Agassiz[1] based his first account of Brazilian Cretaceous fishes in 1841.

This memoir, published by the Brazilian government, and in press since 1910, is based on various specimens obtained by Dr. John C. Branner together with all the material contained in the Museo Nacional at Rio de Janeiro, the latter sent by courtesy of the Brazilian ichthyologist, Dr. Alipio de Miranda Ribeiro.

The volume constitutes a quarto of 97 pages, very fully illustrated, and is the most important contribution to the knowledge of fossil fishes of Brazil. The text is in parallel columns of English and Portuguese, the latter the translation of Dr. Ribeiro.

An analytical key to the fossil fishes reported upon is given at the beginning. Descriptions of genera and species follow, with generic and specific synonymies. Pertinent remarks are made upon related species, living and extinct, as well as upon other specimens known to the author by descriptions or pictures. The completeness and general condition of the specimens at hand is well described.

The 16 plates contain 50 separate figures. Among them are restorations of *Rhacolepis buccalis, Calamopleurus brama* and *Vinctifer comptoni,* showing approximately the general appearance of these forms in life.

Most of these fishes are preserved under peculiar circumstances. It is evident that on a flat beach of very fine silt these fishes, most of them of large size, came in with the tide and were left stranded. Rolling about in the silt they became encrusted in it, and in the hot sunshine this crust became firm. The next tide covered them further until finally each fish was the center of an elongate concretion. Breaking this, the form of the fish, usually petrified, and with the scales intact, was preserved. In one species, *Calamopleurus brama,* even the dark spots along the rows of scales and the eyeballs themselves are preserved after being hermetically sealed up since the Cretaceous Age.

In one specimen (*Cladocyclus gardneri*) there is preserved the very long and narrow epipleural attachment or "occipital brush," looking like the fin of a flying fish (though the bones are neither divided nor jointed). This is three times as long as the head, and seems to grow from the side of the occiput, extending backward along the side, under the scales, and crossing the interspinal bones. Traces of this structure are found in other genera, and in some living fishes, but in no known group does it have the expansion seen in *Cladocyclus.*

Eleven species are fully described and figured. *Vinctifer comptoni, Lepidotus temnurus, Tharrias araripis, Tharrhias (Cearana) rochei, Brannerion vestitum, Calamopleurus brama, Rhacolepis buccalis, Anaedopogon tenuidens, Enneles andax, Ennelichthys derbyi* and *Cladocyclus gardneri.*

EDWIN CHAPIN STARKS
STANFORD UNIVERSITY

[1] On the fossil fishes found by Mr. Gardner in the Province of Ceara in the north of Brazil, 1841.

## SPECIAL ARTICLES

### EXPERIMENTS WITH RATS ON THE INHERITANCE OF TRAINING

SUCCESSIVE generations of white rats were trained in a circular maze of the type described by Watson.[1] Beginning at the age of 49 days each rat was fed daily in the inner compartment of the maze shut off from the alleys. At 56 days the training was started. By the opening of a door in the entrance chamber the rat was introduced to the outer alley of the maze. The following results are based upon stop-watch records of the time required to reach the food in the center, and upon the camera lucida tracings of the course taken in each trial. Curves based upon time and the length of course in successive trials show that in general the learning is very rapid at first and that the habit is practically established by the 6th–9th trial; after this only slight improvement is shown (MacDowell).[2]

The rats employed belong to four strains, A, B, C and L; the first three are inbred descendants from three litters born in the Standard Stock of the Wistar Institute; the fourth, strain L, consists of rats in the third and fourth generation of brother by sister matings of a stock raised at this laboratory.

The following table is based on the number of trials before and including the first two successive trials in less than 20 seconds. The averages are first presented according to strains and families; the number of animals in each case is given within brackets. Each average includes sibs, or sibs and double first cousins from the same single pair of grandparents. Averages on the same horizontal line represent successive inbred generations within the same family. All matings throughout are between brothers and sisters. The sub-families *b* in strains A, C, and L are given separately because their parents were treated with alcohol. In strains A and C these parents were trained, but obviously their records can not be included with the averages of their sibs given in the first column of the corresponding *a* families. In strain L the treated animals were not trained. The results are further summarized by (1) combining all the rats in the strains in which two generations were trained, and (2) combining all the rats in strains

[1] Watson, J. B., 1914, *J. Animal Behav.,* Vol. 4, pp. 56–59.

[2] MacDowell, E. C., 1923, *J. Exp. Zool.,* Vol. 37, pp. 417–456.

in which three generations were trained. Probable errors have been calculated for these larger groups.

The main feature shown by the table is the variability in the direction of the differences between successive generations. The summaries show that these differences, when combined, are nearly cancelled out and that whatever differences remain are too small to be significant. In other words, children from trained parents, or from trained parents and grandparents, take as long to learn the maze habit as the first generation trained.

Among various other criteria that have been studied may be mentioned, (1) the number of trials before the first trial in less than 10 seconds, (2) the number of trials before the first trial in less than 24 seconds, (3) the number of trials before the first perfect trial (the perfection being based on the course taken, irrespective of time). Each criterion gives the same conclusion, *i.e.*, in no case is found a significant difference between averages for different generations. This agreement indicates that the results do not depend upon the criterion chosen.

A parallel experiment was reported by Bagg,[3] who trained a pair of albino mice and their inbred descendants in a simple maze. The findings may be illustrated by the average time per trial for each of the first five generations, namely: 15, 60, 23, 74 and 66 seconds. These results are in full accord with those given above; they indicate that the training of the ancestors did not facilitate the learning of the descendants.

TABLE I

AVERAGE NUMBER OF TRIALS BEFORE AND INCLUDING THE FIRST TWO SUCCESSIVE TRIALS IN LESS THAN 20 SEC.

| Generations trained | I | II | III |
|---|---|---|---|
| Strain A fam. 569 | 13.9 ( 8) | 17.6 (13) | ..... |
| 572a | 11.1 ( 7) | 12.6 ( 8) | 12.7 (10) |
| 572b | ..... | 11.6 ( 5) | 15.7 (11) |
| 573a | 17.1 ( 7) | 11.7 ( 6) | 12.5 ( 2) |
| 573b | ..... | 11.2 ( 4) | 13.5 ( 2) |
| Strain B fam. 575 | 14.7 ( 8) | 12.5 (10) | ..... |
| Strain C fam. 580a | 11.1 ( 8) | 12.3 ( 6) | 9.6 ( 5) |
| 580b | ..... | 15.5 ( 6) | 12.3 ( 6) |
| Strain L fam. 605a | 17.6 (23) | 14.5 (14) | ..... |
| 605b | 16.0 (17) | 17.2 (14) | ..... |
| All strains with 2 gens., trained | 15.32 ± 0.35 | 14.41 ± 0.42 | |
| | Diff. 0.91 ± 0.55 D/PE 1.6 | | |
| All strains with 3 gens., trained | 13.26 ± 0.53 | 13.95 ± 0.56 | 13.16±0.63 |
| | Diff. I–II 0.69 ± 0.77 D/PE 0.9 | | |
| | Diff. I–III 0.10 ± 0.82 D/PE 0.1 | | |

E. C. MACDOWELL

CARNEGIE INSTITUTION,
COLD SPRING HARBOR,
LONG ISLAND

[3] Bagg, H. J., 1920, *Archiv. Psychol.*, No. 43.

## THE NON-INHERITANCE OF THE EFFECTS OF TRAINING

THE experiments reported here deal with four successive generations of mice (247 animals) trained in a simple maze. The proficiency of the parents was known in each case. The results are based on the complete history of each individual.

The effects of the training are recorded in terms of the reaction time (seconds) and the number of perfect trials (in which the mouse makes no wrong turns) in 12 successive trials (one trial a day). Each individual was trained separately at the same age and with the same technic. For each trial the animal was placed in an ante-chamber shut off from the maze by a glass door. Opening this door was the signal for the mouse to make its way through the maze and find its food.

TABLE I

AVERAGE REACTION TIME PER TRIAL PER MOUSE

| Generation | Seconds per trial | Number individuals |
|---|---|---|
| 1 | 53.0 | 62 |
| 2 | 44.5 | 113 |
| 3 | 72.8 | 58 |
| 4 | 58.9 | 14 |

Tables I and II give the results of training in the first generation and three generations of descendants produced by inbreeding. Table I gives the average time per trial per individual, and the number of individuals trained in each generation. Table II gives the total number of perfect trials per individual in 12 trials. In considering the number of perfect trials, the number of mice that failed to make one perfect trial should be taken into account. So in the next column is given the percentage of individuals not making perfect trials during the 12 trials. In the third column is given the average number of trials before the first perfect trial was made, including only mice that made at least one perfect trial. The number of mice in each generation in this table is the same as given in Table I.

TABLE II

NO. PERFECT TRIALS; 12 TRIALS PER INDIVIDUAL

| Gen. | Number of perfect trials | % Individ. failed | No. trials before 1st p. t. |
|---|---|---|---|
| 1 | 1.27 | 37% | 6.9 |
| 2 | 1.60 | 53% | 6.0 |
| 3 | 0.94 | 58% | 6.5 |
| 4 | 0.64 | 71% | 3.0 |

It seems clear that the later generations have not been aided in learning the maze by the training of their ancestors.

E. M. VICARI

ZOOLOGICAL LABORATORY,
COLUMBIA UNIVERSITY