

## RESEARCH NOTES.

**Arithmetical Investigation of Elliptic Integrals.**—Schneider (*Math. Ann.*, Band 113, Heft 1, pp. 1-13) has proved three general theorems from which a variety of interesting results concerning the transcendency of elliptic integrals can be deduced. These are the following: I.—The six numbers  $a, b, g_2, g_3, \wp(\beta), a\beta + b\zeta(\beta), \{\wp(\beta), \infty, |a| + |b| \neq 0\}$  cannot all be algebraic. II.—If  $\wp(x)$  and  $\wp^*(q^x)$  be algebraically independent and  $x = \beta$  not being a pole for either, then at least one of the seven numbers  $g_2, g_3, g_2^*, g_3^*, \wp(\beta), \wp^*(q\beta), q$ , is transcendent. (These theorems are slightly sharpened by him by utilising the transformation  $\beta' = \lambda\beta$ .) III.—If  $\wp(\beta) \neq \infty$  and  $g_2$  and  $g_3$  are algebraic, then at least one of the three numbers  $\wp(\beta), q \neq 0$ , and  $e\beta$ , is transcendent. The proof consists in constructing a polynomial

$$L(x) = \sum_{\lambda=0}^{n-1} \sum_{\mu=0}^{n-1} C_{\lambda\mu} \wp^\lambda(x) [ax + b\zeta(x)]^\mu$$

which  $r$ -ply vanishes at the points  $\alpha_k = k\beta$  ( $k = 1, 2, \dots, t$ , under the supposition that if  $\wp(k\beta) = 0$ , the corresponding  $\alpha_k$  is omitted), where  $t = 24s + 1$ , and  $s$  is the degree of the algebraic field to which the numbers belong (assuming that all the sets of numbers in the theorems to be algebraic) in such a way that the coefficients  $c$  are all algebraic integral and all their conjugates are

$$< K_3^r \cdot r^{2r}, \text{ where } r = \left\lceil \frac{n^2}{2t} \right\rceil$$

This is constructed by making use of the formulae and some inequalities of elliptic functions. Then he proves that if  $L(x)$  possesses these properties, then it should be identically equal to zero by which the theorem is obtained.

The results obtained are extremely general and a few particular results are stated below: (1) The length of an arc of an ellipse whose axes-lengths are algebraic between algebraic values of the ordinates cannot be algebraic. (2) In case  $g_2$  and  $g_3$  are algebraic  $\omega, \eta, \omega/\eta, \omega/\pi$ , are all transcendental. (3) If  $J(\tau)$  is algebraic, then  $\tau$  is either imaginary-quadratic or transcendental. (4)  $a$  and  $\wp(\pi a)$  cannot both be algebraic.

K. V. I.

**Series-Developement in Invariant Theory Particularly in the Quarternary Field.**—B. L. Vander Waerden (*Math. Ann.*, 113 Band, I Heft, 14-35) has obtained important generalisations of some fundamental results in the theory of invariants and has proved some unproved results of Gordan. In this article he builds up the theory of invariants and covariants of any system of group-numbers (i.e., *Gruppen-Große*) with respect to any group of transformations. As he presupposes a bare acquaintance of the theory of representations of groups, the article can be read with profit by those wishing to learn the modern conceptions of invariant theory and the beautiful and simple modern proofs of the results. (A synopsis of the foundations is given

in Weyl—Group-theory and quantum-mechanics, Ch. III).

At the outset he defines a group-number as any quantity which is transformed linearly by the operators of a group  $G$ , viz., vectors, tensors, spinors. (in connection with the orthogonal group), linear forms in any number of variables, etc. We obtain therefore a representation of the group with respect to a group-number. A covariant of a group-number  $f$  (or a system of numbers) is another group-number whose elements are homogeneous polynomials of those of  $f$  which is transformed in the same way as  $f$ . The fundamental problem of covariant theory consists in finding a process of building up of all the covariants of a given system. This problem is resolved finally to the problem of expressing the product of two irreducible representations of a given group in terms of the irreducible representations of the group. The true significance of the Clebsch-Gordan series of the classical theory of invariants is that it gives us the product of two irreducible representations in terms of the irreducible representations of the linear group. An invariant is obviously a covariant corresponding to a space of order one. First of all the (linearly independent) linear invariants of a homogeneous form

$$f = \sum a_{r_1 r_2 r_3 \dots r_k} x_1^{r_1} x_2^{r_2} \dots x_k^{r_k}$$

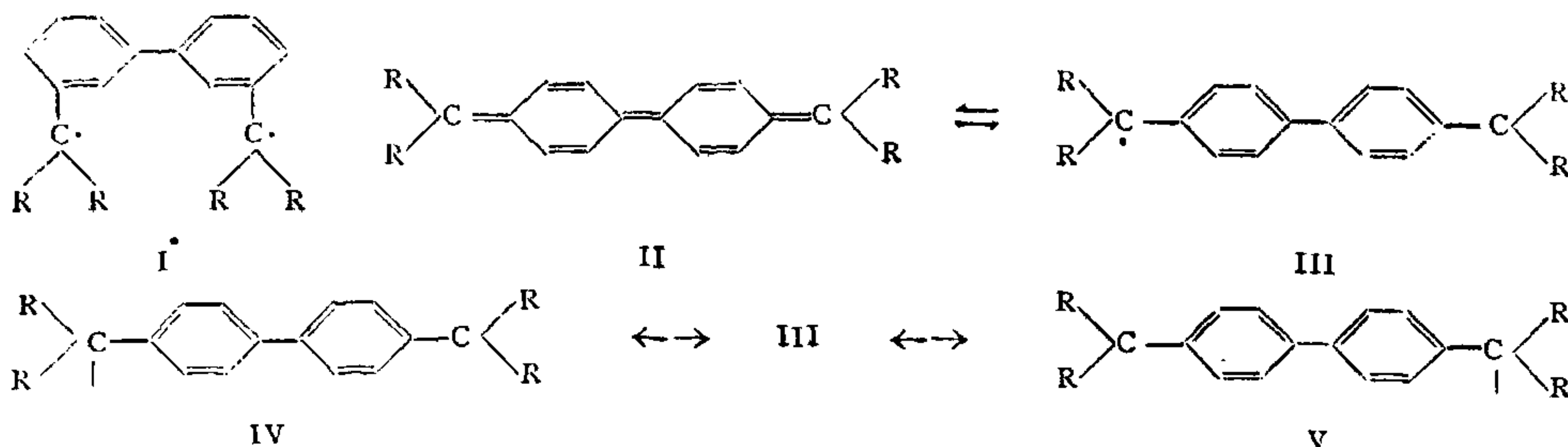
are found out as follows. The group induces a representation with respect to the form  $f$ . Now if this representation is resolved into irreducible representations, the number of linearly independent invariants is easily seen to be, equal to the number of irreducible representations of order one occurring in the representation  $f$ . The number of linearly independent linear covariants of  $f$  is easily seen to be equal to the number of irreducible contra-gradient representations of order  $k$  (assuming  $k$  to be the number of variables in  $f$ ) occurring in the representation  $f$ . Invariants and covariants of higher orders involving higher powers of the coefficients of  $f$  are obtained by resolving the powers (formed in the Kronecker-way) of the representation  $f$ . (The process is called the polar process.) It is easily seen that the process gives not only the number but the invariants and covariants themselves.

In the latter part of the article he considers the special linear group and particularly the quarternary forms. Making use of the connection between the irreducible representation of this group and the corresponding permutation group (i.e., the Frobenius-Young theory) he deduces many important results in particular generalisations of some of Study's results in the ternary case and some results given without proof by Gordan.

K. V. I.

**Valence-Tautomerism in Unsaturated Compounds.**—It is known that the presence of uncompensated single electrons in organic compounds such as in the mono radicals triphenylmethyl or tribiphenylmethyl, makes them paramagnetic. The same paramagnetism has





also been observed in a typical bi-radical, viz., *m, m'*-Diphenylene-bis-(diphenyl methyl) I. One should expect on similar grounds that the mesomeric form III of tetraphenyl-dimethylenediphenoquinone II, which is the *p*-analogue of the *m*-bi-radical and shows chemically a bi-radical nature, must also be paramagnetic.

The observed diamagnetism of this compound is therefore very striking and indeed E. Müller has pointed out that in all bi-radical compounds which can be mesomeric with a quinonoid structure, only diamagnetism is to be found. In the observed bi-radical form therefore it must be postulated that the spin of the two lone electrons in the two separate atoms must be compensated, and this would mean a new kind of chemical binding. B. Eistert (*Ber.*, 1936, 69, 2393) has discussed this difficulty and explains that these two electrons responsible for colour and unsaturation are not separate but paired as indicated by the observed magnetic property and that the paired free bond is alternately on either of the two methyl C-atoms, the structures III, IV and V being in quantum-resonance.

A number of other similar cases are also discussed in this interesting paper.

M. A. G.

**Contact Potentials of Reversible Soluble Films of Lauric Acid.**—The accumulation of surface-active solute molecules on a freshly swept surface of solutions of benzopurpurin and nonylic acid has been studied by Doss (*Curr. Sci.*, 1935, 4, 405; *Proc. Ind. Acad. Sci.*, 1936, 4, 97). A similar observation has been made by Harkins and co-workers (*Nature*, 1936, 133, 405), with saturated solutions of lauric acid by measurement of the variation of surface pressure and contact potential with time. Upon sweeping the surface rapidly the surface-active molecules slowly accumulate by diffusion from below with a rise in the surface pressure by about 6 dynes per cm. and fall in contact potential by 120 m.v.

Upon compression the surface pressure may increase to about 25 dynes per cm. and the contact potential may drop to -200 m.v. which return to the equilibrium values, in about half an hour owing to the diffusion of molecules of the compressed film into the interior.

The observations indicate the importance of time factor in the determination of surface tension of solutions of surface-active substances and the imperfectness of the dynamic methods for determination of surface potentials.

K. S. RAO.

**The Role of Certain of the So-called Non-Essential Elements in Plant-Growth.**—The response of wheat grown in water cultures to the elements cobalt, iodine, zinc, aluminium, manganese, lithium and sodium supplied in the form of their chlorides is the subject of a study by B. N. Singh and S. Prasad (*Ind. Jour. of Agric. Sci.*, 6, Part III). The culture solutions contained these compounds in four different concentrations, viz., .01M, .005M, .0005M and .0001M. In addition to the growth characters recorded estimations were also made of the dry matter, the different carbohydrates, and the nitrogen content. The first two strengths have proved toxic while the second two have had a stimulating effect in all cases except NaCl in which the effect has been quite the contrary, viz., the highest strength was stimulative, the second less so, the third not stimulative at all and the last slightly retarded the growth. ZnCl<sub>2</sub> was remarkable in the stimulative effect, growth being very vigorous and the dry matter yield also higher than in the controls. The chlorides of cobalt and iodine were found to be the most toxic, even the lowest strength was not free from toxicity. As regards the accumulation of carbohydrates, the effect is very varied; the sucrose content is in almost all cases below the controls; the starch content, in the majority of cases is higher than in the controls; the glucose was either just equal to or less than the controls except in the case of NaCl where it was greater; the total carbohydrates in the case of Na, Li, Zn and Mn, were higher at the stimulative strengths. The nitrogen in practically all the cases was lower except in the case of ZnCl<sub>2</sub> at the higher strengths which however are toxic strengths. On the whole it is difficult from these experiments to stress the importance of any of these elements, as the stimulative and beneficial effect in one direction appears to be counteracted by the baneful effect in other directions.

**Quality of Lint in Relation to Ginning Factors.**—The effect of changes in the setting of the moving knife in a roller gin and of different speeds in a saw gin on the quality of the resulting lint has been studied by Nazir Ahmad and R. P. Richardson (*Tech. Bull. Series A.*, No. 31, of the Indian Central Cotton Committee Technological Laboratory). The studies relate to two adjustments in the roller gin, viz., an overlap of  $\frac{3}{8}$ " and  $\frac{4}{8}$ " for some and  $\frac{4}{8}$ " and  $\frac{5}{8}$ " for some others of the nine samples of cotton studied, while the saw gin speeds were 325 and 425 r.p.m. for all the samples. The latter comprised types of long,



medium and short staple cottons ranging from 0.70 to 0.94 inches of mean fibre length. It is concluded from the results that in respect of the important quality factors staple length and strength of yarn, and in cleanliness, the smaller overlap in the roller gin and the lower speed in the saw gin were more beneficial than the larger overlap and the higher speed. Better out-turns however resulted from the larger overlap and the higher speed, so that it looks as though the interests of the ginner, and the millowner looking for better quality, cannot both be served at the same time by any particular setting of the gin. The larger overlap also gave the higher ginning percentage with the majority of the varieties, but in the saw gin neither of the speeds made any appreciable difference; likewise no difference was made in the yarn neppiness by any of the adjustments of either the roller or the saw gin. The complexity of the factors involved in a study of this kind due both to ginning methods as well as to the character and condition of the seed cotton is referred to and the present study is stated to be the first of a series. We would at this stage ask the authors to consider if it will not be possible without sacrificing accuracy to carry out these tests with actual Factory units and thereby make the results applicable directly to ginning factory practice.

A. K. Y.

**Cytological and Morphological Researches in Some Indo-Malayan Lorantheae.**—A paper of great interest, concerning one of the three recent works on Lorantheae, based on material collected by Prof. A. Ernst and his wife, Dr. M. Ernst-Schwarzenbach, during their botanical excursion to the Indo-Malayan region in 1930-31, has recently been published (Rauch, Konrad von, "Cytologisch-embryologische Untersuchungen an *Scurrula atropurpurea* Dans. und *Dendrophthoe pentandra* Miq.," *Ber. Schweiz. Bot. Ges.*, 45, 5-61).

The development of the male gametophyte proceeds in a normal way. The tapetal cells are mostly uninucleate and the mature pollen grains are 2-nucleate. In both species the diploid number of chromosomes is 16 and haploid 8.

The development of the gynoecium shows some extraordinary phenomena. As in other Lorantheae, investigated by older authors, ovules in the usual sense are absent. There are no integuments and even the nucellus is not marked out from the surrounding tissue of the inferior ovary. There is a many-celled archesporium; the number of megagametophytes varies from 3 to 5 in *Sc. atropurpurea*, but goes up to 12 in *D. pentandra*. The embryo-sacs elongate considerably both upward and downward. Their progress on the lower side is soon checked by a layer of collenchymatous cells, but the upper end continues to grow aggressively and penetrates far up into the stylar canal—in *D. pentandra*, where the style has an average length of 15.5 mm., one embryo-sac was only 4.5 mm. below the stigma! Protrusions of nucelli and embryo-sacs into or through the micropyle have, it is true, been recorded before in other angiosperms, but such an extreme case is not known outside its family. Indeed, the downcoming pollen tubes and the up-growing 'embryo-sac-tubes' offer, in the opinion of the reviewer, a parallel to the condition in *Welwitschia*, although

the two plants are too differently related to permit much speculation. Double fertilisation occurs in the usual way, but this event takes place in the style and not in the ovary! The endosperm seems to be cellular from the very beginning. The first division of the egg is longitudinal, followed by some transverse divisions, resulting in a 2-rowed suspensor and a bi-celled embryonal primordium at the tip. In the mature fruit only a single embryo is present, since the others degenerate at one time or the other during the course of their development. By a fusion of neighbouring embryo-sacs the different endosperms become united to form a common nutritive mass for the surviving embryo.

Dr. Rauch's work is of more than usual interest and readers would consequently have welcomed a more detailed account of the earlier development of the embryo-sac. The statement—"es werden drei Makrosporen gebildet, von denen die oberste zum Embryosack auswächst"—is ambiguous. Strictly speaking, a row of "three megaspores" does not occur at all, for one of the three must be a *dyad cell* that has failed to undergo the second reduction division. Whether the uppermost cell, in this case, is a dyad or a real megaspore, is not made clear by the author, and so it is impossible to say if the development is of the "*scilla*-type" (it would be more correct to call it the "*Allium*-type," since it was first discovered in *Allium fistulosum*) or Normal-type.

A study of the embryology of some Indian Lorantheae is now being carried on at Cuttack in Prof. P. Parija's laboratory and the results thereof will be awaited with keen interest.

P. MAHESHWARI.

AN attempt to use the structure of the generative cell as an aid in the solution of systematic problems (Wunderlich, *Oster. Bot. Zeit.*, 1936, 85, 30-55) has been made by Miss Wunderlich. She herself calls it only an attempt, since the aceto-carminic method, which she employed, does not give good results in every case.

It has been found that, as a general rule, species of the same sub-tribe show a similar structure of the generative cell and nucleus. Since it is quite impossible to mention all the details, the reviewer is citing just one instance here. In the tribe Asphodeloideae, members of the two sub-tribes Asphodelinae and Anthericinae were investigated. In *Asphodeline lutea*, *A. liburnica* and *Eremurus spectabilis* (Asphodelinae) the generative plasma could not be made visible but the long thin generative nucleus stained well. In *Paradisialia liliastrium*, however, which is included by Krause in the same sub-tribe, a spindle-shaped generative cell was clearly visible and the generative nucleus was found to be broader and shorter than in the other two genera of this sub-tribe. A similar structure of the generative cell was seen in the sub-tribe Anthericinae in 3 species of *Anthericum*, in *Chlorophytum Sternbergianum* and *Escheandia ternstroffii*. On the other hand, *Bulbine caulescens* (placed by Krause in the Anthericinae) showed a structure comparable to that in *Asphodeline* and *Eremurus* (Asphodelinae). Miss Wunderlich concludes from this that the genus *Paradisialia* ought to be transferred to the sub-tribe Anthericinae and *Bulbine*,



on the other hand, to the Asphodelinæ. This is in accord with the conclusions reached by Stenar (1928) and Schnarf (1929, 1931) on embryological grounds.

It may be noted that in some cases (*Haworthia*, *Fritillaria*, *Tulipa* and *Ornithogalum*) the generative plasm could be seen even in the unstained pollen grains mounted in water. The reviewer can add to these *Hippeastrum hybridum* (Amaryllidaceæ) from his own experience.

It is to be commended that the author is very cautious in her conclusions. In those cases where the generative plasm was not stained with aceto-carmin, she does not conclude (like some other authors!) that it *did not exist at all*, but that it *could not be made visible*. The same care is exercised in statements with regard to the existence of the vegetative nucleus. In species of *Allium* it stained as deeply as the generative nucleus itself, in some other cases it stained very lightly, while in still others where it could not be stained at all, Miss Wunderlich avoids the usual (and hasty!) conclusion that it had degenerated.

H. D. WULFF.

**Fossil Algae from the Trichinopoly Cretaceous-S. India.**—About 5 years back, in August 1911, Prof. L. Rama Rao reported through the columns of *Nature* the discovery of numerous algae in the uppermost Cretaceous beds (the Niniyur group) of the Trichinopoly District, S. India. These have now been studied by Dr. Julius Pia of the Natural History Museum, Vienna, who is a well-known authority on fossil algae and the results published in a recent *Memoir of the Geological Survey of India* (Pal. Ind. N. S., 21, 4) under the joint authorship of Prof. L. Rama Rao and Dr. Julius Pia. In part I of this memoir, Prof. Rao has given a detailed account of the geology of the Niniyur group, with special reference to the algae-bearing rocks. The flints and cherts associated with this group have been proved to be the result of silicification of limestones, which they resemble both in general appearance and the character of the included fossils. Regarding the mode of origin of the Niniyur rocks, it has been shown that they were deposited during a local and independent post-Senonian transgression of the sea in the north-eastern part of the Trichinopoly Cretaceous area, and are of Mæstrichtian-Danian age. In part II, Prof. Pia describes the fossil algae present in these rocks—chiefly belonging to the four families: Solenoporaceæ, Corallinaceæ, Dasycladaceæ, and Chaetophoraceæ. Of these the most important from a botanical and stratigraphical point of view are the Dasycladaceæ, of which several new genera and species have been described. Of the Corallinaceæ the most common form is *Archæolithothamnium*. The general character of the Niniyur algal flora suggests an age transitional between the Cretaceous and Eocene systems. While these algae cannot be employed to decide stratigraphic questions in this area, the sequence of strata in this region will be a typical section, and the algae could be used to correlate strata in other parts of the earth with those in the Trichinopoly District and thus to fix the geologic age of these foreign sediments.

**Growth of Colpidium in Relation to Certain Incomplete Proteins and Amino Acids.**—Hall and Elliott (*Arch. f. Protistenk*, 1935, 85, 443) have demonstrated that growth of *Colpidium* is accelerated by several amino acids and asparagin when each of these substances is added to a medium which supports a relatively slow but steady growth of ciliates. The addition of a series of single amino acids and asparagin to a gelatin medium produced increases in growth ranging from 20% to more than 50% than in the gelatin controls. These authors therefore suppose that *Colpidium* is able to make use of a number of single amino acids, although none of them alone is adequate for growth of the ciliates. A combination of gelatin and a very small amount of yeast extract or liver infusion or tryptone supports the growth of ciliates continuously which does not happen in gelatin alone.

M. K. S.

**Studies on the Physiology of the Euglenoid Flagellates. V. The Effect of Certain Carbohydrates on the Growth of *Euglena gracilis* Klebs.**—The effect of various carbohydrates upon the growth of *Euglena gracilis* in bacteria-free culture has been studied quantitatively (Jahn, *Arch. f. Protistenk*, 1935, 86, 238). When transferred from an inorganic medium to one containing carbohydrate in addition to inorganic substances *E. gracilis* undergoes encystment or an acceleration or deceleration of division rate. The effect varied with the carbohydrate used and also to some extent by the physiological condition of the stock cultures, intensity of light, temperature and the pH of the medium. *E. gracilis* does not secrete sucrase or amylase.

M. K. S.

**Isolation of *Glaucocystis ficalia* Kahl in Bacteria-Free Cultures, and Growth in Relation to the pH of the Medium**—Growth of *Glaucocystis ficalia* occurs within the pH range of 4.9–9.5 and that of *G. piriformis* within the range of 4.0–8.9 (Johnson, *Arch. f. Protistenk*, 1935, 86, 263). In general the pH optimum is somewhat lower for *Glaucocystis piriformis* (4.8–5.3) than for *G. ficalia* (5.1–6.0). The type of growth-pH curve for either species depends upon the type of medium used.

M. K. S.

**Growth of *Glaucocystis ficalia* Kahl in Cultures with Single Species of Other Micro-Organism.**—Johnson (*Arch. f. Protistenk*, 1936, 86, 359) has successfully cultured *Glaucocystis ficalia* in suspension of 21 species of living bacteria, one species of living yeast, and one species of algae; in suspension of 11 species of dead bacteria, a species of dead yeast and 6 species of dead flagellates. The usefulness of yeast and small Protozoa as food for *G. ficalia* depend largely upon the size of such organisms, the larger forms not being ingested by the ciliates. In suspensions of Bact. (*Erythrobacillus*) prodigiosus the division rate of *G. ficalia* was approximately the same from pH 4.5 to pH 8.6 while in suspension of three other species of bacteria the ciliates showed a bi-maximal growth-pH curve with maximal development at pH 5.0 bis 5.2 and at pH 7.6.

M. K. S.