Speaking generally, I regard cœnenchyme as an elaboration or extension of mural and murocostate structures, formed above or within the epitheca.

I have above referred exclusively to the kind of wall which has been termed a "eutheca" (Fig. 8) or "true theca." Dr. Ortmann has defined it as a wall having distinct centres of calcification independent of these in the septa. In the case of

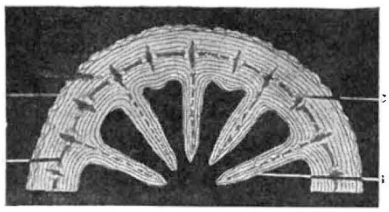

FIG. 8.—*Eutheca.* Transverse section showing the structural relations of *s.* = septa, *c.* = costa, *th.* = theca, and *ep.* = epitheca, in a typical Turbinolid. The section is cut some little distance below the calycinal edge.

the primitive one-sided wall, I would remark that the layers are often so smooth, that no particularly marked ring of "centres" is seen next the epitheca.

The "pseudotheca" (Fig. 9) is defined as a "false wall" formed by lateral thickening of the septa, with or without the participation of basal structures. I find that "pseudothecal" thickening is a very general characteristic in the families with

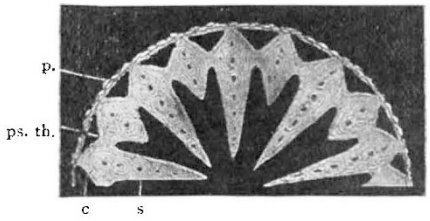

FIG. 9.—*Pseudotheca.* Transverse section showing the structural relations between *s.* = septum, *c.* = costa, *ps.th.* = pseudotheca, and *ep.* = epitheca. All grades occur between a position of the pseudotheca very near the centre and very remote from it, until it may be almost coalescent with the epitheca; the costa is respectively longer or shorter.

Pollaplophractic septa. Two walls, *i.e.* both pseudotheca and eutheca, were present temporarily or permanently in many fossil colonial genera belonging to Cyathophyllidæ, Stylinidæ, Amphiastræidæ, but, as a rule, the permanent presence of a pseudotheca is correlated with retrogression or absence of the primitive wall-lining of the epitheca, and even the epitheca itself, around individual calyces.

Evolution in the general Architecture of the Calyx.

The internal construction of the calyx has altered very considerably during the history of the Madreporaria. Originally, the Madreporarian calyx was shallow, with low septa ribbing the walls and base, and from one to four grooves (fossulæ) in the wall and base. Now, it has become typically deep-cupped, the septa are relatively higher and more ornate, centrally a columellar "style" rises upwards, or the septal ends meet irregularly in a columellar mesh-work, and instead of one to four special grooves, it is as if the whole base of the cup were grooved and deepened. These changes I take to be correlated, *and to have been initiated by an increase in the number of mesenteries bearing reproductive organs, and increase in the demand for space in which to accommodate and protect these organs in the calyx.* It is generally presumed that the primitive fossulæ were pits for the accommodation of a very few mesenteries specialised for reproduction. Whereas now all, or nearly all of the mesenteries in living corals can exert this function. The multiplication of reproductive organs in any species is, we may safely argue, an advantage to it in propagating its kind; certainly it is a change which has proved successful in all Madreporarian families adopting it. The Cyathophyllids were the most precocious of the Palæozoic corals in modifying their calyx; and I attribute to this fact the marvellous rapidity with which their descendants, the families of Astræidæ and Fungidæ, spread over early Mesozoic seas. To this day these families are probably the richest in genera and species.

The change in the architecture of the calyx was effected by a gradual modification of existing skeletal structures. The "tabula" degenerated or was changed to "columella"; it was only retained in its primitive form in the calyces of polyps which have never specially multiplied the number of their mesenteries, but have held their place owing to some other advantageous resource, *e.g.* cœnosarc. These are comparatively few.

The wall-lining of the epitheca was modified as I have indicated above. The septa were modified, giving rise to pseudothecæ inside the calyx, a valuable means for the support of mesenteries. In living families, the complicate Pollaplophractic type of septum goes hand in hand with much pleating and greater muscular vigour of the mesenteries. There can be little doubt that higher musculature and sensibility of mesenteries aids reproduction, hence these correlated features in septa and mesenteries were probably adaptations to this end. The synapticular base is another modification closely associated with the mesenteries, occurring as an occasional correlate in types with Pollaplophractic septa and a much-pleated aboral polypal surface.

In short, by comparison with well-known facts in the anatomy of living Madreporaria, it becomes clear that all the important changes which have taken place in the history of the group, are secondary features correlative with change in the mesenteries. There is also good evidence that the change in the mesenteries has assisted the polyp's powers of propagation. We need look no further for an explanation of the "hastening" in the stages of cyclical development of mesenteries or septa. The history of the embryo summarises that of the race; tetrameral symmetry is now for the most part an evanescent phase in embryonic development. On this point, any evidence I have gathered from Mesozoic corals only corroborates the published views of Prof. Quelch and Dr. Ortmann against a subdivision of Madreporaria into Tetracoralla (Rugosa) and Hexacoralla, and helps to still more emphatically knit continuity into the thread of Madreporarian descent from Palæozoic to recent time. Even now the change to radial symmetry of the polyp is often incomplete, and will be while there still are "directive" mesenteries.

In conclusion, I claim in this work to have shown that the great impulse of evolution—viz. the successful continuation of the race—is the agent to whose steady working the main changes in Madreporaria may be traced. I claim to have vindicated this position by demonstrating the same structural unit in the simplest and the most complicate skeletal structures known in Madreporaria through all ages, by finding in all skeletal parts one and the same fibrous equivalent of the living, lime-forming, unit cell, and by tracing a correlated series of modifications which primitive forms have undergone in response to the need of safeguarding the race. MARIA M. OGILVIE.

THE POSITION AND WORK OF THE CENTRAL TECHNICAL COLLEGE.

THE Report of the Special Committee appointed by the Governors of the City and Guilds of London Institute, at the instance of the Court of Assistants of the Mercers' Company, to inquire into the expenditure of the Central Technical College as compared with results, has just been published. The Committee comprised not merely representative members of the City Companies, but present and past Presidents of the Royal Society, the Institution of Civil Engineers, the Chemical Society, and other societies interested in the advancement of knowledge, so that its opinion may be regarded as that of the scientific public. Sir John Donnelly was elected chairman of the Committee.

The volume runs into eighty pages, and deals with (1) building and equipment, (2) current expenses, (3) cost of the College per student and comparison with other colleges, (4) methods of administration and control over expenditure. We are glad to give it prominence, first, because the Central Technical College is not supported as a commercial concern to make money, but to provide, at small cost, a sound education in the applications of the principles of science to industry; and secondly, because the members of the teaching-staff are earnest and enthusiastic in their efforts to carry ont the scheme formulated some years ago, when the estimates of the cost of the College were drawn up by Huxley and others.

It would be a distinct impediment to the progress of the higher technical teaching, if the present scheme (which supplies education to students at one-third of the annual cost, or for about one sixth of the total cost if interest on capital expenditure be added) were interfered with, by the obstruction offered by those who would prefer that the City Companies' funds should be spent on food for the body rather than for the mind.

From the Report of the Sub-Committee on Finance and Administration the following particulars have been derived :—

The Central Technical College was completed in 1884, and cost £79,200. The original equipment cost £22,600; making a total of £101,800.

In the following table is given the original capital expenditure on the College as compared with the capital expenditure estimated by the Livery Companies' Committee of 1878, in consultation with the expert advisers, together with capital expenditure on other colleges in England and abroad—

Central Technical College		£101,800
Approximate cost as suggested by—		
Prof. Huxley	£100,000	
Sir Douglas Galton ...	150,000	
Sir John Donnelly ...	100,000	
Sir H. Truman Wood...	150,000	
Mr. Bartley, M.P. ..	75,000	
King's College		215,970
University College		300,000
Owens College, Manchester		313,525
Yorkshire College, Leeds (buildings only) ...		167,000
University College, Liverpool		128,750
McGill University, Montreal (Engineering and Physics Departments only)		202,000
Cornell University		550,000
Massachusetts Institute of Technology		210,000
Technical High School, Berlin (building only), 1884		450,000
Technical High School, Munich, 1884		193,000
École Centrale des Arts et Manufactures, Paris (building only)		250,000

Since the original equipment of the Central College was furnished, a further sum of £9500 has been spent on apparatus, books and fittings of a permanent character, partly out of the general funds of the Institute, and partly out of special grants.

It is instructive to notice the cost to the College per student in comparison with other Colleges.

In England, Cooper's Hill Engineering College provides a training in engineering and forestry for about 100 students, more especially with reference to the requirements of the Indian Service; the College is under the India Office, and the gross cost per student amounts to about £170 a year; this, however, includes residence, the cost of which does not exceed £50 per student. The Royal College of Science, under the Science and Art Department, is attended by about 300 students, about half of whom are free scholars; the cost, exclusive of scholarships and exhibitions, is estimated for the current year at £20,364 (Civil Service Estimates), but this does not appear to include charges for rates, repairs, or library. The amount received for fees is about £3200, leaving the net cost at about £16,800. The gross and net cost per student is therefore about £67 and £57 respectively.

In the United States, America, the technical school which most nearly resembles the Central Technical College in its organisation is the Massachusetts Institute of Technology, at Boston, which, however, includes in its curriculum, in addition to the subjects of civil, mechanical and electrical engineering and chemistry, taught at the Central Technical College, several others which in England are provided for at the Royal College of Science, besides sanitary engineering, architecture, and shipbuilding. The courses of study cover a period of four years, and the total number of students is between 1100 and 1200. The institute has several buildings, each about the size of the Central Technical College. The expenditure in 1894 was £70,610—namely, salaries £41,900, laboratories and library £6760, and sundries £21,950. The income derived from the students' fees, £44,190. The gross and net cost per student was about £60 and £22 respectively. The gross annual cost per student at Cornell University, where science and engineering students greatly preponderate, is about £63; the number of students during the session 1894-5 was 1503, and the income derived from fees £30,000, or on an average £20 per student, making the net cost per student about £43. The income and expenditure of the Johns Hopkins University, Baltimore, was in 1893-4 £36,250, and the number of students in 1894-5, 589; the fees charged to students vary from £30 to £40. The gross and net cost per student would therefore be about £61 and £25 respectively.

At the McGill University, Montreal, the expenditure of the Faculty of Applied Science for the session 1895-6 amounted to £60 per student, and the net cost per student, after deducting receipts from fees, to £29.

The organisation of, and conditions of admission to, the technical high schools or polytechnics of Germany are so different from the Colleges just mentioned, that no accurate comparison can be drawn between them; but the following statement from the second Report of the Royal Commission on Technical Education, 1884, is of interest as showing what Germany was at that time doing for technical education:—"It may be mentioned that in the polytechnics of Germany there is accommodation for about 6000 students, whilst the total attendance is little more than 2000, and the annual cost to the State of each student, exclusive of interest on capital, is about £100" (vol. i. p. 209). Since that Report of the Commissioners, the accommodation in Germany for technical students has greatly increased, and at Charlottenberg (Berlin) alone there are over 2000 students, including, however, occasional students. The fees at the technical high schools in Germany amount, for a full attendance, to about £12 a year.

Perhaps the most celebrated polytechnic on the continent is that at Zurich, Switzerland, which in its organisation closely resembles the Central Technical College, although several times as large, and embracing a much wider range of courses of study. Her Majesty's Secretary of Legation at Berne, in a recent report on education in Switzerland, states that—"In the Polytechnic School of Zurich, to which the Federal Government makes an annual grant of £36,800, there are 720 pupils, of which 309 are foreigners. Instruction is given in architecture, civil engineering, mechanics, chemistry, forestry, and training of teachers. The fees are about £8 10s. per pupil." Assuming that there is no other source of income, this would make the gross and net cost per student about £59 and £50 respectively.

The foregoing approximate results, excluding board and lodging, are shown in the following table:—

—	No. of students.	Gross cost per student.	Net cost to Institute per student.
		£	£
Central Technical College ...	210	54	31
ENGLAND—			
Cooper's Hill	100	120	—
Royal College of Science...	300	67	57
AMERICA—			
Massachusetts Institute ...	1200	60	22
Cornell University ...	1503	63	43
Johns Hopkins University	600	61	25
McGill University (applied science only)	175	60	29
GERMANY—			
(Report of Royal Commission, 1884)	2000	—	100
SWITZERLAND—			
Polytechnic, Zurich ...	720	59	50

The Sub-Committee on the educational work of the College report that three classes of students attend the courses. There are those who hope to qualify for the diploma and take the three years' course of instruction as laid down in the programme; those who attend one or more departments only with a view of completing or continuing their instruction in special directions; and those who attend short courses of lectures or laboratory work in some special branch of applied science.

The questions set at the entrance or matriculation examina-

tion of the Central Technical College during the last few years show that no institution in the kingdom requires from candidates for admission the same standard of attainments. Indeed, with the exception of two institutions, none of those receiving any part of the Government Grant of £15,000 a year allocated to University Colleges, require students above sixteen to submit to any entrance examination whatever, and the examination of these two is of the simplest character, and bears no comparison with that of the Central Technical College. The Committee considers, therefore, that the Central Technical College is somewhat handicapped in its competition for students by the difficulty of its matriculation examination. At the same time they are of opinion that it is important that an institution, avowedly intended for higher education, should require candidates for admission to pass such an entrance examination.

There is another class of students for whom provision was made in the original scheme, in attendance at the College, who are not required to pass the matriculation examination, nor to take any prescribed course of study. These are the so-called "special" students. They are in most cases students of more advanced age, who are desirous of pursuing for a session, or even a part of a session, a special line of study, with a view to qualifying for some particular industrial position or for teaching purposes, or for research work. Of such students, some have graduated at other universities, here or abroad; others have already been engaged in commercial works; and the evidence received from former students of this class satisfies the Committee as to the advantages derived from the facilities which the Central College offers for such specialised study. The gain to industry and commerce, and to the progress of science by the steady work and the careful researches of such students, is alone ample justification for the expenditure which the maintenance of an institution affording such facilities involves.

Although the number of students in attendance at the College cannot be considered, by itself, a sure criterion of its success, there is no other institution in Great Britain or Ireland in which so large a number of student are receiving advanced instruction of the same character as that given at the Central Technical College.

In considering the educational work of the College, the large number of contributions to the advancement of science which have been made by the Professors individually and in co-operation with their students are referred to. Indeed the spirit of research pervades every department of the College.

The teaching is well calculated to give to the student that general knowledge of scientific principles which all practical men regard as of primary importance, supplemented by the experience in the application of those principles to the methods of original investigation.

The knowledge which the students are enabled to acquire in the engineering workshops, of the construction and use of machine and other tools, is especially useful in subsequently helping them in their own experimental work, and in enabling them to profit more quickly by the experience of the factory or workshop.

As regards the salaries of the Professors, that there are four Professors who each receive a fixed stipend of £1000 a year without any share in the students' fees. At most other Colleges the practice is to give the Professor a smaller salary and a share in the fees. Both practices have advantages; but the Committee are disposed to give the preference to the system adopted by the City Guilds—of making the Professor quite independent of his students' fees, so that he may have no interest in admitting unqualified and insufficiently prepared students into the College. Indeed, with a difficult entrance examination, such as that of the Central College, the fact that the Professors' remuneration depends in no way upon the fees paid by the students removes any suspicion of a tendency to undue leniency on their part in the admission of the students. Several of the Professors in other institutions are more highly remunerated, and enjoy at the same time a larger measure of liberty than those at the Central Technical College. At Liverpool, the payment to the Professor of Physics for the year 1894–5 was £1177 16*s.* 7*d.*; to the Professor of Engineering £1039 17*s.* 7*d.* At University College, London, the payment to the Professor of Chemistry for the same year was £1100 13*s.* 4*d.* At Owens College, Manchester, the Professor of Mathematics received £1048 6*s.* 8*d.*; the Professor of Chemistry £1220 13*s.* 8*d.* At the Scotch Universities the salaries of the Science Professors are considerably higher.

The Educational Committee, finally, express their opinion that the work of the College has been eminently successful, and that the City Guilds Institute is to be congratulated on what it has accomplished. The results achieved are, in their opinion, fully commensurate with the expenditure involved.

Having regard to the higher appreciation of the advantages of advanced technical instruction, which a further knowledge of what is being done on the continent and in the United States is likely to bring about, it is believed that in the near future, the Central Technical College will be found too small for the number of students who, attracted by the excellence of the training it offers, will seek admission, and that the question of the extension of the building may before long have to be considered.

The Reports of the Sub-Committees on Finance and Administration, and on the Educational Work of the College, were adopted by the Committee. To sum up the case, this Committee reports that, in their opinion, the Governors of the City and Guilds of London Institute possess in the Central Technical College an Institution which has well and economically carried out the objects for which it was founded; and that those objects are well deserving of every support and encouragement that the Corporation and City Companies of London can give to them.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—Dr. James Ward, whose name is well known as a physiological psychologist, was on Saturday elected to the new Professorship of Mental Philosophy and Logic. Dr. E. Barclay-Smith has been appointed Senior Demonstrator, and F. C. Kempson Junior Demonstrator in the department of Anatomy. Dr. J. N. Keynes has been appointed by the Council of the Senate to act on the joint committee for promoting legislation on secondary education now sitting in London. Mr. Yule Oldham, University Lecturer in Geography, is this term lecturing on the geography of Central Europe, and also (in conjunction with Mr. J. E. Marr, F.R S.) on the scientific study of scenery. The geographical classes have of late been larger than in any previous year, and Mr. Oldham is steadily gaining ground for his subject in the University. Certain changes in the Historical Tripos will lead students to devote more of their time to political geography, and a new section of the higher local examination deals with the wider aspects of the science. The studentship of 100*l.* offered by the Royal Geographical Society to members of the University attending his lectures, will be awarded at the end of the present term. Mr. W. Bateson, F.R.S., of St. John's College, is this term giving a special course of lectures on the study of variation, which he has made peculiarly his own. A Shuttleworth Scholarship of 55*l.* a year for three years will be awarded at Gonville and Caius College in March. The subjects are botany and comparative anatomy, and candidates must be medical students of not less than eight terms' standing.

LORD WANTAGE, Mr. Richard Benyon, and Mr. Herbert Sutton have each given 1000*l.* to the building fund of the University Extension College, Reading. Mr. G. Palmer, Mr. G. W. Palmer, Mr. W. Palmer, and Mr. A. Palmer have each contributed 500*l.* for the same object, and the Drapers' Company have promised 1000*l.* on condition that a sum of 12,000*l.* is raised without delay. The Hampshire County Council have voted 1000*l.* out of accumulated surplus for the foundation of exhibitions in connection with the College.

THE following are among recent announcements:—Dr. Wilhelm Valentiner, formerly director of the astronomical observatory at Karlsruhe, to be professor of astronomy at the University of Heidelburg, whither that observatory has been removed; Dr. v. Buchka has taken up his residence at Berlin as successor to the late Dr. Eugen Sell in chemistry; Mr. J. G. Luehmann, for many years assistant to the late Baron von Mueller in the Government Botanist's Department, to be curator of the Melbourne Herbarium; Prof. B. Hatsheck, of Prague, to the chair of zoology in the University of Vienna, vacant by the resignation of Prof. K. Claus; Prof. Th. Curtius, of Kiel, to be professor of chemistry at Bonn, in succession to the late Prof. Kekulé; Dr. P. E. Study, associate professor of mathematics at Bonn, to be professor of mathematics at Greifswald; Dr. G. A. Tawney, Princeton, to be professor of philosophy in