Call in his 'Life and Writings of Rafinesque' these must have been written but five months before his decease and his quarrel with Professor Wagner probably ended his scientific associations in this City.

In looking up the date of his death I have been struck with the fact that Lippincott's Biographical Dictionary, Simpson's 'Lives of Eminent Philadelphians' and Appleton's Cyclopedia of American Biography quote the date of his death as September 18, 1842 and the National Cyclopedia of American Biography is the only authority that I can find for the year 1840, which is used by Call.

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WAGNER FREE INSTITUTE OF SCIENCE,
March 2, 1900.

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*SOME OBSERVATIONS CONCERNING SPECIES AND SUBSPECIES.**

SOME few weeks ago I gave to this Society a brief general account of the investigations which the Fish Commission carried on at Lake Maxinkuckee during the past summer and fall.

At this time, I desire to speak briefly concerning two new fishes obtained in these investigations, and certain questions concerning species and subspecies which their study has suggested.

In the first place, permit me to repeat some of the statements regarding the lake and its small tributary streams.

Lake Maxinkuckee is located in the southwest corner of Marshall County, Indiana, on the Logansport and Terre Haute railroad, 32 miles north of Logansport, or 34 miles south of South Bend, Indiana. It is about 2.75 miles long, from north to south, 1.75 miles wide, and is quite regular in outline. This, like all the lakes of northern Indiana, is of glacial origin. Its greatest depth, so far as known, is 86 feet. The bottom is of compact sand and gravel near the shore, then a wide bed of marl, and soft mud in the deeper parts. There are only 1 or 2 short reaches near the shore where the bottom is soft. The water is relatively pure and clear. The bottom temperature in summer is 47° to 50° Fahr., while the surface gets as warm as 77° to 80°.

The lake is well supplied with aquatic vegetation; *Chara*, *Potamogeton*, *Myriophyllum*, *Ceratophyllum*, *Nitella*, *Vallisneria* and *Scirpus* being abundant. At least ten species of *Potamogeton* occur and two species of *Scirpus* are found. *Chara* is very abundant, great beds of it covering the bottom in many places from near shore out to a depth of 12 or 15 feet.

The catchment basin of the lake is small. There are no tributary streams except one very small brook at the south end, a somewhat larger one at the southeast corner, and three small ones upon the east and northeast sides. The total amount of inflow from these little creeks is but a few gallons per minute. They are all short, sluggish streams and do not vary greatly in size at any time. Perhaps the only ones deserving mention are (1) the one at the southeast corner which is popularly known as 'the inlet,' (2) one near the middle of the east side, and (3) one at the northeast corner flowing into Culver Bay, and which has come to be known as Culver Inlet. The stream on the east side has been called Aubeenaubee Creek, from the Pottowattomie chief of that name who at one time owned the land on the east of the lake. It was from this small creek that the specimens of the new species were obtained. Aubeenaubee Creek does not exceed 1.5 miles in length. It has its source in a small marsh, and is a sluggish stream flowing through a low, level meadow or prairie region. It is about 4 feet wide and averages only 3 to 6 inches deep, with deeper holes at intervals. Through most of its

* Read before the Washington Biological Society, Jan. 26, 1900.

length the stream is overhung by bushes and briars, and is full of sticks and brush. The bed and banks are of black mud with a mixture of sand. In some places the ground is quite boggy. The midday summer temperature of the water in this stream is about 72°. The species of fishes found in this stream are almost wholly different from those found in the lake proper, a fact illustrating clearly the importance of even slight differences in geographic location if accompanied by stable environmental differences. The principal fishes occurring in this creek are *Semotilus atromacalatus*, *Campostoma anomalum*, *Umbra limi*, *Lucius vermiculatus*, *Notropis cornutus*, and young *Micropterus salmoides*. Crawfishes were abundant.

The two new fishes discovered are both darters, one belonging to the genus *Hadropterus* and the other to the genus *Etheostoma*.

I may say, in passing, that the darters are members of the Percidæ or Perch family, to which belong the walleyed pike, the Sauger and the Yellow perch. Sixteen genera and 85 species of darters are recognized. They are all small, active fishes, usually brilliant in coloration and have much the same position among fishes that the warblers have among birds.

Both of the new darters obtained at Lake Maxinkuckee were found in Aubeenaubee Creek and nowhere else.

The nearest relative of the species of *Hardopterus* is *H. scierus*, which, though not known to occur in Lake Maxinkuckee, is found in Yellow River of the Kankakee drainage, only a few miles north, and also in Tippecanoe River five miles south of the lake. The form found in the creek is well set off from its nearest relative and is described as a species.

The other darter, described as new, is evidently derived from *E. iowœ*, which is found, not only in many of the streams of western Indiana, but also in Lake Maxinkuckee in some abundance. It is, however, not known to occur in Aubeenaubee Creek.

Etheostoma iowœ, in extending its range from its original center of distribution, in all probability, found its way into Lake Maxinkuckee from the Tippecanoe River. Having once become established in the lake, individuals sooner or later began entering its tributary streams. Among the individuals entering Aubeenaubee Creek there were some that, finding the conditions easy, remained and bred there, and thus a creek colony was established. It is altogether probable that for some, possibly many years, individuals from the colony would occasionally return to the lake and interbreed with individuals that had never left the lake. And the reverse would also take place: individuals from the lake would probably continue for many years to invade the domain of the creek colony and interbreed with its members. Under conditions such as these, the members of the colony going farthest toward the head of the creek were probably the ones which soonest became free from the influence of the lake and, breeding only among themselves, were modified most rapidly by the new environment. In time they became so well differentiated as to render them readily distinguishable from the parent form in the lake. During the continuance of the conditions mentioned, however, the migration and countermigration between the lake and the stream, there would be found in the lower part of the stream and in the lake about its mouth, the progeny of the individuals from the lake and creek which had interbred. These would possess characters more or less intermediate between the parent species (*E. iowœ*) and the derived form inhabiting the creek. So long as these intermediate forms continued to exist, the form found in the creek would be only an incipient species. As an incipient species it would

be a subspecies of *E. iowæ*, and would receive a trinominal name.

But if, in the course of time, invasions of one habitat by individuals from the other should cease, then the intergrading forms would, through interbreeding with the extreme forms, be gradually absorbed by them and finally disappear altogether. In the creek would then be found a form differing clearly and constantly from the lake form and without any connecting forms. Under these circumstances the form in the creek, as well as that in the lake, must rank as a distinct species.

This is the present condition, so far as our investigations have enabled us to determine. There is no difficulty in distinguishing individuals taken in the lake from those found in the creek, and neither form seems to invade the habitat of the other. Large collections were made, not only of the fishes inhabiting the lake, but also of those in the creek. The latter was carefully seined twice, from its source to its mouth, and not a single example of *E. iowæ* or any form showing intergradation was seen. Similarly careful investigations were made in the lake without discovering any individuals of the creek form or any showing intergradation. Whether further collecting will discover connecting forms cannot, of course, be stated. The small size of the creek and of the lake, and their close geographic relation, render it almost certain that individuals of the one form would occasionally invade the habitat of the other, and *vice versa*. While the environment of the creek is markedly different from that of the lake, it is improbable that a change from one to the other would prove disastrous to the individuals concerned. Some of such individuals would, it seems, be able to survive, and some would probably interbreed with individuals of the other form whose habitat they had invaded. This was, quite likely, the condition in the beginning, and the creek form, so long as it remained connected with the parent species by the intergrading forms resulting from such interbreedings, would be a subspecies of the parent species. But, as already stated, no such connecting forms have yet been found and the form inhabiting the creek is a distinct species.

There is one other possible condition worth considering. Let us suppose that, after the creek colony had become well established, and for many generations had not intermingled in any way with the parent species in the lake, the habits of one or the other, or both, should change somewhat and that they should again begin to invade each other's habitat and to interbreed. The result of this interbreeding would be the appearance of individuals possessing morphological characters more or less intermediate between the lake and the creek forms. In other words, individuals would be found showing that the two forms intergrade and placing them again in the relation of species and subspecies. If we could *know* this to have been their history, however, we should certainly not place them in the relation of species and subspecies. We should regard them as two distinct species, and the individuals which seem to show intergradation we would call hydrids, which they really are. But we can rarely, if ever, *know* that such has been the history. So long as intergradations are found connecting the two forms, the one last discovered must be regarded as a subspecies of the other. In the present case, however, no intergradations seem to exist, and the relation is that of two distinct species. While the occurrence in nature of hybrids is doubtless very unusual, such a condition as the one supposed is certainly not improbable.

And this suggests a further consideration of subspecies. An examination of the descriptions of forms which have been published as subspecies does not show that the

describers have all been governed by the same principles, or that all who have described subspecies have had very well-defined ideas as to what a subspecies really is. I am sure that I myself have given trinominal names to new forms with rather hazy ideas upon the relation of species and subspecies.

The present practice of most systematists in this country seems to be to regard any two given forms as distinct species, unless they are known to possess morphological characters which intergrade. If characters showing intergradation are present, the one later described is regarded as a subspecies of the other. The intergrading may be of two kinds of categories:

1. It may be associated with the known joining of the two respective habitats. In this case the individuals possessing the intermediate characters would come from the region where the two forms, or the habitats of the two forms, join or overlap. If *E. iowæ* were known to intergrade with the *Etheostoma* of Aubeenaubee Creek, the connecting forms, if of this category, would be found in the mouth of the creek, or in the lake near the mouth of the creek. This, it seems to me, would be a good example of what we mean by a subspecies.

2. In the other case, the two habitats do not join, but an examination of a series of specimens from each will show an intergradation of characters. Though the sum total of the characters is different, individuals will be found in one series which possess, in varying degree, all the characters shown by those of the other. The individuals showing the intergradation come from the same localities from which have been obtained the typical individuals. They do not come from intervening localities because the habitats do not join.

Is it correct to regard these two forms as sustaining the relation of species and subspecies?

Trinominal names have, in many instances, been given because the differences separating the form under consideration from some previously-known form are slight. But now, the almost uniform practice seems to be to regard constant differences, however slight, in the absence of known intergrading forms, as of specific value; and differences, however great, if known to intergrade, to be only of subspecific value.

If this view be correct, there are many trinominals in current faunal and floral lists which are there without sufficient warrant. In the latest systematic work on American fishes 3255 species and subspecies are recognized. Of these, 125 are ranked as subspecies. But an examination of the facts regarding each shows that very few of them should stand as subspecies, but as species. They have, in most cases, been called subspecies simply because they differed but slightly from the most closely related species. I doubt if intergradation is *known* to exist in 25 per cent. of the cases.

I have been told that many of the trinominals in current use in ornithology rest upon the same insufficient evidence.

It is the practice of some, I believe, to describe as subspecies forms which, though not *known* at the time to intergrade, will in all probability, be found to do so. The describer's knowledge of the group to which they belong, the principles of geographic distribution, and the geography of the country in which they are found, justify him in anticipating the evidence of actual intergradation.

Personally, I doubt if this is the best course to pursue. Would it not be better, either to wait until the evidence is in hand, or describe the new form as a species?

We sometimes hear the remark that systematists often go too far, and describe as new species or subspecies forms which differ but slightly from known forms; that they give

specific or subspecific value to differences which are due merely to some slight difference in environment. This, it seems to me, misses the whole point. What produces species and subspecies, anyway, except slight differences in environment, together with greater or less geographic isolation? And when we see these differences why should we refuse to admit their existence or their meaning?

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BREATHING OXYGEN.

THE experiments here described were carried out during the course of an investigation to determine the quantity of carbon dioxide exhaled from the lungs of different persons under stated conditions.

The method of procedure was as follows: (1) Ordinary air was inhaled through the nostrils and exhaled through the mouth (the nostrils being closed) into an inverted receiver filled with water. The quantity of carbon dioxide in the exhaled gases was determined in the usual manner. (2) A mixture of air and oxygen containing 26.4 % of oxygen was inhaled and exhaled as in (1). (3) Pure oxygen was employed and the experiments conducted as in (1) and (2).

The breathing experiments were made by three different persons, A, B, and C, under conditions as nearly indentical as possible.

The following results were obtained:

A		B		C		
Exp.	CO_2	Exp.	CO_2	Exp.	CO_2	
1	3.8	10	3.6	19	3.8	Ordinary air.
2	5.2	11	4.4	20	5.1	
3	5.6	12	4.6	21	5.8	
4	4.0	13	4.0	22	4.0	Air and oxygen.
5	5.6	14	5.2	23	5.4	
6	—	15	5.6	24	5.6	
7	4.2	16	4.8	25	4.4	Pure oxygen.
8	5.8	17	5.6	26	5.8	
9	6.2	18	6.2	27	6.4	

The figures given express percentages by volume; they are lower than those that would be obtained if the exhaled gases were collected over water saturated with carbon dioxide. The object of the experiments was to get relative rather than absolute values. In experiments 1, 4, 7, 10, 13, 16, 19, 22 and 25, the gas (air, mixture of air and oxygen, or oxygen) was inhaled for five seconds and then exhaled for five seconds.

In experiments 2, 5, 8, 11, 14, 17, 20, 23 and 26 the lungs were inflated as fully as possible with the gas, which was retained *fifteen* seconds and then exhaled.

In the other experiments, 3, 6, 9, 12, 15, 18, 21, 24 and 27, the lungs were fully inflated and the gas retained *thirty* seconds before exhalation.

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THE SOCIETY OF AMERICAN BACTERIOLOGISTS.

THE following are abstracts of papers read at the first meeting of the Society of American Bacteriologists, held at New Haven, December 27th to 29th.

Natural varieties of Bacteria: PROFESSOR H. W. CONN.

Professor Conn exhibited some cultures of a highly variable Micrococcus which he had isolated many times from milk. Its color ranged all the way from a snow white to a deep orange, and in power of liquefying gelatin it ranged from a form that liquefied with great rapidity to one that had apparently no liquefying power. All these varieties, with numerous intermediate stages, have been found in nature and are not the result of cultivation. Professor Conn showed, however, what a great change can apparently be produced in the character of a species, by a simple process of selection. Starting with a pure culture of this organism, he was able to produce from it a white and an orange culture, by simply replating many times, and selecting the whitest color, on the one hand, and the