solved in 500 cubic centimetres of water, and then dilute sulphuric acid added till the hydrazoic acid was liberated. The solution was then distilled till the distillate ceased to give a precipitate with silver nitrate.

The distillate was then diluted to a definite volume and its strength determined by titration with standard ammonia solution. The yield of the acid was 87 per cent of the theoretical, 500 cubic centimetres of nearly 4 per cent solution being obtained.

A part of the acid solution was neutralized with potassium carbonate, and evaporated to crystallization. Beautiful, tabular, transparent crystals of the potassium salt, KN_3, were formed.

The salts of hydrazoic acid, excepting the salts of the alkali metals and the metals of the alkaline earths, are explosive. In some respects the acid resembles hydrochloric acid. With soluble silver salts a white precipitate, AgN_3, is formed. Lead acts similarly. These salts explode very violently when heated.

The most remarkable property of hydrazoic acid and its soluble salts is their physiological action. In this respect they resemble the nitrite of amyl, $C_5H_{11}NO_2$, having a marked influence upon the action of the heart. The author found by experiment that one-tenth of a grain of the potassium salt, KN_3, dissolved upon the tongue (the resulting solution not being swallowed, but ejected from the mouth) was sufficient to increase the pulse from 96 beats per minute to 153. This required only five minutes' time after the dose was taken. This rate of heart-beat is not sustained, however. A sudden and rapid reduction takes place, and ten minutes after the dose was taken the heart was giving 60 feeble beats per minute, making a total variation of 97 beats per minute. Considering the fact that this effect was produced by the small quantity of the substance which was absorbed by the mucous membrane of the tongue, this property is certainly remarkable. The vapors of the hydrazoic acid produce similar effects when inhaled.

The laboratory work reported in this article was performed in the chemical laboratory of Cornell University; and the author wishes to acknowledge that the success of the work was largely due to the aid and direction given by Dr. W. R. Orndorff. Thanks are also due him for his kindness in reading and correcting the manuscript.

ON PROTOPTERUS ANNECTENS.

BY DR. R. W. SHUFELDT, WASHINGTON, D.C.

THERE has been very recently published in the Transactions of the Royal Irish Academy (Vol. XXX., Part III., pp 109–230, Plates vii. to xvii.) the long-delayed work of Professor W. N. Parker of the University College, at Cardiff, Wales, "On the Anatomy and Physiology of *Protopterus annectens*." Through the courtesy of its author, a reprint of that most valuable quarto is now before me, and it is my wish to write a brief notice here in regard to it. The elaborate manner in which the Transactions of the Academy are published is too well know to require remark, but in the present instance it is impossible to pass this work without a word upon the truly superb plates that illustrate it. These, some ten in number, were chromo-lithographed by Professor Parker's younger brother, M. P. Parker, and printed by West, Newman. They present us with much of the anatomy and histology of *Protopterus*, and are throughout perfect masterpieces of the kind, and of the very highest order of merit.

As is well known, this genus formerly was written *Lepidosiren*, the South American species being *L. paradoxa*, and the African one *L. annectens*,[1] and among the first to pay any attention to it, of a reliable nature, was Sir Richard Owen, who, in 1839–1841, published his "Description of *Lepidosiren annectens*" in the Transactions of the Linnæan Society of London (Vol. XVIII.), since which time naturalists have never ceased to furnish various accounts of the biology of this extremely important form, but usually based, as Professor Parker remarks, upon badly preserved material. Our present author was far more fortunate as he had perfectly fresh specimens to work upon. Of these he has said in his "Introduction," that "All my material, with the exception of two specimens, purchased last autumn, were placed at my disposal by Professor Wiedersheim. These were received alive direct from the neighborhood of the Gambia, and to Dr. J. Beard is due the credit of having arranged for their transport. While in the torpid condition about one hundred specimens had been dug out, each surrounded by a clod of earth,[2] and the clods were then packed together in open crates. In this manner they travelled without harm, nearly all of them being alive and in a healthy condition on their arrival in Freiburg. On being removed from the clods, they were, by the kind permission of Professor Hildebrandt, placed in a large wire cage, sunk beneath the water in a basin used for the culture of water plants in one of the hot-houses of the Botanical Gardens, in which a constant temperature of 22.5° C. was maintained."[3] . . . "Protopterus lives probably to a great age, and this supposition is supported by the somewhat incredible statement of the natives mentioned by Stuhlmann, that some specimens reach a length of six feet. From the observations of Hyrtl and Bischoff, it appears that Lepidosiren also attains a large size, reaching, at any rate, three feet in length" (p 112).

It was found that *Protopterus* grows very rapidly, has great vitality, and, although able to sustain fasts, is exceedingly voracious, devouring all the abundant snails, earth-worms, and small fish given them, and then killing and eating each other, making it difficult in the extreme to preserve the specimens.

Protopterus is most active at night, and appears to keep mostly to the shallow water, where they move deliberately about on the bottom, alternately using the peculiar limbs of either side, though their movements do not seem to be guided by any strict regularity. "Gray has compared these movements with those of a Triton, and several other observers have noticed them. The powerful tail forms a most efficient organ for swimming rapidly through the water."

"It is well known that Protopterus comes to the surface to breathe at short intervals, and thus it is evident that the lungs perform an important, if not the chief, part in respiration during the active life of the animal. The air passes out again through the opercular aperture, and the movements of the operculum itself indicate the fact that bronchial as well as pulmonary respiration takes place."

Externally, the sexes present no characters whatever distinguishing them apart, and even in immature specimens it is difficult to tell ovary from testis.

In the present brief notice it will be impossible for us to even abstract the positive advances Professor Parker has made for us in our knowledge of both the anatomy and physiology of this instructive Dipnoan. He sums up handsomely on page 213, under his "General Abstract, Summary of Chief Results, and Conclusions."

His researches convince him that, although many points of resemblance exist between Protopterus and certain Elasmobranchs and Ganoids on the one hand, and on the other to some of the lower Amphibians, it exhibits numerous distinctive characters of its own, both primitive and specialized, and so, together with Lepidosiren and Ceratodus, must be placed at a great distance from either class. Further, he believes that the Dipnoi, as a group, should not be retained among the fishes, still less among the Amphibia.

[1] Dr. Günther classifies them as follows: —

		Suborder III.	Families.	Genera.
ORDER II.— Ganoidei	Dipnoi.	1.	Sirenidæ	Lepidosiren, incl. Protopterus Ceratodus.
		2.	Ctenododipteridæ	Two extinct genera, Dipterus and Heliodus.
		3	Phanceropleuridæ	Extinct Phancropleuron.

And he remarks that "Two species are known, L. paradoxa, from the system of the river Amazon, and L. (Protopterus) annectens, which abounds in many localities of the west coast of Africa, is spread over the whole of tropical Africa, and in many districts of the central parts forms a regular article of diet."

[2] To those less familiar with the habits of this extraordinary fish, I would say that the species averages about four feet in length, and is an inhabitant of the Gambia River in Africa. They bury themselves in the mud during the dry season, making a kind of nest in which they pass a period of torpidity. Here they may remain for the best part of the year, but on the return of the wet season resume again their aquatic mode of life.

[3] In 1889, it will be remembered, Stuhlmann also gave an interesting account of Protopterus, published in German. (Berlin.)

Highly specialized in some respects, in both Protopterus and Lepidosiren, this specialization is largely due to a change of habit, and that, undoudtedly, these two types are, genericly, very distinct.

In conclusion, I may simply add that this classical work will, in the future, prove to be one of the very greatest value to all students of the morphology of the Amphibia and of Pisces, as it will be indispensible to the general biologist.

OBSERVATIONS ON A CYCLONE NEAR WILLIAMSTOWN, KANSAS.

BY E. H. S. BAILEY, UNIVERSITY OF KANSAS, LAWRENCE, KAN.

A SEVERE and fatal cyclone visited a small area of country in the Kaw valley, in Jefferson County, on June 21, at about six o'clock in the evening, and the peculiar topography of the country gave an opportunity to make some observations that may be of scientific interest. The valley at this point is about two miles in width, the river running nearly east. On the south side it is bounded by bluffs about a hundred feet in height, and on the north side there is a strip of level meadow, something over a mile in width, before one reaches the bluffs, which are of about the same height as those on the south side.

The general trend of the broad valley is east, but at a point a mile or so beyond where the cyclone lifted the river runs toward the southeast for perhaps a mile. On the particular afternoon in question the weather had been extremely hot and sultry, the mercury ranging between 90° and 95° F. The weather had been warm and dry, with only one local shower for about two weeks. About two hours before the cyclone burst upon the valley there was a gathering of clouds in the northwest, with thunder and lightning. A short time before the storm burst an ominous stillness was noted, and a sudden darkening of the sky. During the heaviest of the storm a peculiar green tint of the sky was noticed in the locality.

As the storm came from the west, it seemed to settle near the ground at the base of the bluff, and, wherever the bluff was not broken by lateral valleys, its path was about one-half on the side of the hill and the other half on the sloping meadow to the south.

Wherever the cyclone crossed the course of lateral ravines, even if they were quite narrow, it dipped down into them and destroyed trees and buildings. It was not swerved from its general eastward course even at one point where a broader valley joined that of the Kaw. At this point, as the country was heavily timbered, there was a special opportunity to observe the action of the wind. Elm and walnut trees, two or three feet in diameter, were either torn up by the roots, laid prostrate, or twisted off fifteen or twenty feet from the ground. Here the track of the cyclone, where it did appreciable damage, was a little less than 600 yards in width. There were, occasionally, wrecked chimneys and slightly injured roofs on the outer edges of this path. All along the course of the storm the debris was deposited in the peculiar way that is characteristic of these furious whirlwinds. The material north of the centre of the track was deposited in lines from northwest to southeast, and that on the south side of the centre in lines running from southwest to northeast. In the centre of the track there was a tendency to distribute the material in an east and west direction. A line of telephone poles on the south side were laid in parallel lines, thus, ////. Fields of grass and wheat were beaten to the ground and the stalks laid in the directions above noted: W. \\\\\\ / / / / / / → E. The wires of the telephone line and of the barb-wire fence were lifted into the tree-tops about fifty feet north of their original position. There was a little debris deposited on the west side of some of the buildings demolished, but most of it was carried along the track and thoroughly pulverized. Strong, new farm wagons were wrenched to pieces, and the spokes were even broken off near the hub, before they were deposited half a mile away.

The terrible force of the wind could be seen in the beheading of the wheat, the uncovering of potatoes in the hills, the transportation of grave-stones 300 yards, and the picking of all the feathers from the chickens

One of the most interesting effects that was noticed was upon the trees that were left standing or laid prostrate and bereft of every vestige of foliage and of nearly all the bark. All the wood on the west side of these trees, often being exposed by having the bark torn off, was roughened as if by a sand blast; while that on the east side was smooth. This roughness was uniform, showing that it was not produced by occasional missiles hurled through the air. This roughening, if not produced by the actual friction of the air, must have been produced by the sand and gravel in the air, or by the rain that beat against the surface.

Some who witnessed the storm saw the clouds of dust that accompanied the wind, so the sand-blast theory is no doubt the correct explanation.

The most serious work of destruction was accomplished just before the cyclone lifted. Here the valley broadened out towards the north, and the bluff for a distance of a mile or more disappeared. With one last sweeping blow the storm lifted, and the only other evidence of its work was a partially demolished barn. Just at the point where the intensity seemed concentrated, the path was much narrower than farther west. The strip of land devastated was about five miles in length. From the manner in which it followed the base of the bluff, one would infer that had it not been for this obstruction the storm would have passed off towards the northeast instead of pursuing, as it did, a direction a little south of east.

NOTES ON THE COPEPODA OF WISCONSIN.

BY C. DWIGHT MARSH, RIPON, WISCONSIN.

In the waters of Wisconsin and in the adjacent lakes are found the following twenty-one species of free-swimming copepods: *Diaptomus sanguineus*, Forbes; *D. leptopus*, Forbes; *D. pallidus*, Herrick; *D. sicilis*, Forbes; *D. ashlandi sp. nov*; *D. minutus*, Lillj.; *D. oregonensis*, Lillj.; *Epischura lacustris*, Forbes; *Limnocalanus macrurus*, Sars; *Cyclops americanus, sp. nov.*; *C. brevispinosus*, Herrick; *C. pulchellus*, Koch; *C. navus*, Herrick; *C. parcus*, Herrick; *C. leucarti*, Sars; *C. signatus*, Koch; *C. modestus*, Herrick; *C. fluviatilis*, Herrick; *C. serrulatus*, Fischer; *C. phaleratus*, Koch; *C fimbriatus*, Fischer.

Although two of these, *D. ashlandi* and *C. americanus*, are new species, it is not probable that they are peculiar to the Wisconsin fauna. The copepods of America have thus far received very little attention, the only important publications on the subject being by three men, Professor Cragin, Professor Herrick and Professor Forbes. If more were known of our copepods it is probable that it would be found that there are few local differences in the faunæ of our northern States. The copepods are readily transported from one body of water to another and, without change of structure, seem to endure great changes in their environment In fact, half of our species of cyclops are not only widely distributed in America, but are identical with those of Europe. Those that may be considered distinctly American are closely allied to well-known European forms.

C. leucarti is found in nearly all parts of the world where collections have been made and, so far as can be inferred from the published descriptions, varies but little, even in the minute details of its structure.

C. americanus closely resembles *C. viridis*, and is probably the species which has by other American authors been identified with *viridis*. Although there seems to be good reason for separating it from the European species, the similarity of the two forms is so great that it is only by a close examination that the structural differences become apparent.

It is very possible that *C. brevispinosus* should be considered a pelagic variety of *C. americanus*, thus reducing by one the number of species peculiar to America. There is some reason, too, for supposing that *C. navus* is not specifically distinct from *C. pulchellus*.

C. pulchellus is the common pelagic form of the Great Lakes. Although found in smaller lakes, it is more commonly replaced by *C. brevispinosus*, which is a species of wide distribution.

C. navus is found only in stagnant pools.

The most common of all our species is *C. serrulatus*. Rarely is a collection without this form, which seems to adapt itself easily to very different surroundings. It has, however, wide