fication of bases it has been found that all strong bases exert about the same action. The velocity of reaction at 9°.4 is:

NaOH	2.31	$Sr(OH)_2$	2.20
KOH	2.30	$Ba(OH)_2$	2.14
$Ca(OH)_2$	2.29		

The numbers are for 1/40 normal solutions, in which the strong bases may be regarded as completely dissociated." As the dilution of the alkali at which death was produced was much greater the dissociation must have been complete, hence the death must have been caused by the OH and Na or K ions. And as the total growth of the seedlings in KOH solutions is nearly equal to the total growth in NaOH solutions, we can conclude that the toxic effect of Na ions is approximately equal to the toxic effect of K ions.

From a table of electrical conductivity* the degree of dissociation of HCl at $n/256$ was found to be 98.9, at $n/512$ it was found to be 99.5. The degree of dissociation of H_2SO_4 at $n/256$ was found to be 91, at $n/512$ it was found to be 95.6.

By comparing the dilutions at which the seedlings were found dead with the degree of dissociation given above it will be seen that there is quite a difference between the degrees of dissociation at the strength of the two solutions (HCl and H_2SO_4). While at the greatest dilution in which the seedlings lived in both solutions the difference is not so great. This difference in the degree of dissociation was manifest in the difference in the total growth of the seedlings in the different solutions; the solution less dissociated producing the greater total growth.

Thus we see that the corn seedling lived and grew in a $n/128$ solution of KOH and NaOH, and in $n/512$ solution of HCl and H_2SO_4. While Kahlenberg and True showed that a seedling of *Lupinus albus* L. just lived in $n/400$ solution of KOH and in $n/6,400$ solution of HCl. This shows that corn seedlings lived in a solution of KOH more than three times as strong, and in a solution of HCl more than twelve times as strong, as that in which the seedling of *Lupinus albus* just lived.

* Arrhenius, *l. c.*, p. 135.

Although a seedling of a widely different species was used by Kahlenberg and True, yet it is remarkable that the corn seedling should resist the toxic effect of OH ions in a solution three times as concentrated, and that it should resist H ions in another solution twelve times as concentrated.

If the difference between the effects of the OH ions in one case is three times, why should we not expect the difference between the effects of the H ions in the other case to be about three times also? It seems logical to expect that the ratio between the effects of like solutions upon two different seedlings would be about the same in any solution.

It is my purpose to continue the investigation of this problem to find the exact dilution in which the seedling will just live; and how this death limit varies with different seedlings.

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June 16, 1903.

THE SPONGY TISSUE OF STRASBURGER.

MANY students of the gymnosperms have commented upon the peculiar structure of the cells immediately surrounding the female gametophyte during the period of its development. Both Hofmeister* and Strasburger† believed that two prothallia were formed in those members of the Abieteæ which require two years for the maturation of their seeds. They thought that the first or transitory prothallium was characterized by thickened cell-walls and that this cellular body was dissolved in the spring, giving place to the true or normal prothallium.

In 1879 Strasburger‡ established the fact of the existence of a single prothallium in the Abieteæ, and described a band of loosened

* Hofmeister, 'Vergleichende Untersuchungen höherer Kryptogamen und der Samenbildung der Coniferen,' 1851.

† Strasburger, 'Die Befruchtung bei den Coniferen,' 1869. 'Ueber Befruchtung und Zelltheilung,' 1878.

‡ Strasburger, 'Die Angiospermen und die Gymnospermen,' 1879.

cells or spongy tissue about the young gametophyte both in *Thuja* and in *Pinus*. He considered that it was the presence of this tissue which led Hofmeister to conclude that a transitory endosperm was formed in these plants. So far as one is able to learn from the literature, these early observations and conclusions of Strasburger's have remained unquestioned except by a few recent writers.

In describing the development of the ovule in Stangeria, Lang* (June, 1900) makes no mention of a spongy tissue, but says: "Around the megaspore a layer of cells was present which is clearly to be traced to the sporogenous group. The thick zone of sporogenous tissue present in earlier stages has, however, become reduced to a single layer. The cells of this persistent layer (Fig. 16) are very large, and stand with the longer axis at right angles to the surface of the megaspore. How long this layer of cells, which at this stage shows no signs of crushing or disintegration, persists, can not at present be determined; in the fertilized seeds all trace of it was gone. In the light of the present facts it would appear to be a probable conclusion that, while the majority of the sporogenous cells surrounding the embryo-sac simply become disintegrated and absorbed, the outermost form a more definite tapetal layer. This tapetum, while persisting longer than the more internal cells, ultimately disappears." The figure 16 to which Lang refers shows the persistence of this layer after the prothallium has become a multicellular body.

The manuscript of a paper by the writer† dealing with the development of the pollen tube in the pines had been in the hands of the publishers some weeks before Lang's paper appeared in America. It was not my purpose to give a detailed description of the development of the prothallium and related phenomena in that paper, inasmuch as this was to form the basis of a later paper now ready for publication; but incidentally the following statement was made: "The prothallium now consists of a uniform layer of protoplasm in which numerous free nuclei are embedded, no cell-walls as yet having been laid down. Immediately surrounding the endosperm, there is a definite band or hollow sphere of cells which is limited on its outer surface by a thin stratum of the disintegrating nucellus. These two layers constitute the so-called spongy tissue. The inner portion of this tissue, *i. e.*, the prominent band in immediate contact with the prothallium, must be intimately connected with the nutrition of the young endosperm. The true structure and function of this layer seem to have escaped the notice of previous writers. Its cells contain large nuclei, and are abundantly supplied with protoplasm. The karyokinetic figures so frequently observed in these cells show that this tissue increases in size by the growth and division of its cells as do the other portions of the ovule. As it enlarges, the cells of the nucellus in contact with its outer surface become disorganized and are absorbed (Fig. 3)." The figure referred to shows the prothallium and the disintegrating nucellar tissue separated by a definite zone of tissue two layers of cells in thickness. The cells of this band are conspicuous for their size and three of them show mitotic figures representing different stages of division. In Fig. 4 of the same paper this tissue is shown to be still present, but in a state of disorganization, at the time when the prothallium has become a solid multicellular body, and shortly before the division of the central cell.

Coker* finds that in *Podocarpus* "the macrospore arises deep in the nucellus and is not surrounded by spongy tissue such as is found in the Abieteæ, Cupresseæ, and Taxodieæ, and which has so often been erroneously described as of sporogenous character." To this statement he adds the remark: "Miss Ferguson's suggestion that the spongy tissue

* Lang, 'Studies in the Development and Morphology of Cycadean Sporangia.' II., 'The Ovule of *Stangeria paradoxa*.' *Ann. Bot.*, **14**: 281–306. 1900.

† Ferguson, 'The Development of the Pollen-Tube and the Division of the Generative Nucleus in Certain Species of Pines.' *Ann. Bot.*, **15**: 193–223. 1901.

* Coker, 'Notes on the Gametophytes and Embryo of *Podocarpus*.' *Bot. Gaz.*, **33**: 89–107. 1902.

is active in nourishing the prothallium is probably correct; an interpretation I had arrived at from a study of *Taxodium.*"

I discussed somewhat in detail the structure and function of this tissue in a paper given before the Society for Plant Morphology and Physiology at its Washington meeting in 1903. In a brief summary of the paper* this sentence occurs: "The spongy tissue is not disintegrating tissue, as previously stated, but it forms a zone of physiological tissue which plays an important part in the nutrition and support of the developing gametophyte."

In a paper appearing in the current number of the *Botanical Gazette* (July, 1903), Coker† devotes three pages to a discussion of this tissue in *Taxodium,* designating it 'The large-celled tissue or tapetum.' His very clear description is accompanied by several figures representing this tissue at different periods in the development of the gametophyte. He finds that a definite band of large-celled tissue is early organized about the macrospore separating it from the disorganizing nucellar tissue. This large-celled layer continues until the prothallium has nearly or quite reached maturity. He ascribes to this tissue 'an active part in the nourishment of the young gametophyte,' and believes that it 'may be considered as a tapetum.' But he makes no reference at all to the application by Lang of the term tapetum to a similar tissue in *Stangeria;* neither does he in any way indicate that the active nature of this tissue has been noted by any other investigator. Furthermore, one can but be surprised to find such unqualified statements as: 'Moreover, this tissue in the Abieteæ is always spoken of as disorganizing'; and, 'I do not know of any case, however, where this tissue is said to persist in later stages.'

The tissue in contact with the outer surface of the gametophyte during its period of growth in *Taxodium,* as described and figured by Coker, is very similar to that occurring in *Pinus.* The various stages in the life history of the spongy tissue in *Pinus* are fully described and illustrated in a paper now in the process of publication, and I will not, therefore, repeat the details of its development here.

The presence of an active tissue about the growing prothallium in many gymnosperms is now an established fact, but our knowledge of the true nature of this tissue remains for the present more or less obscure. Lang (1900) speaks of it as both sporogenous and tapetal in nature. Coker (1903) suggests that it may 'represent an originally archesporial tissue which has given up its function of spore production and taken up the new rôle of nourishing the young plant within,' but he prefers to consider it a tapetum. It is not impossible that these cells are sporogenous in nature, each being a potential macrospore-mother-cell, but in a careful study of their origin and development I find no evidence that such is the case. If they represent the sporogenous tissue of some remote ancestor, they have beyond any question now lost their primitive function and have acquired a new and important function in connection with the development of the gametophyte. It is probable that this tissue not only passes on to the endosperm the nutritive substance derived from the nucellus, but that it is itself active in the manufacture of food, as Coker reports the presence of numerous starch grains within its cells in *Taxodium* and I have often observed them in *Pinus.* Furthermore, I believe that, in addition to its physiological rôle, this tissue serves an important mechanical purpose. It not only affords support for the prothallium during the long period in which it consists of a thin layer of cytoplasm containing free nuclei, but, gradually receding, it pushes before it, as it were, the tissue of the nucellus, thus making room for the growth of the delicate gametophyte.

There is certainly a very strong analogy between this tissue and a tapetum, but we are entirely in want of any evidence that the two are homologous structures. It does not, therefore, seem to me wise at present to apply to it the name tapetum, or to suggest a

* Ferguson, 'The Development of the Prothallium in *Pinus.*' *Science,* N. S., **17**: 458. March, 1903.

† Coker, 'On the Gametophytes and Embryo of *Taxodium.*' *Bot. Gaz.,* **34**. July, 1903.

new name by which to designate it. Strasburger's term 'spongy' tissue, although given when the nature of these cells was not understood, and being a misnomer so far as their structure and function are concerned, has obtained a wide usage in the literature of the gymnosperms and should be retained, just as the term cell is still retained in all biological literature.

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RECENT LITERATURE ON TRIASSIC ICHTHYOSAURIA.

WITHIN the past few months two important contributions have been made to our knowledge of the Triassic Ichthyosauria of the Eastern Hemisphere. The more extensive of these papers is one by Dr. E. Repossi,* giving the long-desired exact description and illustration of the material upon which Baur based the genus *Mixosaurus*. In this paper the statements of Baur concerning the primitive characters of this genus are strongly supported and many previously unknown and even unsuspected characters have been brought to light.

One of the most important contributions made by Repossi is the description of the pectoral and pelvic arches. These are quite unlike those of any Post-Triassic form of the order, but show a strong similarity to the corresponding structures in the Californian genus *Shastasaurus*. All of the elements excepting the ilium and clavicle are much broader and more robust than in *Ichthyosaurus*. The inter-clavicle is more nearly triangular than T-shaped and is hence more stegocephalian. The scapula, like that of *Shastasaurus*, has more of a mosasaurian than of an ichthyosaurian aspect.

Beautifully preserved specimens show the limbs to be pentadactyle with elongated epipodial bones and notched or sometimes shafted phalanges. A peculiar feature is found in the presence of four elements in the proximal row of the carpus and tarsus. Were it not for the character of the specialized mesopodial region, these limbs might well be considered as the primitive types from which the limbs of *Ichthyosaurus* were derived. The limb structure differs considerably from the types found in the Californian genera, both in the number of digits and in the character of the mesopodial region.

Another interesting discovery is the fact that the dorsal ribs of *Mixosaurus* are mainly single-headed. Those who have concerned themselves with this group seem generally to have taken for granted a double rib articulation.

A second paper of interest dealing with Triassic Ichthyosauria is one by N. Yakòwlew on 'New Finds of Triassic Saurians in Spitzbergen.'* One of the specimens here described was found near the locality at which the type of Hulke's *Ichthyosaurus polaris* was discovered by Nordinskiöld, and as it resembles *I. polaris* in the size and general form of the vertebræ, it has been referred to this species. A posterior dorsal vertebra which has been figured is shown to differ from *Ichthyosaurus* in possessing a single broad apophysis for the articulation of the rib. This species is, therefore, placed by Yakowlew in the genus *Shastasaurus*. The vertebra is certainly very similar to some of the posterior dorsals of *Shastasaurus*. After a study of Hulke's descriptions and measurements of the type material, the writer has already expressed the opinion† that a careful examination would show it to belong in the Californian genus.

In this paper the valuable suggestion is made by Yakowlew that the ribs of the Ichthyosauria were primitively single-headed and that the double-headed form has been produced by more complicated and stronger movements of the ribs, causing disappearance of the middle portions of the rib heads and of the corresponding parts of the lateral apophyses

* 'Em. Repossi. Il Mixosauro degli strati triasici di Besano in Lombardia,' *Atti della soc. ital. di scien. natur.*, Vol. XLI., Fasc. 3, p. 361–372 tav. VIII., IX. Novemb., 1902.

* 'Neue Funde von Trias-Sauriern auf Spitzbergen,' *Verhand. der Kais. Russ. Mineralog. Ges.*, Bd. XL., S. 179–202.

† 'Triassic Ichthyopterygia of California and Nevada,' p. 88.