$$c(a) = \frac{B_{(t-a)}}{N_t} p(a)$$

Now if general conditions in the community are constant, $c(a)$ will tend to assume a fixed form. A little reflection shows that then both N and B will increase in geometric progression with time,[1] at the same rate $r = (b - d)$. We may, therefore, write:

$$B_{(t-a)} = B_t e^{-ra}$$

$$c(a) = \frac{B_t}{N_t} e^{-ra} p(a)$$

$$= b e^{-ra} p(a) \qquad (1)$$

Now from the nature of the coefficient $c(a)$ it follows that

$$\int_0^\infty c(a)\, da = 1$$

Substituting this in (1) we have:

$$\frac{1}{b} = \int_0^\infty e^{-ra} p(a)\, da \qquad (2)$$

Equation (1) then gives the fixed age-distribution, while equation (2) (which may be expanded into a series if desired), gives the relation between b, the birth rate per head, and r, the rate of natural increase per head, and hence between b and d, since $r = b - d$.

Applying these formulæ to material furnished by the Reports of the Registrar-General of Births, etc., in England and Wales, the following results were obtained:

ENGLAND AND WALES 1871–80 (MEAN)

	Observed[2]	Calculated
Birth-rate per head ...... b	.03546	.0352
Death-rate per head ...... d	.02139	.0211
Excess .... $(b - d) = r$	.01407	(.0141)

$p(a)$ from Supplement to 45th Ann. Rep. Reg. Gen. Births, etc., England and Wales, pp. vii and viii, assuming ratio:

$$\frac{\text{male births}}{\text{female births}} = 1.04.$$

Age Scale.—1,000 individuals, in age-groups of 5 and 10 years

$a_1 a_2$	$1000 \int_{a_1}^{a_2} c(a) da$	
0 – 5	136	138
5 – 10	120	116
10 – 15	107	106
15 – 20	97	97
20 – 25	89	87
25 – 35	147	148
35 – 45	113	116
45 – 55	86	87
55 – 65	59	59
65 – 75	33	33
75 – ∞	13	13

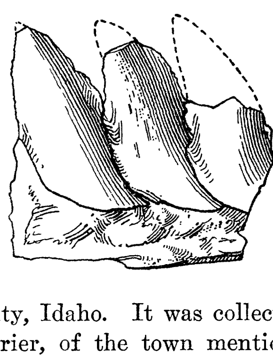
It will be seen that in the above example the values calculated for the age-scale and especially for b and d, show a good agreement with the observed values.[3]

The above development admits of further extension. But this, as well as further numerical tests, must be reserved for a future occasion. In view of the recent note of the work by Major Woodruff, it appeared desirable to the writer to publish this preliminary note.

ALFRED J. LOTKA

A NEW GENUS AND SPECIES OF FOSSIL SHARK RELATED TO EDESTUS LEIDY

THE specimen which serves as the type of the new genus and species, *Lissoprion ferrieri*, was secured in what are regarded as Permo-Carboniferous deposits near Montpelier, Bear



Lake County, Idaho. It was collected by Mr. W. F. Ferrier, of the town mentioned. The specific name is given in his honor. The

[1] Compare M. Block, "Traité théorique et pratique de statistique," 1886, p. 209.

[2] Mean b and d from 46th Ann. Rep. Reg. Gen. Births, etc., England and Wales, p. xxxi.

[3] The calculation is based on the observed value of $r = .0141$, as indicated by the brackets.

specimen was transmitted to me by Mr. Fred Boughton Weeks, of the U. S. Geological Survey.

Three segments are represented in the specimen, as shown in the drawing. As in *Edestus,* there are enameled crowns of teeth supported on a shaft of vasodentine. Two of the crowns are practically complete, the third lacks a considerable portion. Much of the shaft is splintered off, so that its form and dimensions can not be determined.

Evidently our fossil does not belong to the genus *Edestus,* for not only are the bases of the teeth fused so that no traces of the constituents appear in the shaft, but the crowns themselves are fused to more than one half their height. The crowns differ from those of all the known species of *Edestus* in being devoid of all serrations. The crowns of *E. giganteus* are of nearly the same form and are so closely placed that their edges overlap, but they are not fused.

Karpinsky in 1899 described a remarkable genus, *Helicoprion,* related to *Edestus,* in which a series of about 150 teeth form a spiral of 3½ whorls. From the Idaho specimen it is impossible to determine the extent of the whole series or how much it curved during life. However, it certainly was not a species of *Helicoprion;* for the crowns of the latter are serrated, narrow, elongated, bent forward at a moderate angle, and prolonged so as to reach beneath the second crown forward and nearly to the base of the shaft. In *Lissoprion ferrieri* the crowns are broader, much shorter, more abruptly turned forward, and prolonged only to the middle of the next crown and far from the base of the shaft.

Another genus, *Campyloprion,* was proposed by Dr. C. R. Eastman, in 1902, which had for its type *C. annectans* Eastman and included *Edestus davisii* H. Woodward and *E. lecontei* Dean. The species were believed to have had a bent but not volute shaft and fewer teeth than *Helicoprion;* while they differed from *Edestus* in having crowns of different form and bases thoroughly fused.

In 1903 Dr. Eastman appears to have concluded that his species *annectans* belonged really to *Helicoprion* and he therefore substituted, as type of *Campyloprion, Edestus lecontei.* This substitution is not permissible, according to the rules of nomenclature. If *annectans* is really a species of *Helicoprion, Campyloprion* becomes a synonym of the former; and *Edestus lecontei* and *E. davisii* require a new generic name.

Lissiprion ferrieri differs from *Edestus lecontei* in various respects. The crowns of the teeth of the latter are narrower, higher, the divisions between the bases are seen to descend to near the base of the shaft and the slope of the axis of the tooth is rather forward than backward. It does not appear probable that the two species belong to the same genus.

Whether or not there was a longitudinal median channel along the under side of the shaft of *Lissoprion,* as in *Helicoprion,* can not be determined from our specimen.

The anterior end of the specimen is broken at right angles with the axis of the shaft and from it we can learn something of the internal structure. A figure of this would be practically identical with that presented by Karpinsky of the shaft and crown of his *Helicoprion.* The central portion of the section is occupied by a triangular core of spongy vasodentine. Near the base of this triangle are seen the longitudinal canal of the shaft and a smaller canal alongside of it. At the top of the triangle is the canal which leads into the broken crown. The triangle has its base near the lower border of the specimen, and it is probable that this border is very close to the roof of a longitudinal channel. On each side of the mass of spongy vasodentine are the denser layers of vascular and tubular dentine and, outside of all, the enamel of the crown.

The structure above described shows that the bases of the teeth, originally distinct, have become fused so completely that the boundaries between them no longer appear even in the microscopic structure.

The following diagnosis of the genus *Lissoprion* may be given:

Symphysial dentition, a series of fused teeth of unknown number, with broad, high, and laterally compressed crowns, without serration, the crowns fused for the greater part of their height, the lower portion of each suddenly contracted, shortened and turned forward, and lacking much of reaching the base of the shaft. Bases of all the teeth indistinguishably fused into a shaft which was probably more or less curved. Median longitudinal channel at the base of the shaft probably, but not certainly, present.

DIMENSIONS OF L. FERRIERI

	Mm.
Greatest extent of the crown of hinder tooth ..	44
Greatest anteroposterior breadth of same crown	17
Thickness of base of same crown	13

The figure of the specimen is two thirds the natural size. OLIVER P. HAY

COON MOUNTAIN CRATER

CONSIDERABLE interest has been manifested during the past year or two concerning the origin of a remarkable crater-like depression located on the summit of a slight elevation known as Coon Mountain or Coon Butte. It may be found on the plateau region of northern Arizona, but slightly removed from a locality of recent extreme volcanic activity where over a hundred volcanic cones may be seen, many of which still possess well-defined craters. Interest in this phenomenon has been revived as the result of the adoption and elaboration on the part of a few writers of the local common talk of the inhabitants of the immediate neighborhood of the mountain. Here it is religiously believed that an immense meteor nearly one half mile in diameter buried itself in the earth, forming a deep cavity with an upturned edge or rim very much as when a bullet is allowed to fall into soft mud. Some of the reasons cited for this belief are: (1) The circular shape of the depression, (2) the large amount of meteoric iron fragments[1] (over ten tons) which has been collected in the immediate vicinity, and, (3) the entire absence of all kinds of volcanic ejectamenta, or even heated or metamorphosed material, within the area covered by a radius of several miles.

During the summer of 1906 the writer, while studying the crater cones and lava flows of the San Francisco Mountain district, incidentally made a visit to this interesting locality and this report is the result of the impressions received at that time.

[1] Known as the Cañon Diablo meteorites.

An admirable description of the elevation has recently been presented to the public through the publications of D. M. Barringer and B. C. Tilghman,[2] as well as the results of the investigations which they made by means of shafts and borings in the bottom of the crater in search of the great meteorite. It is sufficient here to call attention to only a few of the most important facts. The crater is about 3,500 feet in diameter and nearly 600 feet deep. The elevation on which it is located is about 150 feet above the surrounding planes and from a distance presents the appearance of a narrow circular wall with a very jagged summit. The rocks in the immediate vicinity and also forming the walls of the crater, are made up of layers of sandstone of greatly varying composition. The cementing material is calcareous matter which in some places is present in sufficient quantities to classify the rock as a silicious limestone. The whole formation is known as the Aubrey limestone (and sandstone).

The strata is upturned, forming the rim of the crater exactly as one would expect if it had been lifted by some force from below. It has been frequently faulted and displacements of a few feet can readily be seen in several places on the walls of the crater. The most remarkable feature to be observed, however, is the complete absence of any evidence of vulcanism. No lava is found and not the slightest metamorphism of any kind has taken place in the sediments. Further, there is no evidence of solfataric action, or changes of any kind except mechanical erosion, having taken place after the cavity was formed. The nearest lava fields are located nearly fifteen miles distant. These are in the vicinity of San Francisco mountain and are associated with a remarkable crater cone known as Sunset Peak, an elevation made up of fine ash, lapilli, and lava blocks. In the lava blocks are frequently found masses of

[2] "Coon Mountain and its Crater," by D. M. Barringer, and "Coon Butte, Arizona," by B. C. Tilghman, *Proc. Acad. Nat. Sc. of Phil.*, December, 1905.