

STUDIES ON THE BIOLOGY OF LIMPETS

I. THE LATE J. H. ORTON'S WORK ON *PATELLA*

By A. J. Southward and J. M. Dodd

From the Plymouth Laboratory and the Gatty Marine Laboratory, St Andrews

At the time of his death in 1953 Orton had almost completed an extensive study of the biology of the three British species of *Patella*. Although certain aspects of the investigation were dealt with by collaborators and have already been published (Crewe, 1947 on parasites; Goodwin, 1950 on pigments; Jones, 1948 on ecology) most of the breeding and spawning data have been neither analysed nor published. With the knowledge that Orton's records contained the most complete information on breeding yet compiled for a littoral animal, and that these records had considerable bearing on the question of speciation in *Patella*, we have attempted to analyse and present those which are most complete.

Orton first became interested in the biology of limpets during a general study of growth rate in marine animals in which it became necessary to determine the breeding periods of the animals involved (Orton, 1914, 1920a). In *Patella* the preponderance of males in the smaller size-groups and of females in the larger size-groups suggested a change of sex during the life-history similar to that found in other gastropods (Orton, 1909). A preliminary account of the sex proportions (Orton, 1920b) was followed by a fuller account in 1928, when the results of investigations on the rate of growth and on shell dimensions were also presented (Orton, 1928a, b). Other papers dealt with ecology and showed the need for further special studies (Orton, 1929, 1932, 1933).

Orton was unable to resume his investigation of these problems until 1945, and a year later he announced some preliminary results. These confirmed the previous evidence on sex change, and demonstrated differences in the breeding periods of the three British species (Orton, 1946). The investigations proceeded rapidly from this date until his death, the aspects under study including size, sex proportions, breeding cycle, spawning stimulus, rate of growth, parasitization, and general ecology (Orton, 1948, 1949).

To prepare for publication some of the great mass of information collected by Orton, a good deal of selection has had to be practised. In the first place, aspects such as rate of growth, on which the data were very incomplete, have been omitted. The breeding records have been reduced considerably by omitting unnecessary duplicate samples, and small samples. The series of records from Cullercoats has been rejected because of discrepancies between successive samples; in any case this particular limpet population has been

studied in detail by other workers (Das & Seshappa, 1947). Records of parasitized neuter individuals have been omitted since the neuter gonad in these cases may be the result of parasitic castration rather than a stage in the normal gonad cycle.

In his later work on the breeding cycle, Orton classified the gonads into ten stages of advancing ripeness and a similar number of post-spawning stages in each sex. These data have been reclassified on the basis of an earlier and simpler scheme which facilitates comparison with other species.

A representative series of gonad stages of *Patella vulgata* was sent to one of us (J. M. D.) by Orton, and these have been used to describe the histology of the gonad. For the macroscopic description of the gonad stages we were fortunate in having available some of Orton's MS. notes and drawings: these also indicated the method which he intended to use for the diagrammatic presentation of the breeding data. The other tables and diagrams are our own, and for these and for the interpretation of the evidence we are wholly responsible.

The nomenclature adopted is based on personal communications from Mr R. Winckworth to Orton, and is the same as that of Brian & Owen (1952). The three British limpets are therefore *P. vulgata* Linnaeus; *P. aspera* Lamarck, 1819 (= *P. athletica* Bean, 1844, = *P. depressa* Jeffreys, 1865); *P. depressa* Pennant, 1777 (= *P. intermedia* Jeffreys, 1865).

REFERENCES

- BRIAN, M. V. & OWEN, G., 1952. The relation of the radula fraction to the environment in *Patella*. *J. Anim. Ecol.*, Vol. 21, pp. 241-9.
- CREWE, W., 1947. Helminth parasites of limpets. *Nature, Lond.*, Vol. 159, p. 238.
- DAS, S. M. & SESHAPPA, H., 1947. A contribution to the biology of *Patella*: On population distribution and sex-proportions in *Patella vulgata* Linnaeus at Cullercoats, England. *Proc. zool. Soc. Lond.*, Vol. 117, pp. 653-62.
- GOODWIN, T. W., 1950. Carotenoid distribution in the gonads of the limpets *Patella vulgata* and *Patella depressa*. *Biochem. J.*, Vol. 47, pp. 249-57.
- JONES, N. S., 1948. Observations and experiments on the biology of *Patella vulgata* at Port St Mary, Isle of Man. *Proc. Lpool biol. Soc.*, Vol. 56, pp. 60-77.
- ORTON, J. H., 1909. On the occurrence of protandric hermaphroditism in the mollusc *Crepidula fornicata*. *Proc. roy. Soc., B*, Vol. 81, pp. 468-84.
- 1914. Preliminary account of a contribution to an evaluation of the sea. *J. Mar. biol. Ass. U.K.*, Vol. 10, pp. 312-16.
- 1920a. Sea-temperature, breeding and distribution of marine animals. *J. Mar. biol. Ass. U.K.*, Vol. 12, pp. 299-366.
- 1920b. Sex-phenomena in the common limpet (*Patella vulgata*). *Nature, Lond.*, Vol. 104, p. 373.
- 1928a. Observations on *Patella vulgata*. Part I: Sex-phenomena, breeding and shell growth. *J. Mar. biol. Ass. U.K.*, Vol. 15, pp. 851-62.
- 1928b. Observations on *Patella vulgata*. Part II: Rate of growth of shell. *J. Mar. biol. Ass. U.K.*, Vol. 15, pp. 663-874.

- ORTON, J. H., 1929. Observations on *Patella vulgata*. Part III: Habitat and habits. *J. Mar. biol. Ass. U.K.*, Vol. 16, pp. 277-88.
- 1932. Studies on the relation between organism and environment. *Proc. Lpool biol. Soc.*, Vol. 46, pp. 1-16.
- 1933. Some limiting factors in the environment of the common limpet. *Nature, Lond.*, Vol. 131, p. 693.
- 1946. Biology of *Patella* in Great Britain. *Nature, Lond.*, Vol. 158, p. 173.
- 1948. Director's report, 1945-47. *Rep. Mar. biol. Sta. Pt. Erin*, Nos. 58-60, pp. 10-12.
- 1949. Director's report, 1948. *Rep. Mar. biol. Sta. Pt. Erin*, No. 61, pp. 11-13.