Excursions.—The committee have prepared a long list of excursions. Among those for Saturday afternoon are geological excursions to North Berwick and Tantallon, and to the Pentland Hills; a botanical excursion to Gullane; a dredging excursion on the Firth of Forth; and excursions to such places of interest as the Land of Scott, the Fairfield Shipbuilding Works and Glasgow, the Pumpherston Oil Works, Dundee and the Firth of Tay, Stirling, Rosslyn, Dalmeny and the Forth Bridge, Newbattle Abbey, and Dalkeith Palace.

On Thursday, occasion is taken to visit places of interest further afield. St. Andrews, Dunkeld, Scone and Murthly (arboricultural), Croy (archæological), Dobbs Linn Moffat (geological), Moorfoot Waterworks, Hamilton Palace, Drumlanrig, Yarrow, Crieff, the Trossachs, Loch Lomond, the Firth of Clyde, are all brought within the limit of a one-day excursion.

Many of the more important manufacturing and other works in the city and neighbourhood are to be open to members, who will thus have ample opportunity of becoming acquainted with the trade of the district. Visits to the paper works at Penicuik or Currie, to the printing-ink works at Granton, and to the gunpowder mills at Roslin, will form pleasant short afternoon excursions. The printing offices of Edinburgh are of great interest, and many of them have made arrangements for the reception of visitors. Breweries, distilleries, biscuit factories, and hydraulic engineering works have all their special developments here, and are well worthy of visits.

Hospitality and Lodgings.—Perhaps the greatest difficulty that the local committee has had to face has been the date fixed for the visit of the Association. August is *the* holiday month in Edinburgh, and under ordinary circumstances the residential parts of the town are during that month entirely in the hands of the police. For many of the citizens, indeed, holidays are possible only in August. It has therefore been matter of congratulation to the committee dealing with this part of the work to find that many people intend to remain in town during the meeting of the Association and that they have been informed of a large number of offers of hospitality having been sent to visitors.

The hotel accommodation in Edinburgh is considerable, but the strain upon it in August is great. The local committee have secured for members of the Association a considerable number of rooms in hotels, and these are being rapidly allotted on application. Visitors who intend to live in hotels during the meeting will do well to make their arrangements early.

With regard to lodgings, probably no town is so well off as Edinburgh, and fortunately during August many of the best rooms are vacant. A register of lodgings has been opened at the local offices, and the secretaries are prepared to give assistance to visitors desiring to secure apartments. A provisional list of hotels and lodgings has been prepared and may be had on application. The principal clubs have offered to admit visiting members of the Association as honorary members during the meeting, subject to such conditions as are required by the constitution of the club.

Publications.—The programme of local arrangements will contain a hotel map of Edinburgh, a large scale map of central Edinburgh, including all the buildings used in connection with the meeting of the Association, and a general map of Edinburgh and Leith, on which all the works open to visitors are specially marked.

The "Excursions Handbook," published by the committee, gives details of the various transit arrangements and general sketches of the routes to be taken. It also indicates the nature of the interest attached to each excursion. The handbook will be illustrated by a special map of the South of Scotland and by section maps on a larger scale showing details of excursions.

F. GRANT OGILVIE.

THE ORIGIN OF LAND ANIMALS: A BIOLOGICAL RESEARCH.[1]

THIS remarkable and very unequal work, many-sided and heterogeneous, is worthy of careful consideration. It is not wanting in imagination, more or less disciplined, and it is loaded with information from the works of contemporary naturalists, now for the first time brought together in a single volume. One great merit it has of regarding plants and animals, not merely as forms of life, but as living forms: the machinery is exhibited to us in motion.

The title of the work scarcely conveys an adequate idea of its comprehensiveness; it might just as well have been styled "The Evolution of the Living World [for plants are not excluded from its universal purview], and the way it has been brought about."

The leading idea appears to be that a change from marine to terrestrial habitat has taken place much earlier in the history of the higher forms of life than is generally supposed, that the land from the early beginnings of geologic time has been peopled both with animals and plants, and has, more than the sea, been the great arena of progressive change. At the outset, the shore, where sea and land and air all meet and commingle, was the birthplace of life, and from it living forms have continually wandered in all directions—to the open ocean and the abyssal depths, to rivers, marshes, and dry land. From the Algæ, which are almost the only marine plants, the vegetable kingdom was derived. That this is characteristically terrestrial is due to the fact that vegetable protoplasm is less adaptive than animal. "Plants as land proprietors are the true conservatives;" hence, once on land always on land. The terrestrial character of plants offers a suggestive hint as to the place of development of the greater part of the animal kingdom: it also has been on land, but with more numerous offshoots to the sea. In terrestrial plants such as Myxomycetes—"the true Bathybius"—are the roots of the animal world; or if this claim be not admitted, and to Bacteria be assigned this place, a terrestrial origin remains unimpugned, since these organisms are predominantly inhabitants of the land.

The migration of marine animals may be direct, but more usually it is by successive stages, first through fresh water—"the great highway to land-life"—then to damp places, and finally to the dry land itself, which, however, at the time of migration may have been subjected to a damper and warmer climate than at present prevails. With change of medium progressive modification has been associated, for existence in the air makes three great demands on the organism, it must protect itself against being dried up, acquire new modes of respiration, and more substantial organs of support.

Many animals, ennobled by their response to these demands, have returned to the sea, and exercise dominion over it, undergoing, of course, fresh modifications, particularly of the respiratory organs; while others have retained possession of the terrestrial domain, adapting themselves to minor changes of habitat and climate. Thus far more groups of land-animals are derived from a terrestrial ancestry than we imagine, and the next-of-kin of orders now characteristically marine are less frequently than we suppose to be found in the sea, but must be sought for on the land. The whale and sea-turtle, land crabs and climbing fish, so far from being rare and exceptional cases, are instructive examples of great migratory movements and associated anatomical change.

The hypothesis not only supplies a needed stimulus, powerful enough to account for the evolution of the organic world, but at the same time it explains the futility of our search in marine strata for connecting links between lead-

1 "Die Entstehung der Landtiere: ein Biologischer Versuch." Von Dr. Heinrich Simroth, Privat-docent an der Universität, Leipzig. Pp. 492, with 254 Illustrations in the Text. (1891.)

ing types of life, since the most critical steps in evolution have been taken on the land, and terrestrial fossils are of the rarest occurrence.

In illustration we may select the author's treatment of the Arthropoda, which have their origin in some ancient Annelid, probably a marine Polychæte, and not an Oligochæte, since no Arthropod possesses the red blood which the Oligochæta have acquired as an adaptation to land life.

The absence of cilia and a thoroughgoing chitinization, which are the most striking peculiarity of the Arthropoda, are a direct adaptation to land life; the chitinous envelope furnishing on the one hand protection against desiccation, and on the other organs of support, whilst its extensive development necessarily involves the disappearance of cilia, and the development of fresh contrivances for respiration.

Another important character common to the Arthropoda is the transverse striation of the muscle fibre; but transverse striation is generally admitted to be correlated with excessive functional activity, from which, according to the author, it results. Encase an animal in chitin, and its movements will, from the mechanical conditions of the case, be "acrobatic,"—to move at all it must move strenuously, by this excessive exercise transverse striation will develope in all the voluntary muscles, and "by correlation" in those of the alimentary canal as well. So much is the author impressed by the cogency of this reasoning that he regards the striation of the musculature as a direct indication of the terrestrial origin of the animal possessing it, and ventures to apply this formula to Sagitta, the direct development of which he gives as an additional argument for its descent from some terrestrial species.

The parapodia of the Annelida naturally gave rise to the appendages of the Arthropods, and it was while these were still short, scarcely-jointed stumps that the Trilobites branched off in one direction, converting all their parapodia into legs, and the Scorpions and Merostomes, which discarded their abdominal appendages, in another. The Crustacea, retaining like the Trilobites all their appendages, branched off at about the same level, and their connection with the Arachnida is confirmed by Jaworowski's recent observation of the exopodital and endopodital splitting of the appendages in Tarentula. A confirmation of the terrestrial habitat

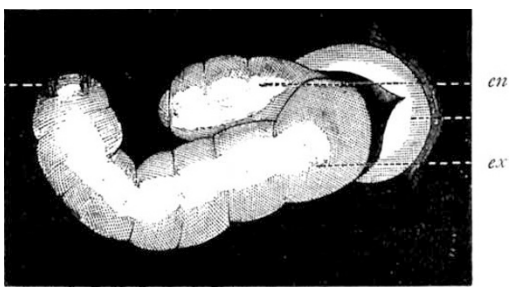

FIG. 1.—Pedipalp of an embryo of *Trochosa singoriensis*; *en*, endopodite; *ex*, exopodite; *h*, hairs (after Jaworowski).

of the primitive Crustacea is suggested by the fact that the most archaic existing forms are the Branchiopoda, which still live in fresh-water and salt marshes, can survive drying up, and indeed seem to require it for the production of sexual eggs. The remarkable diversity of the respiratory organs in the Crustacea is another important piece of evidence, since it points to their having been acquired as secondary adaptations.

Of Arachnoid forms, some entered the sea, probably the majority of the Merostomata and the Xiphosura, but Limulus still gives evidence of its original home, since it comes to the shore for begetting, and lays its eggs at the highest tide-mark.

No doubt the notion that the immediate ancestors of Limulus were land animals will excite scorn in prejudiced minds; but it is one that Balfour long ago suggested (the author does not seem to be aware of this), led to it probably by his recognition of the close relationship between Limulus and the Arachnoids on the one hand, and the Arachnoids and Insects on the other—the latter connection lately so much strengthened by Jaworowski's remarkable discovery of rudimentary antennæ in Tarentula. In

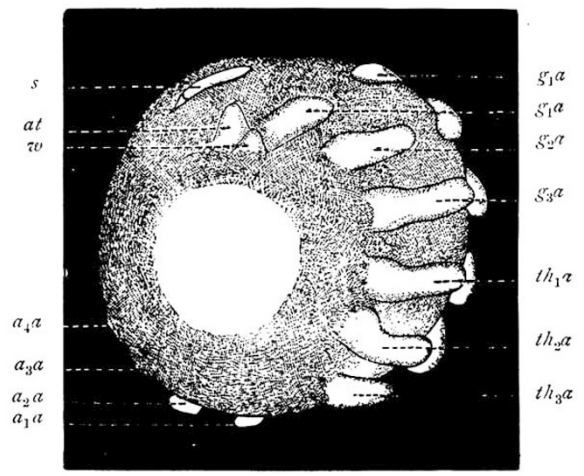

FIG. 2.

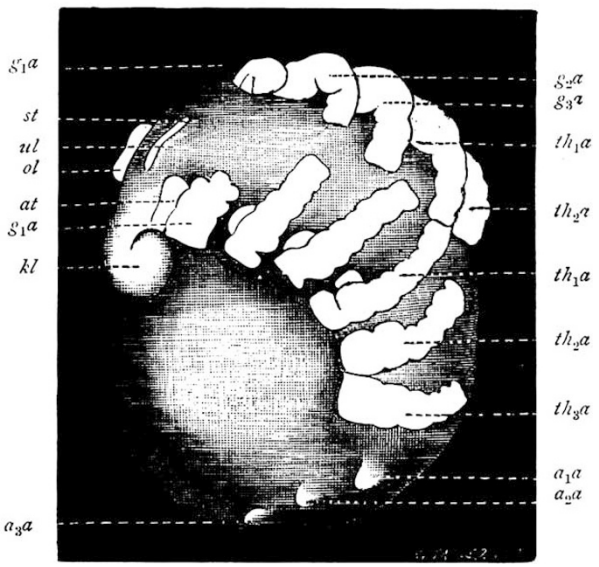

FIG. 3.

this direction may be looked for a reconciliation of the views of Lankester and Lang.

The mild surprise with which we learn that Trilobites and Crustacea were originally denizens of the land has scarcely given place to conviction before we encounter the chapter on fishes. We shall be prepared to find that these can claim terrestrial ancestry too. The earliest fossil vertebrates of which we know anything are the Placoderms; these were dwellers in the Old Red Sandstone lakes, and, as our author remarks, "from fresh water to the land is only a step." That the Placoderms were

well able to take this step is proved by the character of their pectoral limbs, which, unlike the fins of fish, are provided with a transverse joint in the middle—"an elbow joint"; and this, while clearly helpful in walking, would not be well fitted for swimming. No doubt the animal was also a swimmer; the dorsal fin shows so much, but it was also a walker, travelling over hard, uneven ground; indeed, to this habit is attributable the turning up of the tail-fin (!), which formed the third point of support. A

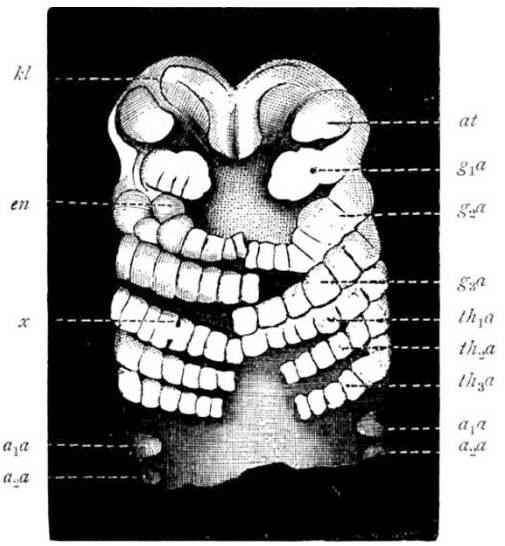

FIG. 4.

FIGS. 2 to 4.—Embryos of *Trochosa singoriensis*. Fig. 2 on the 13th day. Figs. 3 and 4 on the 15th day; Fig 4, the anterior end seen *en face*. *st*, stomatodæum; *kl*, frontal lobes; *ol*, upper and *ul*, lower lip; *at*, antennae; *w*, wall-like thickening of marginal groove; g_1a, chelicerae; g_2a, pedipalp; g_3a, 1st pair of limbs; th_1a–th_3a, thoracic appendages (2nd to 4th pairs of limbs); a_1a–a_4a, abdominal appendages; *x*, a deep constriction; *en*, rudiment of endopodite (after Jaworowski).

drawing, subscribed "original," representing Pterichthys "as it might have moved," is so full of unconscious humour that we are tempted to reproduce it. From such amphibious primitive vertebrates the fish branched off in one direction and descended to the sea—the swimming-bladder represents the original lung; in another direction proceeded the Stegocephala, the ancestors of reptiles, birds, and mammals. Primarily the Vertebrata are derived from Annelids, but the claim put forward for the Placo-

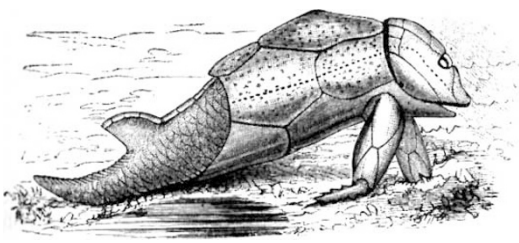

FIG. 5.—*Pterichthys*, as it might have moved. (Original.)

derms is more in harmony with Patten's view, connecting them with the Arachnoids; for the grave difficulties which beset this view, however, let Smith Woodward's trenchant criticisms be considered.

The main line of argument is followed into a number of collateral branches, all elaborately discussed. There is a powerful chapter on the strand fauna, in which are arrayed the great host of marine animals, including fishes, which temporarily leave the sea to breathe the air. This is regarded as a fact of profound significance, indicating a general tendency of the strand fauna to come on shore.

Recent investigations by Zacharias, Nusbaum, Chun, and others are made good use of in discussing the distribution of fresh-water fauna. Aërial transport, particularly by birds, is accepted as accounting for most of the facts. The survival of the transported forms is insured by the chitinous investment either of the animals themselves or more usually of their eggs. It is pointed out that most pelagic fresh-water species are provided with means of attachment: such are the spines of pelagic species of Daphnia, the abdominal processes of Bythotrephus, and the singular antennæ of Bosmina. Copepods which lay eggs which sink to the bottom are restricted in distribution; those which carry them about in egg-sacs are world-wide.

An attempt is made to prove that fresh water opposes some obstacle to the secretion of carbonate of lime; and though a comparison of the thickness of marine and fresh-water shells is far from bearing this out, yet some interesting results are elicited; as, for instance, the suggestion that the chitinous bristles of the young of *Paludina vivipara* are probably the last traces of originally calcareous spines.

In illustration of the various stages of land life, the Testacillidæ are cited as an interesting example of adaptation to a terricolous existence. *Daudebardia*, one of the family, begins life as a form precisely like a *Hyalina*, but with growth passes through the successive stages shewn in the figure (fig. 6) till it becomes the worm-like adult.

A good deal of space is naturally devoted to the subject of encystment, which is regarded as a protection against desiccation. In the course of this discussion an earlier origin is attributed to the Heliozoa than to the

FIG. 6.—*Daudebardia* in different stages of growth; on the right, youngest, on the left, oldest stages. The buccal mass is shaded. (Original.)

Radiolaria, since they do not possess the central capsule of the latter, which are consistently regarded as the marine descendants of an ancient fresh-water group related to Heliozoa. The suggestion is added that the withdrawal of plasma in the Radiolaria into the central capsule as a preliminary to spore formation is not really with a view to this event, but a reminiscence of encystment, which occurred in ancestral fresh-water forms. Bald suggestions such as this, and another which occurs in the work, to the effect that chlorophyll first acquired its fluorescence as the primæval sky cleared of clouds and permitted an extension of the solar light towards the violet end of the spectrum, should, from motives of prudence, have been omitted. A total *bouleversement* of accepted views on main lines of descent is sufficient for a great work without the added irritation of superfluous conjectures. Summer and winter eggs belong more or less to the question of encystment, and the author regards winter eggs as "an adaptation to small pools, and threatened destruction by drying up." This, like the statement that the chitinous shells of the eggs of pelagic Crustaceans were acquired as a protection against desiccation during their aërial flight, might have been expected from an ultra-Darwinian, but in an author who wishes to explain evolution by physical causes, and not by chance, it is less pardonable. "An adaptation to threatened drying up" is an expression which would please the metaphysicians, who have lately been contending that an effect may precede its cause.

The bibliography at the end of the work will be found most useful, especially to Englishmen, who will find in it a guide to a great deal of interesting German literature; but it is without form, and this to a great extent is true of

the work itself. There are citations to the number of 423, and more, not numbered, yet, although we have a long discussion on the relationship of Limulus to Scorpion, Lankester's work is not mentioned; with chapters on fresh-water faunas, no allusion to "The Origin of Fresh-water Faunas," by Sollas; W. Marshall, a German author, is set forward in the text as an authority on pelagic and coast faunas, and Moseley overlooked; titles are sometimes given without place or date of publication, a defect which becomes serious when periodical literature is referred to without mention of volume. The illustrations are numerous and excellent.

The author has produced a fresh and promising thought, but one cannot help regretting that he did not wait—like, say, Darwin—till it was full time for bringing forth. W. J. SOLLAS.

THE PHOTOGRAPHIC MAP OF THE HEAVENS.[1]

THE first number of the second volume of papers published under the auspices of the Permanent Committee charged with the execution of the photographic map of the sky has made its appearance at a sad moment in the history of the undertaking. For simultaneously with its appearance is announced the death of him who, more than any other man, has contributed to its success, and brought it within the range of practical science. Admiral Mouchez has known how to secure not only the active co-operation of many astronomers, but also how to make them zealous in the great work, the arrangement of the details of which has occupied the last years of his life. He has awakened enthusiasm for the success of his scheme, and smoothed many difficulties which might have hindered its progress, and probably few undertakings of equal magnitude and equal importance, breaking new ground in many directions, have been got under way with less friction and fewer disappointments. We may well hope that the same sauvity and diplomacy which has characterized the conduct of the late Director of the Paris Observatory will be found in the counsels of his successor, and that a work begun in so much hope will be carried to a successful issue.

The papers in the volume before us can be brought roughly under two heads, both, notwithstanding the lapse of time from the inception of the scheme, betokening an initial stage in the preparation. One of the topics under discussion has for its aim the selection of a method which shall secure on the photographic plates, destined ultimately to furnish a catalogue, the impression of stars of the eleventh magnitude with certainty and uniformity; the other, a means of deriving the co-ordinates of the star images so impressed with the greatest facility and sufficient accuracy.

To deal with the second of these proposals first, we may remind our readers that whatever method of measuring the positions of stars on a plate may be adopted, the resulting co-ordinates must be purely differential, and probably referred to the axes of the réseau impressed upon the plate as a latent image, and developed under the same conditions as the stars themselves. To pass to the determination of R.A. and declination, a great deal of information, entirely independent of photography, will have to be made available. The readiest means of effecting this last step in the reduction, as it appeared to a committee of experts appointed to consider this question, was to determine by meridian instruments the absolute co-ordinates of six stars on each plate. It is needless to comment upon the magnitude of the labour thus undertaken, or at least contemplated. This preliminary work would demand a catalogue of some sixty or seventy thousand stars, most of them below the ninth magnitude and not found in existing catalogues. In order to give to each determination the necessary accuracy, it is desirable that each star should be observed twice in both elements and at two observatories. When we remember the length of time that the re-observation of Argelander's zones has consumed, and is still incomplete, we can form some estimate of the time that must inevitably elapse before the results of the photographic catalogue can be made available for astronomical purposes.

In presence of these difficulties, and many more which occur to the practical astronomer, we must be very grateful to M. Loewy for elaborating a scheme which, if it be found practicable, will materially shorten the time necessary for the production of the catalogue. M. Loewy proposes to avail himself of the fact that the plates are taken in two series, in such a manner that each corner of a plate in one series will form the centre of four other plates in the second series. When, therefore, the astronomer has determined the rectilinear co-ordinates of the stars on *one* plate relatively to the central lines of the réseau, each of these stars will belong in common to the plate considered, and to one of the four plates of the second series, partially covering the first. M. Loewy's scheme consists in making the stars on the four plates thus connected available for the reduction of the first. And, on paper at least, it is not difficult to extend the scheme still further, and to make the plates contiguous to these four contribute to the reduction of the original plate by means of an extended triangulation. In this way a plate would not be considered as an isolated fact, but a considerable area, of 36, 64, 100 or more square degrees could be woven into a harmonious scheme of reduction. And such a plan possesses this very obvious advantage, that on even a lesser area, as of 36 square degrees, we may well expect to meet a sufficient number of bright stars whose places are already so well determined that the reduction of the plates could go on immediately without waiting for the observations of the stars on the meridian. And independently of this evident advantage, it seems highly probable that two of the elements of reduction, viz. the orientation of the plate, and the value of the scale, will be determined more accurately, if the stars which are used for the derivation of these corrections are separated by a considerable distance, that is greater than a single negative would permit.

M. Loewy considers the various sources of errors and their necessary correction with all the detail required to submit the plan to practical application, and this is precisely the test that is needed. This appears to be also the opinion of Dr. Gill, expressed in a very cautious approval of M. Loewy's scheme, and he further quotes a remark of Prof. Auwers, which contains a very salutary caution. That astronomer points out that the reduction of the catalogue plates will be most accurately effected from the position of *faint* stars, rather than from bright ones. In that case since our present most accurate catalogues do not give the positions of the fainter stars, those catalogues will still need to be supplemented by many meridian observations. Dr. Sande Bakhuyzen, however, expresses the opinion that the zones of the *Astronomische Gesellschaft* will, when completed, furnish the necessary data for all reductions, or, at most, require additional observations in some portions of the sky, which he is able to point out from a careful examination of the number of the stars contained in these zones.

The second topic which has received much consideration in this volume is, as before mentioned, the adoption of a method to secure the registration of stars of the eleventh magnitude. It will be remembered that the International Congress of 1891 proposed to place in front of the object glass of the telescope, screens of fine metallic gauze, identical in manufacture, and of such construction that the amount of light impeded should be equivalent to two magnitudes: the coefficient 2·512 being employed as

[1] "Bulletin du Comité International Permanent," tome ii., premier fascicule.