field is fascinating and complex and attention has been focused on what happens in the soil to the root system of the wheat plant in the presence of the fungus and its metabolites.

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THE PHYSIOLOGY OF *CRUSTACEA**

COMPREHENSIVE studies on the Physiology of individual groups or organisms have formed a refreshingly new avenue in the wide range of publications on biological topics which have appeared in recent years. The Academic Press formerly issued the very useful *Introduction to the Physiology of Fishes* published in 1957 and we have now before us a similarly sumptuous work in two volumes on the Physiology of Crustacea. A comprehensive account of the physiological characteristics of this large group of animals is now presented in two volumes of collected articles written by some of the most outstanding amongst the many contributors to this field and edited by Prof. T. H. Waterman.

The Crustaceans are a group of organisms of quite distinct morphological characters, forming a compact group amongst arthropods, predominently aquatic but occupying almost every niche of biological environments. Within this morphological compactness spread over thousands of species is found an amazing range of physiological features. Whether in reactions to stimuli, relationship between the external and internal media or problems of relative growth the crustaceans pose physiological problems of absorbing interest. Their wide distribution and the comparative facility with which they can be kept and cultured have made possible their extensive use as experimental material on which many recent hypotheses have been put forward, tested and developed.

The book opens with a general review of crustacean biology by Waterman and Chace. In the next chapter WolveKamp and Waterman review the problems of respiration which is probably the field in which the largest number of papers have appeared on the physiology of this group. Summarising their review the authors indicate the urgent need for follow up work made in the beginning regarding respiratory transport. Hæmocyanin although a well-known respiratory pigment from early times, still remains to be investigated on many aspects of metabolism. Goodwin continues in the next chapter with a critical review of the biochemistry of Crustacean respiratory pigments. The blood-chemistry is dealt with in detail by Florkin. Circulation and heart function form the subject-matter of the next paragraph by Maynard, while the vast body of information on feeding and nutrition which is largely drawn from the work on plankton crustacea are dealt with by Marshall and Orr. Crustacean vitamins, digestion and metabolism are reviewed in the two succeeding chapters written by Fisher and Vonk respectively. Osmotic and ionic regulation on which a considerable amount of work has appeared in recent years is dealt with by Robertson who is followed by Parry on the allied problem of excretion. Edney examines the question of terrestrial adaptation in the crustacea. An assessment of ecological adaptation in the whole group is made by Florkin. The recent findings of sex determination in crustacea as illustrated by parasitism are discussed by Cotton. The very critical work on chitin and the formation cuticle and integumental structures is reviewed by Dennel whose account is followed by Passano on moulting and control of this most characteristic arthropod behaviour. Problems of relative growth receive critical survey in the hands of Teissier who is himself one of the pioneers in this fascinating field of bio-mathematics. The last chapter by Bliss discusses autonomy and regeneration.

The second volume is devoted to sense organs and behaviour. The opening chapter in this is by Waterman on vision which is again a field in which a very large volume of work has

* *The Physiology of Crustacea.* Edited by T. H. Waterman (Academic Press, New York and London, India: Asia Publishing House, Bombay), 1960, Vol. I: Metabolism and Growth, pp. 1-670, Price $ 22; 1961, Vol II: Sense Organs, Integration and Behaviour, pp. 1-681, Price $ 22.

appeared in recent times. Cohen and Dijkgraaf deal with mechano-reception followed by Barber on Chemoreception and thermoreception. Advances in the field of pigmentory effector system are discussed in a brilliant chapter by Kleinholz. Newton Harvey surveys the subject of light production. Wiersma contributes the next two chapters on neuro muscular system and the central nervous system. Discussion of neurohumours and neurosecretion in crustacea by Welsh follows. Lochhead deals with crustacean locomotion while Kinetic and Tactic responses form a chapter by Pardi and Papi. Physiological rhythms of crustacea, migration of various kinds and complex behaviour are reviewed in three chapters by Brown, Bainbridge and Schone respectively. The final chapter of the series is on comparative physiology by Waterman which is again an admirable review of problems of comparative physiology as applied to crustacea. In this chapter the author attempts the difficult task of comparing crustacean physiology with that of other animal groups and has endeavoured to present certain concepts of evolutionary relationships amongst the different orders of crustacea. There is also an indication of lines of further research which might be profitable and throw light on aspects in which our knowledge is hopelessly incomplete.

These two volumes present the combined efforts of many distinguished zoologists who have worked on crustacea, and whose labours have made possible such a comprehensive approach to this group. Prof. Waterman's leadership in this effort has earned the gratitude of all zoologists, both laboratory and field workers, for this most valuable work. The Academic Press is to be congratulated on the production of these volumes which should be in the hands of every student of crustacea and of comparative physiology for many years to come.

N. K. PANIKKAR.

LATTICE-TYPE VIBRATIONS IN ASSOCIATED LIQUIDS AND RAMAN EFFECT

IT is well known that in the spectrum of the Raman Effect in liquids even when strictly monochromatic light is used under ideal experimental conditions, the incident, or Rayleigh, line is always accompanied by a continuum which extends to several angstroms on either side of it. The origin of these Rayleigh 'wings', as they are called, has been the subject of many previous studies. In unassociated liquids and their corresponding solids, rotation of the molecules should give rise to broad wings on either side of the exciting line, the broadness of these wings depending on the rotational constant and the temperature, and in general being less than 100 $cm.^{-1}$ for all but very light molecules.

In associated liquids and solids although rotations of molecules may still occur, the major cause of the Rayleigh wings probably arises from excitation of the optical modes of an associated or lattice-like structure. Such excitation of the optical modes may give rise to both a first- and a second-order Raman effect, the frequency maximum of the former corresponding to the optical frequency observed in the infra-red while the second-order Raman effect will extend out to nearly twice this frequency.

In the case of highly associated liquids, excitation of the optical branch of the quasi-lattice-like structure has not been reported previously. In a note to *Nature* (1961, **192**, 1061) J. K. Wilmshurst reports his observations on the low-frequency infra-red spectra of some highly associated liquids and their corresponding solids; *e.g.*, water , aqueous lithium nitrate, fused lithium nitrate, chlorate and hydroxide, and fused sodium nitrate and hydroxide.

The one-angle reflection technique was used to obtain the low-frequency spectra, and the optical constants in the 200–1000 $cm.^{-1}$ region have been calculated in the above cases by suitable analysis. These results show that the intense band in the low-frequency region studied can be assigned in every case to the excitation of the optical branch of a quasi-lattice, and the frequency of this band suggests that the Raman effect should show broad wings out to 400–900 $cm.^{-1}$ in fused salts, and $\sim$ 1600 $cm.^{-1}$ in aqueous solutions, consistent with the Raman spectra observations.

It would be of interest to study the anomalous Rayleigh wings more fully in highly associated liquids. In this direction the 'laser' giving an intense monochromatic light source with no spurious arc continuum, should be ideal as a Raman source and should certainly clarify this question.