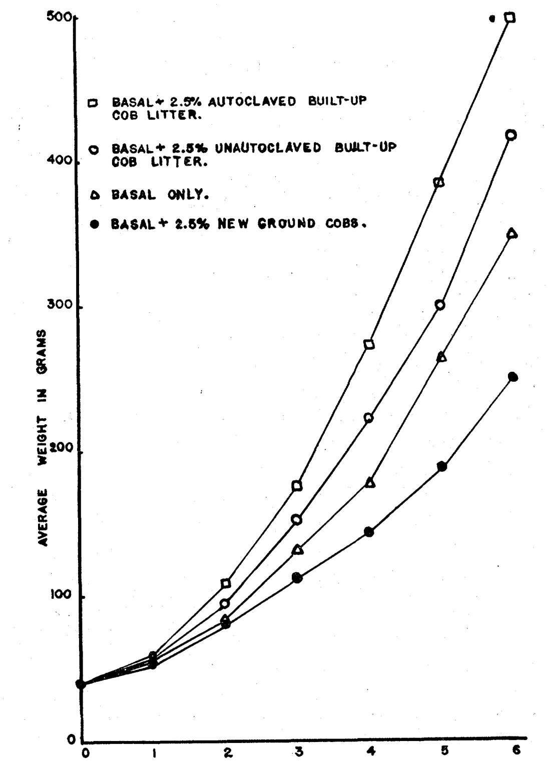

FIG. 1. Chick growth on all-vegetable vitamin B_{12}-deficient basal diet vs. basal plus 2.5% of various kinds of litter.

B_{12}-deficient diet. The autoclaving of this built-up litter for 15 min at 15 lb pressure made it decidedly more effective at the higher levels and produced a growth stimulation of 49, 121, and 142 g for the 1%, 2.5%, and 5% levels, respectively. Addition of ground corncobs to the basal diet, at the rate of 2.5% and 5%, decreased growth by 95 and 80 g, respectively (Fig. 1).

Autoclaving of the built-up litter may release a bound form of vitamin B_{12}, or it may destroy a toxic factor in unautoclaved litter that has a counteracting inhibitory effect on chick growth used at fairly high levels. The increase in growth obtained upon adding 1% of unautoclaved built-up litter as compared to 2.5% tends to support the theory that a toxic factor is present in the litter that has an inhibitory effect on growth, and that this factor is destroyed by autoclaving.

References

1. KENNARD, D. C., and CHAMBERLIN, V. D. *Poultry Sci.*, 1948, **27**, 240.
2. ———. *Ann. N. Y. Acad. Sci.*, 1949, **52**, Art. 4, 583.
3. KENNARD, D. C., BETHKE, R. M., and CHAMBERLIN, V. D. *Poultry Sci.*, 1948, **27**, 477.
4. MCGINNIS, J., STEVENS, J. M., and GROVES, K. *Poultry Sci.*, 1947, **26**, 432.
5. MISHLER, D. H., *et al.* *Poultry Sci.*, 1946, **25**, 479.
6. MISHLER, D. H., CARRICK, C. W., and HAUGE, S. M. *Poultry Sci.*, 1949, **28**, 24.
7. RUBIN, M., BIRD, H. R., and ROTHCHILD, I. *Poultry Sci.*, 1946, **25**, 526.
8. SCHLAMB, K. F., and WINTER, A. R. *Poultry Sci.*, 1948, **27**, 492.

Preliminary Results on the Crystal Structure of Some Ammonium Salts with Substituted Aliphatic Chains

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Because of renewed interest in the structure of aliphatic compounds, especially amines with straight and branched chains, preliminary investigations have been made upon the normal temperature modifications of the dodecyl-, tridecyl-, tetradecyl-, hexadecyl-, and *n*-methyldodecylammonium chlorides. Dodecylammonium, tetradecylammonium, and hexadecylammonium chlorides are monoclinic, space group $P2_1$ or $P2_1/m$, with $n=2$. Chemical considerations give preference to $P2_1$. Tridecylammonium chloride is orthorhombic, space group $C2ca$ or $Cmca$, with $n=8$. Cell dimensions of these compounds are:

	a	*b*	*c*	*β*
$C_{12}H_{25}NH_3Cl$	5.66 A	7.18 A	17.73 A	92° 30′
$C_{14}H_{29}NH_3Cl$	5.67 A	7.20 A	20.13 A	95° 52′
$C_{16}H_{33}NH_3Cl$	5.71 A	7.24 A	22.56 A	98° 21′
$C_{13}H_{27}NH_3Cl$	7.57 A	7.61 A	56.49 A	90°

N-methyldodecylammonium chloride is triclinic, space group $P1$, with $n=2$. Cell dimensions are: $a=4.98$ A; $b=5.29$ A; $c=29.92$ A; $\alpha=90°\ 52'$; $\beta=91°\ 52'$; $\gamma=90°\ 45'$.

The Buerger precession camera was used almost exclusively for unit cell and space group determinations. Laue photographs of these compounds, especially dodecylammonium chloride, show strong diffuse reflections which will be further investigated.

Patterson-Harker projections have been completed, and Fourier analyses are under way on molecular configurations and bond lengths.

[1] This work is being carried on under a fellowship sponsored by Armour and Company.

Growth Layers on the Teeth of Pinnipedia as an Indication of Age

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Government biologists engaged in research on the Alaskan fur seal, *Callorhinus ursinus* (L.), in recent years have marked 80,000 young seals by means of hot-iron brands or numbered metal tags. As a result, thousands of animals of known age are now available for study on the Pribilof Islands, in the Bering Sea, where the adult seals gather each summer to breed, and the young seals to rest. While examining the skull of a known-age specimen in 1949 we observed faint concentric ridges around the roots of the teeth. The age of the seal in

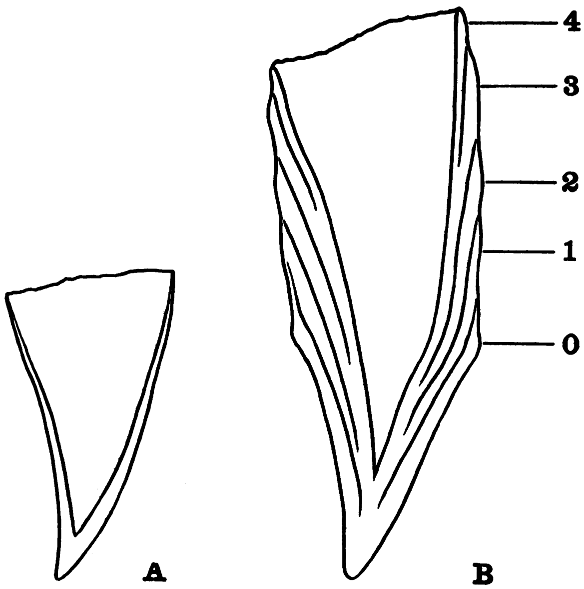

FIG. 1. Teeth of male fur seals, longitudinal section through right upper canines of newborn (*A*) and 4-year-old (*B*). Numbers show approximate position of the annual winter growth ridge, with 0 representing the winter of the fetal year. (Twice natural size.)

years corresponded to the number of ridges. This discovery prompted us to ask: "Do growth ridges indicate the true age of a seal, and if so, within what limits of accuracy? Are they present in all members of the Pinnipedia? Why are they found on the teeth of seals but apparently not on the teeth of land mammals?"

At the start of our study we selected the right upper canine, or "fang," of the fur seal as the tooth upon which the growth ridges are most clearly displayed. They are present, however, on all the teeth. When the fur seal young is born in midsummer the canine, as well as most of the other permanent teeth, have erupted. At birth, the crown of the canine is fully developed (Fig. 1). Once erupted, it does not change in size as a result of growth, although it may be reduced through attrition. The *crown* is covered with a glossy enamel and is marked by a longitudinal keel ending at a minute cusp on the neck, or cementoenamel junction. (The length of the root may conveniently be measured from this cusp.) The *root* of the tooth increases in length throughout the life of the seal, or at least to the age of senility, a matter of perhaps 20–25 years. The *pulp* deposits dentine, or ivory, in the root canal until, at an approximate age of 10 years, the canal is completely filled. (The growth of the tooth may be illustrated by stacking cones, one inside the other, each smaller than its predecessor, until a virtually solid object is developed.) Differential deposition of dentine is responsible for the growth ridges visible on the root of the tooth, each representing a winter's growth (Figs. 1, 2).

On canine teeth taken from 75 fur seals of known age, the growth layers accurately represent the age of the individual up to 4 years, and occasionally up to 7 or 8 years, but tend to give false evidence above age 4. On certain teeth the layers are beautifully displayed, on others barely discernible. The ridge marking the seal's first winter is usually a faint one, an observation in line with the known fact that many members of the yearling class do not return to the Pribilof Islands to rest. Observations of the teeth under ultraviolet illumination give no better results than those under tungsten-filament illumination. Radiographs of entire teeth or of thin sections are, unfortunately, of little value in this connection.[1] The presence of thin layers deposited at intervals of less than a year is one source of confusion, and the extremely variable growth rate among fur seals is another. In mature animals approximately 10 years old and older, the ridges had disappeared—whether by the addition of dentine or by its absorption is not clear.

The differential growth of the tooth root in fur seals is a reflection of an amphibious life. In winter and spring the seals are at sea, spread thinly over the Pacific Ocean from the Aleutian Islands to Southern California. In summer and fall they are on, or adjacent to, the Pribilof Islands. Thus their oceanic pasture and food supply vary markedly from one season to the next. Second, the males tend to abstain altogether from food and drink during the summer season. This is increasingly true with growth and accelerated sexual activity. Prime, breeding males may remain virtually rooted to one station on land for more than 2 months, living on their reserve

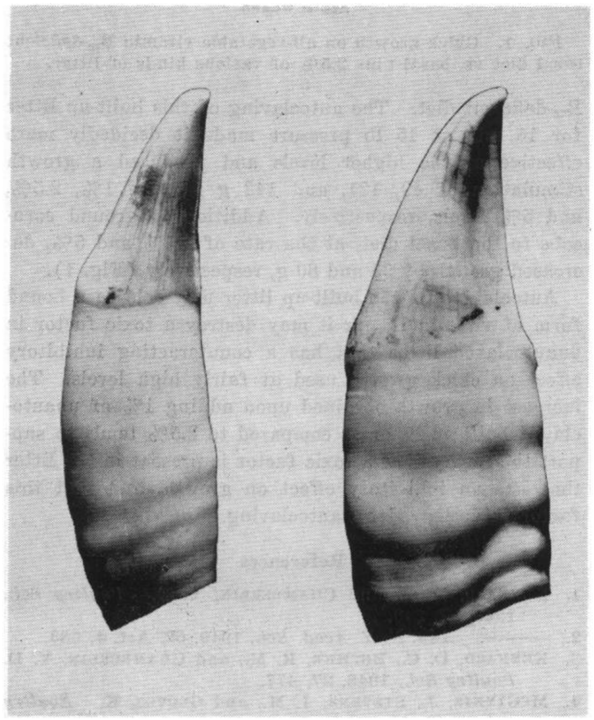

FIG. 2. Teeth of fur seals showing annual growth ridges of 4-year-old male (left) and 7-year-old female (right). (Twice natural size.)

[1] We acknowledge the kindness of B. O. A. Thomas and R. J. Nelsen of the University of Washington School of Dentistry, who prepared radiographs of selected teeth.

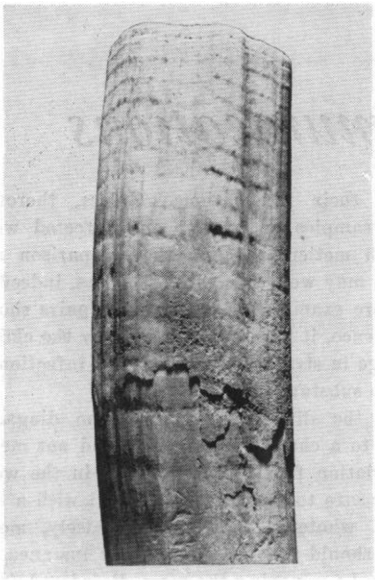

FIG. 3. Root of tusk of very old male walrus showing transverse growth ridges that are quite certainly annuli. (One-third natural size.)

fat. Third, the adult females nurse their young in summer for a relatively long period (4 months), during which time the average pup attains a weight one-third to one-half that of its mother. This presumably drains the mother's reserves and retards the growth of her teeth. Growth ridges are evident on the teeth of the female seal, although they are less prominent than on the male.

A brief survey of material in the U. S. National Museum has revealed that growth ridges on the teeth are characteristic not only of the Alaska fur seal but of certain other Pinnipedia as well. (Study of museum skulls is hampered by the fact that in a well-tended collection the teeth are firmly glued in their sockets.) In the family Otariidae, whose members (the fur seals and sea lions) breed on land and form into definite harems, we have observed well-marked rings on the teeth of *Callorhinus, Eumetopias,* and *Arctocephalus* and dubious ones on *Zalophus.* In the family Phocidae, whose members (the hair seals and elephant seals), with one exception, breed in the water, we have observed growth rings on an adult female *Phoca vitulina,* but not on certain other species of *Phoca, Cystophora,* or *Monachus.* On *Mirounga,* the elephant seal, which breeds on land and develops a harem structure, the teeth rings are well shown. On one specimen tooth we counted at least 10 rings. In the family Odobenidae, with a single member, the walrus, breeding takes place on land, and a loose harem structure is formed. Tooth rings are present. On a large male walrus tusk lent to us recently, there appear 18 or more evenly spaced rings, the distal ones becoming increasingly faint (Fig. 3). (This tusk, incidentally, weighs 11 lb, 13 oz, and is apparently the heaviest one on record for North America.)

In practical application to wildlife management research, the growth ridges on the teeth of pinnipeds may be compared to the annuli on certain hard parts of fishes and on the shells of mollusks. Highly specialized techniques have been developed for estimating the age of a fish by means of growth lines on the scales, otoliths, vertebrae, and bony fin rays. A difference may be pointed out, however. The period of rapid growth in seals corresponds to the colder months of the year; in fishes, to the warmer—a logical relationship in view of the fact that fishes adopt the temperature of their environment, and their metabolic rate increases as the temperature of the water rises.

The presence of growth marks on the hard parts (other than teeth) of mammals has been demonstrated by a number of workers. Space does not permit a full account here. Plehanov (*2*), studying the claws of the Greenland seal, found transverse growth ridges that enabled him to estimate the ages of individuals up to 13 years. He was working with specimens of unknown age, however, and was unable to check his conclusions. The claws of the Greenland seal are long and well developed, enabling the owner to crawl about on the floe ice where it spends a good part of its life. The claws of the Alaskan fur seal, however, are used for little else than scratching the body. In this species we have been unable to find growth rings either on fresh claws or on claws treated with boiling NaOH solution. Ruud (*3*) has pioneered a method of estimating the age of a whale by counting selected growth ridges on the baleen plates. Cowan (*1*) has described well-marked annuli on the horns of mountain sheep. Seth B. Benson (in conference) stated that the annuli are especially prominent on sheep from Canada and Alaska, where the difference between summer and winter temperatures is relatively great. We have mentioned the fact that tooth ridges are distinct on the Alaska fur seal and the northern sea lion (*Eumetopias*) but not on the closely related California sea lion (*Zalophus*). This discrepancy is quite possibly a reflection of the north-south temperature gradient in the oceanic environment.

We have examined the *os penis* of the fur seal in the hope of finding evidence of interrupted growth, but, although the bone grows greatly during postnatal life, increasing some 1,500 times in weight, it seems to develop at a steady rate. The possibility is not excluded that growth lines are present and that a technique as yet unexplored will someday reveal them. On logical grounds one would expect to find them.

References

1. COWAN, I. M. *Amer. mid. Nat.,* 1940, **24**, 512.
2. PLEHANOV. A. P. *Abst. Works Zool. Inst. Moscow Univ.,* 1933, 88.
3. RUUD, J. T. *Hvalrådets Skrifter,* 1945, **29**, 68.