evolution of the Crustacea, the biramous form of limb has been arrived at more than once by different modifications of the phyllopod type. In view, however, of the simple biramous form of the limbs in the nauplius larva and in the Trilobites (the close relationship of which to the Crustacea cannot now be doubted), and of the persistency with which the same type emerges in the most diverse groups of Crustacea, it seems more reasonable to assume that it represents the deep-seated plan of symmetry on which all crustacean limbs are built. It is indeed possible that the phyllopod type preceded the biramous and that Lepidocaris preserves the transition from one to the other. This would seem to be the view taken by Mr. Scourfield, who, although he gives us little in the way of speculation, does imply that the biramous hinder limbs of Lepidocaris are derived from the phyllopodous type of those in front. It is, however, a very general rule among Arthropoda that specialisation begins anteriorly and works backwards; we should expect the posterior limbs to be the more primitive; and Lepidocaris gives the impression of having had primitively biramous limbs of which the more anterior pairs have been specialised in adaptation, no doubt, for some special method of collecting food.

A minor problem is presented by the lateral row of large scales (to which the generic name alludes) covering the bases of the trunk limbs. These suggest the small scales at the base of the outer edge of the limbs in Anostraca which are generally interpreted as the proximal exites of the limbs. In Lepidocaris, however, at the posterior end of the series, the scales are seen to be merely the pinched-off pleura of the somites. It is a matter for further inquiry whether the proximal exites of the Anostraca may not also be of pleural origin.

Perhaps the most unexpected feature of Lepidocaris, however, is the structure of the last segment of the body. In many Crustacea, in the larva if not in the adult, the termination of the body is forked. Very often this fork is nothing more than a notch in the hinder edge of the telson, but sometimes the two prongs of the fork are movable rods jointed to the segment, and in a few cases (Notostraca, Cirripedia) they are long, many-jointed filaments. In Lepidocaris we see clearly, for the first time, that these movable appendages are not, as has been generally supposed homologous with the two branches of the notched telson. In the earliest larva found the telson is notched, and this notch persists in the adult to form what Mr. Scourfield calls the "primary furca." In the later larvæ, however, a pair of rod-like appendages grow out at the sides of the primary furca and become separated by articulation from the body of the telson, forming a "secondary furca" which is evidently the homologue of the articulated furca of Anostraca, Copepoda and Phyllocarida. In still later larvæ a second smaller pair of appendages appear at the sides of the telson in front of the secondary furca. Just above the articulation of each of these two pairs of appendages is set a small spine. The somites immediately in front of the telson bear no appendages, but each has, on either side, a similar spine, and as these spines are traced forwards they are plainly seen to be in series with the spines which tip the lateral scales already mentioned above the insertion of the limbs.

It seems impossible to avoid the conclusion that the appendages of the telson in Lepidocaris and the furcal rami of the groups mentioned above are serially homologous with the true limbs of the anterior part of the body. Now it is the general rule in the development of Arthropoda that the somites and their appendages appear and become differentiated in regular order from before backwards, new somites being added from a 'formative zone' in front of the telsonic region. In Lepidocaris alone do we find evidence of true appendages on the telson itself, *behind* the formative zone; and, emphasising the singularity of their position, the order of their development is the reverse of that of the pretelsonic appendages, the hinder pair appearing first.

It must be borne in mind that, at the time when Lepidocaris lived, the Crustacea had already behind them a long evolutionary history. It is now known from Walcott's remarkable discoveries that, so early as the Middle Cambrian period, a varied crustacean fauna existed and that several of the forms had at least a superficial resemblance to Anostraca. Unless some chance discovery, as fortunate as that at Rhynie, and an investigator with Mr. Scourfield's indefatigable patience and skill, combine to reveal a great deal more than we know at present about the structure of these early forms, speculations on phylogeny must go very cautiously.

Obituary.

Dr. Edward J. Bles.

BY the recent death of Edward J. Bles, zoological science has lost a devoted worker whose qualities of mind and character were of the highest. It is the faith of many of his friends that, but for factors of temperament, and health, he would have become a leader of thought in the subject of his choice. His publications, though of high merit, were relatively few; but his intimates know that they were far from representing all that he accomplished, and are aware of the temperamental restraints but for which he could and would have published much more. He was one of those investigators—deserving sympathy from colleagues with easier standards—who would fain allow publication to wait for perfection, and yet realise even better than others that perfection never arrives. In spite of such inhibitions, or perhaps because of them, his published output is of high value and stamped with the quality of absolute reliability.

For elementary teaching, or, at any rate, for the shackles of departmental teaching and organisation, Bles had some distaste. On the other hand, he was the ideal colleague and one of the most educative influences for the young research worker. He would give his time and ingenuity for days to devise methods for another's work; he was a most sincere and painstaking critic and there never was any one with whom it was more delightful to share the joys of discovery or the fruits of victory. Yet he greatly prized independence, and the freedom to work out his own ideas on his own

lines. Being possessed of sufficient private means, Bles was therefore finally led to avoid all official posts, and for nearly twenty years he worked, first at Iffley, Oxford, and later, until the end, at Cambridge, in private laboratories equipped by himself. This involved, of course, some degree of isolation, and the additional factor of weak health finally led him to become scientifically somewhat of a recluse. In visits from scientific friends, however, he always took the greatest pleasure, and, to the end of his life, those who had the privilege of paying such visits profited always from contact with a truly philosophic mind and a stimulating personality. His wide learning was at the service of all.

Born in 1864, he was the son of A. J. S. Bles of Manchester. When fourteen years old he was sent to a school in Hanover where the teaching of science seems to have been exceptionally good. Family interests led him at the age of eighteen years to start in his father's business at Manchester; but his own interests directed him from the first into scientific company. He joined the Manchester Microscopical Society and became its secretary. Thus arrived the turning-point of his life. He came under the influence of Milnes Marshall, who saw his bent and genius, and for whom Bles then acquired, and ever afterwards retained, great love and admiration. He joined the Owens College, attended Milnes Marshall's classes, and in 1890 became, with his teacher, joint author of papers dealing with the development of amphibia, a subject which for some time remained one of his chief scientific interests. About this time he went to occupy a table at Naples and returned to carry out the duties of junior demonstrator of zoology at the Owens College. From 1892 until 1894 he was Director of the Marine Biological Association's Station at Plymouth. He went up to Cambridge in 1895 and took a research degree in 1898. When Prof. J. Graham Kerr was appointed to the chair of natural history at Glasgow, Bles accompanied him as his assistant and remained at the University until 1907, when he went to live at Iffley, Oxford.

In 1911 Bles removed to Cambridge. Before his last migration his scientific reputation had been made by the publication of important papers; especially by one which appeared in the *Transactions of the Royal Society of Edinburgh* in 1905 on the life-history of *Xenopus Lævis*, and another dealing with the development of certain Anura published in the volume issued by the Cambridge University Press as a memorial to John Samuel Budgett. Of these two papers describing work of fundamental importance, Prof. W. E. Agar writes: "They are very characteristic of Bles' work and scientific attitude. He would take an immense amount of trouble over the smallest detail, lingering over it with a loving care. . . . The plates in these two papers could scarcely be surpassed, either for accuracy of detail or beauty of execution—the result of laborious co-operation between the author and the artist, Mr. A. K. Maxwell. It is worthy of note that these plates contain the first scientific illustrations produced by this artist whose work is now so well known to biologists." The interest of the artist in such work must have been stimulated by his early collaboration with an investigator like Bles, whose own love of accuracy and beauty of execution were so great.

After his Cambridge laboratory was equipped, Bles started to breed various species of rare amphibia, a difficult enterprise in which he had the assistance of his devoted wife. This work was carried out with elaborate care and led to most interesting scientific observations, especially with regard to certain little-studied aspects of metabolism, to the significance of which Bles was keenly alive. The most important work of his Cambridge period had been begun at Oxford. It consisted of an elaborate and highly original study of Arcella by microchemical methods, during which Bles developed a very beautiful technique and obtained results of great importance. Unhappily, the inhibitions to which reference has been made became exaggerated in his latest years, largely because of continued ill-health, and the results of this prolonged research, though known to many, have not yet appeared in print. A paper was practically finished, however, and very fine drawings are available for its illustration. Its publication will be secured in the immediate future under arrangements made in the author's will.

Bles was not merely a scholarly biologist in a very wide sense, he was also a man of fine general culture; music, literature, and the arts all made a vivid appeal to him. He had, moreover, a true sense of values and a very beautiful appreciation of the relative importance of things. His knowledge was of the widest, but so philosophic was the cast of his mind that synthetic thought was essential to him. He endeavoured always to see things as a whole. F. G. HOPKINS.

PROF. V. A. STEKLOV.

PROF. VLADIMIR ANDREJEVICH STEKLOV, member and vice-president of the Russian Academy of Sciences, an eminent and well-known mathematician, died at Ialta (Crimea) on May 30.

Steklov was born in 1863 in the province of Nishni-Novgorod as the son of a country priest. He attended a classical school at Nishni-Novgorod and afterwards entered the University of Moscow to study medicine, but he soon left Moscow and went to Kharkov to study mathematics under Liapunov and became his most gifted pupil and lifelong friend. He graduated at Kharkov, took the usual degrees of magister and doctor of mathematics, and was appointed professor at this University. His first work, "On the Motion of a Rigid Body in a Fluid," was published in Russian in the *Memoirs of the Mathematical Society of Kharkov*. In this paper he found several new 'integrable' cases of this problem. His thesis for his doctorate was "On the Principal Problems of Mathematical Physics." Such problems formed the basis of his subsequent numerous investigations, extending over a period of nearly thirty years. In these investigations he established his "théorème de fermeture," relating to the development of arbitrary functions in infinite series of "fundamental functions" depending on the roots of transcendental equations. Such expansions occur frequently in mathematical physics, the Fourier series being the simplest special case. Steklov introduced the necessary rigorousness into the problems of mathematical physics, in proving the existence of the solutions and the conditions of convergence for the series used. He summarised his researches in a treatise "On