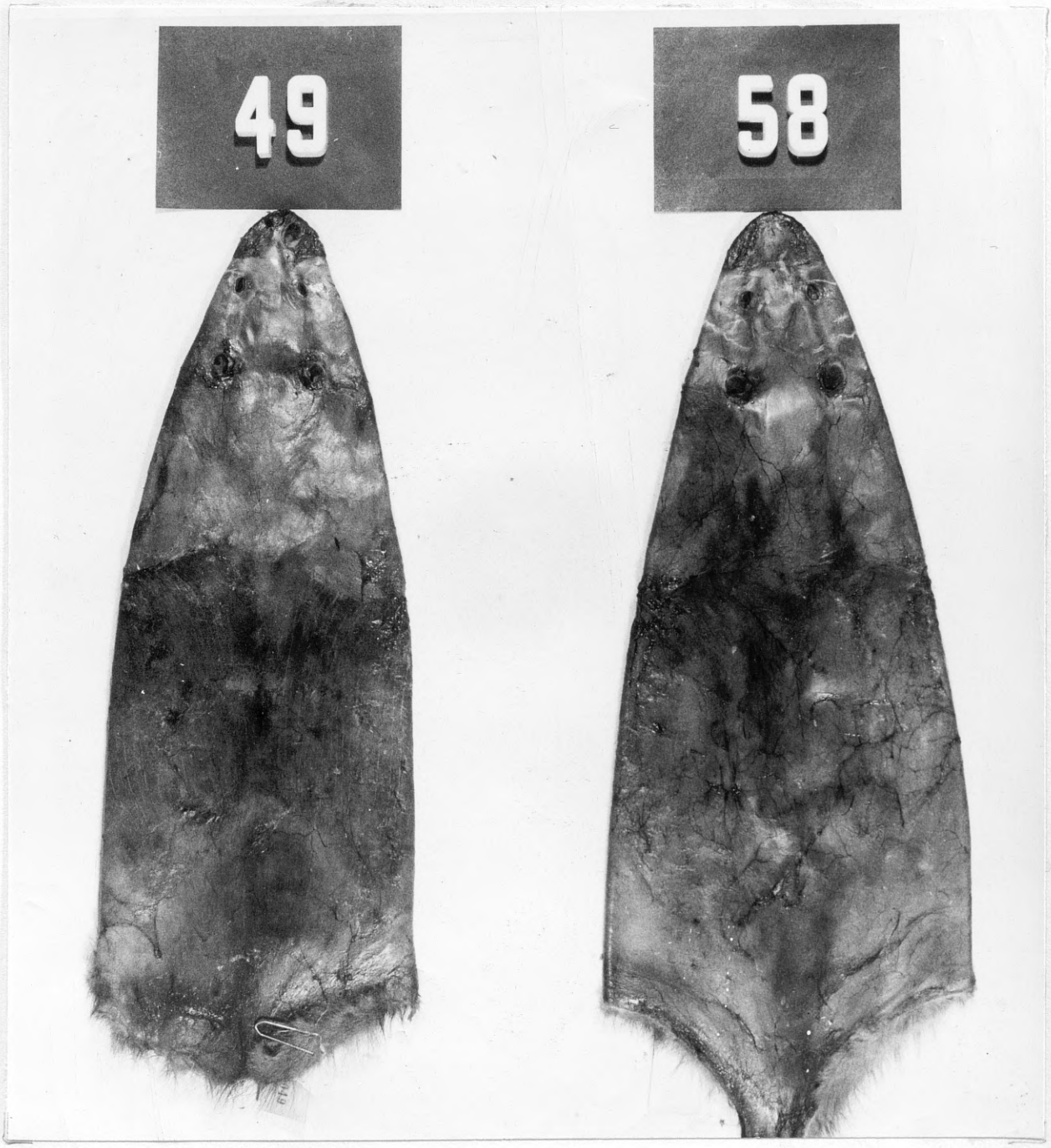


PLATE 12

Adults Ventral

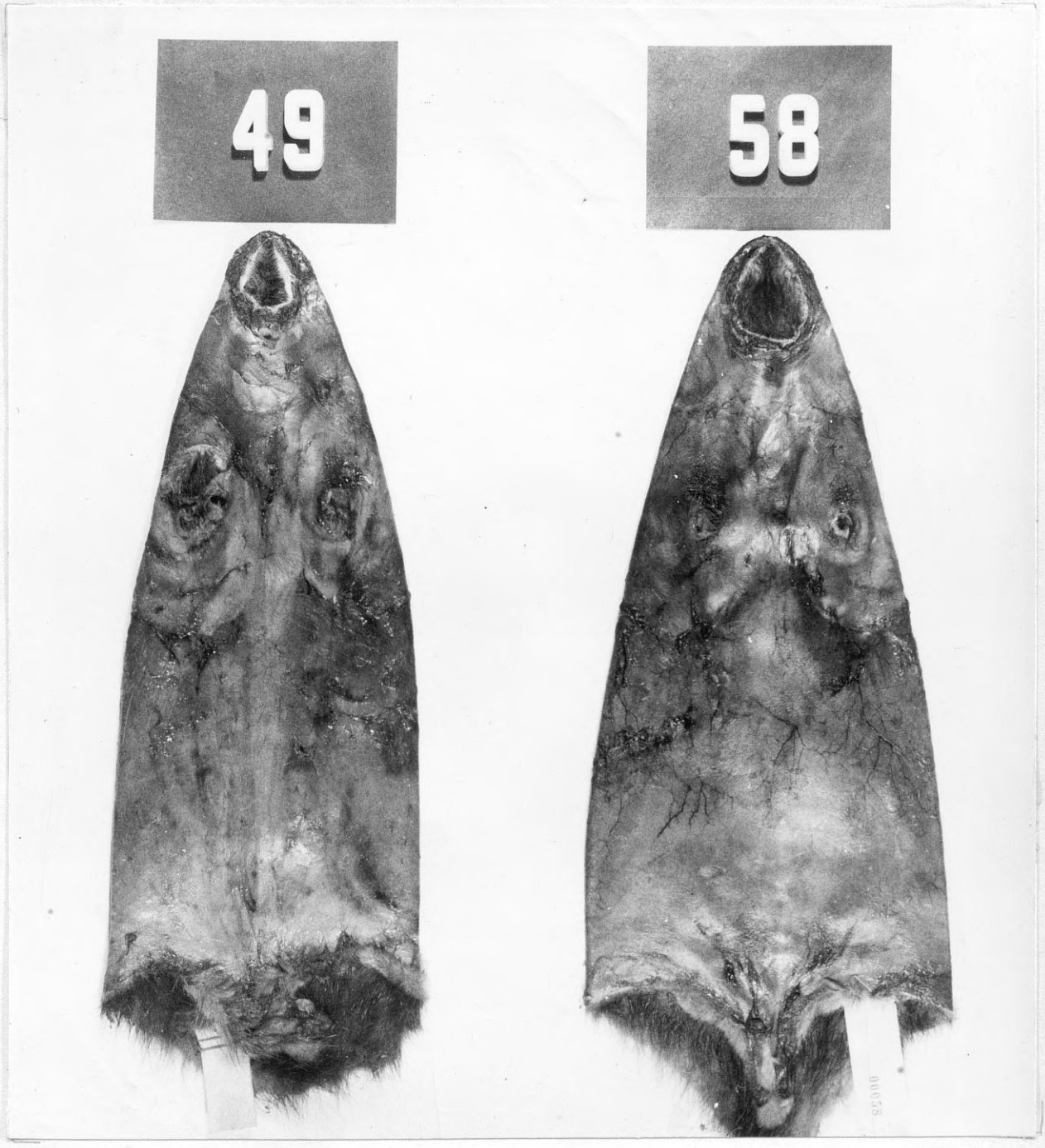


TABLE 4.

Summary of All Muskrats in Chronological Order of Capture, and Segregated as to Age Classes, Showing Relative Degree of Primeness.

Specimen Number	Date of Coll. 1946	Locality	DEGREE OF PRIMENESS: Adults ✓ Dorsal	Adults ✓ Ventral	Larger Subadults Dorsal ✓3	Larger Subadults Ventral ✓2✓4	Small Subadults (kits) 1 Dorsal	Small Subadults (kits) 1 Ventral ✓2
1	10/13	Clinton R. Drayton Plains Oakland Co.			II	Unprime		
2	10/13	do.			II	Prime		
3	10/18	Huron R. Washtenaw Co.			III	Prime		
4	10/18	do.	95% Prime	Fully Prime				
5	10/20	do.			II	Prime		
6	10/20	do.			III	Prime		
7	10/20	do.	33 1/3% Prime	60% Prime				
8	10/23	Deep Lake, Oakland Co.			III	Prime		
9	10/27	Huron R. Washtenaw Co.					Prime mid-dorsally; unprime elsewhere	Unprime
10	10/27	do.			II	Prime		
11	10/27	do.					Unprime except for two small spots	Unprime
12	10/27	do.			IV	Prime		
13	10/27	do.	Unprime except for few spots	50%Prime				
14	10/27	do.	Unprime except for few spots	50% Prime				
15	10/28	do.			No data	No data		
16	11/4	do.			I	Unprime		
17	11/4	do.			I	Unprime		
18	11/10	Loch Alpine Lakes, Washtenaw Co.			I	Unprime		
19	11/10	do.			II	Unprime		
20	11/11	Huron R. Washtenaw Co.			II	Unprime		
21	11/11	do.	(Not evaluated; believed improperly aged)					

22	11/11	Loch Alpine Lakes Washtenaw Co.			III	Prime		
23	11/11	do.			III	Prime		
24	11/11	do.					Unprime except for two small spots.	Unprime
25	11/11	do.			I	Unprime		
26	11/11	do.			II	Unprime		
27	11/11	do.	50% Prime	75% Prime				
28	11/11	do.			II	Unprime		
29	11/11	do.			I	Unprime		
30	11/11	do.			I	Unprime		
31	11/12	do.	80% Prime	90% Prime				
32	11/12	do.			I	Prime		
33	11/12	do.			III	Unprime		
34	11/12	do.			III	Prime		
35	11/12	do.			I	Unprime		
36	11/13	do.	(Not evaluated; believed improperly aged)					
37	11/13	do.			III	Prime		
38	11/13	do.			II	Unprime		
39	11/13	Huron R. Washtenaw Co.			II	Unprime		
40	11/14	Loch Alpine Lakes, Washtenaw Co.			V	Prime		
41	11/14	do.			II	Prime		
42	11/15	do.			III	Prime		
43	11/16	do.			(Atypical	see text)		
44	11/17	do.					Prime mid-dorsally; unprime elsewhere	Unprime
45	11/17	do.	75% Prime	80% Prime				
46	11/17	do.			III	Unprime		

47	11/24	do.			II	Unprime		
48	11/24	do.	75% Prime	50% Prime				
49	11/25	Huron R. Washtenaw Co.	95% Prime	Fully prime				
50	11/25	do.			II	Unprime		
51	11/25	do.			IV	Prime		
52	11/25	do.			III	Prime		
53	11/26	do.			II	Prime		
54	11/28	do.					Dorso-lat."lyre-shaped"prime area;sides beginning to	prime Unprime
55	11/28	do.	90% Prime	95% Prime				
56	11/28	do.					Same as #54	50% Prime
57	11/29	do.	95% Prime	Fully Prime				
58	11/29	do.	95% Prime	Fully Prime				
59	11/29	do.	95% Prime	Fully Prime				
60	11/29	do.					Mid-dorsal area unprime; sides partially prime	Nearly Prime
61	12/7	do.			II	Unprime		
62	12/9	Huron R.,Livingston Co.			IV	Prime		
63	12/9	do.			II	Prime		
64	12/9	do.			II	Prime		

[1] Degree of primeness based on visual estimates. Intermediate states between unprime and fully prime have been evaluated.

[2] Those specimens assessed as any degree of unprime ventrally were prime in a limited area under the neck.

[3] Degree of dorsal primeness in conformity with text descriptions of subphases (I to V) may be evaluated on a scale of I to V where I represents a quite unprime condition and V represents a prime condition.

[4] Evaluated only as unprime or prime upon judgement of the observer.

THE LARGE SUBADULTS

The pelts of 38 muskrat of this age class were examined. The characteristic pattern of prime and unprime areas in this group can best be visualized by following it through its sequent changes. In reconstructing the sequence of priming patterns, the collection was first arranged in chronological order of collection. Only a general trend in pattern changes could be noted since, as stated previously with reference to the adults, a collection of subadult muskrat taken from the same population on a given day, or in a short period of time, displayed a wide range in degree of primeness. This is illustrated in numerous instances in Table 4. However, the general features and progressive changes in the priming patterns was unmistakable. Had it not been, it would not originally have been a relatively simple task to sort the pelts into age classes. The entire collection was then rearranged, without regard to date of collection, so that the apparent sequence of priming patterns was portrayed. Arranged thus, it became possible to describe verbally the sequent patterns. For descriptive convenience, the pelts were separated into five groups, termed hereafter as subphases I to V, wherein subphase I contains the most unprime specimens and subphase V the most prime specimens. It should be understood that each subphase intergraded with its successor and that descriptions are based on type specimens selected from each group.

A description of each subphase follows:

Subphase I.---Dorsal: All subadults in this group were unprime in the mid-dorsal areas and along the sides of the cased pelt (sides and flanks of the animal). Dorsolaterally, between the mid-dorsal and flank unprime areas, was a "lyre-shaped" area of variable width that was prime. This "lyre-shaped" dorsal prime area was characteristic of certain subadults and was utilized in sorting the cased pelts into age classes.

Ventral: These muskrats were generally quite unprime with but one exception which was prime midventrally. All were prime in a very limited area under the neck.

Typical specimens of this subphase are illustrated in Plates 13 and 14.

Subphase II.---Dorsal: The mid-dorsal unprime area is becoming prime; (a) priming uniformly over entire mid-dorsal area or (b) priming gradually in a posterior-anterior direction or (c) priming eratically or spottily throughout the mid-dorsal region. Adjacent to, and lateral to, the "lyre-shaped" prime area is a band of approximately the same width which tends to remain quite unprime. This band of unprime pelt replaces the early "lyre-shaped" prime area as the distinctive marking of the subadult pelt in later phases. Progressing ventrally from this narrow unprime band, the sides and flanks show evidences of collateral priming and those specimens that were most prime mid-dorsally were generally most prime on the sides and flanks.

However, several specimens, nearly prime mid-dorsally, were somewhat retarded on the sides.

Ventral: In this subphase the ventral areas are becoming prime. Nearly as many pelts were prime as were unprime on the ventral surfaces. Those pelts that were most prime in the mid-dorsal and flank areas were fully prime ventrally, and it is reasonable to assume, after examination of the pelts, that priming in the mid-ventral and ventro-lateral areas preceded or in some few instances was collateral with the priming of the mid-dorsal areas. When examined very critically, the ventral areas of these pelts displayed a variety of intermediate stages of priming which indicated that the belly and sides became prime in a more or less uniform manner rather than in patterned, local areas.

Typical specimens of this subphase are illustrated in Plates 15 and 16.

Subphase III.---Dorsal: The mid-dorsal areas are fully prime and the sides and flanks have become prime. The band of unprime pelt lying immediately ventro-lateral to the early "lyre-shaped" prime area has replaced this later feature as the distinctive marking of the dorsal surface of these pelts.

Ventral: All but two of these pelts were fully prime. The two pelts classed as unprime ventrally were in reality in an intermediate stage between unprime and prime. Both were considered slightly in excess of 50 percent prime.

Typical specimens of this subphase are illustrated in Plates 17 and 18.

Subphase IV.---Dorsal: The mid-dorsal areas are now fully prime. The distinctive unprime band of the latter phases appears to be becoming constricted and more clearly defined. The sides and flanks are generally prime. One pelt appeared to be retarded in priming in these latter areas.

Ventral: All were fully prime.

Typical specimens of this subphase are illustrated in Plates 19 and 20.

Subphase V.---Dorsal and Ventral: The distinctive dorsal band of unprime pelt appears to be priming first at the extremities of the body leaving two brief unprime stripes in the mid-body region. Other than that, the pelt is fully prime.

This phase is represented by only one specimen and is illustrated in Plate 21.

One somewhat atypical pelt was not placed in the above series. It was unprime mid-dorsally. The dorsolateral and all ventral areas were in an almost uniformly advanced state of primeness. The pattern strongly resembles that exhibited by certain of the smaller subadults and suggests that any distinct separation of the subadults into two groups may not prove feasible after examination of a larger series of specimens (see Plate 22).

The sequent arrangement of the entire series and a summary of much of the foregoing data is incorporated in Table 5. The sequence of priming patterns and their characteristics in the entire series are illustrated in Plates 23 to 46. Briefly,

progressive priming in this age class appears to take place as follows: (1) prime areas appear under the neck and dorso-laterally in a "lyre-shaped" area of variable width; (2) primeness increases mid-dorsally; collaterally, the sides and flanks are becoming prime. Ventrolateral to the "lyre-shaped" prime area, an encompassing band of about the same width remains most unprime and is becoming the distinctive marking of pelts of this age class. Ventral (belly) areas may or may not be becoming prime. At this stage, all degrees of ventral priming are displayed in a large series of pelts; (3) the mid-dorsal areas and the sides and flanks now become quite prime. The band of unprime pelt that remained ventro-lateral to the early "lyre-shaped" prime area remains unprime. Ventrally, the pelts have most generally become prime; (4) the muskrat is now prime except for the dorsal bands of unprime pelt. This band becomes constricted in width and more clearly defined. It appears to disappear (become prime) rather erratically both posteriorly and anteriorly and disappears last in the mid-body region. When this has occured, the subadult pelt is fully prime.

No significant difference could be found in the relative degree of primeness of males and females taken in the same sample area, either within limited periods of time or in the total sample period. A study of Tables 4 and 5 will corroborate this. One case may be cited. Twelve females and 7 males (subadults) were taken in the Loch Alpine impoundments in a period of 13 days. Combining the evaluations of dorsal and ventral primeness for these specimens utilized elsewhere in this report,

the following results were obtained: of the 12 females, 7 were unprime and 5 were prime; of the 7 males, 4 were unprime and 3 were prime. It is possible, that when a large series of pelts from one locality are examined, sexual differences in degree of primeness may become apparent.

PLATE 13

Large Subadults Dorsal

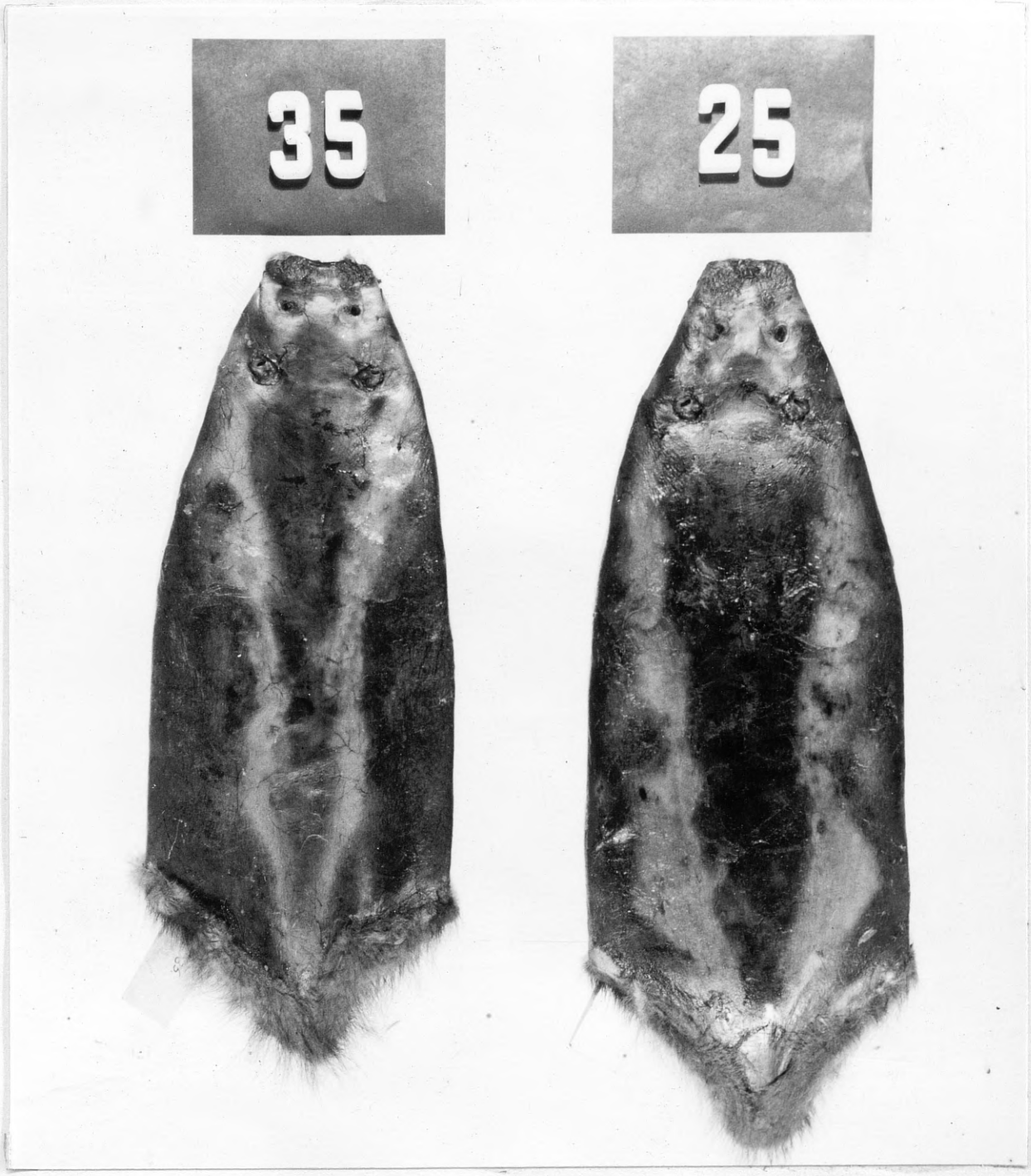


PLATE 14

Large Subadults Ventral

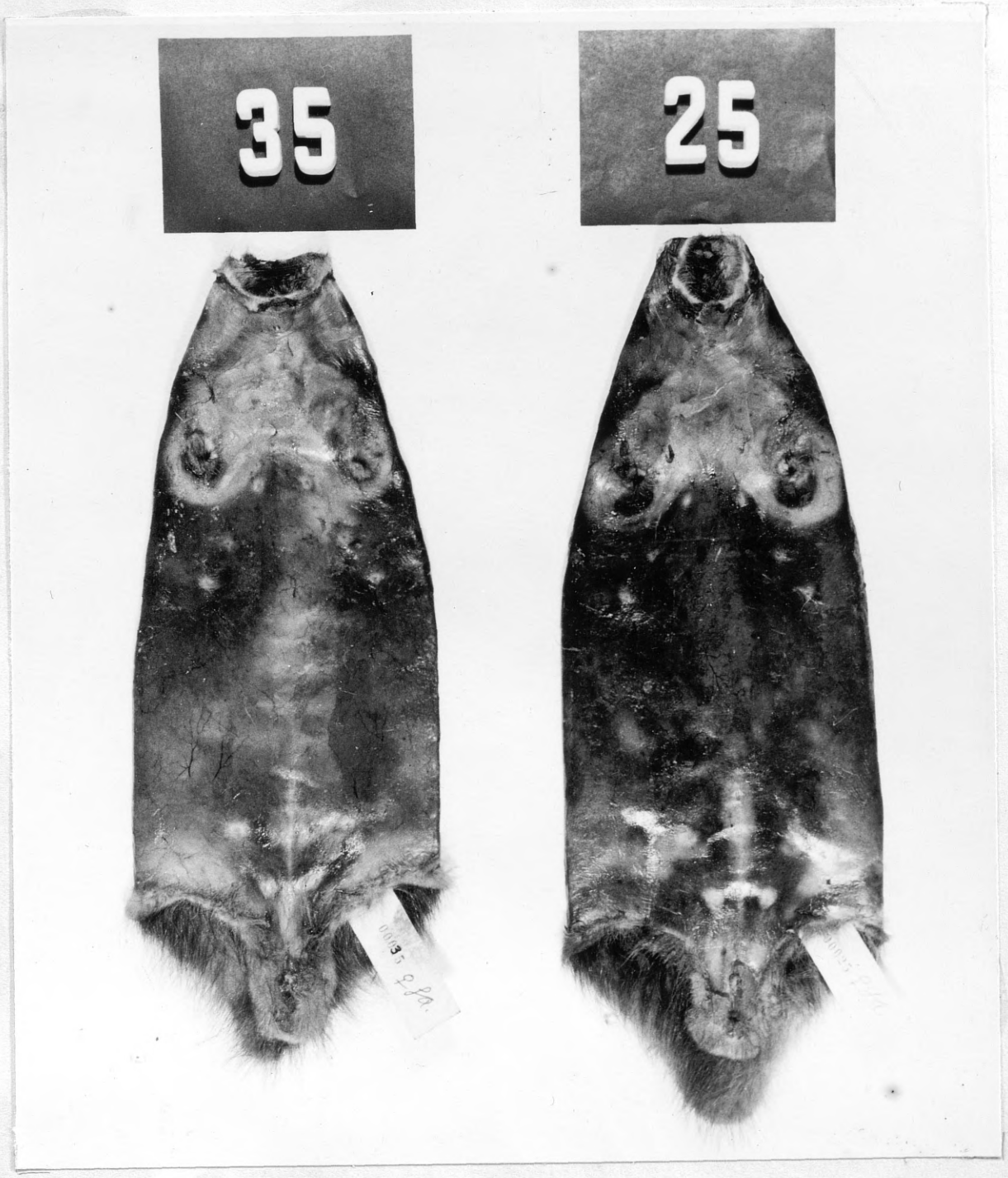


PLATE 15

Large Subadults Dorsal

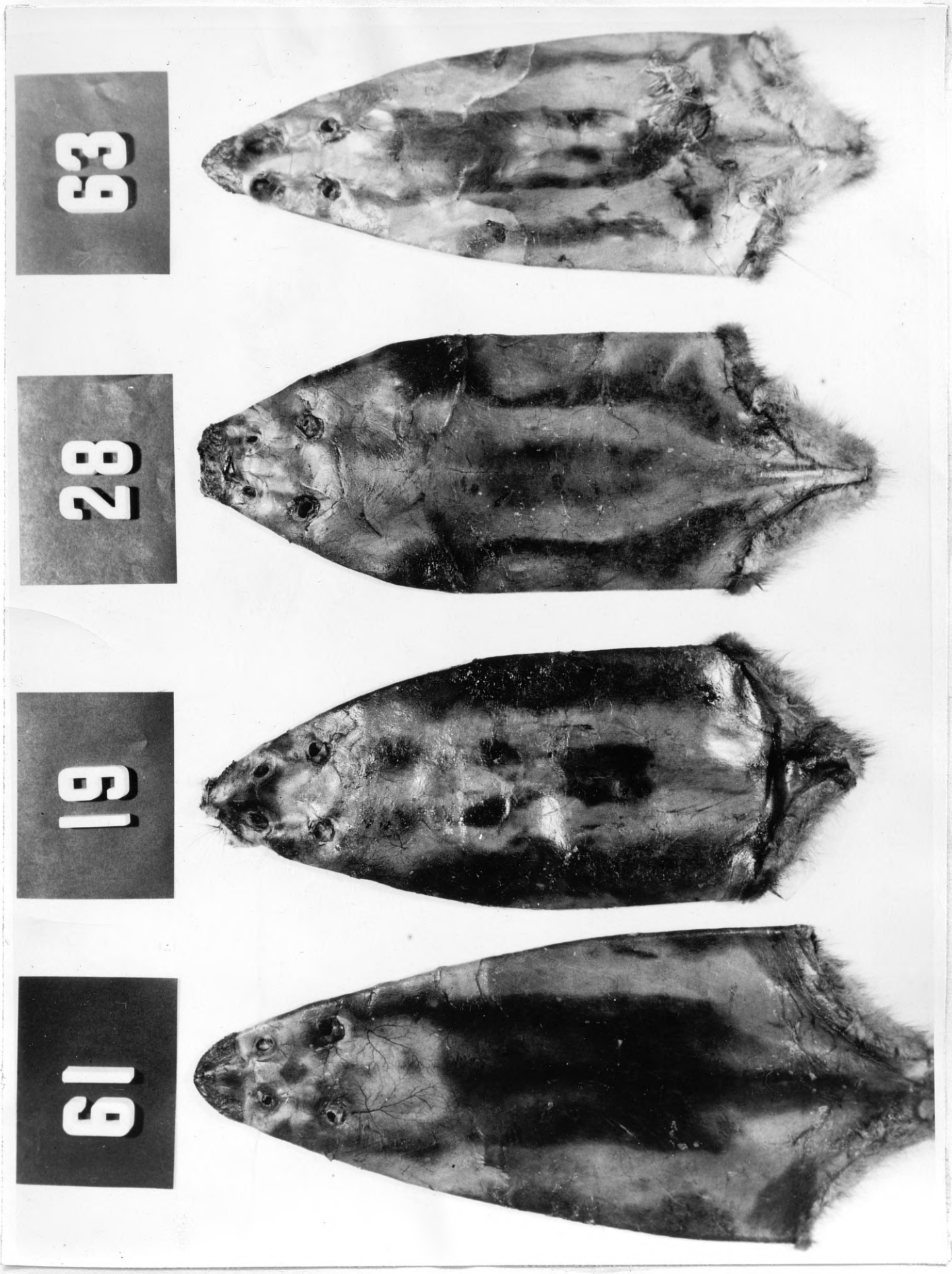


PLATE 16

Large Subadults Ventral

PLATE 17

Large Subadults Dorsal

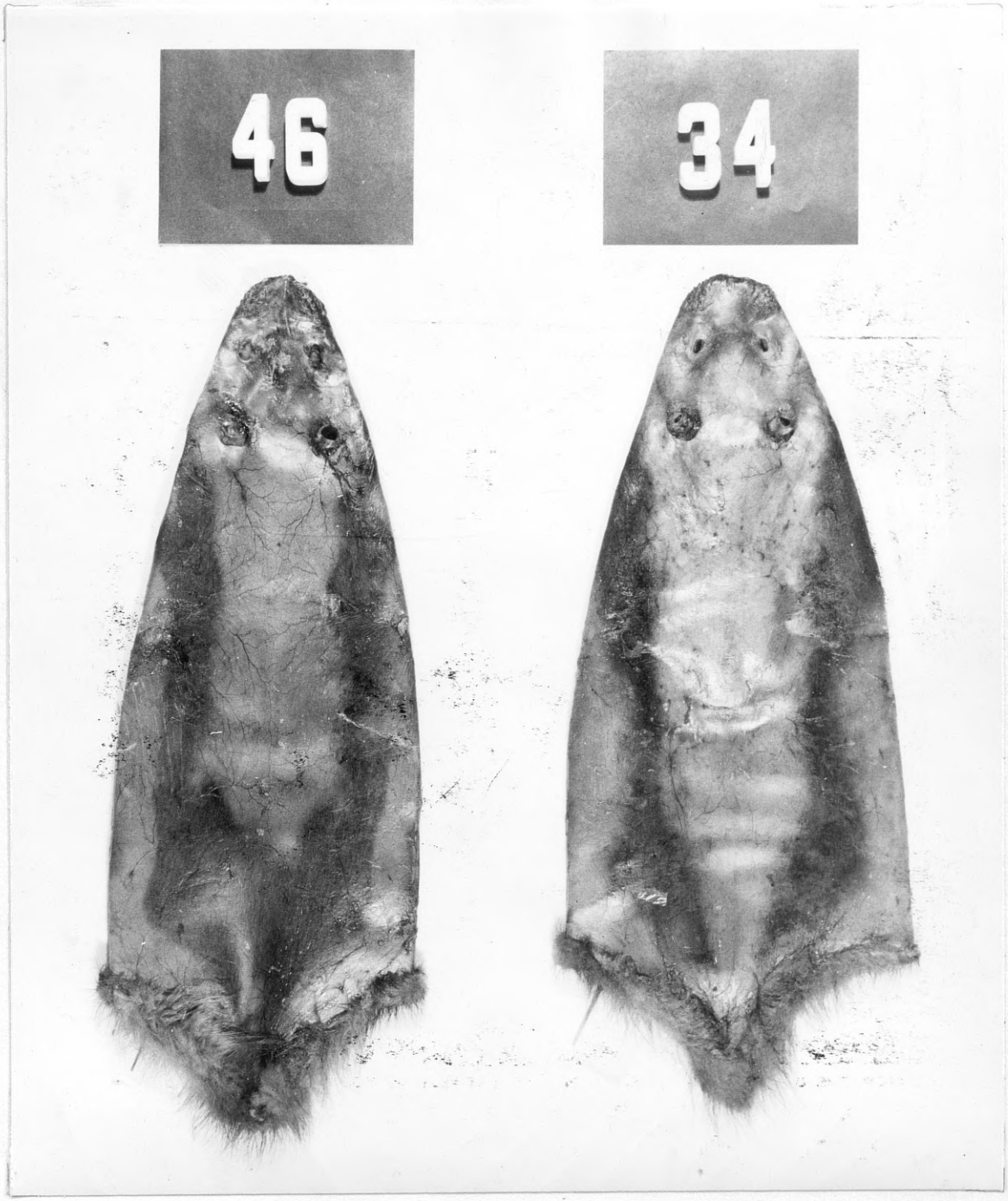


PLATE 18

Large Subadults Ventral

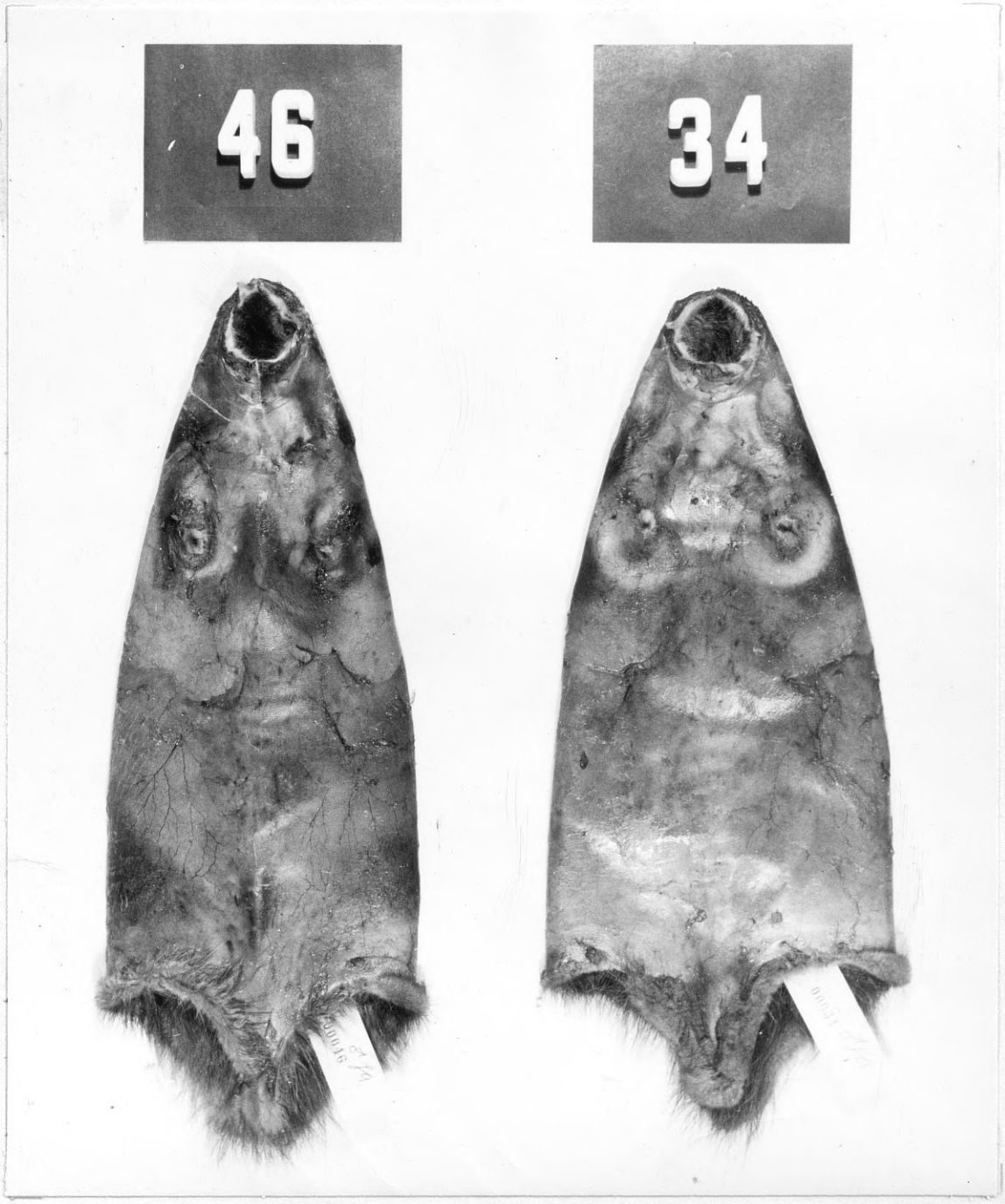


PLATE 19

Large Subadults Dorsal

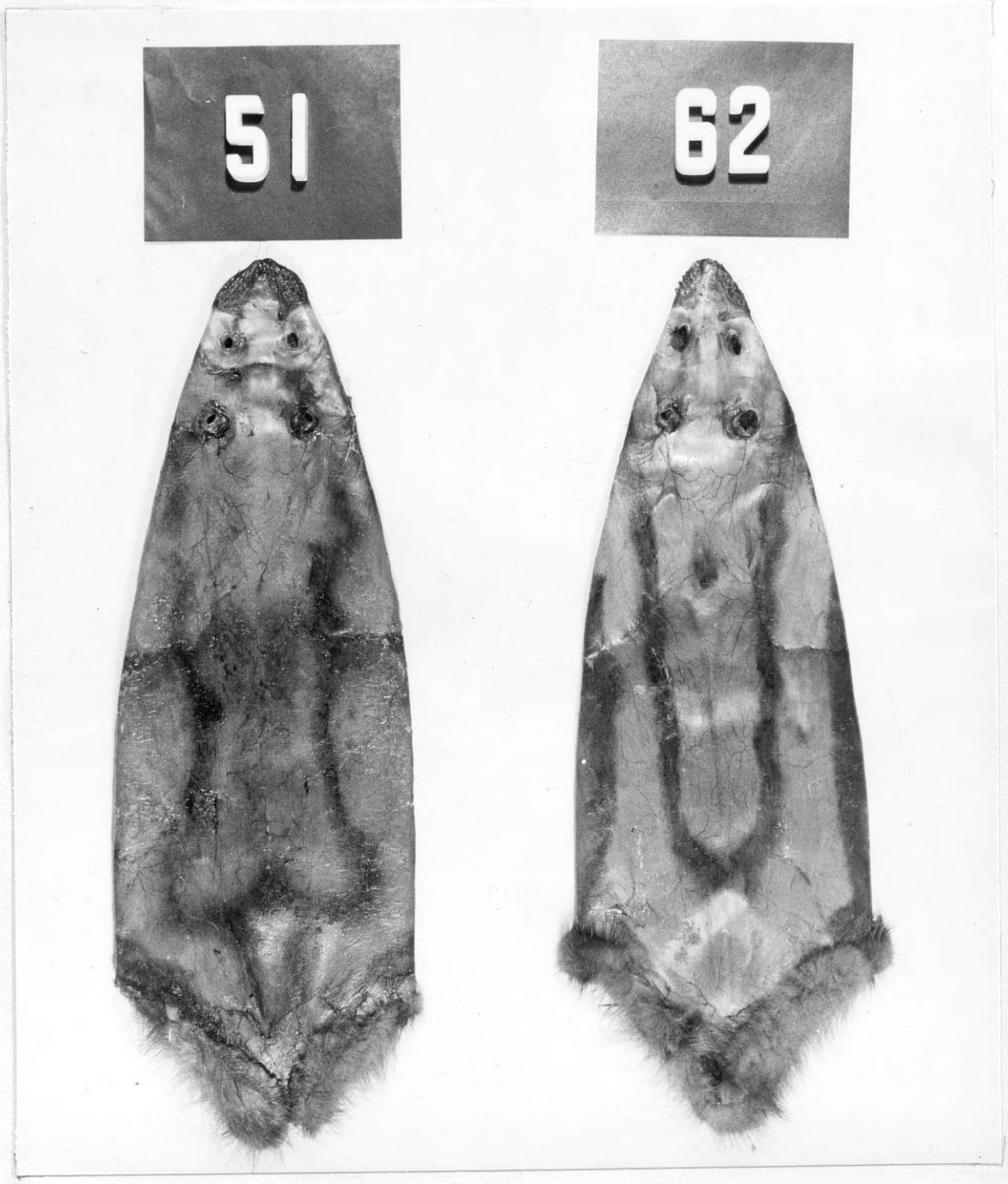


PLATE 20

Large Subadults Ventral

PLATE 21

Large Subadult Dorsal and Ventral

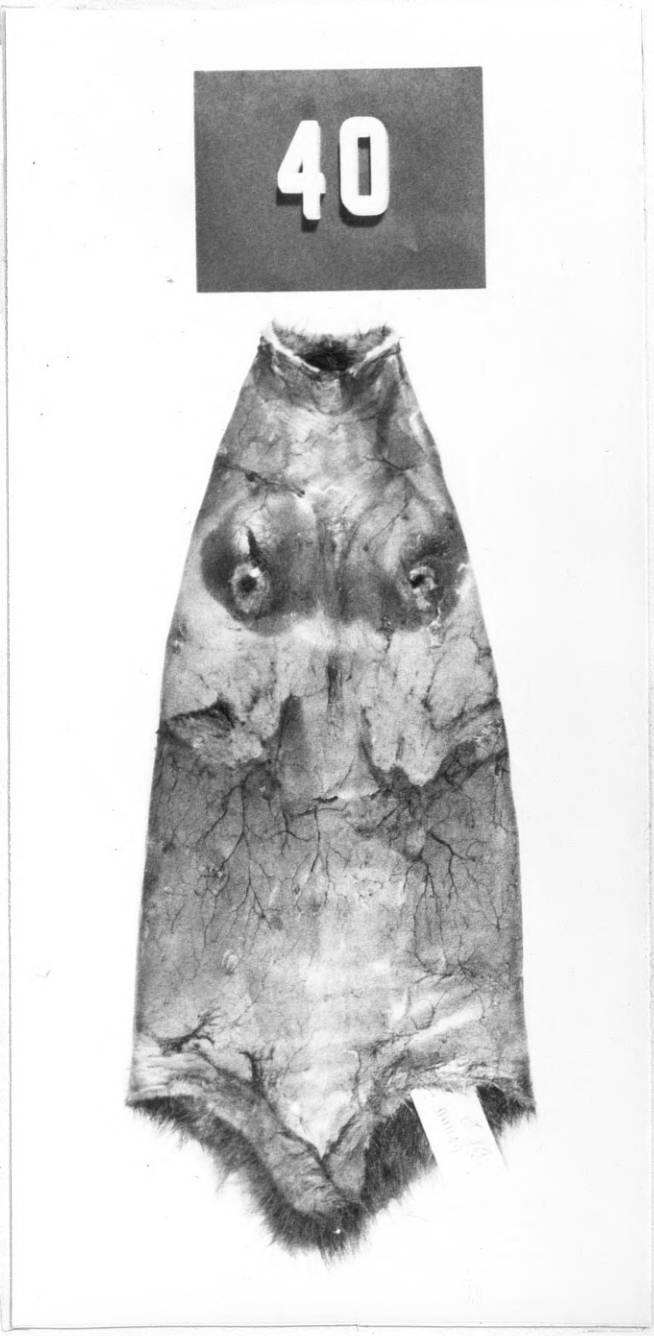


PLATE 22

Subadult (Large or Small?) Dorsal and Ventral

Table 5.--Larger subadults grouped progressively in the "subphases" utilized in the synthesis of the sequence of priming in this age class.

Subphase	Spec. number	Date of collection	Sex	Primeness Dorsal	Primeness Ventral	Remarks
		(1946)				
I	30	11/11	F	Prime only in dorso-	Unprime	
	35	11/12	F	lateral "lyre-	Unprime	Type
	16	11/4	F	shaped" area of variable	Unprime	
	18	11/10	F	width and intensity.	Unprime	
	17	11/4	M		Unprime	
	25	11/11	F		Unprime	Type
	29	11/11	F		Unprime	
	32	11/12	M		Prime	
II	61	12/7	F	Becoming prime mid-	Unprime	Type
	39	11/13	M	dorsally; collaterally	Unprime	
	5	10/20	M	sides and flanks are	Prime	
	64	12/9	F	becoming prime; ventro-	Prime	
	19	11/10	F	lateral to the "lyre-	Unprime	Type
	47	11/24	M	shaped" prime area, an en-	Unprime	
	10	10/27	F	compassing band of about	Prime	
	20	11/11	M	the same width is re-	Unprime	
	2	10/13	F	maining most unprime.	Prime	
	53	11/26	M	This unprime band becomes	Prime	
	26	11/11	M	the distinc-	Unprime	
	50	11/25	F	tive marking of this age class in	Unprime	
	28	11/11	F	latter sub-	Unprime	Type
	38	11/13	F	phases of increasing primness.	Unprime	

Table 5.--Continued

Subphase	Spec. number	Date of collection	Sex	Primeness		Remarks
				Dorsal	Ventral	
		(1946)				
	41	11/14	F		Prime	
	63	12/9	F		Prime	Type
	1	10/13	M		Unprime	
III	42	11/15	F	Mid-dorsal area fully prime; sides and flanks have become prime; the band of unprime pelt that remained ventro-lateral to the early "lyre-shaped" prime area remains as the distinctive marking of these pelts.	Prime	
	46	11/17	M		Unprime	Type
	3	10/18	M		Prime	
	34	11/12	M		Prime	Type
	52	11/25	F		Prime	
	8	10/23	F		Prime	
	33	11/12	F		Unprime	
	23	11/11	F		Prime	
	22	11/11	F		Prime	
	6	10/20	M		Prime	
	37	11/13	F		Prime	
IV	12	10/27	M	Mid-dorsal area fully prime as are sides and flanks. The distinctive band of unprime pelt is becoming constricted and more clearly defined.	Prime	
	51	11/25	F		Prime	Type
	62	12/9	M		Prime	Type

Table 5.--Continued

Subphase	Spec. number	Date of collection	Sex	Primeness		Remarks
				Dorsal	Ventral	
V	40	(1946) 11/14	M	Band of unprime pelt appears to prime anteriorly and posteriorly first leaving short unprime strips in the mid-body region.	Prime	Type
Atypical	43	11/16	F	Unprime mid-dorsally; prime elsewhere.	Prime	

[1] General degree and pattern of primeness only described. Variation in degree and pattern in any subphase may be ascertained from plates and from the text.

[2] Muskrat listed as unprime ventrally were, without exception, prime in a limited area under the neck.

PLATE 23

Large Subadults Dorsal

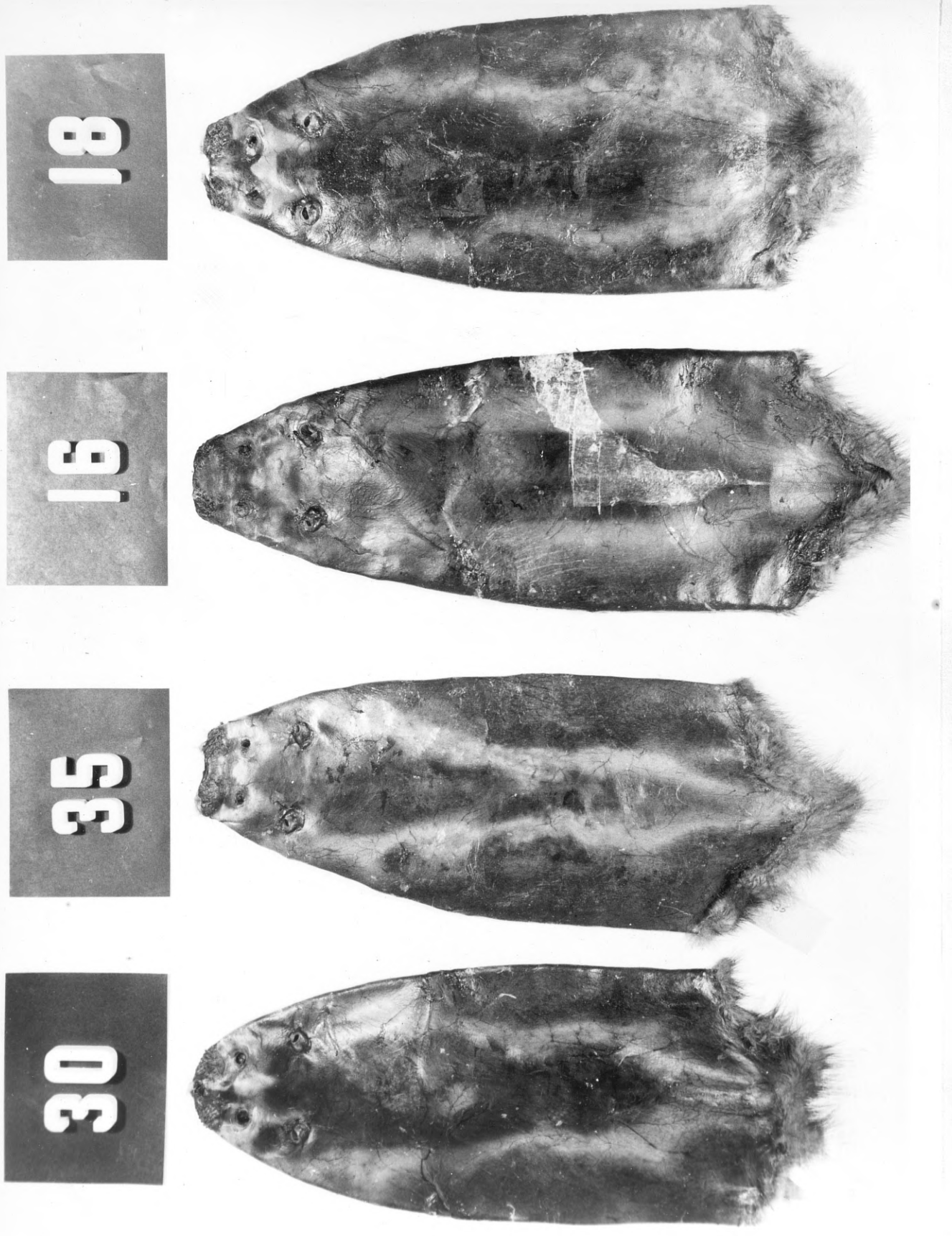


PLATE 24

Large Subadults Ventral

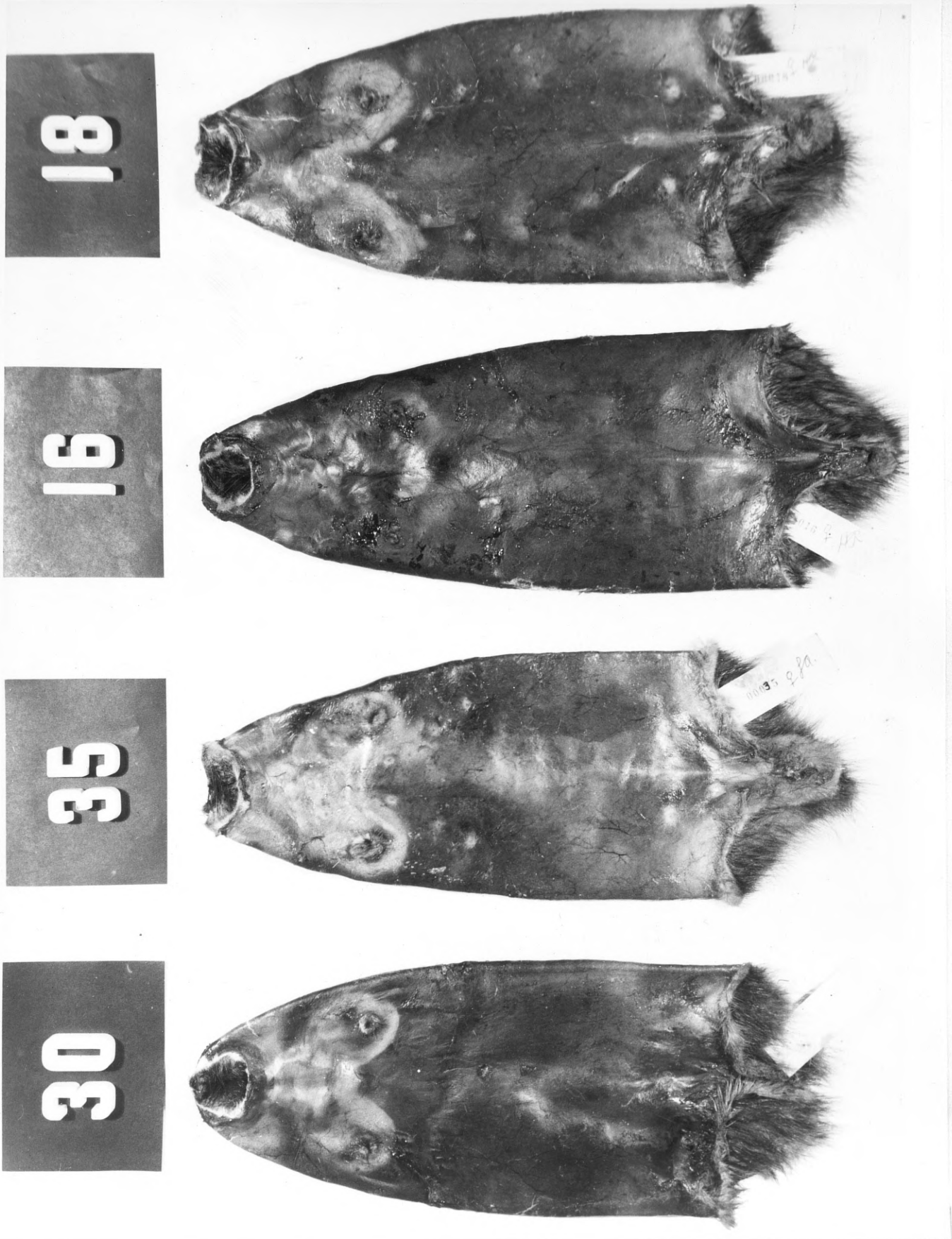


PLATE 25

Large Subadults Dorsal

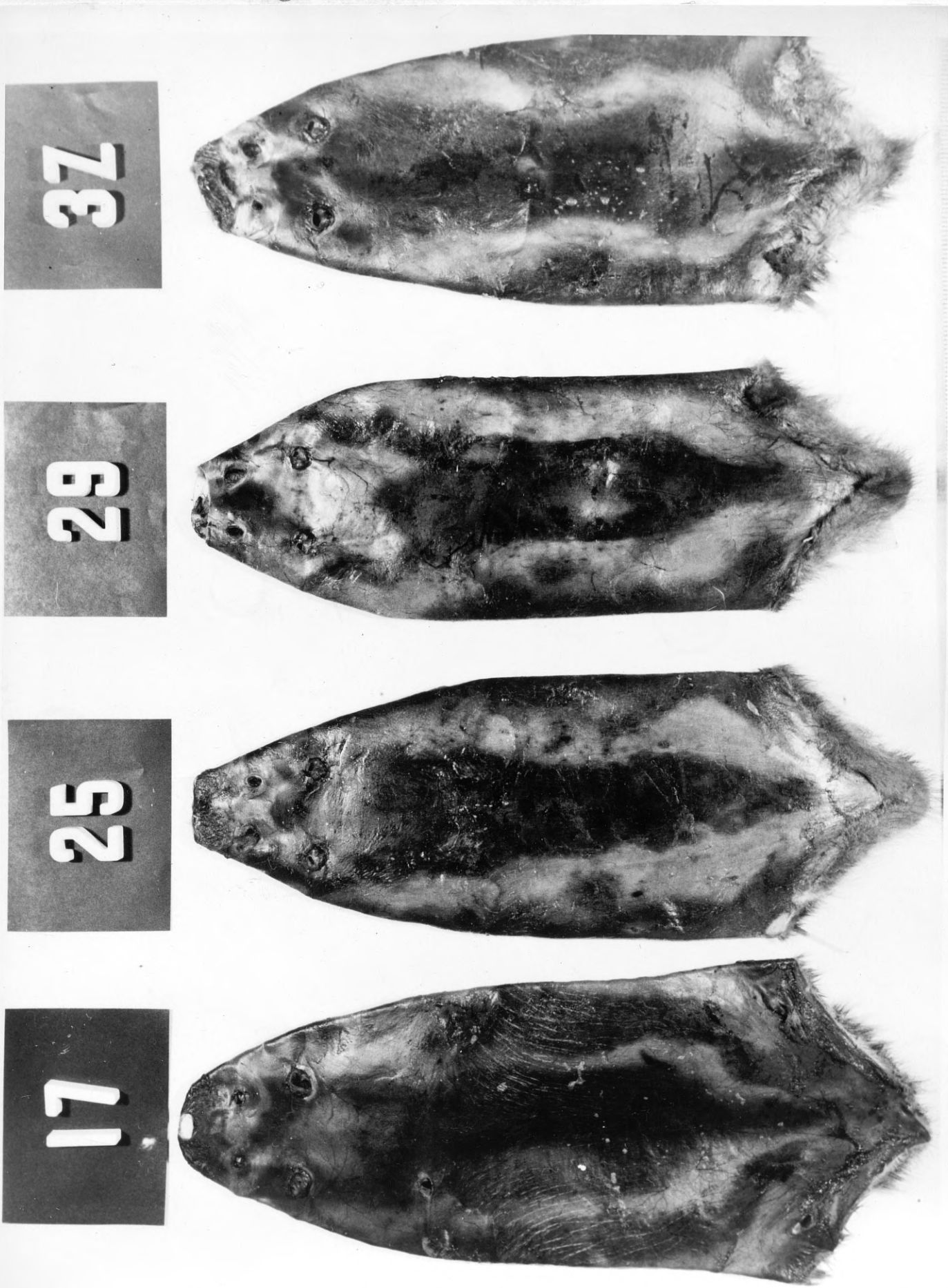


PLATE 26

Large Subadults Ventral

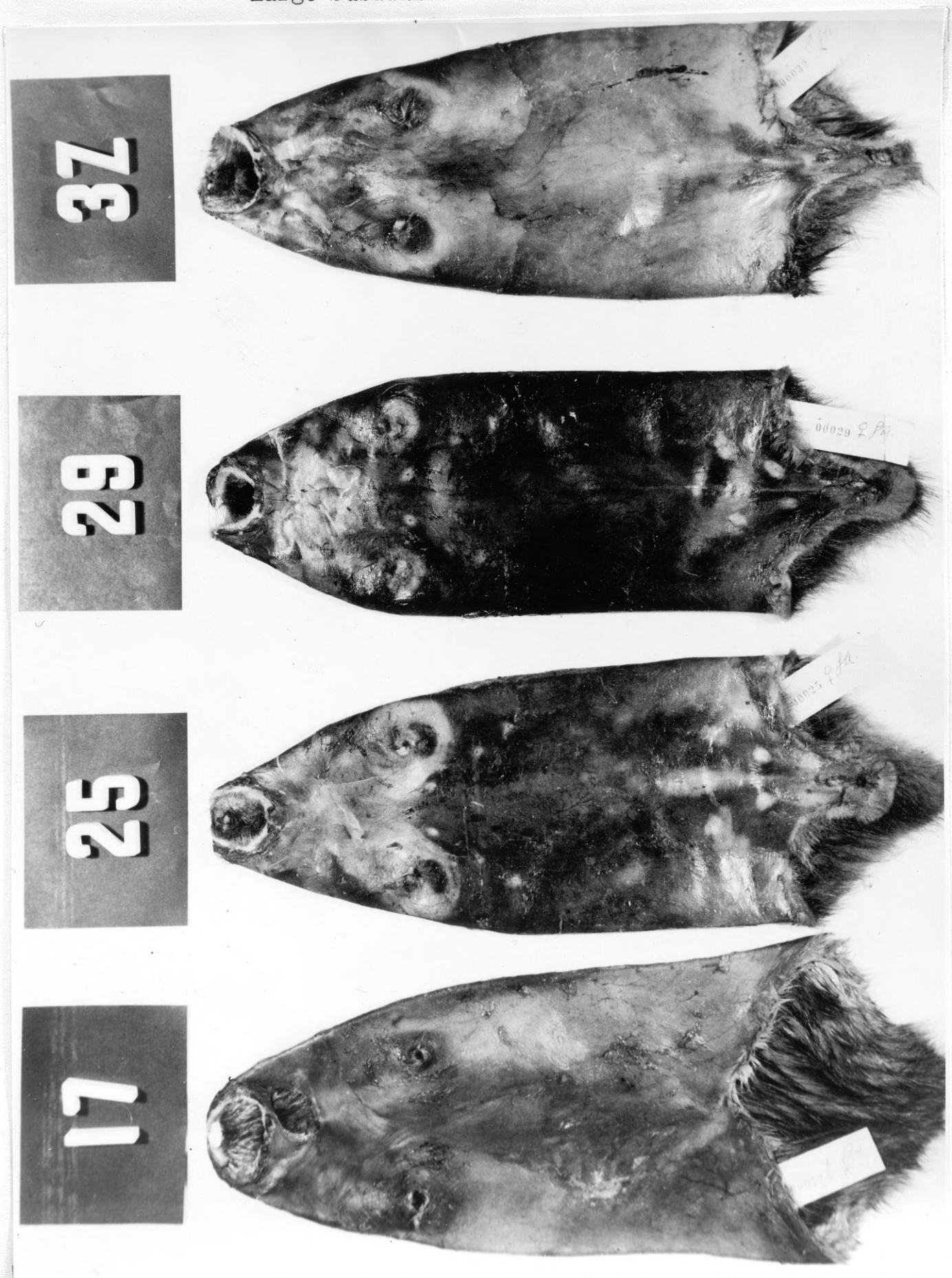


PLATE 27

Large Subadults Dorsal

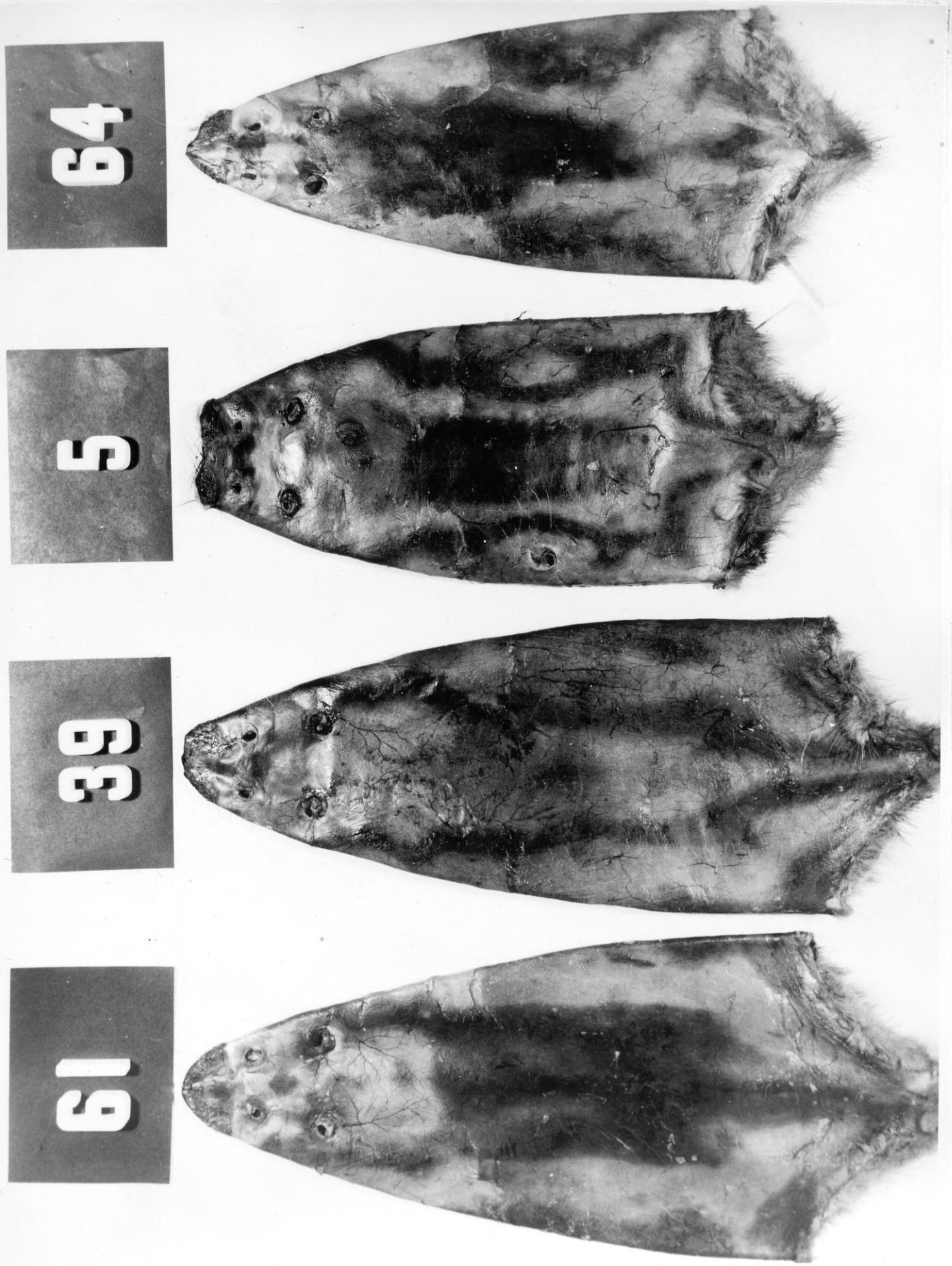


PLATE 28

Large Subadults Ventral

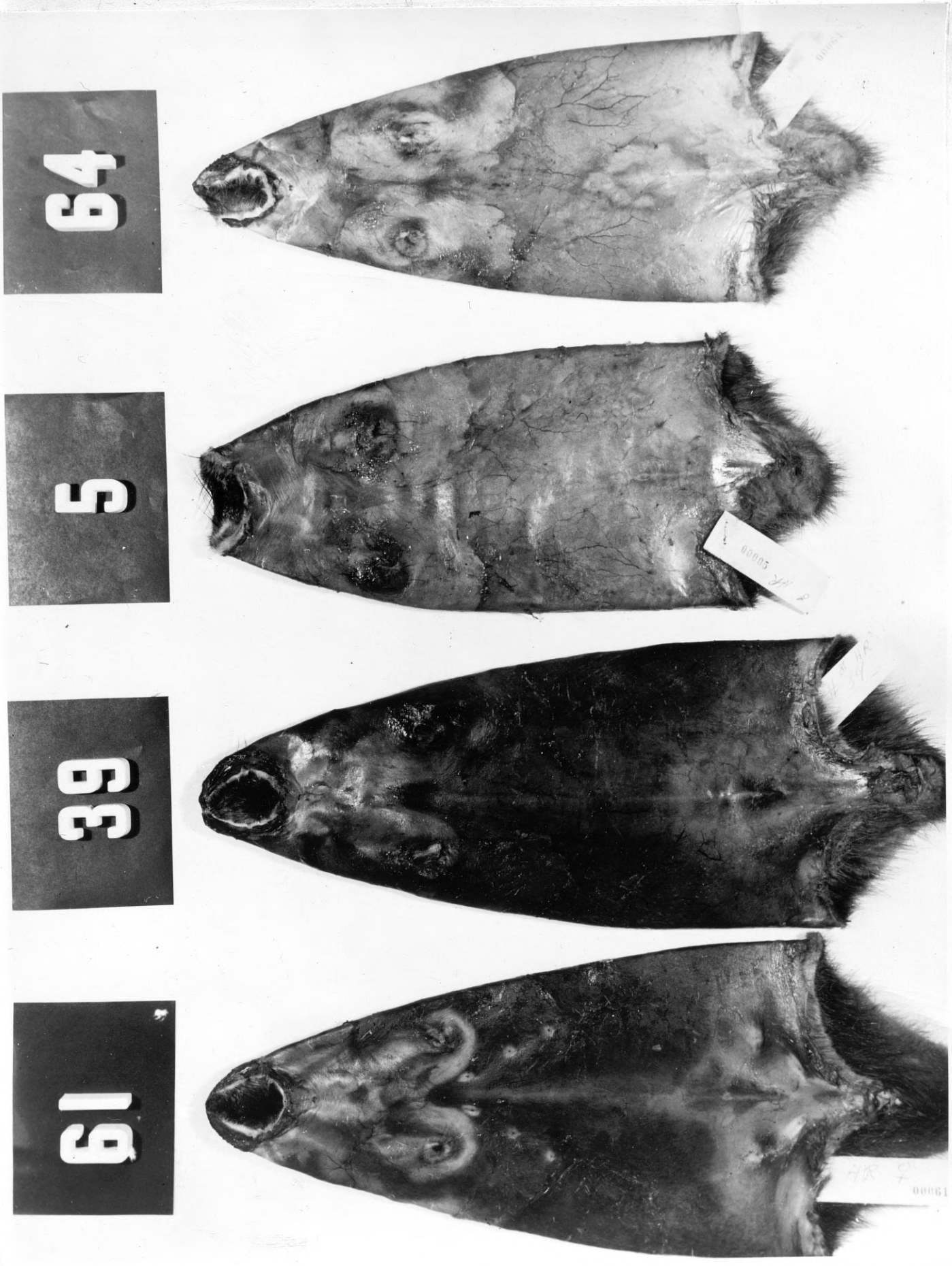


PLATE 29

Large Subadults Dorsal

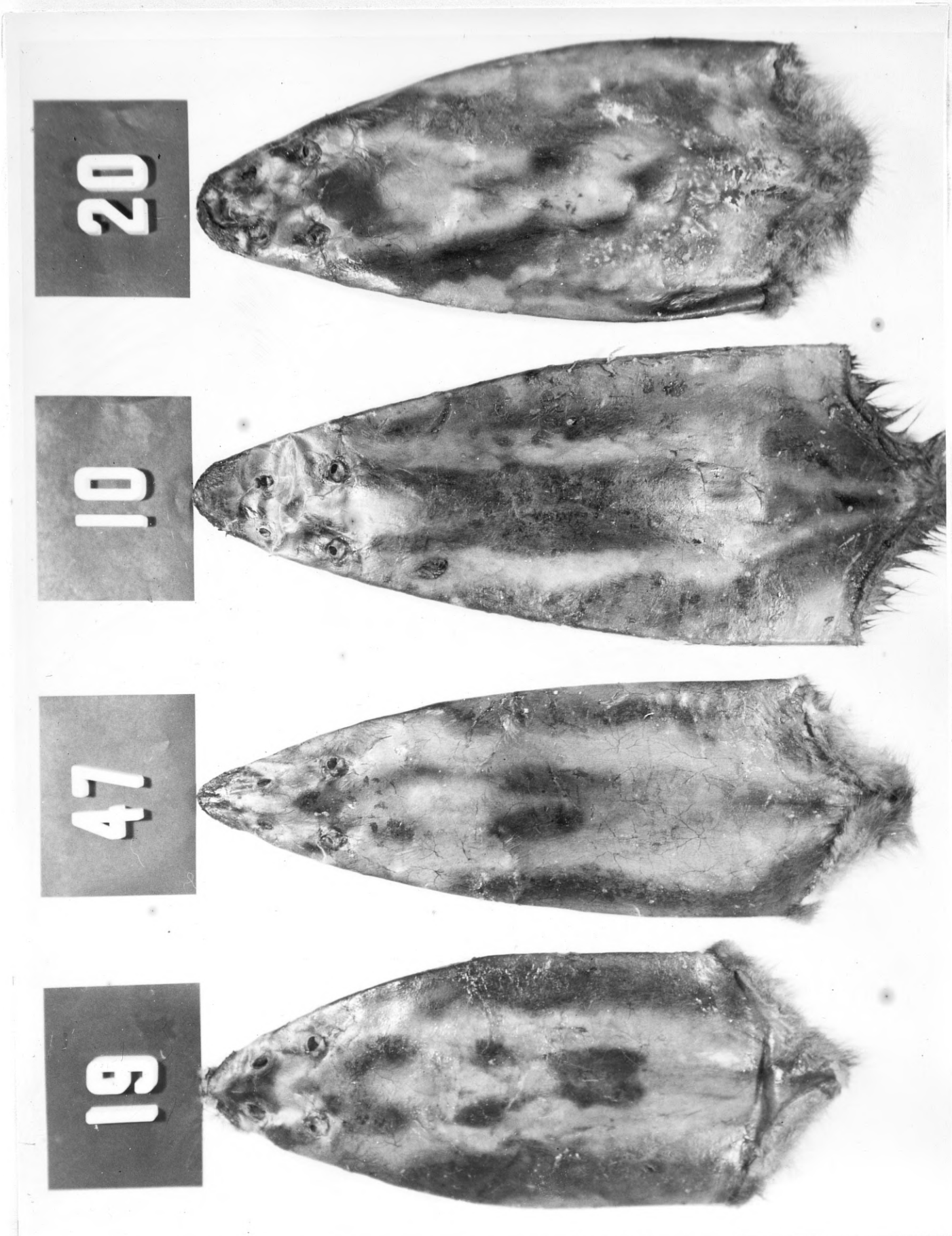


PLATE 30

Large Subadults Ventral

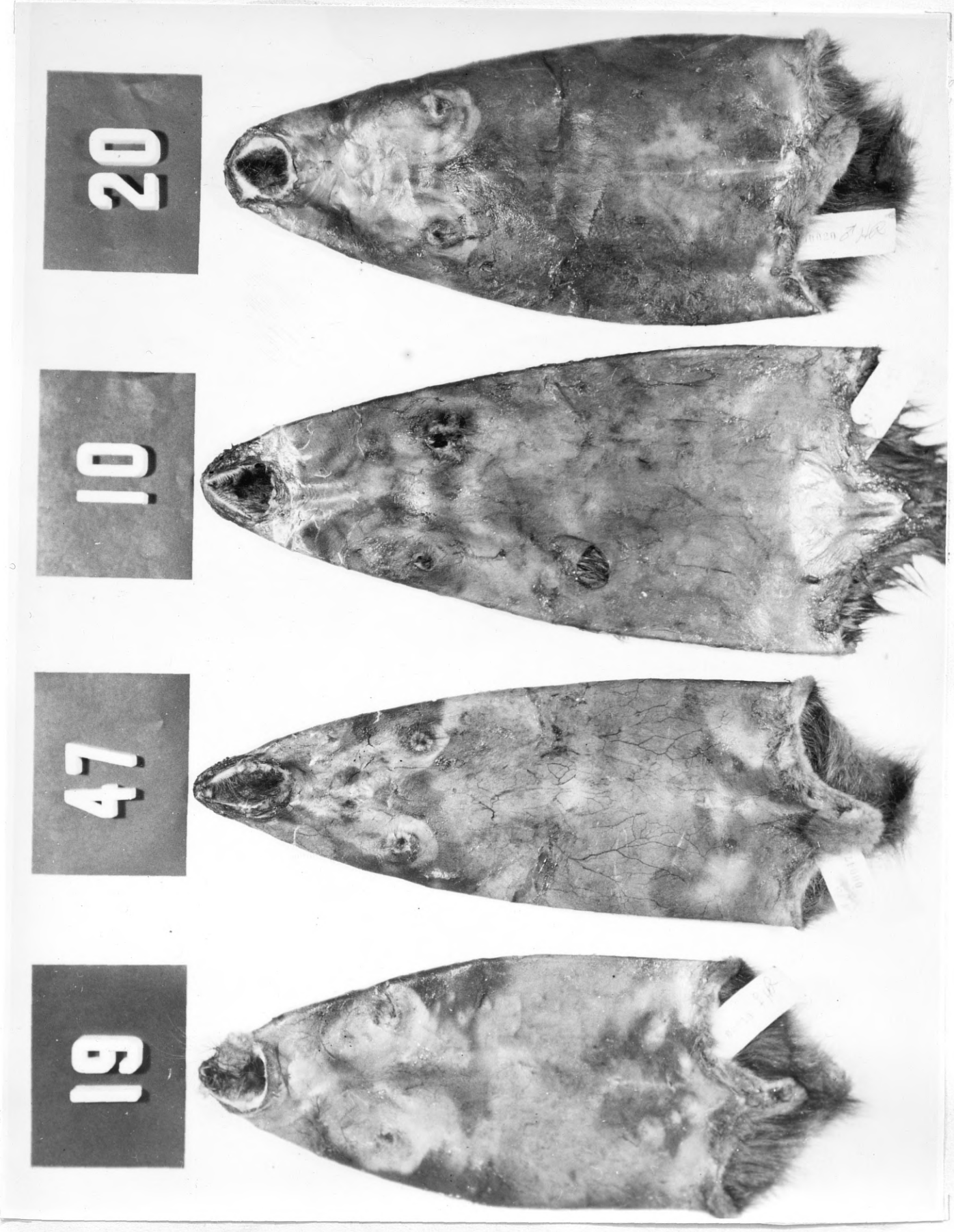


PLATE 31

Large Subadults Dorsal

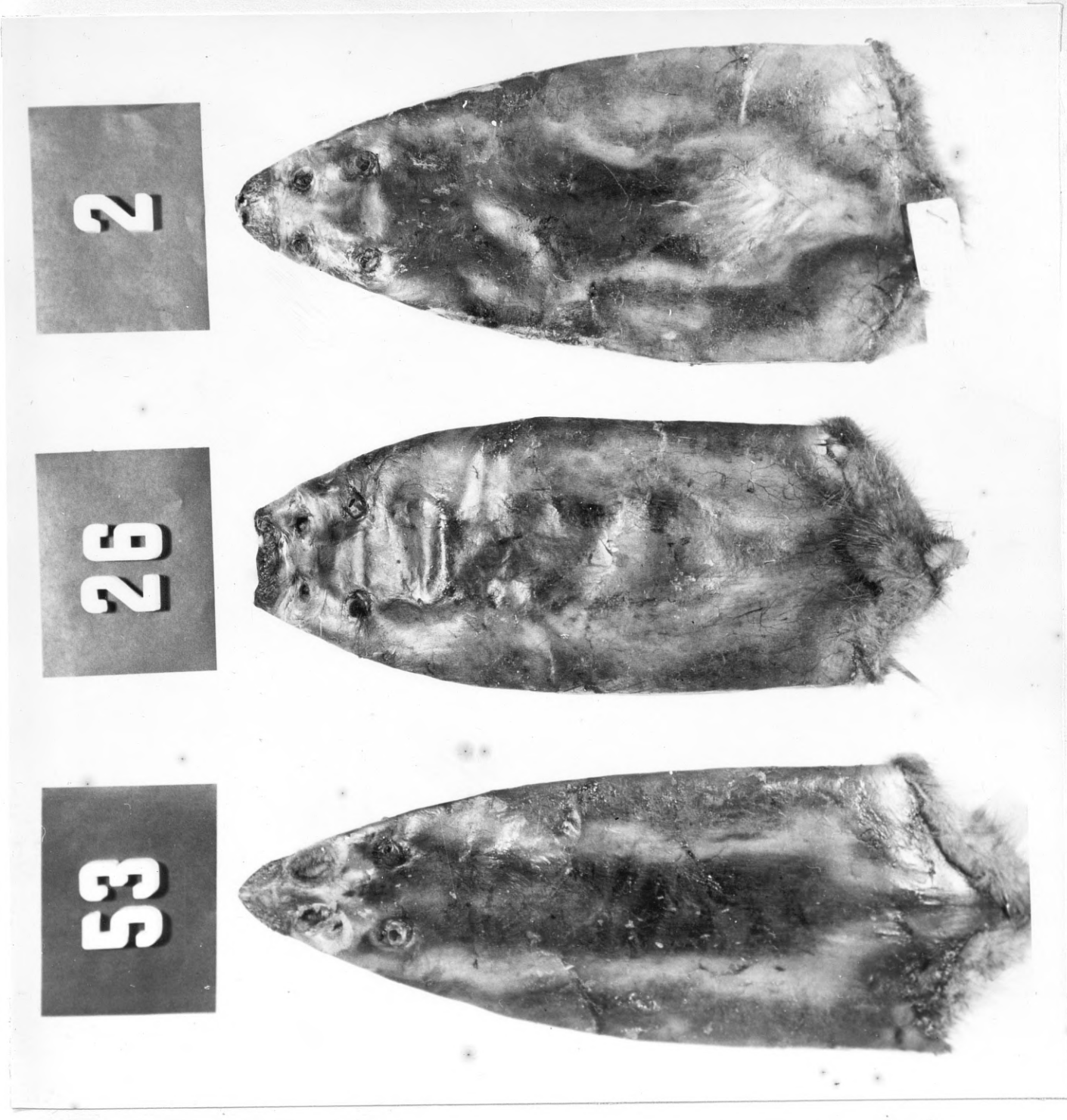


PLATE 32

Large Subadults Ventral

PLATE 33

Large Subadults Dorsal

PLATE 34

Large Subadults Ventral

PLATE 35

Large Subadults Dorsal

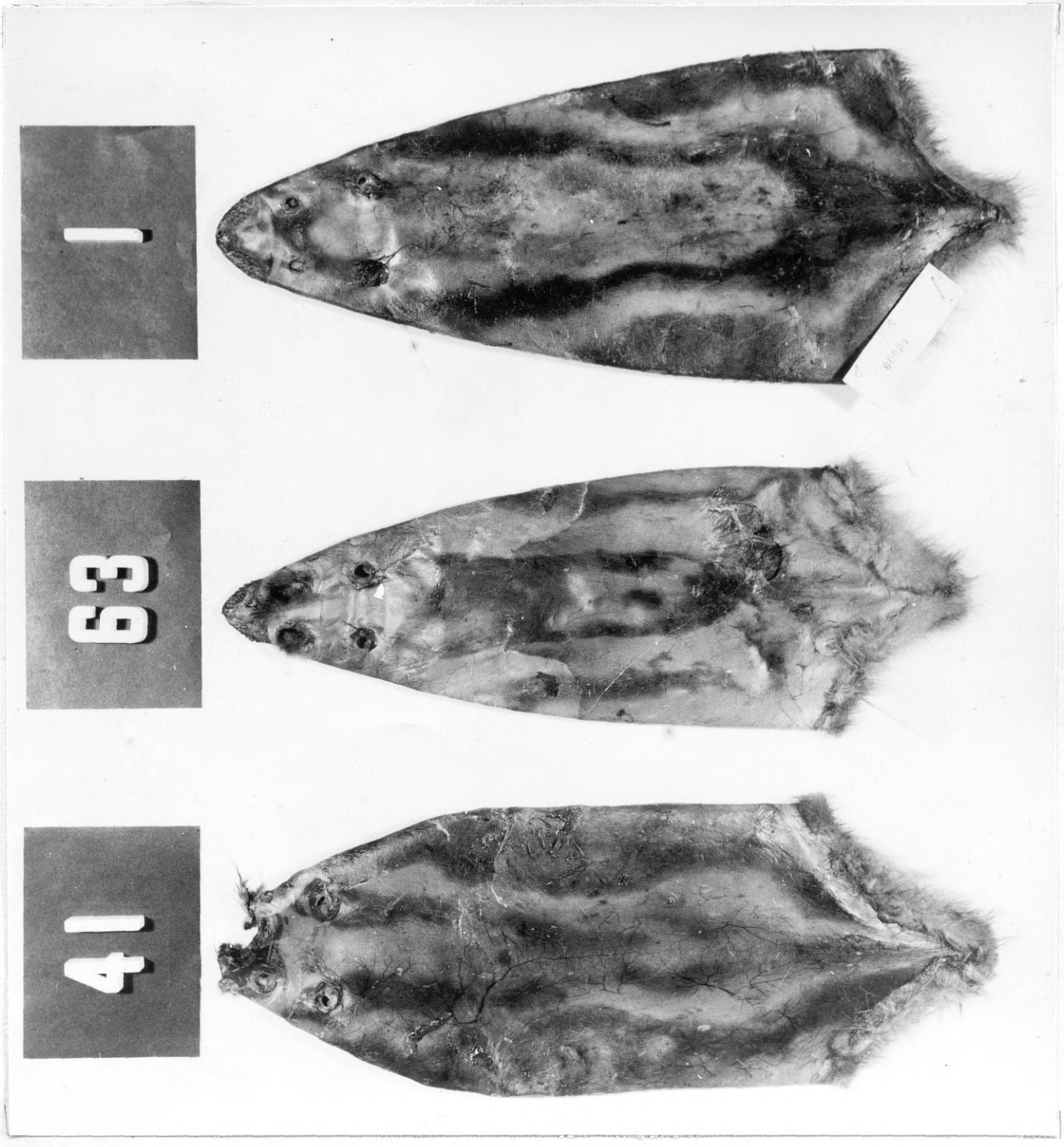


PLATE 36

Large Subadults Ventral

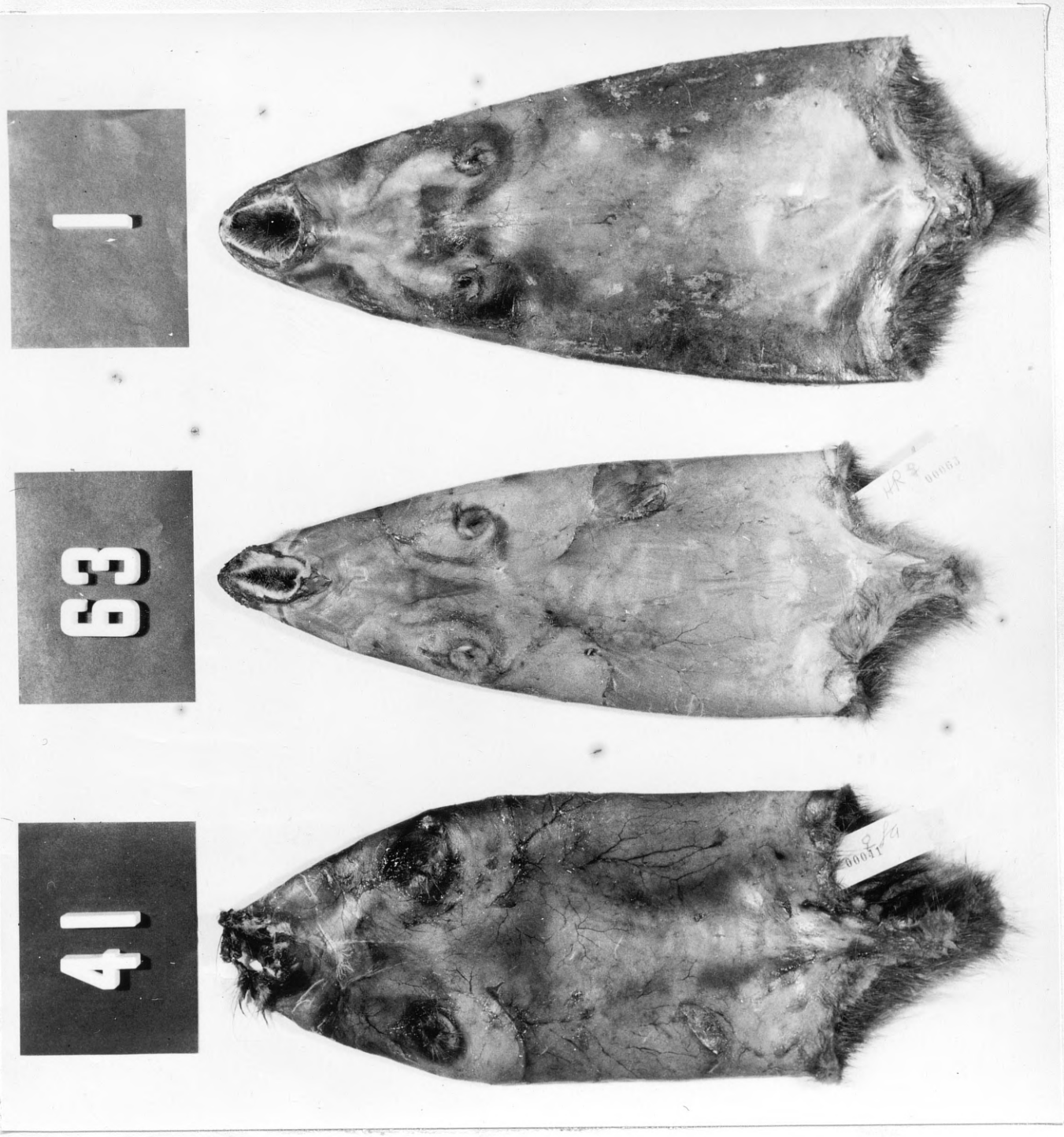


PLATE 37

Large Subadults Dorsal

PLATE 38

Large Subadults Ventral

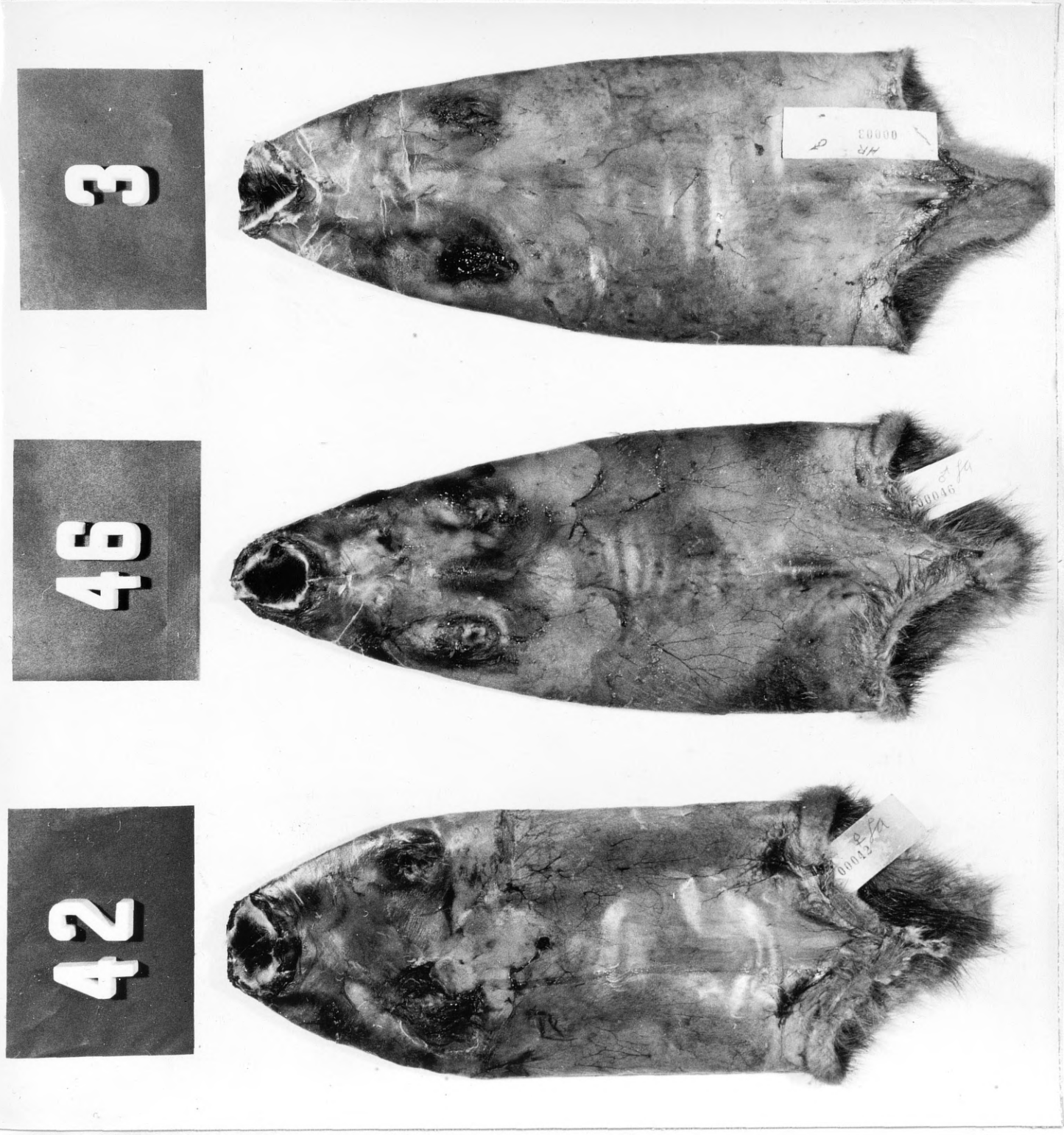


PLATE 39

Large Subadults Dorsal

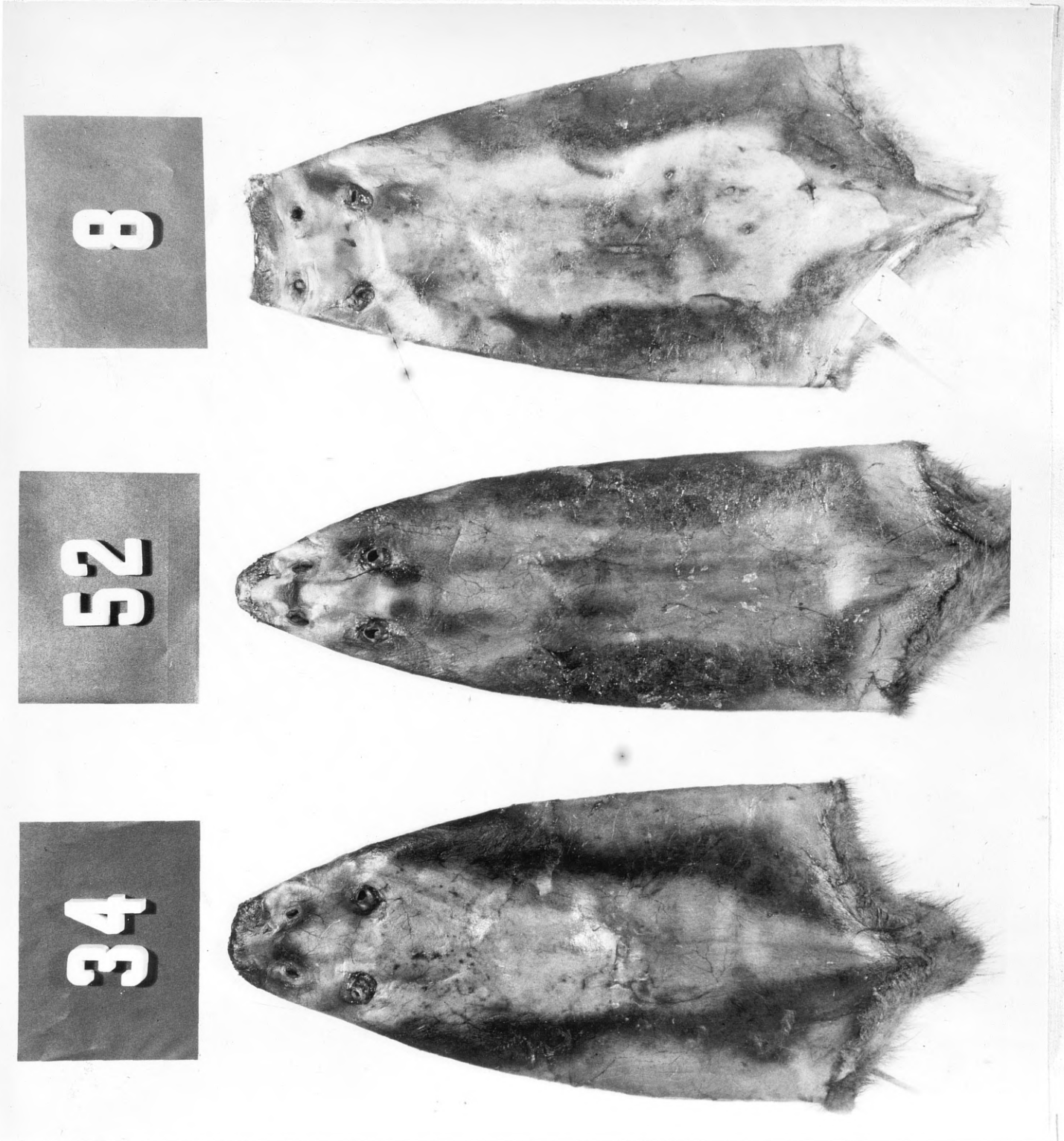


PLATE 40

Large Subadults Ventral

PLATE 41

Large Subadults Dorsal

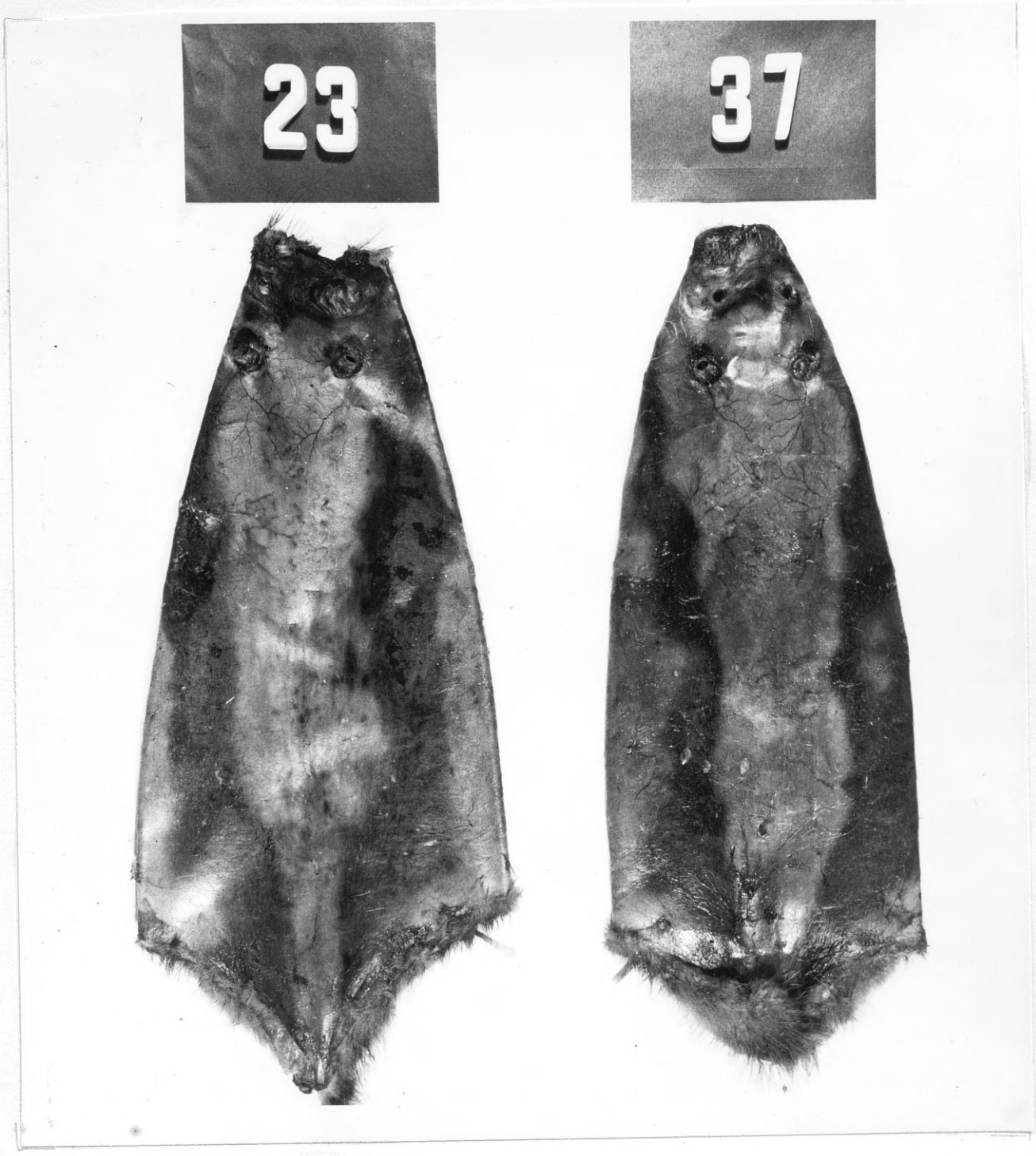


PLATE 42

Large Subadults Ventral

PLATE 43

Large Subadults Dorsal

PLATE 44

Large Subadults Ventral

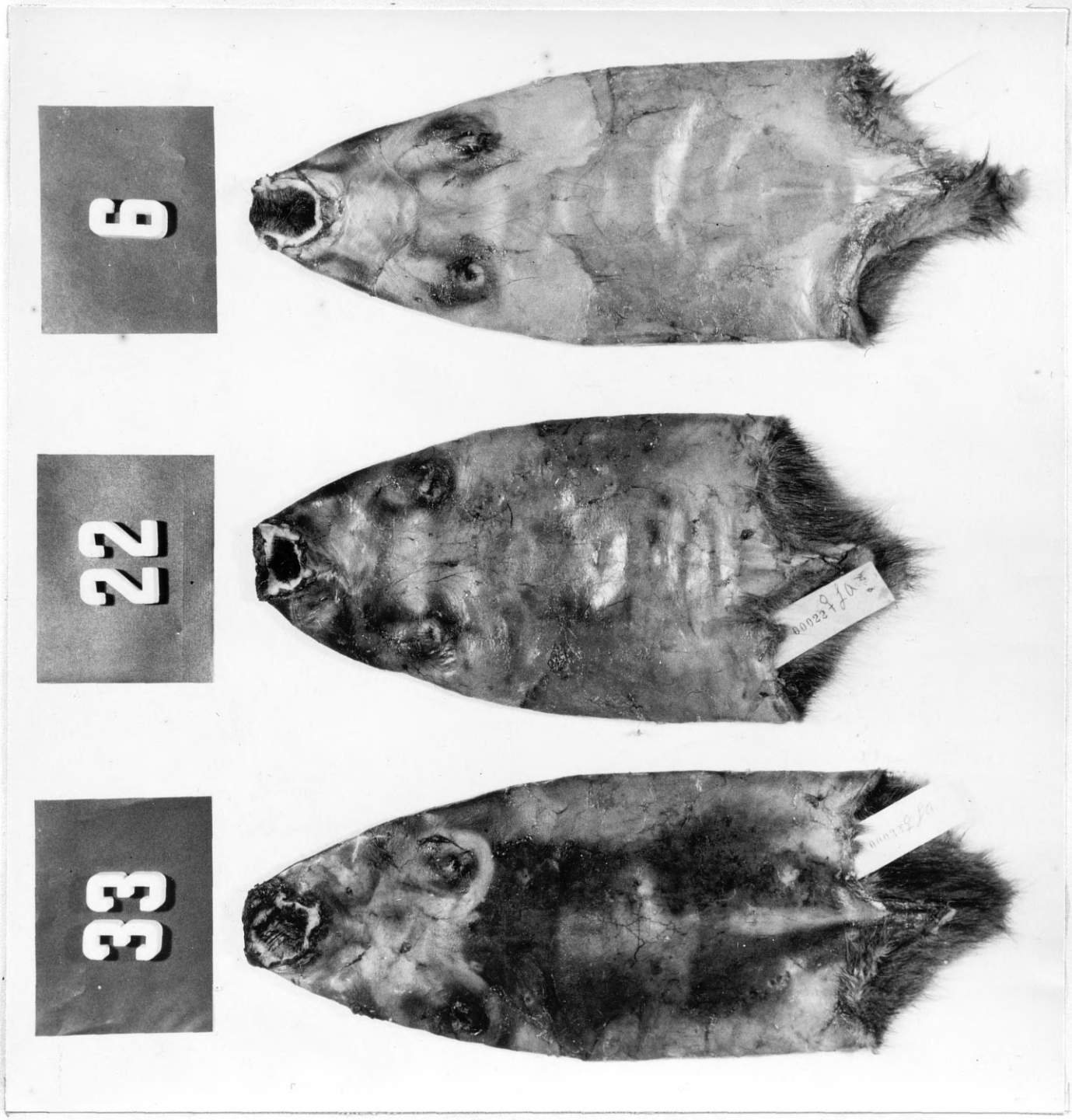


PLATE 45

Large Subadults Dorsal

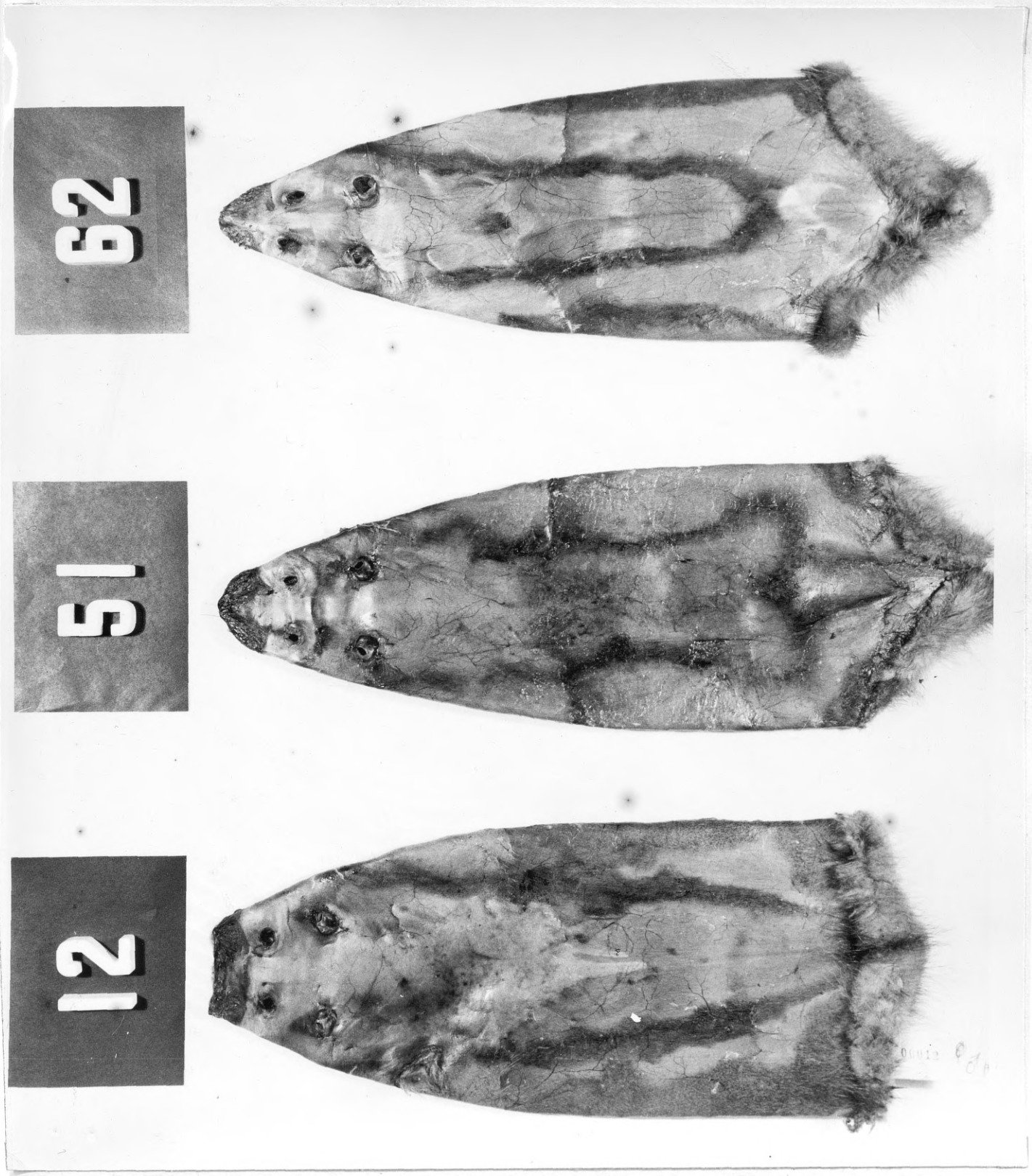
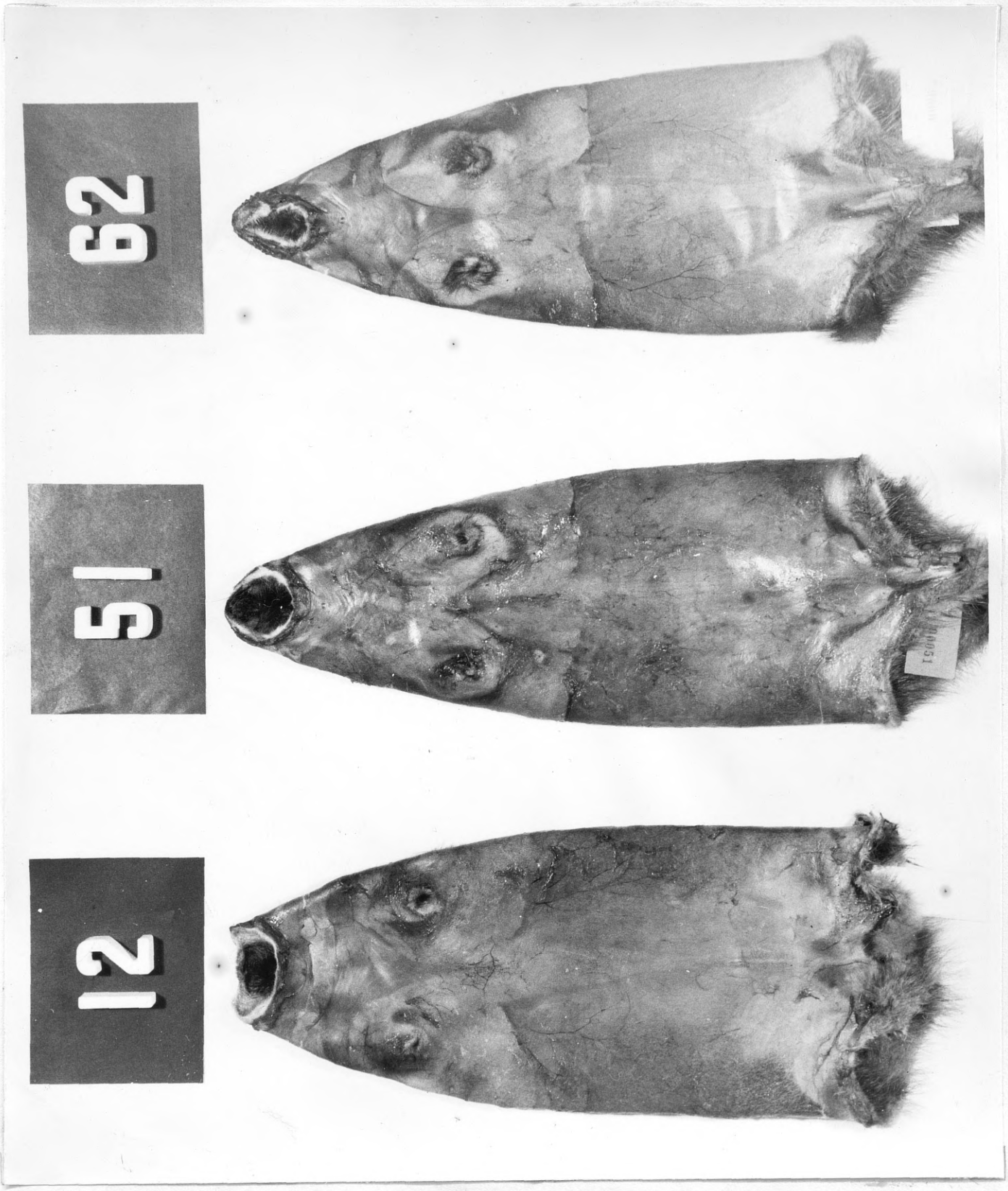


PLATE 46

Large Subadults Ventral



THE SMALL SUBADULTS OR "KITS"

For descriptive purposes, seven specimens were placed in this category. The sequent patterns of priming among the "kits" in the phases leading to full primeness are characterized by the same general features as those described for the larger subadults. The small subadults differ in that the contrast between prime and unprime areas is more sharply delineated. This is illustrated in Plates 49 and 50 which are typical specimens (?).

Unlike the adults and large subadults, the "kits" displayed an increasing degree of primeness with time. In view of the data presented for the balance of the series examined, this condition may very well be the result of too few specimens and/or the arbitrary separation of this group from the larger subadults.

Two almost completely unprime specimens are represented in the series and provide a clue as to the early character of the "lyre-shaped" prime area that is typical of all subadults examined (Plates 47 and 48). These specimens may be said to complete the synthesis of the sequence of priming of all subadult muskrat studied. The sequence of priming interpreted for the "kits" draws heavily on the information synthesized for the large subadults and upon the few specimens at hand. This sequence appears to take place as follows: (1) priming occurs first under the neck and between the forelegs; (2) two prime spots appear dorsolaterally in the mid-body region (Plate 47); (3) these prime spots extend progressively dorsad and ventrad

to produce the dorsal "lyre-shaped" prime area described for the larger subadults. On the pelts of the "kits" examined, all of the preceeding occured prior to any general priming of the ventral (belly) surfaces; (4) the sides and flanks appear to prime next. Collaterally with this, the ventral areas are becoming prime. On the most prime "kit" taken, all areas were nearly prime except the mid-dorsal region which was still quite unprime. Some variation exists at this point in the sequence as will be seen by comparing Plates 51 and 52 with Plates 49 and 50. The former plates illustrate specimens which became prime mid-dorsally (as in the larger subadults) in advance of the time that the sides and flanks were becoming prime. This was not the case with the specimens illustrated in Plates 49 and 50 which remained unprime mid-dorsally. It is not deemed advisable to carry this synthesis beyond this point as specimens approaching full primeness are not present in the series, nor is adequate material available to define fully the variation in the latter sequences of priming.

PLATE 47

Small Subadults Dorsal

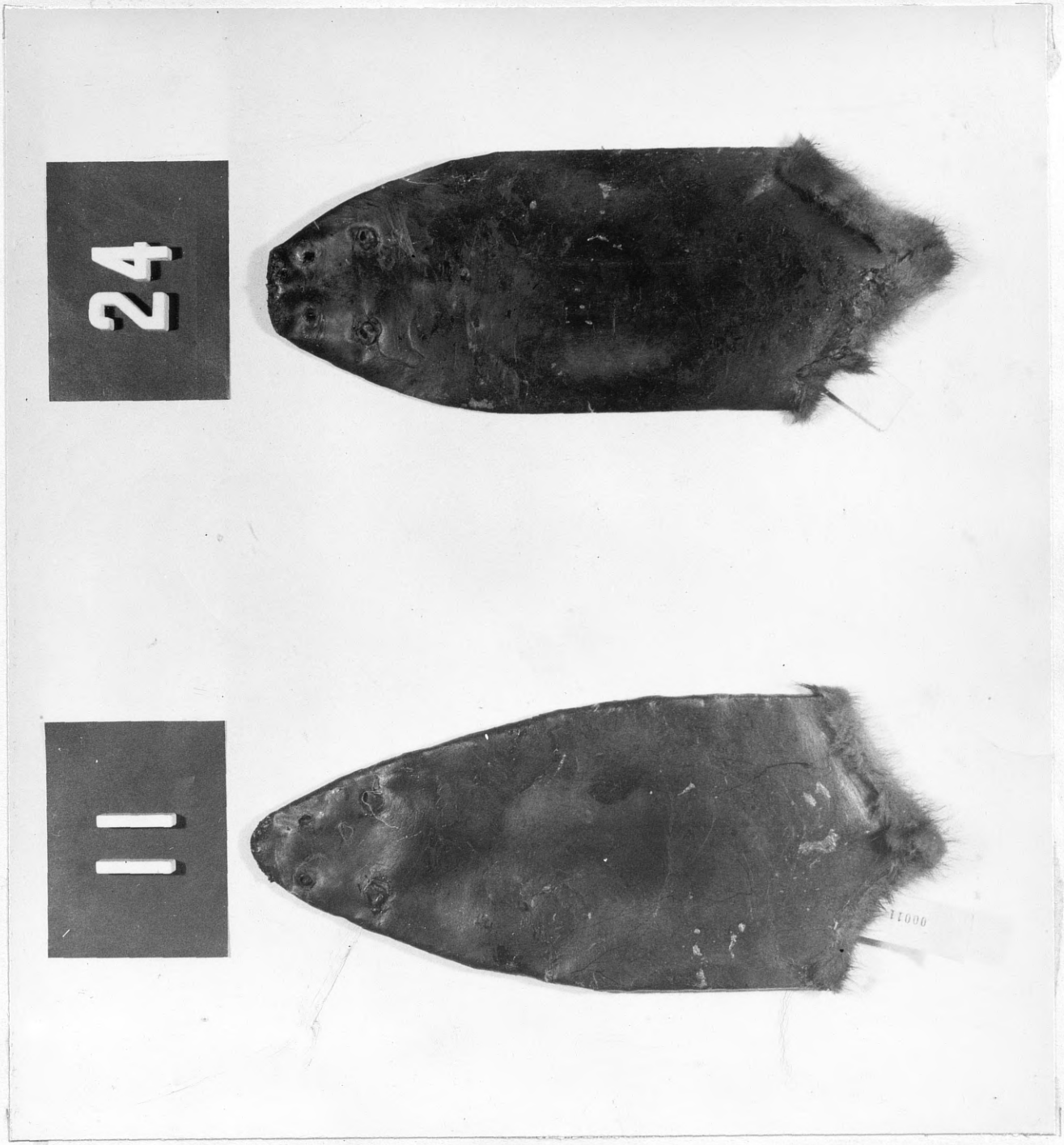


PLATE 48

Small Subadults Ventral

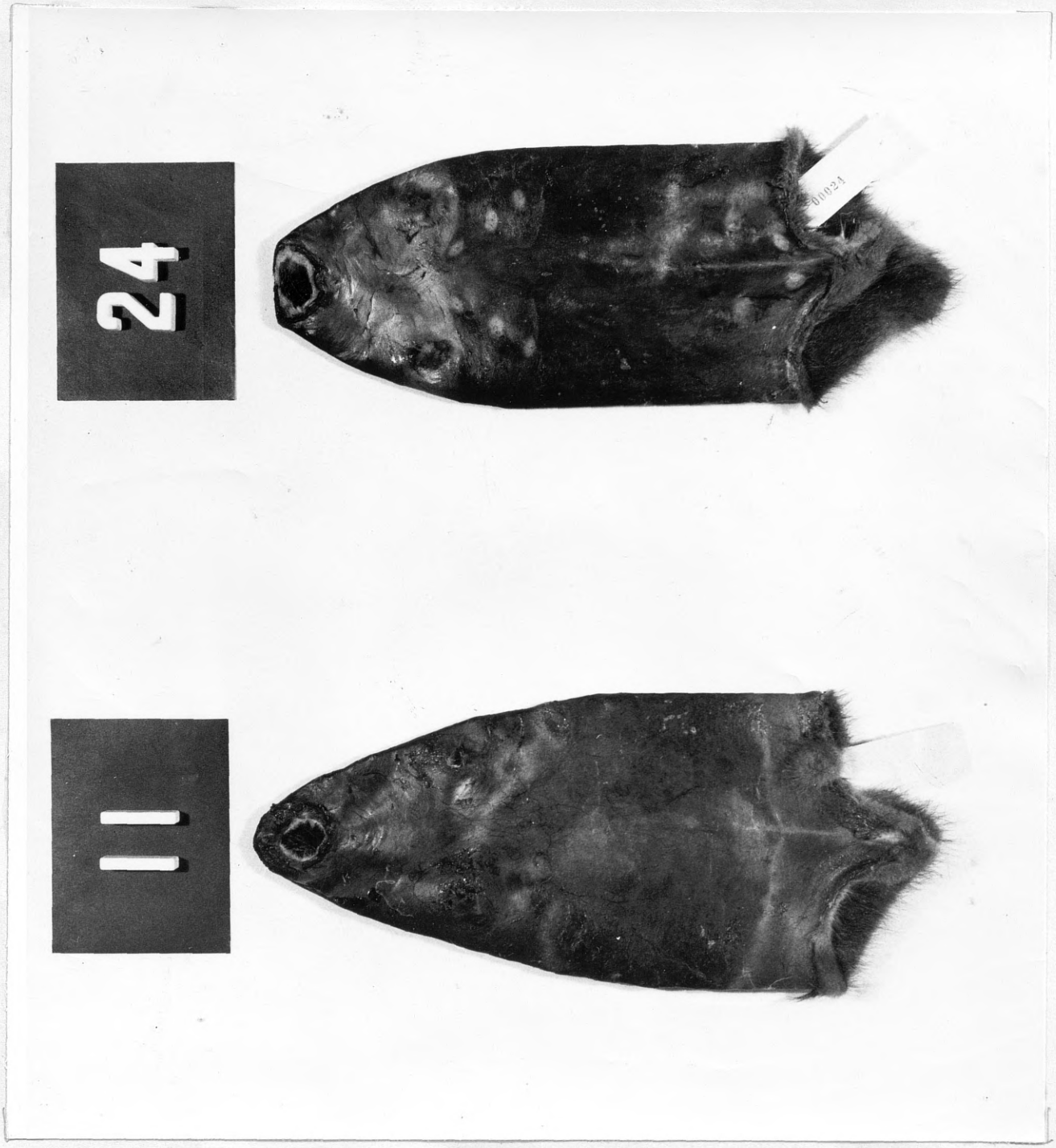


PLATE 49

Small Subadults Dorsal

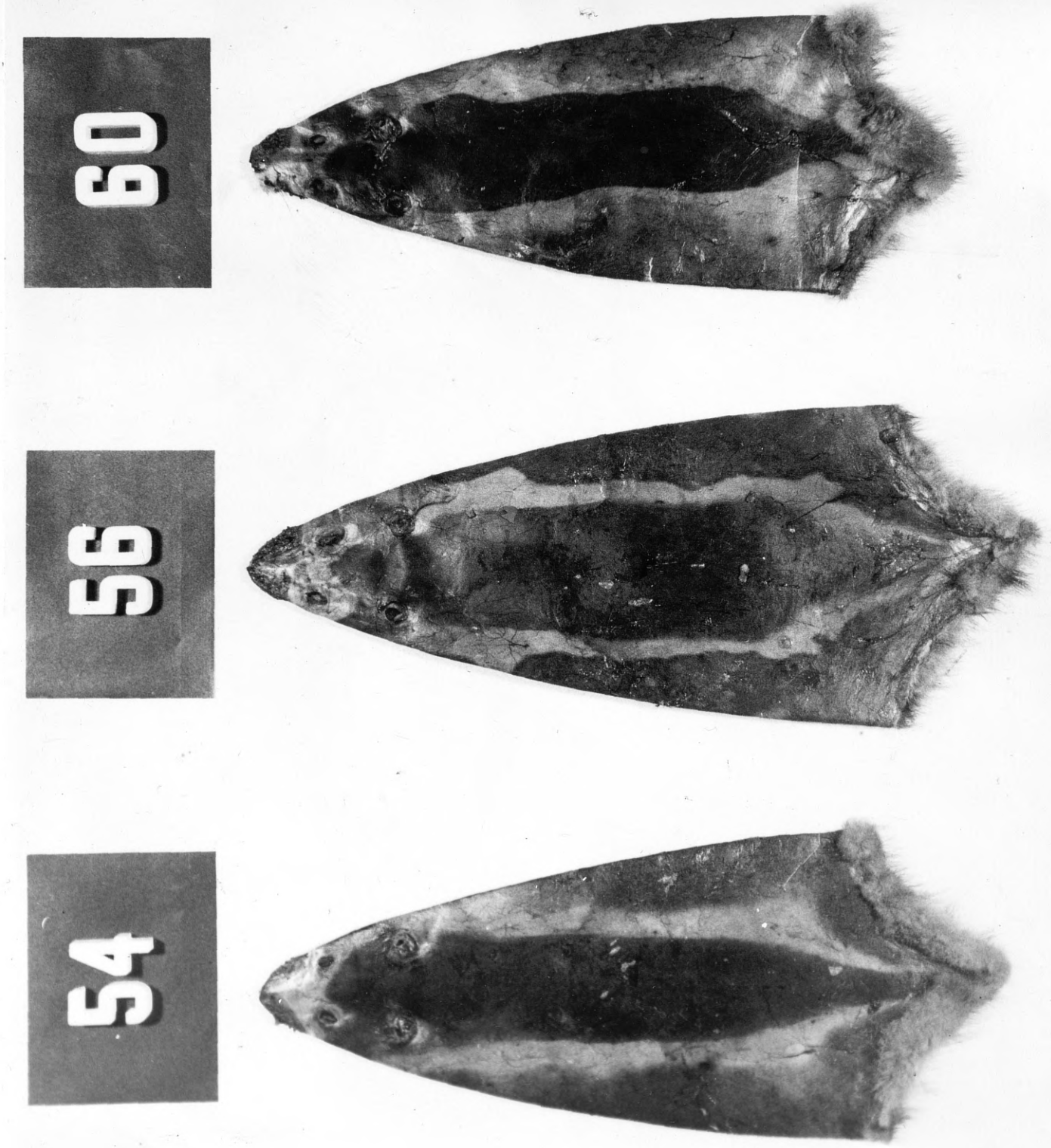


PLATE 50

Small Subadults Ventral

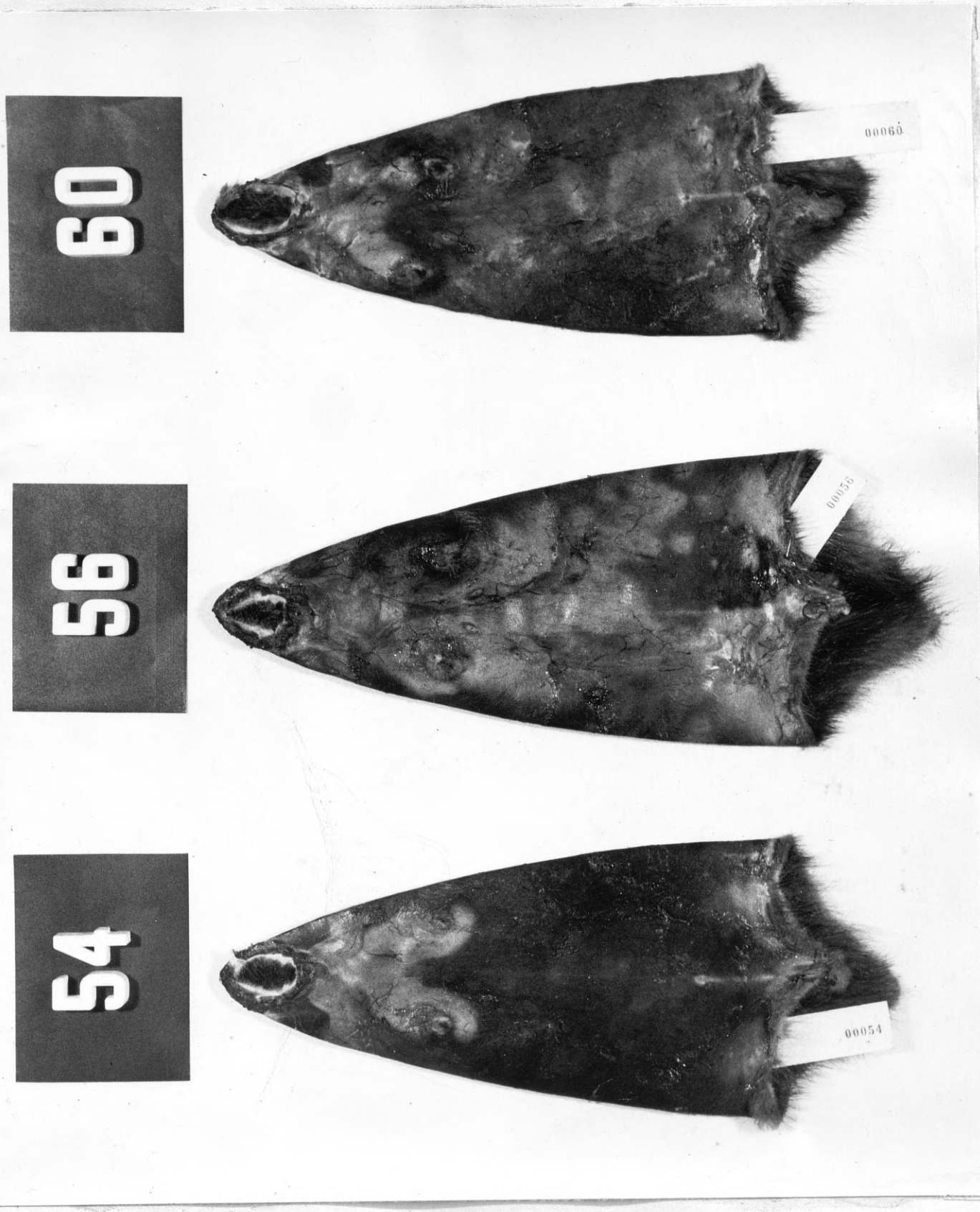


PLATE 51

Small Subadults Dorsal

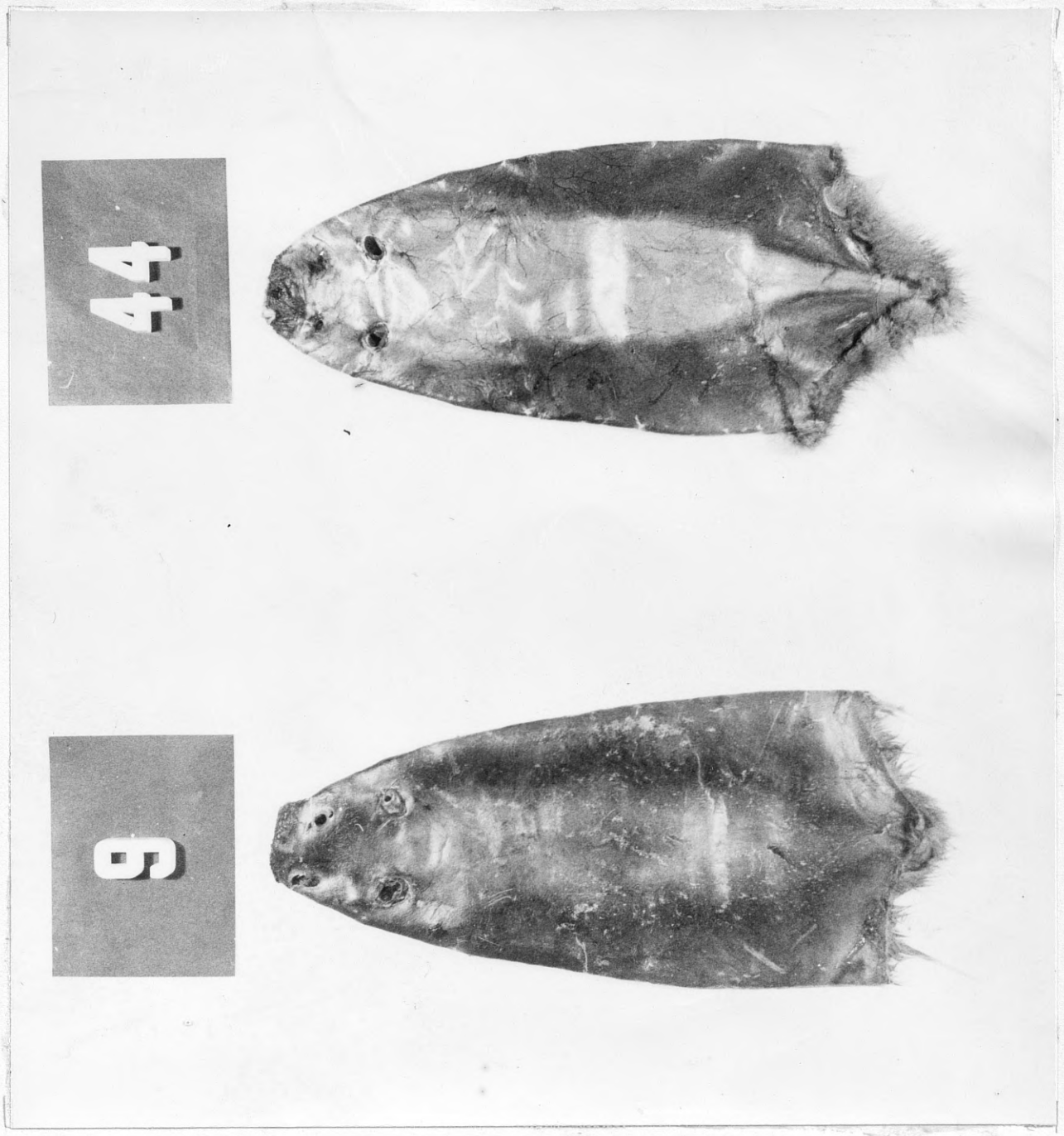


PLATE 52

Small Subadults Ventral

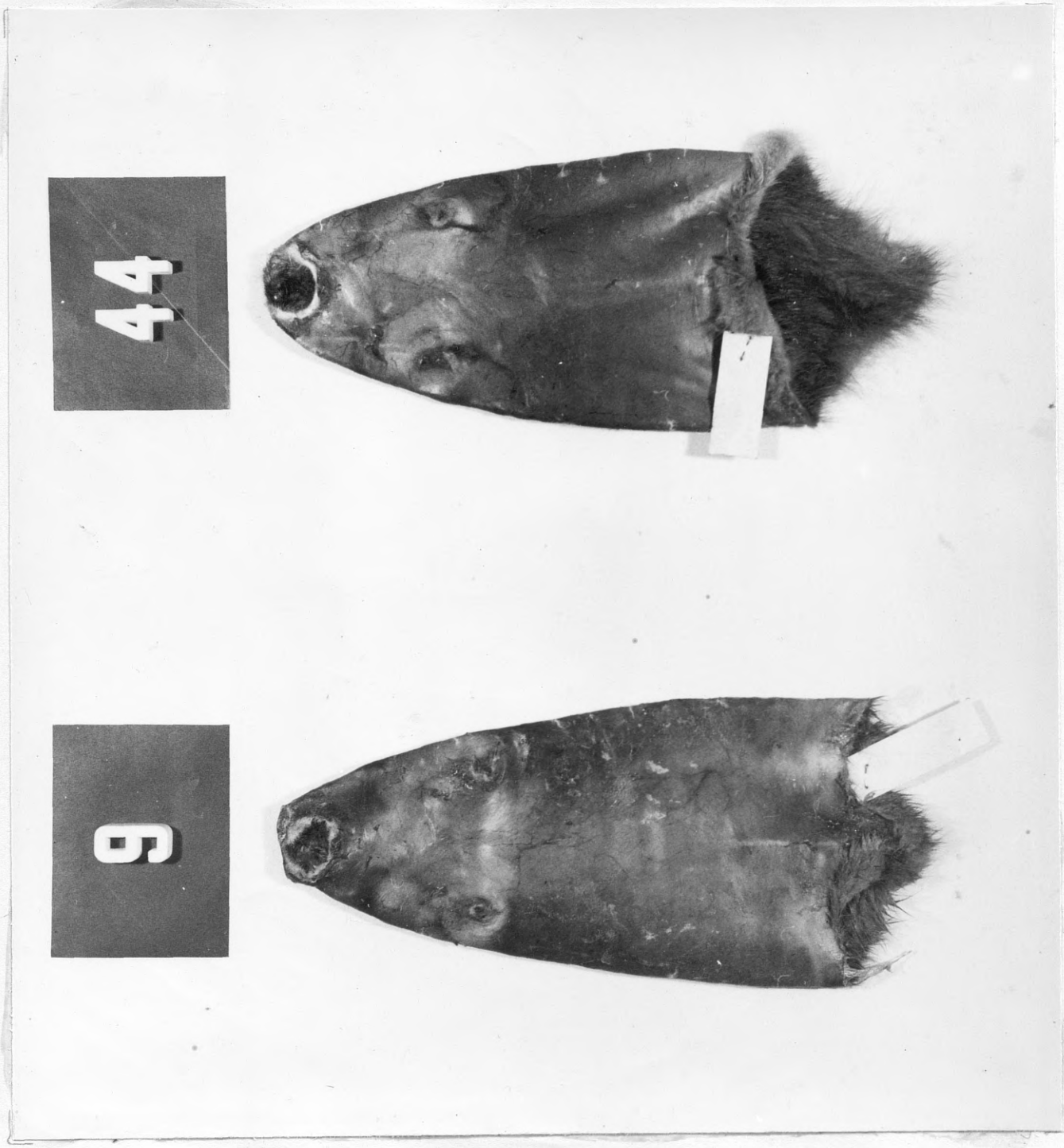


PLATE 53

Adults (??) (Discarded) Dorsal

PLATE 54

Adults (??) (Discarded) Ventral

RELATIONSHIP OF DEGREE OF PRIMENESS TO AGE CLASSES

A careful examination of Table 4 reveals an interesting phenomena that was evident when the entire series of pelts, placed in chronological order of collection, was viewed as a whole. It appears that at any particular time during the fall, when priming is occuring, the adults are generally more prime than the large subadults and the large subadults are generally more prime than the small subadults. For example, of ten specimens taken on November 11, one adult was 50 percent prime dorsally and 75 percent prime ventrally. Eight large subadults varied from subphase I to III in dorsal primeness and only two were prime ventrally. One "kit" was almost completely unprime. All of these were taken from the same population. Other instances of this are apparent in Table 4. The difference is particularly marked between the adults and the "kits". The reason for this variance of degree of primeness with age is not apparent at the present time.

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