the relative amounts of the platinum metals in nature, considering platinum as 100,000, become:

Platinum	100,000
Iridium	8,793
Osmium	4,046
Rhodium	3,947
Palladium	924
Ruthenium	236

Using the estimate of these metals in the Canyon Diablo meteorite, and combining it with Clarke's estimate of the relative amounts of iron, nickel and cobalt, we arrive at the following figures for the amount of the metals of the eighth group in the earth, considering iron as 1,000,000,000.

Calculating from *platinum* in the Canyon Diablo meteorite:

Iron	1,000,000,000
Nickel	59,524,000
Cobalt	4,122,000
Platinum	12,043
Iridium	1,055.1
Osmium	488.5
Rhodium	343.6
Palladium	106.8
Ruthenium	28.3

If the calculations are based on the *iridium* reported in the Canyon Diablo meteorite, the figures become:

Iron	1,000,000,000
Nickel	59,524,000
Cobalt	4,122,000
Platinum	70,926
Iridium	6,236.6
Osmium	2,868.0
Rhodium	2,094.7
Palladium	656.8
Ruthenium	167.9

but owing to the difficulty of determining iridium accurately, it is doubtful if these figures can be considered reliable.

If calculation were made from South African iridosmium, the osmium figures would be larger, as this iridosmium apparently runs much above the average in osmium; on the other hand, osmium analyses are apt to be low, owing to volatilization. The palladium is lower than would be anticipated; in the Sudbury ores the palladium runs much higher in proportion to the platinum. The ruthenium is unexpectedly low, but is probably approximately correct.

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THE ENCYSTMENT OF PARAMOECIUM IN THE RECTA OF FROGS

So far as I know *Paramoecium* has not been definitely shown to encyst in nature nor in laboratory cultures. In fact, most of the investigators who have worked with this organism state that they have never seen it encyst and are of the opinion that it does not possess the ability to do so. Hence the following observations, though incomplete, seem worthy of record.

Two to three c.c. of rich, milky-white cultures of *Paramoecium* (species not determined) were injected (by attaching a short catheter to a syringe) into the recta of frogs, with the result that encystment occurred in about two per cent. of the frogs injected. In all, encystment has been observed in three frogs. When it was first observed, two hours had elapsed since the paramoecia were introduced into the rectum. When a portion of the rectal contents was examined a fair number of individuals were observed in what later seemed to be the beginning of encystment, although at first they were very nearly overlooked for *Opalina*. More careful observations, however, disclosed a very thin membrane-like substance surrounding them. By continued observations it was finally possible to observe six individuals regain their normal *Paramoecium* shape, appearance and activity by freeing themselves of the peculiar substance enclosing them. It was really not possible until the organisms had freed themselves of the membranes to determine whether I was observing *Paramoecium*, some undescribed parasitic ciliate of frogs, or *Opalina* in an abnormal condition, because they presented a very unusual appearance due to the fact that they were folded and rounded so as to occupy about half their normal space. Others, however, were not able to free themselves and, after an hour or two, became more and more rounded and definitely enclosed within what, by this time, could be called a definite membrane—perhaps a cyst membrane.

In another frog which was examined five and a half hours after injection per rectum only encysted paramoecia were present. These were placed in three depression slides, four organisms on one slide and several on each of the others, and kept in a moist chamber and observed several times daily. No change was noticed for the first three days, but on the fourth day some of the cysts were undergoing fission, and on the fifth day two organisms were seen within a single cyst. A fairly heavy cyst wall was clearly visible. On the fifth day some paramoecia excysted.

When a considerable amount of tap-water was added, it was noticed that very soon the movement, which had been quite slow, was gradually increased and in three instances was observed to bring about excystation after two hours. As the movement of the organism became more rapid the cyst wall became thinner and thinner until the organism was finally able to free itself and swim away. Shortly before the organism was free, it could be seen pushing against the cyst wall which by this time had become a very thin membrane which would bulge out as the organism pushed against it from within. Several of the cysts produced in this experiment were observed for eight days when they were accidently lost due to evaporation of the water containing them. None of the encysted paramoecia were ever observed to lose movement entirely, although movement in some was very feeble indeed.

In another instance paramoecia were injected into the recta of five frogs. After four and a half hours the frogs were examined; four contained a few free and fairly active paramoecia and no cysts, and one contained cysts with thick heavy walls and no free paramoecia.

In many instances the paramoecia were all dead within three to four hours after injection into the frog's rectum. A very high percentage were killed and disintegrated (digested perhaps) within one to two hours, or before encystment was ever observed to occur.

All attempts to bring about encystment in removed recta, in removed rectal contents, in the recta of killed frogs, and in the stomach and intestines failed.

We may have in these meager observations an inkling as to the origin of parasitism; during the protection afforded by encystment a free-living organism may gradually become acclimatized or adapted to its new and unfavorable environment and finally become a parasite. It would perhaps be a worth while undertaking to place in the alimentary tract and in the tissues of animals the cysts and free forms of some of the well-known free-living ciliates which form cysts readily in nature and in culture. After thousands of failures it might be possible to find an organism that could excyst and then maintain itself on the intestinal bacterial flora.

L. R. CLEVELAND

NATURAL AND EXPERIMENTAL INGESTION OF PARAMOECIUM BY COCKROACHES

ABOUT thirty cockroaches were collected in the basement of a department store in Baltimore between eight and nine in the morning. They were placed in a dry bottle and carried to the laboratory where several were dissected about two hours later and their stomach and rectal contents examined microscopically. Three of those examined had *Paramoecium* in their stomachs. No attempt was made to determine the species of *Paramoecium,* but the observation was verified by three individuals in the laboratory who were familiar with this well-known organism. The usual parasitic protozoa were seen in the rectal contents, but *Paramoecium* was only observed in the stomach. The remaining cockroaches (17 in all) were left to be examined later to see if *Paramoecium* remained present and if it reached the rectum. These were all opened up and observed between three and four in the afternoon, seven to eight hours after they were collected, and no living paramoecia were present in any of them, but the remains of paramoecia were clearly visible in the stomach contents of two individuals.

In order to determine how long *Paramoecium* would live in cockroaches, approximately two hundred individuals were collected and were starved in dry petri dishes from one to ten days before being fed a rich, milky-white culture of *Paramoecium,* containing hundreds of individuals per drop. In most of the experiments the cockroaches were starved four or five days because it was somewhat difficult to get them to ingest paramoecia after one to two days' starvation. Each cockroach was placed in a petri dish and was observed until it ingested from one to three drops of the culture, the time was noted, and then the cockroach was removed from the petri dish with forceps, swabbed off with cotton, and placed in another petri dish with blotting paper in the bottom. A hundred and fifteen observations were carried out in this manner. The cockroaches were dissected at intervals from five minutes to three days after having been observed to feed on *Paramoecium.* The contents of their alimentary tracts were examined microscopically, with the result that few, if any, of the paramoecia were killed during the first two hours after ingestion and that all were killed by the end of five hours except in a single instance where three actively motile paramoecia were found in the stomach contents six hours after ingestion. When the stomach contents were examined three and four hours after the ingestion of paramoecia, mostly broken up or disintegrating organisms were observed together with three or four normally active individuals. This, then, makes it highly probable that the cockroaches in which *Paramoecium* naturally occurred had fed on water containing a fair number of these organisms shortly before they were collected and brought to the laboratory—perhaps a rather unusual occurrence.

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