the series are used as strictly or approximately coordinate with suborders, but once a series (Ostariophysi) is used to include several orders, while in a few instances series are subordinated to suborders.

The most striking taxonomic feature of the whole work—one which will appeal to many systematists as radical—is the extreme multiplication of family divisions. In all, the fishes are divided into 638 families; the teleosts alone are split into 511; the current group Cottidae, to take an example, is analyzed into 12 families. The increase in the number of families has been brought about by the entire elimination of subfamilies, those less sharply marked being merged together, those more clearly defined elevated to family rank.

This minute division of fishes into families is justified by the statement, often used by the author, "that analysis must precede synthesis." It must be remarked, however, that in actual practice analysis seldom has led to synthesis. To use more familiar terms, "splitting" leads to further "splitting," not to "lumping."

It seems impossible to arrive at any conclusion as to whether this multiplication of families is or is not justified. There is no known clear-cut criterion by which to decide whether any natural assemblage of genera should be called a subfamily or a family, or a "series" or suborder. There is, as indeed the present work strongly suggests, a very large if not a preponderating element of the subjective in the estimation of taxonomic rank.

Under each family the pertinent generic names, with authorities and dates, are listed chronologically. With each name is given a page reference to "The genera of fishes," which was published by the same author, in four parts, from 1917 to 1920. That work and "A classification of fishes" will for many years be two of the most used of any works in the libraries of systematic ichthyologists.

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SPECIAL ARTICLES

BLACKENED SPHERES FOR ATMOMETRY

Since the time when spherical, white, porous porcelain pieces first became available for use in the study of evaporation as one of the influential environmental conditions affecting organisms, it has been clear that black, porous spheres, as well as white ones, are much needed in ecological and physiological instrumentation. Two porous-cup atmometers operating side by side, one equipped with a white and the other with a black sphere, the two spheres being practically alike in all respects excepting as to their ability to absorb radiation, constitute what I have called a radio-atmometer. Rates of water loss from the black member are greater than the corresponding rates of loss from the white during periods of illumination, while both members lose water at the same rate in darkness. The difference between the two rates for any period constitutes a valuable index of the intensity of radiation for that period. The radio-atmometer has already established itself as a valuable instrument in the hands of research workers interested in natural solar radiation as the latter influences the growth of plants, and especially as it accelerates the rate of water loss from their foliage.

Although a supply of rather satisfactory black, porous porcelain spheres was secured several years ago, the supply has recently become exhausted and it will probably be a number of months before another supply will become available, for serious difficulties are encountered in the making of these black pieces. In the *interim* I have tried several proposed methods for blackening the ordinary white spheres. The black materials that can be readily applied to such pieces are subject to removal by the action of rain or else, if they adhere well, they often tend to reduce the water-permeability of the porous porcelain. I have recently employed a coating of lampblack with excellent results in instrumentation wherein rain is not encountered. For rainless periods in the open and for greenhouse studies, these lampblackened spheres are more satisfactory in operation than are any black porcelain spheres thus far secured. The purpose of this note is to bring this simple blackening of the white spheres to the attention of those who wish to employ radio-atmometers for studying solar radiation, etc., in exposures where rain does not occur or for periods without precipitation.

Commercial lampblack is first thoroughly washed by repeated boiling in distilled water, the liquid being thoroughly stirred as it boils. After each boiling it is allowed to settle and most of the water is decanted off, a new supply of water being then added for the next boiling. Four or five boilings and decantings result in a material that settles readily in water and exhibits no oily film. The washed lampblack is preserved under distilled water in a stoppered bottle. It is applied to the porcelain sphere, after the latter has been filled and set up for operation, by means of a small camel-hair brush. The excess of water enters the sphere, leaving a uniform layer of wet lampblack on the outer surface. The black coating remains wet with the highest rates of evaporation and the most intense sunshine, it does not significantly alter the evaporation coefficient of the sphere, as far as conditions other than radiation are concerned, and it acts very satisfactorily as an absorber of radiation. The sphere should be cleaned and recoated about once a week—or oftener if the prepared surface is accidentally injured, as by the innocent fingering of the ubiquitous meddling visitor or by rain. Cleaning is accomplished by holding the sphere under a trickle of distilled water while scrubbing it thoroughly with a brush. The white sphere should of course be cleaned in the same way at the same time (employing another brush, free from lampblack!).

Blackened spheres thus prepared and treated have held their coefficients for several months and they should hold them indefinitely. Their rates of water loss are the same as those of the best black porcelain spheres similarly exposed. In the open the hourly rate of water loss from the white sphere may be as great as 9 or 10 cc. (for the hottest part of a dry summer day at Tucson), while the corresponding rate of loss from the black or blackened sphere may be as great as 11 or 12 cc. In the open at Baltimore, in July, the white sphere loses from 30 to 60 cc. per day and the blackened one loses about 16 cc. per day more than the white one, for the clearest July days. The daily index of solar radiation for clear summer days is about 18 cc. for Tucson and about 10 cc. for Baltimore. For the greenhouse at the latter station the average daily radiation index for January is about 1.2 cc., for July about 4.0 cc.

In this and related lines of experimentation I have been ably assisted by Mr. J. D. Wilson, of this laboratory.

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REFERRED SENSATIONS CAUSED BY STIMULATION OF THE INTEGUMENT IN NORMAL GUINEA PIGS

THOUGH the curious reflexes which tactile and pressure stimuli of the integument elicit in the normal guinea pig[1] were clear and unmistakable in their expression, yet their tentative explanation proved highly unsatisfactory until a chance observation in this study gave the clew. It was then realized that many of these responses were not the immediate answers to the original stimulus but were the result of a referred, perhaps centrally radiated, sensory impression which the primary tactile or pressure stimulus had called forth. A few experimental results will illustrate this statement.

When the skin covering the right costal margin is gently rubbed with the rounded end of a slender wooden rod, the animal being free in a spacious box, then under proper conditions the animal sooner or later swiftly wipes the right front foot backwards once or twice, the toes being spread apart. Repetition of the stimulus then causes a very rapid shaking of the foot back and forth; on further stimulation the right front foot is lifted and the animal seizes the nail of the inner toe with its teeth and pulls vigorously; at times it may seize all four front toe-nails in rotation and strip them with its teeth. Stimulation on the left costal margin causes the same reaction with the left foot. Not infrequently a crossed response to the stimulus is observed: stimulation of the right costal margin calls for the reaction in the left foot or vice versa.

Pressure stimuli applied to *one lumbo-pelvic area* may cause some or all of the following responses: lateral arching of the body, the head approaching the site of stimulation; repeated rapid seizure of the hair at the point stimulated by the lips and teeth as if seeking a parasite; the mirror picture of the above, the animal seizing the hair at the symmetrical point on the opposite, non-stimulated side; the lateral aspect of the jaw on the side stimulated is vigorously scratched by the hind leg; the ear, top of the head and the lateral aspect of the jaw is wiped repeatedly by the front foot of the stimulated side, the head being rotated so that the nose is turned towards the non-stimulated side; the wiping movement is repeated by the front foot of the opposite side or the animal may sit up on its haunches wiping the top of the head, the ears and jaws simultaneously or alternately with its front feet.

Another example of dyschiria is seen when the sacro-pelvic portion of the back is stimulated by repeated tactile stimuli (bristle): the perineal region is suddenly depressed and moved forward on the floor, or occasionally both hind legs are extended forwards and by means of its front legs the animal walks forwards, scraping the perineal area along the floor.

An instructive series of motor responses apparently due to a related shifting of referred sensory impressions may be seen when the animal is examined in a small box whose floor and sides are formed by half-inch wire netting; the box is supported at each corner by columns 7 inches high, the bases also support an inclined mirror which permits easy observation of the animal's ventral aspect. Repeated stroking of the sole of the right hind foot with the tip of a wooden rod may cause all or some of the following reactions: the right hind leg is first lifted abruptly and set down with a stamp; on continuation of the stimulation the same leg is again suddenly extended forwards, and one nail of the toes, or all of them in rotation, are seized by the teeth and vigorously pulled; the stimulation being continued, there may be only a slight or no movement of the stimulated right hind foot, but the right front foot is lifted and one or more toe-nails seized and pulled; still later a crossed response is obtained and now the left hind leg is extended forwards and the toe-nails seized and pulled

[1] John Auer, SCIENCE, 1923.