PART I

THE BEHAVIOUR OF THE PLANT-ANIMALS

CHAPTER I

INTRODUCTORY: THE WORMS: CONVOLUTA ROSCOFFENSIS AND CONVOLUTA PARADOXA: THEIR HABITS AND HABITATS.

Biologists who devote themselves to the investigation of the life histories and life processes of the lower animals are apt to encounter the criticism: why expend pain and labour on insignificant creatures when so much remains to discover with respect to the higher animals, including man himself?

This perfectly legitimate criticism admits of a conclusive reply and, since it is possible that a question of the kind may arise in the mind of anyone taking up this book, it shall be answered forthwith. The reply may take one of three forms. In the first place, it may be urged that the most important modern biological discoveries have resulted from researches into the life histories of the lower organisms. Modern surgery relies for much of its technique on the results of investigations into the physiology of the bacteria. Yet more recently, the experimental elucidation of the life-histories of the protozoa—the lowest group of

animals—has laid the foundation of a great and increasing body of knowledge with respect to the cause of malaria, sleeping sickness, and other tropical diseases.

In the second place, it may be urged that, the more complex the organism, the more difficult it is to use the results of observations upon it for the purpose of generalising on important biological problems such as those of the origin of instinct and habit, or of the meaning of heredity and the course of evolution. The higher the organism, the more it has covered up the tracks along which the species to which it belongs has travelled. For this reason alone, the study of the lower organisms is not only to be justified but also urged on zoologists as one bound to lead to results of the greatest value.

In the third place, it has yet to be proved that the higher animals differ in any fundamental respect from more lowly forms of life. Hence, if, as a physiologist must hold, such differences as exist between higher and lower forms are differences of degree and not of kind, it follows that an increased knowledge of the nature of the lower organisms connotes also an increase in knowledge with respect to the higher organisms.

On these grounds, the patient and exhaustive study of the lower organisms is to be justified. Nay more, if the reasons for this study are valid they

should serve to induce some of the younger generation of physiologists to devote their attention to a field of research both rich in promise and too little cultivated by the men of science of this country.

Though the results recorded in this volume are but modest, throwing here and there only a faint light on the problems which they raise, nevertheless they suffice to demonstrate that more skilful observers would, by taking up similar subjects of investigation, make notable contributions to the science of comparative physiology.

Having vindicated the importance of research on the lower organisms, let us proceed to our task.

The plant-animals whose life histories and habits form the subject of this volume are two simple, marine worms, *Convoluta roscoffensis* and *Convoluta paradoxa* (Frontispiece). Both are small, though large enough to be seen easily by the unaided eye, and both are conspicuous by reason of their colours. C. roscoffensis is dark, spinach green, and C. paradoxa yellow-brown.

Even among worms they occupy a lowly place. Unlike the higher members of this group, C. roscoffensis and C. paradoxa are unsegmented. Instead of consisting, like garden worms, of a series of ring-like pieces, the bodies of our plant-animals are in one piece and, consequently, bear no ring-like markings

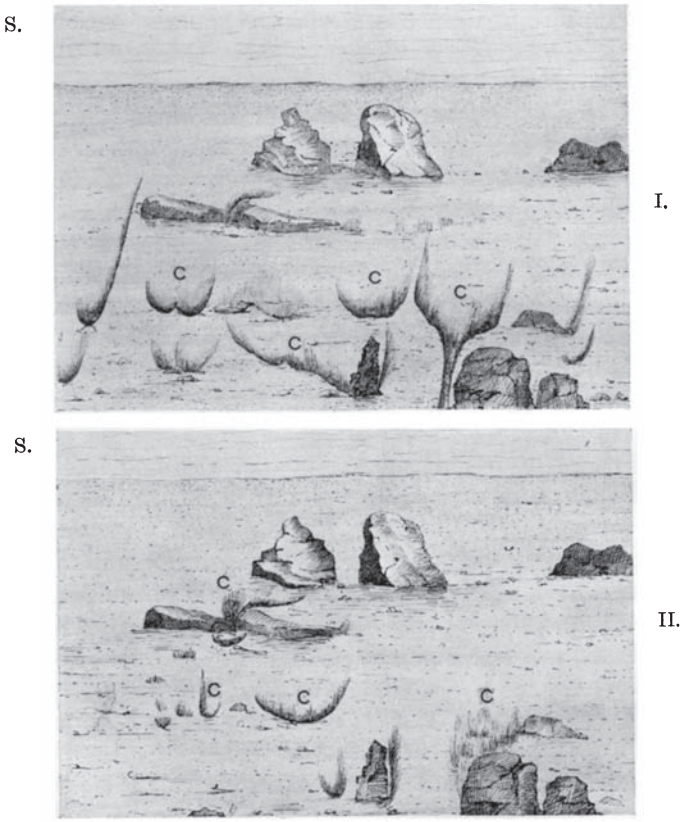

Fig. 1. The distribution of the colonies of Convoluta roscoffensis on the sea-shore. I. at spring-tidal periods (low water): II. at neap-tidal periods (low water). Though a colony remains fixed in position, its size waxes with the spring tides and wanes with the neap tides. C, C = the colonies. S. = sea

on their surfaces (Frontispiece). Imagine a minute, elongated fragment of a most delicate leaf, some $\frac{1}{8}$ in. long by $\frac{1}{16}$ in. broad, and you have a picture of C. roscoffensis. Imagine, further, myriads of such green, filmy fragments lying motionless on moist, glistening patches of a sunny beach between tide-marks and you see the species in its native habitat (Fig. 1). To find C. paradoxa at home it is necessary to follow the receding tide, to gather handfuls of the brown seaweeds (Fig. 2) which are exposed towards the low-water limit of the larger tides and to allow the tips of the weeds to dip into water in a white dish. Singly from their hiding-places chubby, brown C. paradoxa come gliding down with rounded "head" and pointed "tail" to swim uneasily in the water of the dish. C. roscoffensis is pre-eminently gregarious, C. paradoxa by comparison is solitary. Sand from a Convoluta patch scooped up in a cup contains many thousands of C. roscoffensis; a patient fishing throughout the time of low tide may result in a catch of fifty, or at most a hundred, specimens of C. paradoxa.

The surface of the bodies of the plant-animals is somewhat slimy; particularly in C. roscoffensis, and is covered by fine cilia (Fig. 3) which, during the life of the animals, are in constant motion. The cilia, which are protoplasmic projections from the superficial cells, serve, by their unceasing movements, to row the animal through the water.

C. paradoxa possesses, in addition to cilia, occasional, stouter, bristle-like structures which stick out from its body, chiefly in the "tail" region (Fig. 16, p. 84). These structures serve, when put in action by the animal, to pin it down and thus enable it to stop and stick in any position.

Fig. 2. Convoluta paradoxa (C) attached to sea-weeds of the paradoxa zone. (Magnified eight times.)

In both animals, the sides of the body are flexed beneath the under surface, and together form a groove which, in C. paradoxa, serves to fit the animal saddle-wise to the fine sea-weeds over which it glides (Fig. 2). This animal, in its general progress, appears almost to flow over the substratum on which it is moving.

Occasionally, however, on meeting with an obstacle it rears its head-end, caterpillar-wise, relaxes the grip of its flexed sides, readjusts them to the surface and glides on with stealthy motion.

Though we have called C. roscoffensis and C. paradoxa simple worms, it is not to be inferred that the structure of their bodies is really simple. Both species possess a well-defined nervous system and efficient sense-organs. At the front or "head" end of the body, on the upper surface, a little way behind the anterior end, lie two eyes right and left of the median line (Frontispiece and Fig. 3). Though of the simplest construction, each consisting of a minute spot of orange pigment lying over nervous tissue, the eyes are efficient for distinguishing light of different intensities. Numerous orange-pigmented glands, scattered over the surface of the body, function probably as accessory eyes. Between the two eyes, in the median line on the dorsal (upper) side of the body of either species, lies the otocyst (Frontispiece and Fig. 3, *OT*). It consists of a hollow sphere of nervous tissue enclosing a space within which lies a small lump of chalk.

Like a pea in a thimble, the heavy, chalky mass, or otolith, lies freely in the otocyst, and, if the position of the animal change with respect to the line of action of gravity,—the vertical—the otolith falls or rolls on a new part of the otocyst-wall. Pressing on

this area it acts as a stimulus to the nervous tissues beneath. As the result of stimulation of this tissue, nervous impulses may be despatched to the muscles of the body, and, causing them to contract, give rise to movements of the body which are definite in direction.

Thus the otocyst serves as an indicator of the line of gravity; in other words it acts as the organ

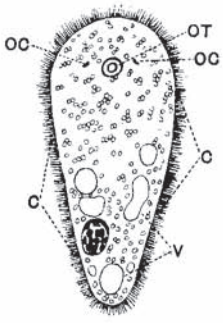

Fig. 3. Young Convoluta paradoxa. C = cilia covering the surface of the body. OT = otocyst. OC = eyes. V = empty digestive vacuoles.

for gravi-perception. By its means, the animal is able to orientate itself with respect to the vertical, and so to find its way downward or upward.

That the otocyst does indeed serve this end has been established by experiments with other animals, and may be inferred in the case of C. ros-